Chapter 5
Ignition system

Refer to the beginning of Chapter 1 for model identification details

Contents

Degrees of difficulty

Easy, suitable for novice with little experience 

Fairly easy, suitable for beginner with some experience 

Fairly difficult, suitable for competent DIY mechanic 

Difficult, suitable for experienced DIY mechanic 

Very difficult, suitable for expert DIY or professional 

Specifications

Spark plug

Type and gap	See Chapter 1
Cap resistance	5 K ohms

Ignition timing

Ignition full advance	
Sfera 50, Typhoon 50 (up to 2006), Zip	15 to 17° BTDC @ 4000 rpm
Sfera 50 RST, NRG MC2/MC3, NRG Power DT, ET2, Zip SP/RS, Zip 50, Liberty 50, Fly 50, LX2 50, LXV 50, S50, Typhoon 50 (2007-on)	16 to 18° BTDC @ 4000 rpm
Sfera 80, Typhoon 80, NRG Power DD	19 to 21° BTDC @ 4000 rpm
LX4 50	21° BTDC @ 4000 to 7000 rpm
Fly 50 4T	not available
Zip 50 4T, Liberty 50 4T, ET4 50	26° BTDC @ 5000 to 6000 rpm
Zip 100 4T and Fly 100 4T	22° BTDC @ 5000 to 6000 rpm
Skipper, Typhoon 125	18 to 20° BTDC @ 4000 rpm
Sfera 125	31 to 33° BTDC @ 7500 rpm
ET4 125, GT200	31 to 33° BTDC @ 6000 rpm
Hexagon	21 to 23° BTDC @ 6000 rpm
Zip 125, Skipper ST	28° BTDC @ 6000 rpm
Liberty 125	27 to 29° BTDC @ 6000 rpm
Fly 125, LX4 125, LXV125, S125	not available
B125, Super Hexagon, X8 125, X9 125, GT125	33 to 35° BTDC @ 6000 rpm
GTS125, GTV125	29° BTDC @ 6750 rpm

Ignition source coil

Coil resistance	
ET2	850 to 1050 ohms
ET4	300 to 400 ohms
NRG Power DT and DD, Fly 50/100 4T, Liberty 50 4T, Zip 50/100 4T, LX4 50	1.0 ohm
Fly 50, LX2 50, LXV50	800 to 1100 ohms
Sfera 125	330 to 370 ohms
Hexagon	122 to 132 ohms
All LEADER-engined models	0.7 to 0. 9 ohm
All other models	930 to 1030 ohms

Ignition pulse generator coil

Coil resistance	
ET2	100 to 130 ohms
ET4, Fly 50, LX2 50, LXV 50	90 to 140 ohms
NRG Power DT and DD, Fly 50/100 4T, LX4 50, Liberty 50 4T, Zip 50/100 4T	170 ohms
Sfera 125	105 to 135 ohms
Hexagon	102 to 112 ohms
All LEADER-engined models	105 to 124 ohms
All other models	83 to 93 ohms
Coil output voltage	
LEADER-engined models	Less than 2 V

Ignition HT coil – 125 cc models

Primary circuit resistance	0.48 to 0.52 ohm
Secondary circuit resistance	
LEADER-engined models	2.7 to 3.3 K ohms
All other models	4.6 to 5.2 K ohms

Immobiliser

Transponder aerial resistance	7 to 9 ohms

1 General information

All models are fitted with a fully-transistorised electronic ignition system, which because to its lack of mechanical parts is totally maintenance-free. The system comprises a source coil, rotor, pulse generator coil, ignition control unit and ignition HT coil (refer to the wiring diagrams at the end of Chapter 9 for details). On all 50 cc and 80 cc models the HT coil is integral with the ignition control unit.

The ignition trigger, which is on the alternator rotor on the right-hand end of the crankshaft, magnetically operates the pulse generator coil as the crankshaft rotates. The pulse generator coil sends a signal to the ignition control unit which then supplies the integral (50/80/100 cc) or separate (125/200 cc) ignition HT coil with the power necessary to produce a spark at the plug.

The ignition control unit (ICU) incorporates an electronic advance system controlled by signals generated by the ignition trigger and the pulse generator coil. There is no provision for adjusting the ignition timing on these scooters.

Depending upon the model and specification, some Piaggio scooters were fitted with an ignition immobiliser. On later models the ignition system incorporates a safety circuit which prevents the engine from being started unless one of the brake levers is pulled in and the side stand is up.

Because of their nature, the individual ignition system components can be checked but not repaired. If ignition system troubles occur, and the faulty component can be isolated, the only cure for the problem is to renew the part. Keep in mind that most electrical parts, once purchased, cannot be returned. To avoid unnecessary expense, make very sure the faulty component has been positively identified before buying a new part.

2 Ignition system – check

Warning: The energy levels in electronic systems can be very high. On no account should the ignition be switched on whilst the plug or plug cap is being held – shocks from the HT circuit can be most unpleasant. Secondly, it is vital that the engine is not turned over with the plug cap removed, and that the plug is soundly earthed when the system is checked for sparking. The ignition system components can be seriously damaged if the HT circuit becomes isolated.

1 As no means of adjustment is available, any failure of the system can be traced to failure of a system component or a simple wiring fault. Of the two possibilities, the latter is by far the most likely. In the event of failure, check the system in a logical fashion, as described below.

2 Disconnect the HT lead from the spark plug. Connect the lead to a spare spark plug and lay the plug on the engine with the thread contacting the engine. If necessary, hold the spark plug with an insulated tool.

Warning: Do not remove the spark plug from the engine to perform this check – atomised fuel being pumped out of the open spark plug hole could ignite, causing severe injury.

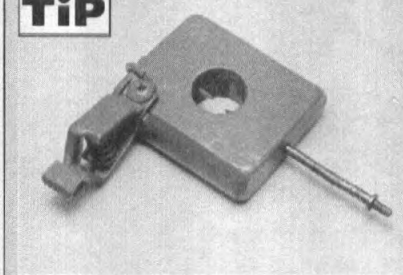
3 Having observed the above precautions, turn the ignition switch ON and turn the engine over on the starter motor. If the system is in good condition a regular, fat blue spark should be evident at the plug electrodes. If the spark appears thin or yellowish, or is non-existent, further investigation will be necessary. Before proceeding further, turn the ignition OFF.

4 The ignition system must be able to produce a spark which is capable of jumping a particular size gap. Piaggio do not provide a specification, but a healthy system should produce a spark capable of jumping at least 6 mm. A simple testing tool can be made to test the minimum gap across which the spark will jump (see **Tool Tip**).

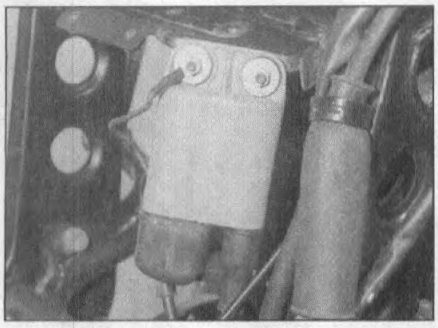
5 Connect the spark plug HT lead to the protruding electrode on the test tool, and clip the tool to a good earth on the engine. Turn the ignition switch ON and turn the engine over on the starter motor. If the system is in good condition, a regular, fat blue spark should be seen to jump the gap between the nail ends. If the test results are good the entire ignition system can be considered good. If the spark appears thin or yellowish, or is non-existent, further investigation will be necessary.

6 Ignition faults can be divided into two categories, namely those where the ignition system has failed completely, and those which are due to a partial failure. The likely faults are listed on the next page, starting with the most

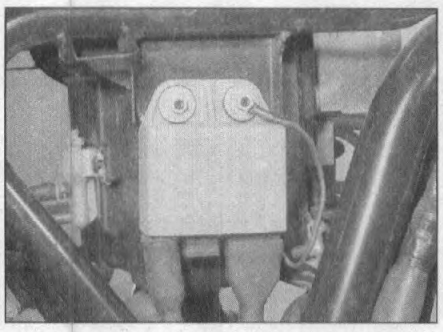
TOOL TiP



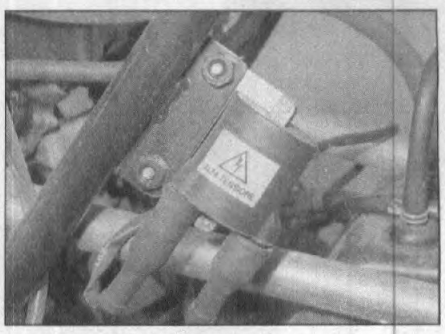
A simple spark gap testing tool can be made from a block of wood, a large alligator clip and two nails, one of which is fashioned so that a spark plug cap or bare HT lead end can be connected to its end. Make sure the gap between the two nail ends is the same as specified.



3.1 Combined ignition control unit and HT coil on Typhoon 50



3.2a Ignition control unit on Hexagon



3.2b HT coil on Hexagon

probable source of failure. Work through the list systematically, referring to the subsequent sections for full details of the necessary checks and tests. **Note:** *Before checking the following items ensure that the battery is fully-charged and that all fuses are in good condition.*

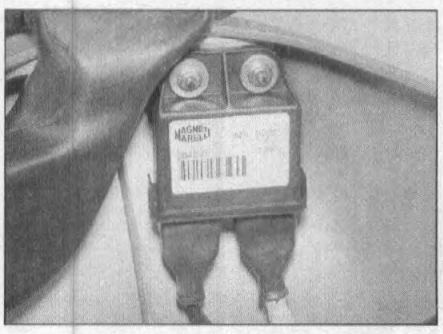
a) Loose, corroded or damaged wiring connections, broken or shorted wiring between any of the component parts of the ignition system (see Chapter 9).
b) Faulty HT lead or spark plug cap, faulty spark plug with dirty, worn or corroded plug electrodes, or incorrect gap between electrodes.
c) Faulty ignition (main) switch (see Chapter 9).
d) Faulty pulse generator coil or damaged trigger on rotor.
e) Faulty ignition HT coil/ignition control unit (50, 80 and 100 cc).
f) Faulty ignition HT or control unit (125 cc).

7 If the above checks don't reveal the cause of the problem, have the ignition system tested by a Piaggio dealer.

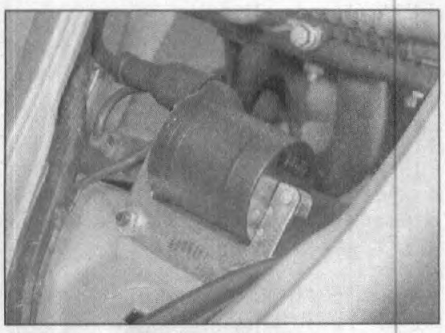
3 Ignition control unit (ICU) and HT coil – check, removal and installation

Check – 50, 80 and 100 cc models

1 On all 50 and 80 cc models the ICU and HT coil are integrated in one unit **(see illustration)**. Piaggio provide no test specifications for this unit. In order to determine conclusively that the unit is defective, it should be substituted with a known good one. If the fault is rectified, the original unit is faulty.



3.2c Ignition control unit on ET4



3.2d HT coil on ET4

Check – 125 and 200 cc models

2 On models with 125 and 200 cc engines, the ICU and HT coil are separate **(see illustrations)**. Piaggio provide no test specifications for the ICU. In order to determine conclusively that the unit is defective, it should be substituted with a known good one. If the fault is rectified, the original unit is faulty.

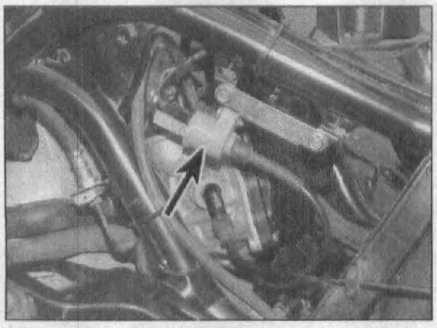
3 The coil should be checked visually for cracks and other damage, then the primary and secondary coil resistance should be measured with a multi-meter. To test the HT coil, first remove the engine cover or bodywork as required according to model (see Chapter 7). Disconnect the battery negative (-ve) lead.

Non LEADER models

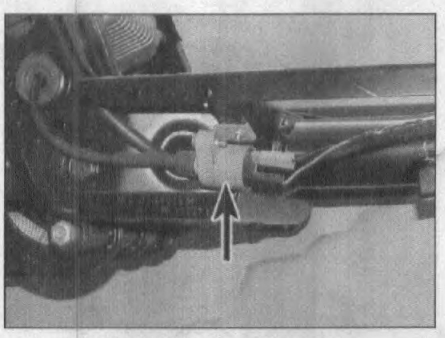
4 Disconnect the primary circuit electrical connector and the HT lead from the coil.

5 To check the condition of the primary windings, set the meter to the ohms x 1 scale and measure the resistance between the primary circuit terminal on the coil and the coil mounting which goes to earth **(see illustration)**. If the reading obtained is not within the range shown in the Specifications, it is likely that the coil is defective and must be renewed.

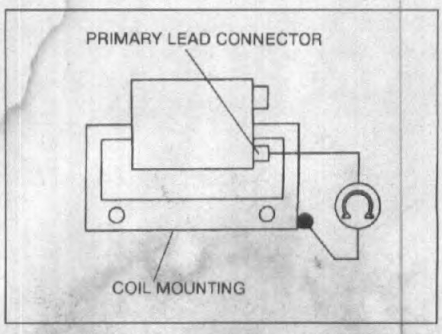
6 To check the condition of the secondary windings, set the meter to the K ohm scale, then measure the resistance between the HT lead socket on the coil and the coil mounting



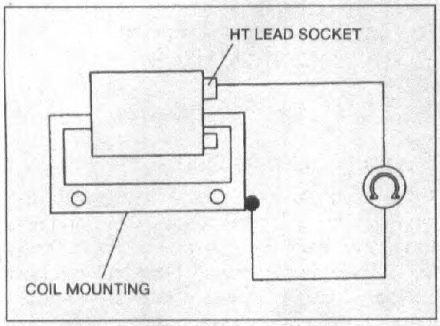
3.2e HT coil on X9



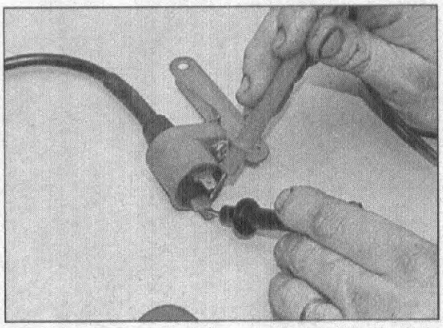
3.2f HT coil on Zip 125



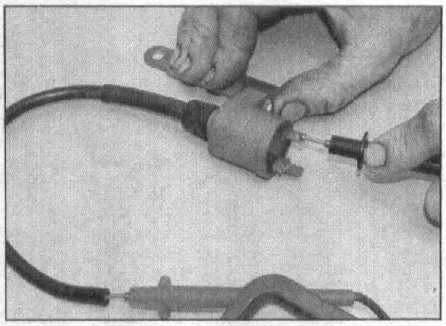
3.5 HT coil primary winding check – 125 models



3.6 HT coil secondary winding check – 125 models



3.8 HT coil primary winding check – LEADER



3.9 HT coil secondary winding check – LEADER, plug cap removed

which goes to earth **(see illustration)**. If the reading obtained is not within the range shown in the Specifications, it is likely that the coil is defective and must be renewed.

LEADER models

7 Disconnect the primary circuit electrical connectors from the coil, noting where they fit, and the spark plug cap from the plug.

8 To check the condition of the primary windings, set the meter to the ohms x 1 scale and measure the resistance between the primary circuit terminals on the coil **(see illustration)**. If the reading obtained is not within the range shown in the Specifications, it is likely that the coil is defective and must be renewed.

9 To check the condition of the secondary windings, set the meter to the K ohm scale, then measure the resistance between the spark plug terminal inside the cap and the black wire terminal on the coil **(see illustration)**. If the reading obtained is not within the range shown in the Specifications, unscrew the plug cap from the HT lead and check again between the black wire terminal and the core of the HT lead. If the reading is still not within the specified range, it is likely that the coil is defective and must be renewed.

Removal

10 Remove the engine cover or bodywork as required according to model (see Chapter 7). Disconnect the battery negative (-ve) lead.

11 Disconnect the electrical connectors from the unit and where applicable disconnect the HT lead from the spark plug. **Note:** *Mark the locations of all wires before disconnecting them.*

12 Unscrew the two bolts securing the unit and remove it. Note the routing of the wiring.

Installation

13 Installation is the reverse of removal. Make sure the wiring connectors and HT lead are securely connected.

Caution: If the ignition control unit has been renewed on a model fitted with an immobiliser, refer to a Piaggio dealer for details of how to programme it.

4 Source coil and pulse generator coil – check, removal and refitting

Check

1 Remove the engine cover or bodywork as required according to model (see Chapter 7) and disconnect the battery negative (-ve) lead.

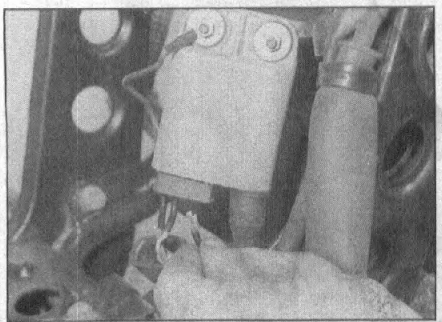
Non LEADER models

2 Trace the source coil and pulse generator coil wiring from the back of the alternator housing and disconnect it at the connector on the ICU **(see illustrations)**. Using a multi-meter set to the ohms x 100 scale, measure the source coil resistance by connecting the meter probes between the green and white terminals on the connector. Also measure the pulse generator coil resistance by connecting the meter probes between the red and white terminals on 50/80/100 cc models with integral ignition control unit and HT coil, and between red and brown on 125 cc models with separate HT coil.

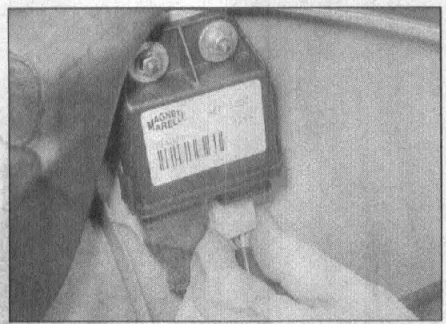
3 Compare the readings obtained with those given in the Specifications at the beginning of the Chapter. If the readings obtained differ greatly from those given, particularly if the meter indicates a short circuit (no measurable resistance) or an open circuit (infinite, or very high resistance), the entire alternator stator assembly must be renewed as no individual components are available. However, first check that the fault is not due to a damaged or broken wire from the coil to the connector; pinched or broken wires can usually be repaired.

LEADER models

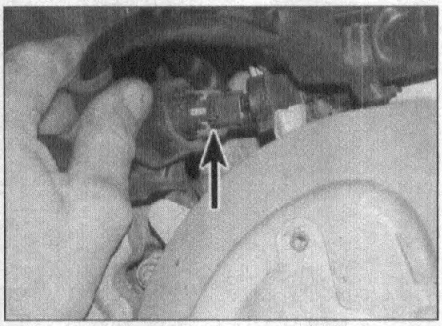
4 To check the source coil, first disconnect the alternator wiring multi-pin connector **(see illustration)**. Using a multi-meter set to the ohms scale, measure the coil resistance by connecting the meter probes between the yellow wire terminals on the alternator side of the connector. Compare the result with the Specifications at the beginning of the Chapter. Also check for continuity between each terminal and earth – there should be no continuity. If the results are good, reconnect the alternator connector and trace the wiring to the regulator. Disconnect the regulator wiring connector and repeat the test between the wire terminals **(see illustrations)**. If the



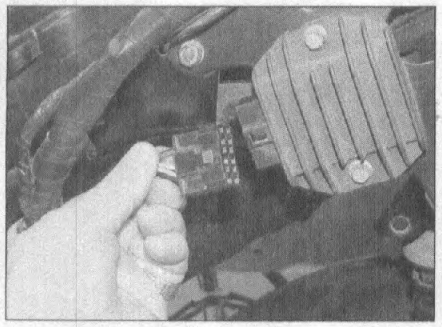
4.2a Disconnecting the pulse generator coil wiring on Typhoon 50



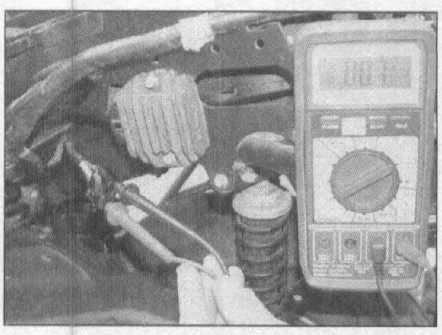
4.2b Disconnecting the pulse generator coil wiring on ET4



4.4a Disconnecting the alternator wiring connector (arrowed) on X9



4.4b Disconnect the regulator wiring connector . . .



4.4c . . . and check the source coil resistance

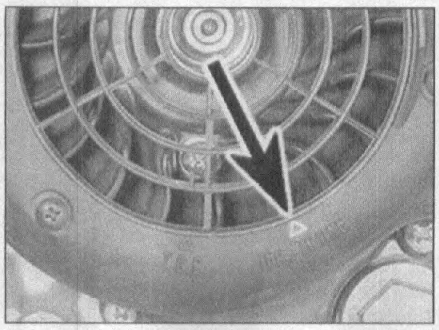
readings differ from those given, there is a fault in the wiring between the alternator connector and the regulator connector.

5 To check the pulse generator coil resistance, connect the meter probes between the green wire terminal and earth (ground). Compare the result with the Specifications at the beginning of the Chapter. If the result is good, reconnect the alternator connector and trace the wiring to the ICU. Disconnect the ICU wiring connector and repeat the test between the green wire terminal in the connector and the black (earth/ground) wire terminal. If the reading differs from that given, there is a fault in the wiring between the alternator connector and the ICU connector. Now set the multimeter to the volts (DC) scale, connect the positive (+) meter probe to the green wire terminal and the negative (-) probe to the black wire terminal. Use the starter motor to turn the engine over and measure the pulse generator coil voltage, then compare the result to the Specifications.

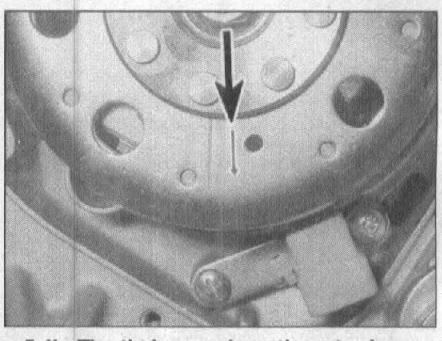
6 If any of the readings obtained differ greatly from those given, particularly if the meter indicates a short circuit (no measurable resistance) or an open circuit (infinite, or very high resistance), the entire alternator stator/pulse generator coil assembly must be renewed as no individual components are available. However, first check that the fault is not due to a damaged or broken wire from the coil to the connector; pinched or broken wires can usually be repaired.

Renewal

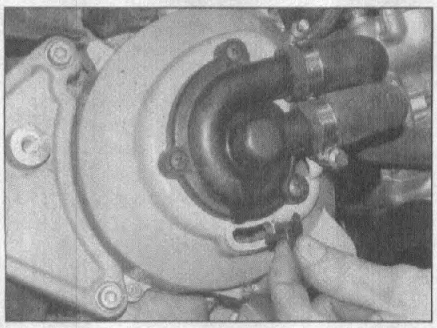
7 The source coil and pulse generator coil are integral with the alternator stator. Refer to the relevant Section of Chapter 2 for the removal and installation procedure.



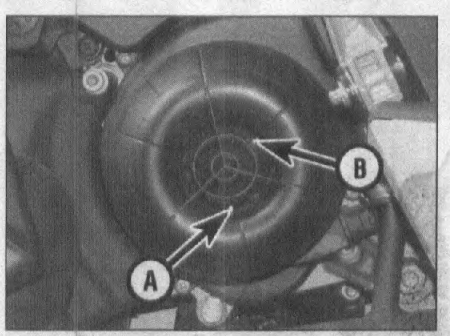
5.4a Static timing mark at idle speed on ET4 (arrowed)



5.4b The timing mark on the rotor is an arrow (arrowed)



5.5 Remove the inspection cap – liquid-cooled LEADER



5.7 Static mark (A) on cover and timing mark (B) on rotor cooling fan highlighted for clarity

5 Ignition timing – general information and check

General information

1 Since no provision exists for adjusting the ignition timing and, since no component is subject to mechanical wear, there is no need for regular checks; only if investigating a fault such as a loss of power or a misfire, should the ignition timing be checked.

2 The ignition timing is checked dynamically (engine running) using a stroboscopic lamp. The inexpensive neon lamps should be adequate in theory, but in practice may produce a pulse of such low intensity that the timing mark remains indistinct. If possible, one of the more precise xenon tube lamps should be used, powered by an external source of the appropriate voltage. **Note:** *Do not use the machine's own battery as an incorrect reading may result from stray impulses within the machine's electrical system.*

Check

3 Warm the engine up to normal operating temperature then turn it OFF.

All non-LEADER engines

4 First identify the static reference mark on the alternator cover. The location of the reference mark will vary according to the machine and its age. Some scooters have two marks – one indicates the timing at idle, the other the TDC position (not relevant for ignition timing) **(see illustration)**. Some machines, especially liquid-cooled models, have an inspection hole in the cover, rather than a mark. If no reference mark is obvious, remove the cover and use the sensor on the pulse generator coil as a static guide. The timing mark is on the alternator rotor **(see illustration)** – if necessary, remove the alternator cover and the cooling fan on the right-hand side of the engine to locate the timing mark (see Chapter 2A, 2B, 2C or 2D).

LEADER engines

5 On all models, the static reference mark is on the alternator cover – on liquid-cooled models, remove the inspection cap, the reference mark is inside the hole **(see illustration)**. On air-cooled models, the timing mark is on the cooling fan; on liquid-cooled models the timing mark is on the water pump drive.

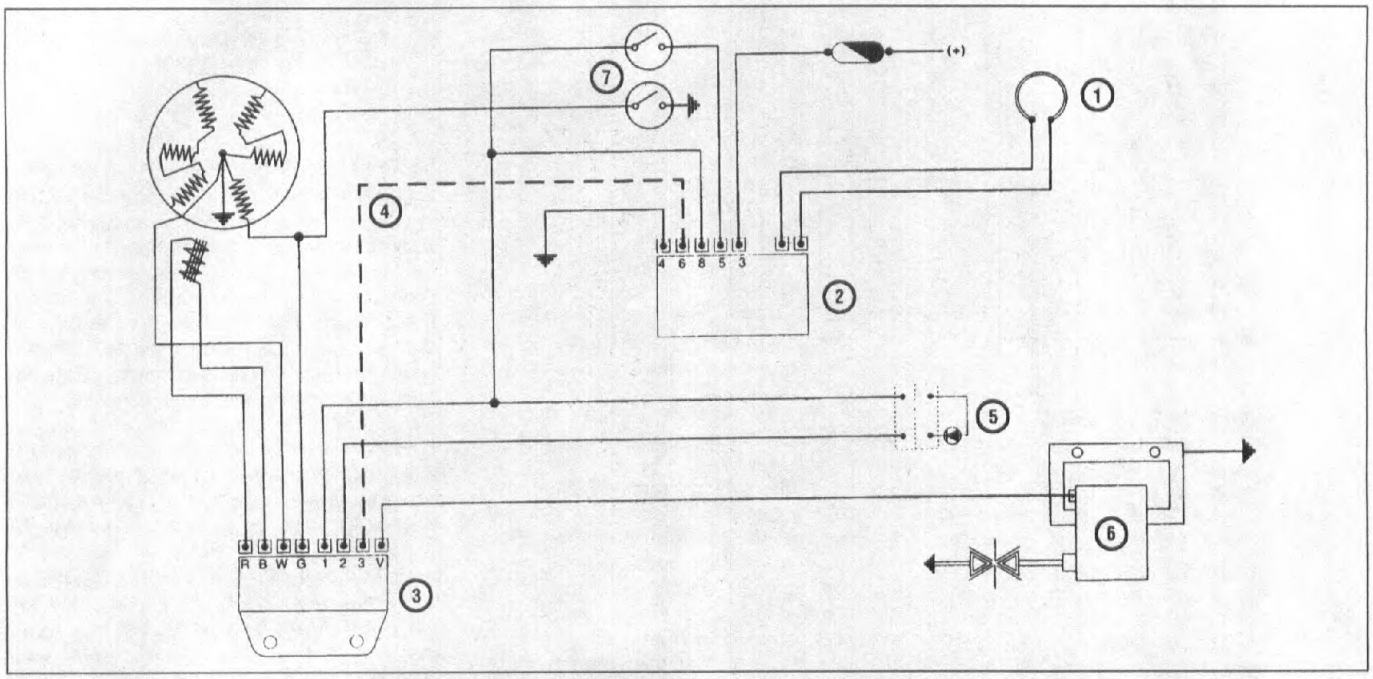
All engines

HAYNES HINT

The timing marks can be highlighted with white paint to make them more visible under the stroboscope lamp.

6 Connect the timing light to the spark plug HT lead as described in the manufacturer's instructions.

7 Start the engine and aim the lamp at the static reference mark **(see illustration)**. With



6.1 Immobiliser circuit diagram as fitted to ET4

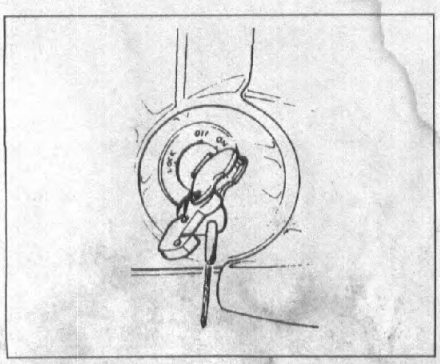
1 *Immobiliser transponder aerial*
2 *Decoder unit*
3 *Ignition control unit*
4 *Orange serial line cable*
5 *Diagnostic tester connector and diode*
6 *Ignition HT coil*
7 *Ignition (main) switch*

the machine idling at the specified speed, the timing mark on the rotor should align with the idle reference mark.

8 Slowly increase the engine speed whilst observing the timing mark. The timing mark should move anti-clockwise, increasing in relation to the engine speed until it reaches the full advance reference mark (where present).

9 As already stated, there is no means of adjustment of the ignition timing on these machines. If the ignition timing is incorrect, or suspected of being incorrect, one of the ignition system components is at fault, and the system components must be tested as described in the preceding Sections of this Chapter.

10 When the check is complete, install the alternator cover or inspection cap.



6.9 Immobiliser programming check using red-tagged key

6 Immobiliser system (ET4) – general information, programming and check

Note: *The immobiliser described in this section is fitted as standard to non-LEADER engined ET4 models. A similar version may be fitted as optional equipment on other models.*

General information

1 The ET4 model is equipped with an electronic immobiliser system **(see illustration)**. The system functions using a coded key.

2 Two keys and a code card are supplied with the vehicle from new, and the system will already have been programmed with your code. The red-tagged key is the master key and should be kept in a safe place along with the code card – if the red-tagged key is lost you will need a new immobiliser system! If required, additional blue-tagged keys can be programmed (to a maximum of seven).

3 Whenever the key is inserted, the immobiliser is disarmed (assuming the code is accepted). When the key is removed, with the ignition in either the OFF or LOCK positions, the system is automatically activated.

4 If the machine does not start when the key is inserted in the lock and the ignition is switched ON, turn the switch back to the OFF position and try again. If the machine still does not start, use the red-tagged master key. If the machine still does not start, contact your Piaggio dealer. They have a special electronic analyser which can locate the fault in the system. There are no testing specifications or procedures which can be applied at home using normal test equipment.

5 If the immobiliser decoder unit (located behind the legshield panel on ET4 models) or the ignition control unit are renewed, the system must be reprogrammed.

Programming

6 With the ignition switch in the OFF position, insert the red-tagged key. Turn the switch on for 1 to 3 seconds, then turn it OFF again. Remove the key.

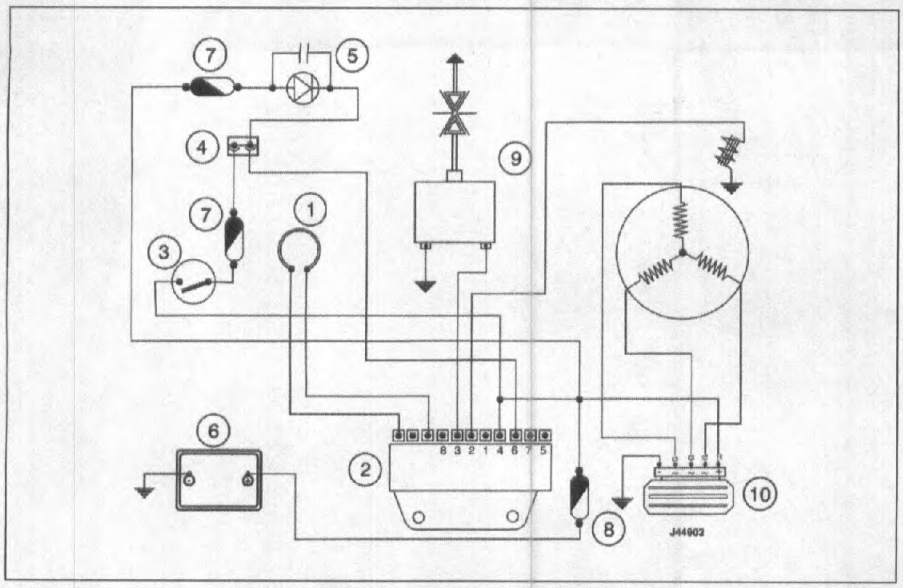
7 Within 10 seconds of removing the red-tagged key, insert the blue-tagged key. Immediately turn the switch on for 1 to 3 seconds, then turn it OFF again. Remove the key. If required, repeat this procedure for any additional blue-tagged keys.

8 Within 10 seconds of removing the blue-tagged key, insert the red-tagged key again. Immediately turn the switch on for 1 to 3 seconds, then turn it OFF again. Remove the key.

Caution: The use of the correct spark plug and suppresser cap is essential to prevent interference with the immobiliser system.

Check

9 To check the system after programming, insert the red-tagged key and flip open the hinged section of the tag. Turn the switch ON and try to start the engine **(see illustration)**. It



7.1 Immobiliser circuit diagram as fitted to X9

1 Immobiliser transponder aerial
2 ICU
3 Ignition (main) switch
4 Diagnostic tester connector
5 Immobiliser LED
6 Battery
7 10 A fuse
8 15 A fuse
9 Ignition HT coil
10 Regulator

should not start. Now insert a blue-tagged key and try to start the engine. It should start.

10 If the system does not perform as described, perform the programming sequence again. If the system still does not perform, contact your Piaggio dealer. They have a special electronic analyser which can locate the fault in the system. There are no testing specifications or procedures which can be applied at home using normal test equipment.

7 Immobiliser system (LEADER) – general information, programming and check

General information

1 The LEADER engined models are equipped with an electronic immobiliser system **(see illustration)**. The system functions using a coded key.

2 Two keys and a code card are supplied with the vehicle from new, and the system will already have been programmed with your code. The red or brown-tagged key is the master key and should be kept in a safe place along with the code card – if the master key is lost you will need a new immobiliser system! The blue or black-tagged keys are the service keys for everyday use – additional service keys can be programmed (to a maximum of seven).

3 Whenever the key is inserted, the immobiliser is disarmed (assuming the code is accepted). When the key is removed, with the ignition in either the OFF or LOCK positions, the system is automatically activated.

4 If the machine does not start when the service key is inserted in the lock and the ignition is switched ON, turn the switch back to the OFF position and try again. If the machine still does not start, use the master key. If the machine still does not start, contact your Piaggio dealer. They have a special electronic analyser which can locate the fault in the system. If the engine starts but will not rev above 2000 rpm (slightly more than idle speed) the immobiliser needs reprogramming (see Steps 8 to 10).

5 The immobiliser LED flashes for 48 hours and then goes out to minimise battery discharge, although the immobiliser system remains active.

6 The LED should flash once when the ignition is switched ON. If the LED stays off, use a multi-meter to check for battery voltage at the ICU. Remove the engine cover or bodywork as required according to model to access the ICU (see Chapter 7). Ensure the ignition is OFF, then disconnect the ICU wiring connector and check for battery voltage between the red/black wire terminal in the connector and earth (ground), and then between the red/black wire terminal and the black wire terminal. If there is no voltage, inspect the wiring between the ICU and the battery and check the ICU 15 amp fuse (see wiring diagrams at the end of Chapter 9).

7 Ensure that the engine kill switch on the handlebar is in the RUN position and that the side stand (where a side stand switch is fitted) is up. Turn the ignition ON and check for battery voltage between the light blue wire terminal in the ICU connector and the black wire terminal. If there is no voltage, refer to Chapter 9 and check the individual components in the starting system. If there is battery voltage, the ICU is probably faulty and should be checked by a Piaggio dealer.

Programming

8 With the ignition switch in the OFF position, insert the master key. Turn the switch on for 1 to 3 seconds, then turn it OFF again. Remove the key.

9 Within 10 seconds of removing the master key, insert the service key. Immediately turn the switch on for 1 to 3 seconds, then turn it OFF again. Remove the key. If required, repeat this procedure for any additional service keys.

10 Within 10 seconds of removing the service key, insert the master key again. Immediately turn the switch on for 1 to 3 seconds, then turn it OFF again. Remove the key. The immobiliser system is now programmed.

Caution: The use of the correct, resistor type, spark plug and suppresser cap is essential to prevent interference with the immobiliser system and possible loss of key programming.

Malfunction codes

11 The LED should flash once when the ignition is switched ON. If the LED then flashes twice and then stays on permanently to indicate an ignition fault, try using the master key to turn the ignition ON. If this works, the service key has lost its programme. If the fault persists, remove the bodywork as required according to model to access the immobiliser transponder aerial located behind the ignition switch (see Chapter 7). Trace the transponder wiring and disconnect it at the connector. Use a multi-meter set to the ohms scale to check the resistance of the aerial. If the result is not as specified, fit a new aerial. If the result is good, the ICU is probably faulty and should be checked by a Piaggio dealer.

12 If the LED flashes three times and then stays on permanently to indicate an ignition fault, try using the master key to turn the ignition ON. If this works, the service key has lost its programme. If the fault persists, the ICU is probably faulty and should be checked by a Piaggio dealer.