



## Section M

# Electronic Network

Service Manual - Backhoe Loader

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# Section M - Electronic Network

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# Servicemaster SYSTEM

## Introduction

This topic contains information about a machine SYSTEM. The system has some devices that connect either mechanically, hydraulically or electrically. Make sure you are referring to the correct system.

Descriptions and procedures relate to the system and not the individual devices. For information about the devices refer to the relevant topics.

This topic is intended to help you understand what the system does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

⇒ [Related Topics \(□ M1-2\)](#)

⇒ [Why Use Servicemaster? \(□ M1-3\)](#)

⇒ [Introduction \(□ M1-3\)](#)

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⇒ [Load the DLA Laptop Driver Software \(□ M1-8\)](#)

⇒ [Configure the DLA Type and Communications Port \(□ M1-9\)](#)

⇒ [Check the DLA Firmware File \(□ M1-10\)](#)

⇒ [Connect Servicemaster to the Machine CANbus \(□ M1-12\)](#)

## Related Topics

**Table 1. Related Topics in This Publication**

<b>The table lists other topics in the manual that contain information related to this topic. Where applicable the text in this section contains cross references to this page to help you find the correct information.</b>		
Sections	Topic Titles	Sub Titles
2	ALL (Care and Safety) <sup>(1)</sup>	ALL

(1) You must obey all of the relevant care and safety procedures.

**Table 2. Service Tools**

<b>The table lists the service tools you will need to do some of the procedures in this topic. Make sure you have the correct service tools BEFORE you start the procedures</b>	
Tool Part Number	Description
892/01174 <sup>(1)</sup>	Data Link Adaptor Kit
718/20235 <sup>(1)</sup>	USB PC Cable
718/20236 <sup>(1)</sup>	Serial PC Cable
728/26500 <sup>(1)</sup>	USB DLA
718/20237 <sup>(1)</sup>	Machine Cable

(1) Tool available from JCB Service, refer to Section 1 - Service Tools

## Why Use Servicemaster?

### Introduction

JCB machines now use the latest developments in electronic management of machine systems. This means that machine systems such as service hydraulics, engine, transmission and steering are controlled using electronic control units (ECU's).

The ECU's process inputs from electrical sensors and then output signals to electrical actuators on the applicable devices. The ECU's are also connected to the machine CANbus electronic communication system.

### Fault Finding

Faults with ECU controlled systems can be difficult or impossible to trace using traditional methods.

In addition to the primary function of machine control the ECU's are also able to detect possible faults with sensors and actuators. The faults are 'logged' using a code system.

Use **Servicemaster** to see and understand these codes.

In addition **Servicemaster** has direct links to relevant on-screen help information about relevant devices. This information is designed to help you identify, test, and if applicable, remove and replace devices.

### Identify Poor Maintenance

System faults that are present, or have happened in the past can be seen. This is not only useful when fault finding but can also identify poor standards of maintenance. For example a log showing a history of water in fuel detected.

Use **Servicemaster** to see and understand these codes.

### Access Machine Set Up Data

Machine parameters such as tyre sizes, gear shift points and engine injector calibration codes are all stored and used by the relevant control ECU's. During the life of the machine it will be necessary to change some of these parameters. Without the correct data the machine will not operate correctly.

This can only be done with **Servicemaster**.

### Re-Programming ECU's

The ECU's use pre-loaded data to compute responses to inputs from sensors. If an ECU is replaced the correct data files must be programmed ('flashed') into the ECU memory.

New data files may also be issued by JCB Service to improve machine operation. This will also require the ECU to be re-programmed.

This can only be done with **Servicemaster**.

### Summary

With the latest **Servicemaster** software loaded on your laptop and you can:

- **Fault find**
- For fast, effective fault finding.
- **Check maintenance standards**
- See if the machine has been abused.
- **View and change machine set up data**
- This can only be done with Servicemaster.
- **Flash ECU's with the correct data files**
- This can only be done with Servicemaster.



C047000

## What is Servicemaster?

### Introduction

JCB Servicemaster is software for use with Microsoft Windows and a laptop personal computer.

The laptop computer is connected to the machine 'diagnostic socket' using special cables and an adapter. Use Servicemaster software to:

- Display data from machine ECU's
- Change data stored in ECU's

### CANbus Communications System

**C** Controller    **A** Area    **N** Network

Servicemaster software communicates with the machine ECU's using the CAN.

CAN is an electronic communications system that connects compatible machine ECU's to one pair of data wires called the CANbus. Coded data is sent to and from the ECU's on the CANbus. By connecting Servicemaster software to the CANbus this data is seen and decoded for use by an engineer.

### Servicemaster Structure

Servicemaster software is supplied as part of the JCB Service data DVD **A** issued to JCB dealers.

The DVD includes all the software tools for all applicable JCB machines. A selector window **B** is used to choose the correct software tool set **C** for each machine range.

### Tool Sets

Tool sets **1-C** are different for each machine range. A typical tool set includes:

 <small>C046750</small>	 <small>C46230</small>
Vehicle Setup tool	Diagnostics tool
 <small>C046760</small>	 <small>C046230-C2</small>
Flash Programmer tool	Data Logger tool

Each tool is specific to the chosen machine range. The tool icons are 'shortcuts' to the tool software files. Detailed information about how to use the tools is given in the applicable machine documentation.

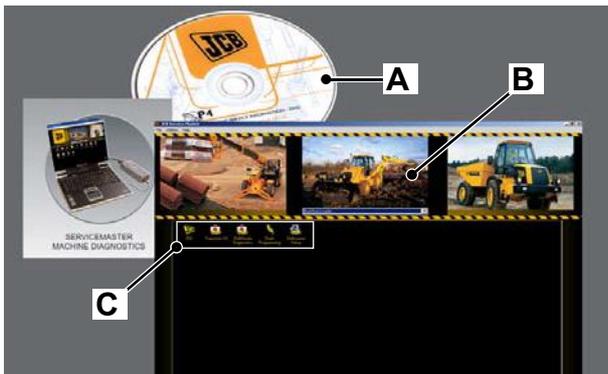


Fig 1.

C047160

## How to Set Up Servicemaster

**Note:** The procedures that follow describe how to set up Servicemaster for USB compatible equipment. There are other procedures and options. These are described in detail in the Servicemaster help files contained on the JCB Service Information DVD.

Before you set up Servicemaster make sure you have:

- A Microsoft Windows compatible laptop computer with a DVD drive and a USB port (A)

**Note:** Servicemaster is compatible with Windows 98, 2000, ME and XP.

- The latest Servicemaster software (JCB Service Information DVD) (B)
- A JCB compatible data link adapter (DLA) (C)
- The correct connection cables (D)

**Important:** DO NOT connect any cables at the laptop, DLA or machine now.

- 4 Configure the DLA type and communications port
- 5 Make sure that the DLA flash memory contains the latest firmware file
- 6 Connect Servicemaster to the machine CANbus

⇒ [Install Servicemaster \(M1-6\)](#)

⇒ [Start Servicemaster \(M1-7\)](#)

⇒ [Load the DLA Laptop Driver Software \(M1-8\)](#)

⇒ [Configure the DLA Type and Communications Port \(M1-9\)](#)

⇒ [Check the DLA Firmware File \(M1-10\)](#)

⇒ [Connect Servicemaster to the Machine CANbus \(M1-12\)](#)



Fig 2.

C047170

To set up Servicemaster for the first time:

- 1 **Install Servicemaster**
- 2 **Start Servicemaster**
- 3 **Load the DLA laptop driver software**

### Install Servicemaster

- 1 Exit all open programs on your laptop computer.
- 2 Insert the 'JCB Service Information Pack DVD' into the DVD drive. The chooser screen will open. Click on the 'S4' icon. [⇒ Fig 3. \(□ M1-6\)](#)

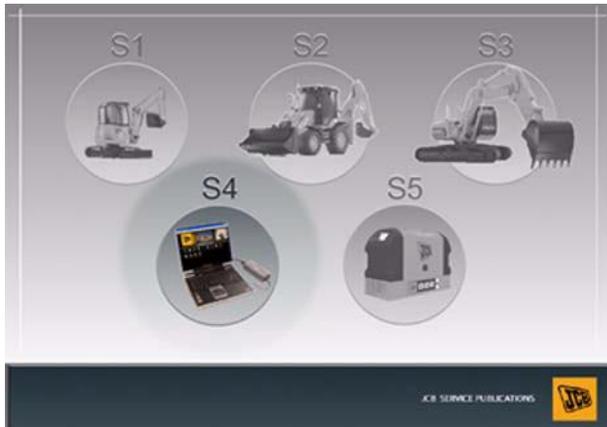


Fig 3.

C047180

- 3 The S4 chooser screen will open. Click on the Servicemaster icon. [⇒ Fig 4. \(□ M1-6\)](#)



Fig 4.

C047190

- 4 The Servicemaster set up screen will open. Click on the 'Install' button. The installation process now starts: [⇒ Fig 5. \(□ M1-6\)](#)



Fig 5.

C047200-C1

- a At the 'installer' screen click 'Next'. [⇒ Fig 6. \(□ M1-6\)](#)



Fig 6.

C047200-C2

- b At the 'destination location' screen click 'Next'.
- c At the 'installation type' screen click 'Next'. (A full installation is recommended.)
- d At the 'installation complete' screen, click 'Finish'.



### Load the DLA Laptop Driver Software

To use Servicemaster for the first time you must load the DLA driver software. You will not have to do the procedure again.

**Important:** DO NOT connect the DLA or cables at the laptop or machine now.

- 1 Start the Servicemaster software on your laptop computer. → [Start Servicemaster \(□ M1-7\)](#)
- 2 Select 'DLA' from the drop down menu. → [Fig 10. \(□ M1-8\)](#)



Fig 10.

C047210-C2

- 3 Double click on the USB driver icon. → [Fig 11. \(□ M1-8\)](#)



Fig 11.

C047210-C

**Note:** Drivers are also available for computers with serial ports (no USB) and other versions of Microsoft Windows. If your laptop does not have a USB port, double click on the correct driver icon.

- 4 The driver installer window will open. → [Fig 12. \(□ M1-8\)](#)

Follow the on-screen installation instructions to complete the installation.



Fig 12.

C047210

### Configure the DLA Type and Communications Port

To use Servicemaster for the first time you must make sure that the correct DLA and laptop port is selected to communicate with the DLA. You will not have to do the procedure again.

- 1 Start the Servicemaster software on your laptop computer. → [Start Servicemaster \(□ M1-7\)](#)
- 2 Select 'DLA' from the Servicemaster drop down menu. → [Fig 10. \(□ M1-8\)](#)
- 3 Double click the COM Port Chooser icon. → [Fig 13. \(□ M1-9\)](#)



Fig 13.

C047220

- 4 The DLA Chooser window will open. Select the 'USB/Serial DLA' device and then click 'Apply'. → [Fig 14. \(□ M1-9\)](#)



Fig 14.

C047220-C1

### Check the DLA Firmware File

**Important:** Do not connect the DLA to the machine until this procedure has been completed.

The DLA has software embedded in its own flash memory. This file must be replaced with a new one when new firmware is released. You will only have to Check the DLA firmware file version if you receive a new Servicemaster version or use a different DLA.

- 1 Make sure that the DLA is connected to the laptop computer. → [Connect the 'USB PC Cable' A to the DLA and a free port on your laptop computer. \(□ M1-12\)](#)
- 2 Start the Servicemaster software on your laptop computer. → [Start Servicemaster \(□ M1-7\)](#)
- 3 Select 'DLA' from the drop down menu. → [Fig 10. \(□ M1-8\)](#)
- 4 Double click on the USB DLA Flash Loader icon. → [Fig 15. \(□ M1-10\)](#)



Fig 15.

C048070-C4

**Note:** Older DLAs and laptop computers may not be compatible with USB ports. Double click the 'Flash loader for Serial/Parallel DLA' icon.

- 5 The device flash update tool window opens. The details of the firmware in the DLA are displayed including the application version, for example 1.04.

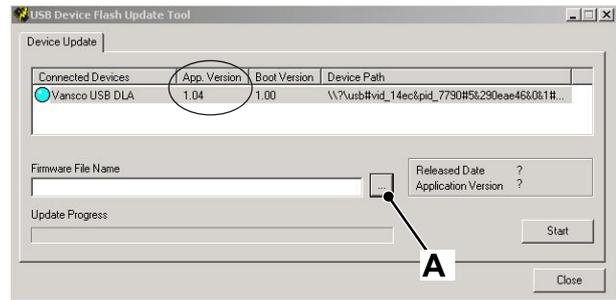


Fig 16.

C048070

- 6 **Check for a new firmware file:** Click on the browse button **A** and locate the file stored within the JCB\_Servicemaster directory on your laptop hard drive.
  - a Click the 'Open' button. The selected file appears in the 'Firmware File Name' field together with its release date and application version, for example 2.01. → [Fig 18. \(□ M1-11\)](#)

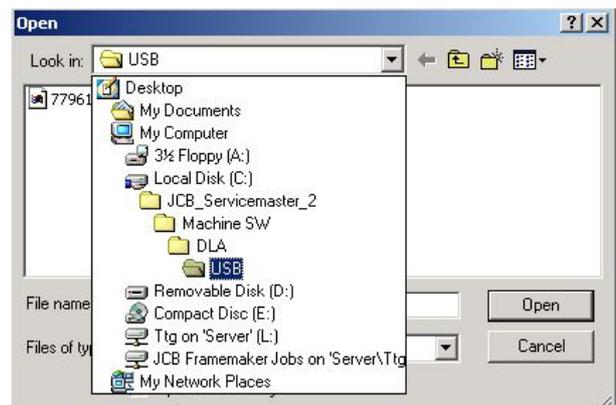
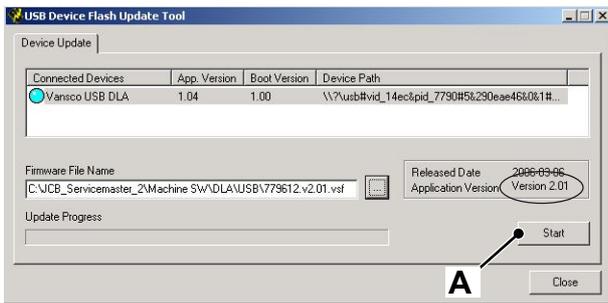


Fig 17.

C048070-C1



C048070-C3

**Fig 18.**

- 7 Load a new firmware file:** If the firmware in the DLA is not up to date, load the new file. Click the 'Start' button **A** and follow the on-screen instructions.
- 8** When the update is complete disconnect the DLA and close the servicemaster application.

**Important:** *The computer must be restarted before the updated software can be used.*

## Connect Servicemaster to the Machine CANbus

To use Servicemaster connect your laptop computer to the machine CANbus. Connection is made using Data Link Adapter (DLA) **19-C** and the applicable cables.

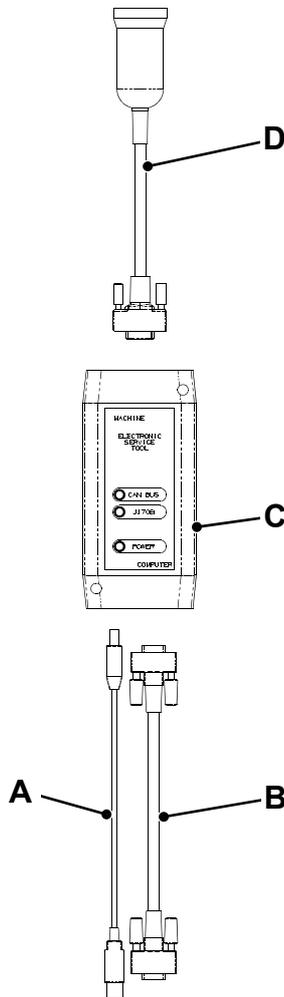


Fig 19.

C032140

Table 3. Component Key

<b>A</b>	USB PC Cable	718/20235
<b>B</b>	Serial PC Cable	718/20236
<b>C</b>	USB DLA	728/26500
<b>D</b>	Machine Cable	718/20237
Kit 892/01174 (includes items A,B,C and D)		

⇒ Fig 19. (□ M1-12)

- 1 Make sure the machine ignition system is OFF.
- 2 Connect the 'USB PC Cable' **A** to the DLA and a free port on your laptop computer.

**Note:** Connect the USB cable directly to the laptop computer. DO NOT connect the cable via a USB hub.

**Note:** Older DLAs and laptop computers may not be compatible with USB ports. Use the serial PC cable **B** to connect the DLA to the laptop serial port.

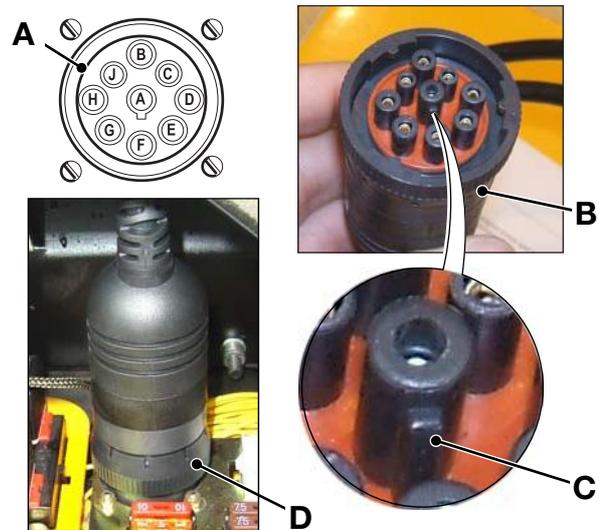


Fig 20.

A405350-C2

- 3 Connect the 'Machine Cable' **D** to the DLA. The 'Machine Cable' has a 15-way D-type connector on one end and a 9-way CAN connector on the other. Plug the 15-way connector into the DLA and tighten the thumb-screws.

⇒ Fig 20. (□ M1-12)

- 4 Connect the 9-way CAN connector into the machines' Diagnostics Connector **A** as follows:
  - a Position the CAN connector **B** to align the centre pin location tab **C** with the diagnostics connector. **A**.
  - b Couple the connectors. Turn the locking ring **D** clockwise to secure the connectors.

# ServiceMaster Tools

## Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

Descriptions and procedures relate to the device and not related systems. For information about the systems refer to the relevant topics.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

[⇒ \*Related Topics\* \(□ M2-2\)](#)

[⇒ \*Summary\* \(□ M2-3\)](#)

[⇒ \*ShiftMaster Diagnostics 2.3 - User Guide\* \(□ M2-4\)](#)

## Related Topics

**Table 1. Related Topics in This Publication**

<b>The table lists other topics in the manual that contain information related to this topic. Where applicable the text in this section contains cross references to this page to help you find the correct information.</b>		
Sections	Topic Titles	Sub Titles
2	ALL (Care and Safety) <sup>(1)</sup>	ALL

(1) *You must obey all of the relevant care and safety procedures.*

**Table 2. Service Tools**

<b>The table lists the service tools you will need to do some of the procedures in this topic. Make sure you have the correct service tools BEFORE you start the procedures</b>	
Tool Part Number	Description
892/01174 <sup>(1)</sup>	Data Link Adaptor Kit
718/20235 <sup>(1)</sup>	USB PC Cable
718/20236 <sup>(1)</sup>	Serial PC Cable
728/26500 <sup>(1)</sup>	USB DLA
718/20237 <sup>(1)</sup>	Machine Cable

(1) *Tool available from JCB Service, refer to Section 1 - Service Tools*

## Summary

Tool	Machine Application	Icon	Description	User Guide
<b>PS760 ShiftMaster Transmission Diagnostics</b>	Machines with PS760 6 speed gearbox	 <p style="text-align: center; font-size: small;">C046750-C1</p>	View gearbox operating parameters in real time. Perform gearbox electrical actuator tests.	<a href="#">⇒ <i>ShiftMaster Diagnostics 2.3 - User Guide</i> (  M2-4)</a>

### ShiftMaster Diagnostics 2.3 - User Guide



C032980

#### Introduction

The **ShiftMaster Diagnostics** software tool is part of the **JCB Service Master** software suite. The diagnostics software is designed to be an easy to use fault finding tool for Powershift PS760 series electronically controlled gearboxes.

**ShiftMaster Diagnostics** employs the graphical strengths of the Microsoft Windows operating environment to simplify electrical fault finding within the gearbox ECU control system.

**ShiftMaster Diagnostics** is only intended for use with ECU 2, ECU 2.2 & ECU 2.3 controlled PS760 gearboxes. The system is not compatible with relay controlled gearboxes. Older versions of Powershift Controllers used on the PS750 series gearboxes are not supported.

**Note:** *This software guide is universal and some functions may not be available on particular machine variants.*

This software is intended for use on IBM Compatible Personal Computers (**PCs**) running **Windows 9x**, **Windows2000** and **WindowsXP** operating systems but is

not compatible with either earlier versions of **Windows 3.x**. Ideally the computer should be a laptop type.

### Care and Safety

#### **WARNING**

**Be sure to read and follow any on screen instructions. Failure to follow correct procedure could result in death or injury.**

2-4-5-5



**Fig 1.**

S404180-C1

### Installing ShiftMaster Diagnostics

The **ShiftMaster Diagnostics** tool is fully integrated within JCB Service Master. To use ShiftMaster diagnostics you must install **JCB Service Master** onto a suitable laptop computer. → [Servicemaster SYSTEM \(M4-1\)](#)

For full instructions on how to install **JCB Service Master** software please refer to the documentation which accompanies JCB Service Master.

## Connecting ShiftMaster Diagnostics

To use ShiftMaster Diagnostics your laptop computer must be connected to the machine transmission ECU diagnostics connector → [Fig 3.](#) ([M2-6](#))

Connection is made using Diagnostic Link Adapter (DLA) **C** and the applicable cables.

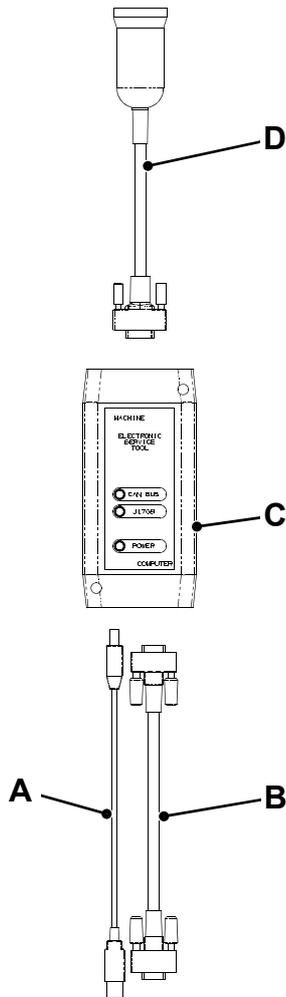


Fig 2.

C032140

Item	Description	Part Number
A	USB PC Cable	718/20235
B	Serial PC Cable	718/20236
C	USB DLA	728/26500
D	Machine Cable	718/20237
Kit 892/01174 (includes items A,B,C and D)		

- 1 Connect either the 'Serial PC Cable' **B** (718/20236) or the 'USB PC Cable' **A** (718/20235) between the DLA **C** and a free port on your laptop computer.
  - a The 'Serial PC cable' has a 9-way D-type connector on one end and a 25-Way D-type connector on the other. Plug the 25-way male connector into the DLA and the other connector into a free port on your laptop PC, remembering to tighten any thumb-screws appropriately.

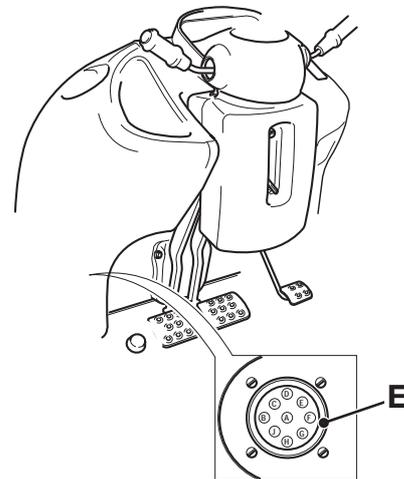


Fig 3.

C096800

- 2 Connect the 'Machine Cable' **D** between the DLA and the machine's Diagnostic Connector **E**. The 'Machine Cable' has a 15-way D-type connector on one end and a 9-way CAN connector on the other. Plug the 15-way connector into the DLA and tighten the thumb-screws, then connect the 9-way CAN connector into the machine's Diagnostics Connector **E** and twist the lock-ring to secure it.

### Starting ShiftMaster Diagnostics

- 1 Turn ON the machine ignition and additionally start the engine if required (taking normal precautions).
- 2 Start **JCB Service Master** on the laptop computer.



Fig 4.

C025190

- 3 Make sure that the correct DLA is selected in the chooser. Click on 'Utilities', DLA Setup. The DLA Chooser window opens. Check the button to match to the Current Device. Click 'Apply'. [⇒ Fig 5. \(□ M2-7\)](#)

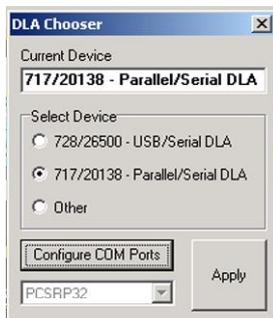


Fig 5.

C033110

- 4 Select 'Loadall' from the drop down list [⇒ Fig 4. \(□ M2-7\)](#)

Start the diagnostics tool running by clicking on the **ShiftMaster Diagnostics** icon. [⇒ Fig 6. \(□ M2-7\)](#)



Fig 6.

C031520

- 5 Warning message appears. Read and understand the Warning message. If you can comply with the requirements press the 'Accept' button. [⇒ Fig 7. \(□ M2-7\)](#)

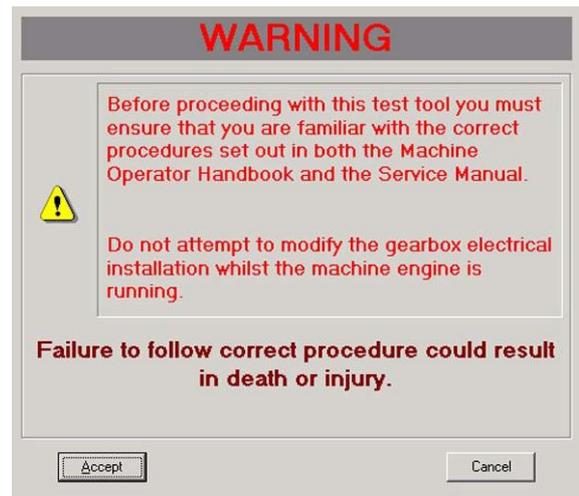


Fig 7.

S404180-C2

- 6 The **ShiftMaster Diagnostics** tool will then open up displaying the main window. [⇒ Fig 8. \(□ M2-8\)](#)



### ShiftMaster Diagnostics Overview

There are several key elements to the **Diagnostics** tool. These can be seen labelled below. Each element is explained in detail in later sections.

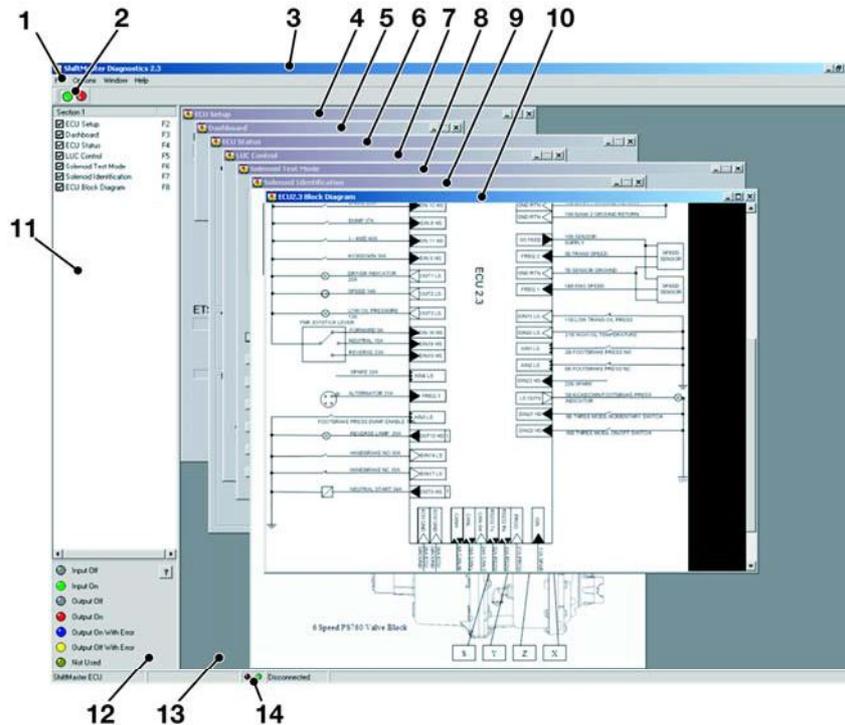


Fig 9.

C052890

Key:					
1	Menu Bar	⇒ <a href="#">M2-10</a>	8	Solenoid Test Mode Page	⇒ <a href="#">M2-21</a>
2	Start and Stop Buttons	⇒ <a href="#">M2-13</a>	9	Solenoid Identification Page	⇒ <a href="#">M2-23</a>
3	Main Window		10	ECU Block Diagram Page	⇒ <a href="#">M2-23</a>
4	ECU Setup Page	⇒ <a href="#">M2-15</a>	11	Page List <sup>(1)</sup>	⇒ <a href="#">M2-14</a>
5	Dashboard Page	⇒ <a href="#">M2-16</a>	12	LED Status Key	⇒ <a href="#">M2-17</a>
6	ECU Status Page	⇒ <a href="#">M2-17</a>	13	Page Display Area	
7	LUC Page <sup>(2)</sup>	⇒ <a href="#">M2-19</a>	14	Status Bar	⇒ <a href="#">M2-14</a>

(1) The page list differs depending on the type of ECU connected (ECU 2 or ECU 2.2 / ECU 2.3)

(2) Lock up torque converter page. Some gearboxes are not fitted with a lock up torque converter. The diagnostics software always displays the page even if it is not applicable.

### Navigating within ShiftMaster Diagnostics

Navigation is designed to be via a mouse. On Laptop PCs this may take the form of a small joystick or touch sensitive pad and some buttons, usually located near to the keyboard.

As with most Windows based programs, it is possible to navigate the **ShiftMaster Diagnostics** software using the keyboard by pressing certain combinations of keys.

***Note:** This can be particularly useful for certain Laptop computers where the mouse/joystick can be over-sensitive. Try out the following, it may come in useful one day.*

There are two main methods of navigation described below;

- Pressing the **ALT** key will cause the File option on the Menu Bar to be highlighted. You can then use the arrow keys to navigate the menus.
- Notice that all the menu items on the Menu Bar have a letter that is underlined (e.g. the 'F' in **File**). Holding down the ALT key and pressing the required letter key will activate that option (i.e. either open the menu or execute a function). For example, if you wish to open the Preferences Dialogue this can be done by pressing **ALT + O** (to open the **Options** menu) then **ALT + P** (to execute the **Preferences** option).

### Menu Bar - File Menu

The File Menu contains an Exit option to close down the program ⇒ [Fig 10.](#) ([□ M2-10](#))



**Fig 10.**

C052900

On exiting the program communications with both ECU and DLA are shut down.

## Menu Bar - Options Menu



Fig 11.

C052940

- **Start Diagnostics** to commence communications with the ShiftMaster ECU. → [Fig 11.](#) (□ M2-11)
- **Stop Diagnostics** to cease communications. → [Fig 11.](#) (□ M2-11)

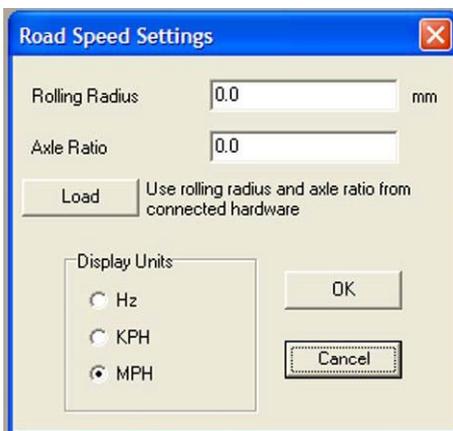


Fig 12.

C031540

- **Road Speed Settings** (ECU 2.2/2.3 only) Opens up the Road Speed Settings window. → [Fig 12.](#) (□ M2-11)
- Press the **'Load'** button to upload the data from the ECU.
- If the rolling radius of the wheel has been changed (due to a tyre fitment change for example) input the rolling radius and the associated axle ratio.
- To change the speed units displayed by the diagnostics software check the required button on the **Display Units** panel.
- Press the **'OK'** button to save the settings and close the window.



Fig 13.

C032160

- **Preferences** option opens up the Preference Dialogue. → [Fig 13.](#) (□ M2-11)



Fig 14.

C032170

- From the Preferences Dialogue there is support for multiple languages. Use the drop-down menu and scroll bar to chose the required language. Languages presently on offer are: → [Fig 14.](#) (□ M2-11)
- **English (Canada)**
- **English (United Kingdom)**
- **French (France)**
- **German (Germany)**
- **Italian (Italy)**
- **Portuguese (Portugal)**
- **Spanish (International Sort)**

**Note:** The language option only effects text within the Main Window (e.g. Page List, LED Status Key, etc.). Language support is not available for the text within the page displays.



**Fig 15.**

S404300-C1

- The Preferences Dialogue also offers the ability to change the background colour of the Page displays. Select the required background colour using the radio buttons. → [Fig 15. \(M2-12\)](#)

**Note:** When using a laptop PC it can often be difficult to see the screen in bright sunlight. Changing the background colour can help improve the contrast (especially with the different LED colours) and so make viewing the screen easier.

Once your preferences have been selected either:

Click on the **OK** button to apply them or click on the **Cancel** button to leave them unchanged.

### Menu Bar - Window Menu

→ [Fig 16. \(M2-12\)](#)



**Fig 16.**

C052950

Like most other Windows based programs where there are multiple sub-windows or Pages used, there are usually options to organise how they are laid-out. ShiftMaster Diagnostics software is no different and offers the following options;

- **Cascade**
- **Tile Horizontally**
- **Tile Vertically**

## Menu Bar - Help Menu

⇒ [Fig 17.](#) ( [M2-13](#) )



**Fig 17.**

C052960

- **About:** Opens a window showing the part number and the version number of the installed copy of the Diagnostics software ⇒ [Fig 18.](#) ( [M2-13](#) )

## Start and Stop Buttons

These offer the same function as the **Start Diagnostics** and **Stop Diagnostics** options within the Options Menu. To start the **Diagnostics** tool communicating with the gearbox ECU simply click on the **Start Button** (large green LED) at the top of the Main Window. Similarly, click on the **Stop Button** (large red LED) to cease communications. ⇒ [Fig 19.](#) ( [M2-13](#) )



**Fig 19.**

C031560



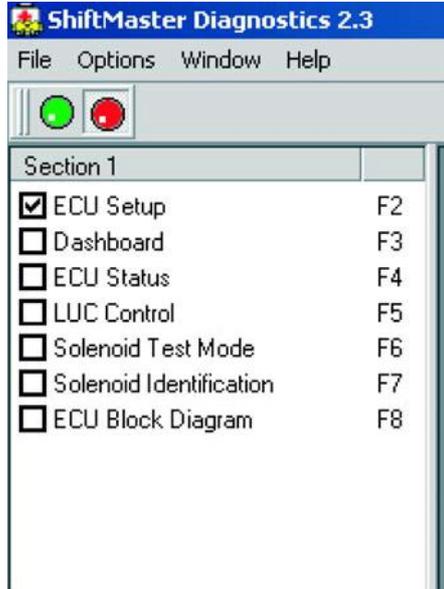
**Fig 18.**

C052970

## Page List

In the top left corner of the main window is displayed a list of pages which can be displayed. ⇒ [Fig 20.](#) ([□ M2-14](#))

**Note:** The page list differs depending on the type of ECU connected (ECU 2 or ECU 2.2/2.3).



**Fig 20.**

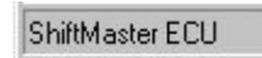
C052980

Clicking in the box next to the required page will make that page appear in the main window display area. (A tick will also appear in the box to show it is being displayed.) At any time the user may swap between displayed pages simply by clicking in the check box of the required page in the page list. The function keys, F2, F3 etc. can also be used to select pages as required.

## Status bar

There are 2 items of interest displayed on the **Status Bar**, which is located along the bottom of the Diagnostics main window.

**Connected ECU:** The type of ECU connected to the Diagnostics tool is indicated on the far left side of the Status bar. ⇒ [Fig 21.](#) ([□ M2-14](#))



**Fig 21.**

S404430-C1

**CAN communications:** Two small LEDs indicate data being transmitted (red) and received (green) over the CAN communications link. ⇒ [Fig 22.](#) ([□ M2-14](#))



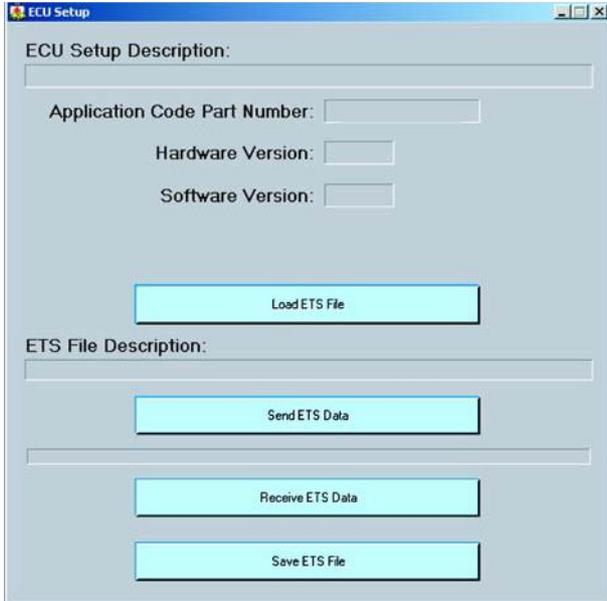
**Fig 22.**

S404440-C1

These LEDs can be seen to be flashing rapidly as data is transported. This can be another useful aid to determining the state of any established communications.

### ECU Setup Page

This page displays crucial information about the ECU configuration. ⇒ [Fig 23.](#) ([M2-15](#))



**Fig 23.**

C053020-C3

It is always useful to confirm that this is the correct configuration for the machine before commencing any fault finding.

The ECU Setup Page displays the following information;

**ECU Setup Description:** As well as its' operating software, the gearbox ECU also stores a group of **Setup Data** (or Settings). This Setup Data is used to tailor how a certain ECU part number functions. The Setup Data is loaded during the manufacturing process and has been approved for use in the intended application.

Contained as part of the Setup Data is a Description. This Description is what is displayed here. The engineer can use this description to verify that the correct Setup Data is being used.

The ShiftMaster Setup software tool is designed to view and update current setup data.

**Application Code Part Number:** During normal operation the application code is displayed. If there are communications errors present then this will contain either:

- a) "NO DLA COMMS" if there are problems in communication with the DLA, or
- b) "NO ECU COMMS" if the DLA is working but the ShiftMaster ECU is not responding.

**Note:** For help on fixing communication problems. ⇒ [Connection Problems](#) ([M2-24](#))

**Hardware Version:** The hardware version is a reference to the build level of the electronics. Future developments may mean that hardware upgrades are required. This may effect which software can be used.

**Software Version:** The software version refers to the issue level of the ECU operating software. Again, future developments may require software revisions.

### ETS Function

The ETS function provides a means of loading and uploading gearbox ECU software setup files between the ECU and the computer. On earlier versions of servicemaster a separate program was required to perform this function. This is now incorporated within shiftmaster diagnostics 2.3. The setup files have a file name extension of .ets.

**Load ETS File:** A revision to the gearbox ECU software file may be supplied by JCB for installation on particular ECU models. Store the file on the computer which is to be connected to the gearbox ECU. The shiftmaster diagnostic program needs to open this file and obtain the software version and other applicable information to make sure it is compatible with the ECU connected to the computer.

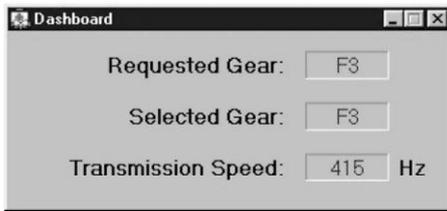
**Send ETS Data:** This allows the computer to send a software setup file to the gearbox ECU.

**Receive ETS Data:** This reads the existing setup file from the gearbox ECU.

**Save ETS File:** This saves the data received from the ECU onto the computer.

### Dashboard Page

⇒ [Fig 24.](#) ([□ M2-16](#))



**Fig 24.**

S404460-C1

- **Requested Gear:** This is the demand from the operator.
- **Selected Gear:** This is the actual gear being selected by the ECU.

**Note:** The operator **Requested Gear** is not always the same as the **Selected Gear**, e.g. when the ECU blocks shifts when offering protection.

- **Transmission Speed:** This is the current transmission output speed which is directly related to the road speed (through axle ratio and tyre size). The transmission speed sensor is located next to the output gear and detects the passing of the gear teeth. The sensor has a fixed installation, no adjustment is necessary. This signal is used by the ECU to determine gear-shifting and protection strategies.
- ECU 2.2/2.3 only. The speed may be displayed as a frequency value or, alternatively, road speed in MPH or KPH. Use the Options Menu, Road Speed Settings to select the required units. ⇒ [Menu Bar - Options Menu](#) ([□ M2-11](#))

## ECU Status Page

This page gives a detailed picture of how the ECU is operating.

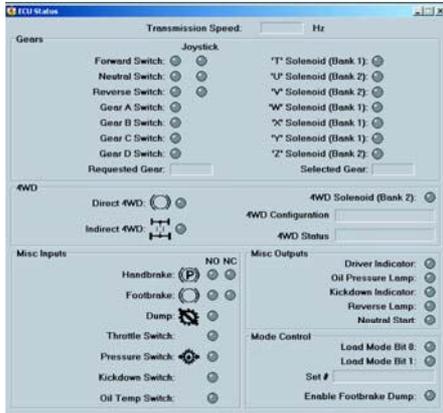


Fig 25.

C052990

Information in this display is constantly updated in real-time. The status of the ECU electrical inputs and outputs is displayed using simulated LED's. The LED's change colour depending on the status of the inputs and outputs. A key in the bottom left corner of the main window explains the colours.

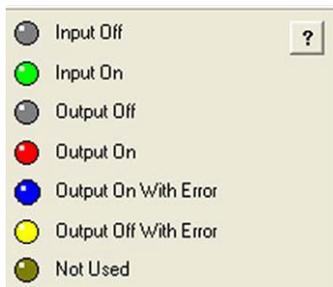


Fig 26.

C032180

The following is a brief explanation of each feature.

### Transmission Speed

This is exactly the same signal as explained in the previous section.

### Gears

- **Inputs:** The items on the left show the signal lines connected to the gear selection lever and where fitted the selection switch on the hydraulic control lever (Joystick). The gear selection lever is the left hand half of the control lever assembly mounted on the steering column. The hydraulic control lever (Joystick ECU 2.3 machines) has a selection switch for forward, neutral and reverse gears. The input status is indicated by a coloured LED, grey - input OFF, green - input ON.
- **Outputs:** The items on the right are the power outputs to the transmission solenoid valves. The output status is indicated by a coloured LED, grey - output OFF, red - output ON (solenoid energised). The ECU and Diagnostics software proactively scans the solenoids for electrical open and short circuits. In the event of a circuit problem the corresponding solenoid output LED will be coloured yellow when ON, or blue when OFF.

*Note: During certain gear-shifts the gearbox ECU will perform electrical **Modulation** to improve gear-shift quality. The ECU does this by adding delays to off-going and/or on-coming clutches and so overlapping energised outputs. These delays are in the order of a few hundred milli-seconds but it is sometimes long enough to be observed on the status LEDs. Thus, during certain shifts it is quite normal to observe more than 2 outputs ON at any one time.*

### 4WD

- **Direct 4WD:** An ECU input which is usually derived from the machine footbrake switch (which also controls the brake lights). Whenever this signal is present the 4WD Solenoid output is energised.
- **Indirect 4WD:** An ECU input which is usually derived from a command from a console mounted '4WD selector' switch. (However, this switch arrangement may change between machines.)
- **4WD Solenoid (Bank 2):** An ECU output to the transmission 4WD solenoid. The output status is indicated by a coloured LED, grey - output OFF, red - output ON (solenoid energised). The ECU and Diagnostics software proactively scans the solenoids for electrical open and short circuits. In the event of a circuit problem the corresponding solenoid output

LED will be coloured yellow when ON, or blue when OFF.

- **4WD Configuration:** Depending on the type of 4WD clutch fitted 4wheel drive OR 2 wheel drive may be selected when the '4WD' solenoid is energised. The clutch may be a '**Spring Applied**' or '**Pressure Applied**' type.
- **4WD Status:** Indicates if 4WD is '**Engaged**' or '**Disengaged**'.

### Misc Inputs

These inputs are derived from the remaining operator controls. The input status is indicated by a coloured LED, grey - input OFF, green - input ON.

- **Handbrake Switch:** Signal derived from the Parkbrake switch. Used to hold the transmission in Neutral if the parkbrake is applied. Two types of switch may be fitted NO (Normally Open) or NC (Normally Closed).
- **Footbrake Switch:** If fitted. Two types of switch may be fitted NO (Normally Open) or NC (Normally Closed).
- **Dump Switch:** (or Transmission Disconnect) Signal usually derived from a momentary switch. Temporarily selects Neutral when pressed (usually to divert engine power to hydraulics).
- **Throttle Switch:** Signal derived from a switch fitted to the machine throttle pedal. Used to interact with the Automatic Mode of gear-shifting.
- **Pressure Switch:** Signal derived from the transmission mounted Low Oil Pressure Switch.
- **Kickdown Switch:** Signal derived from a momentary button used to temporarily select the next lowest gear.
- **Oil Temp Switch:** Signal derived from the transmission oil temperature switch.

### Misc Outputs

These are the additional ECU outputs, generally used to control cab instrumentation such as a **Driver Indicator** (lamp and buzzer where fitted), low **Oil Pressure Lamp** and **Kickdown Indicator**. The output status is indicated by a coloured LED, grey - output OFF, red - output ON.

## Torque Converter Lock Up (TCLU) Page

The TCLU control page displays information relating to the torque converter lock up operation. ⇒ [Fig 27.](#) (□ [M2-19](#))

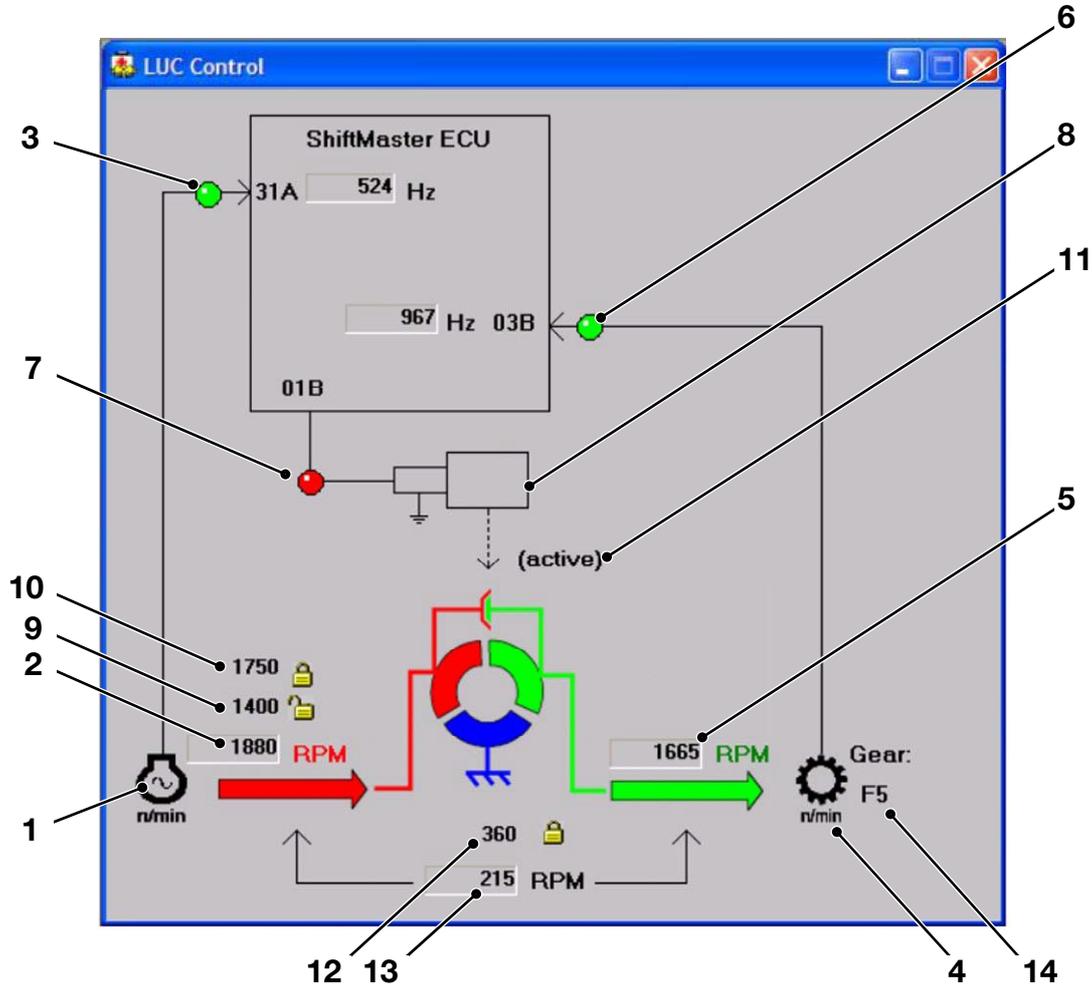


Fig 27.

C014530-C2

Key	
1	Engine speed sensor
2	Engine speed r.p.m. (real time)
3	Engine speed sensor input status LED
4	Transmission output speed sensor
5	Transmission speed r.p.m. (real time)
6	Transmission speed sensor input status LED
7	Lock up clutch solenoid status LED

8	Lock up clutch solenoid valve symbol
9	Engine speed - lock up clutch 'OFF' value
10	Engine speed - lock up clutch 'ON' value
11	Lock up clutch system 'active' or 'inactive'
12	Reference value - engine, transmission speed differential
13	Engine, transmission speed differential (real time)
14	Current gear selected

⇒ [Fig 27. \(□ M2-19\)](#)

For operation of the lock up clutch two speed references are required by the E.C.U.

Engine speed (n/min) is read from the input side of the transmission. The engine speed input is connected to the E.C.U. (pin 31A) and a green input LED **3** indicates the signal status.



**Fig 28.**

C014550-C1

Transmission output speed is taken from the same signal source described in Dashboard. ⇒ [Dashboard Page \(□ M2-16\)](#)

⇒ [Fig 27. \(□ M2-19\)](#)

The transmission output speed is connected to the E.C.U. (pin 03B) and a green input LED **6** indicates the signal status.

Two padlock symbols can be seen above the engine speed display. The locked padlock indicates the speed at which the lock up clutch (LUC) is switched 'ON' and the unlocked padlock indicates when the LUC is switched 'OFF'.



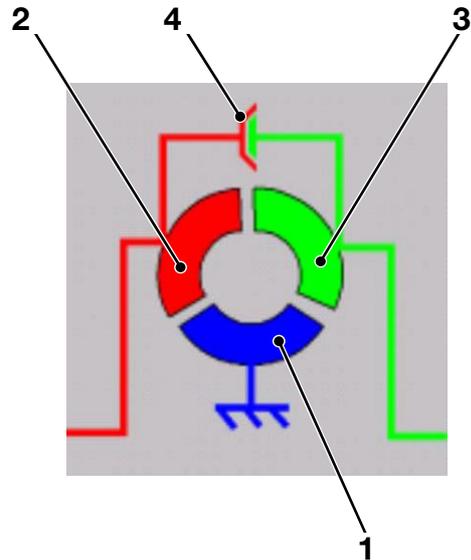
**Fig 29.**

C014550-C3

The circular graphic represents the torque converter and its elements. ⇒ [Fig 30. \(□ M2-20\)](#)

<b>1</b>	Stator
<b>2</b>	Turbine
<b>3</b>	Impeller
<b>4</b>	Lock up clutch

Real time engine and transmission output speed are also displayed on the graphic. ⇒ [Fig 27. \(□ M2-19\)](#)



**Fig 30.**

C014540-C2

⇒ [Fig 27. \(□ M2-19\)](#)

The central graphic **8** attached to E.C.U. output 01B depicts the lock up clutch solenoid. The red LED **7** indicates its status. Reference in brackets **11** displays as (active) if the gear selected is valid for LUC operation, or (inactive) if gear selected is not valid. The current gear selected is shown under the label 'Gear'.

A maximum differential speed reference value **12** is indicated next to a padlock symbol. If all the other interlocks are observed and the differential speed **13** is below that of the reference value, in this case 360 then the LUC is enabled.

### Solenoid Test Mode Page

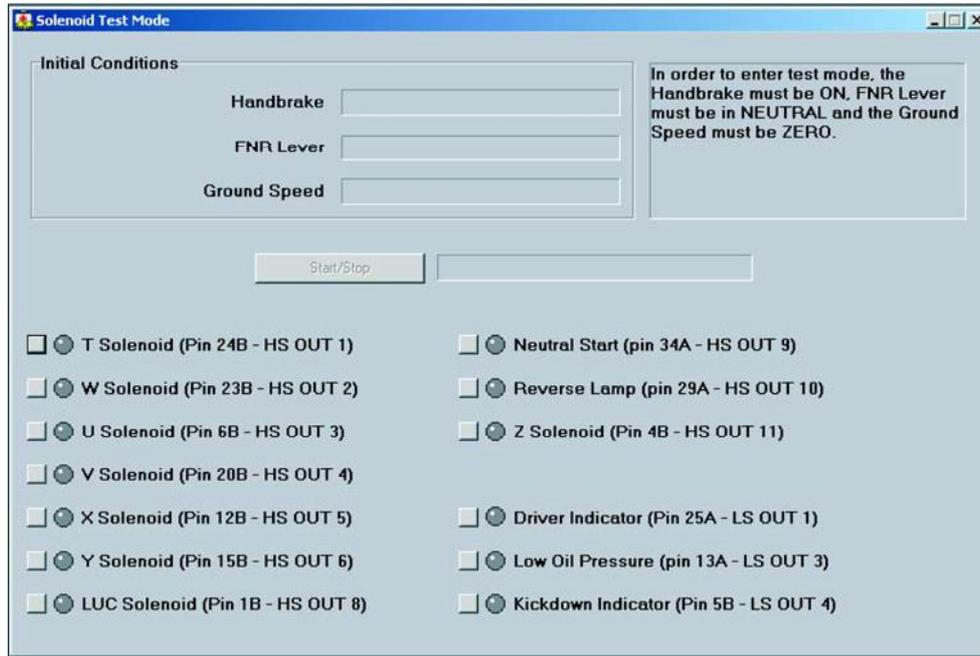


Fig 31.

C053000

The Solenoid Test Mode page allows testing of each transmission solenoid individually. Since gear selection always requires two solenoid valves to be energised the tests can be carried out with the transmission in neutral. For electrical tests the engine does not have to be running. For hydraulic clutch pressure testing the engine must be running, before using the Test Mode facility disconnect the drive shafts at the gearbox.

**Important:** *It is possible that the gearbox may have developed a fault causing a clutch to be permanently engaged. If a second clutch is engaged (by using the Test Mode facility for instance) the gearbox will engage a gear unexpectedly. Before using the Test Mode facility disconnect the drive shafts at the gearbox.*

- **Initial Conditions:** To enable the test mode the handbrake must be ON, the FNR lever set to NEUTRAL and the road speed must be ZERO. The conditions are displayed in the Initial Conditions panel.
- **Start/Stop Button:** Press the button to toggle the test mode either on or off as required. 'TEST MODE READY' or 'TEST MODE ACTIVE' is displayed as

applicable. If the initial conditions are not compatible with the test mode the Start/Stop button is disabled and 'NOT ALLOWED' is displayed.

- **To test a solenoid:** If tests are being carried out with the engine running, make sure that the drive shafts are disconnected at the gearbox. Click the appropriate button using the mouse. The ECU is 'forced' to output power to the selected solenoid. The output status is indicated by a coloured LED, grey - output OFF, red - output ON (solenoid energised). The ECU and Diagnostics software proactively scans the solenoids for electrical open and short circuits. In the event of a circuit problem the corresponding solenoid output LED will be coloured yellow when ON, or blue when OFF.
- **To test the Driver, Kickdown and reverse Indicators:** Click the appropriate button using the mouse. While the button is held down the ECU is 'forced' to output power to the indicator and or warning devices. The output status is indicated by a coloured LED, grey - output OFF, red - output ON. If

the devices are working they will illuminate and, or sound, as applicable.

- **To test the Neutral Start and Low Oil Pressure switches:** Click the appropriate button using the mouse. While the button is held down the ECU is 'forced' to output power to the switch. The output status is indicated by a coloured LED, grey - output OFF, red - output ON.

**Note:** *If the test mode is not enabled make sure that the START button is pressed (large green 'LED' at the top left corner of the screen).*



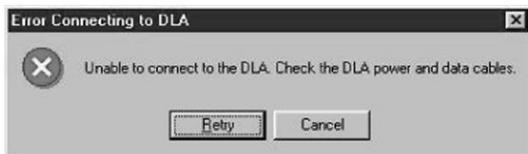
### Connection Problems

In general, whenever there are problems communicating with the DLA there will be an error message displayed. The following section although not exhaustive attempts to identify the more common ECU communication problems.

ShiftMaster PC Service Tools must use the authorised Data Link Adaptor (DLA) contained in the Electronic Service Tool Kit. The latest versions of both the hardware and software can be obtained through authorised suppliers. ShiftMaster software has been designed to run on the Windows 9.X, Windows 2000 and Windows XP operating systems.

A number of reasons can generate software problems and assistance from an Information Technology engineer is advised. In particular, laptop PCs can suffer serial communications conflicts were the PC hardware does not allow the Diagnostic software access to the communication ports. In the majority of cases conflicts are caused by either software already running on the PC, or by certain 'driver' files not releasing the COM port(s).

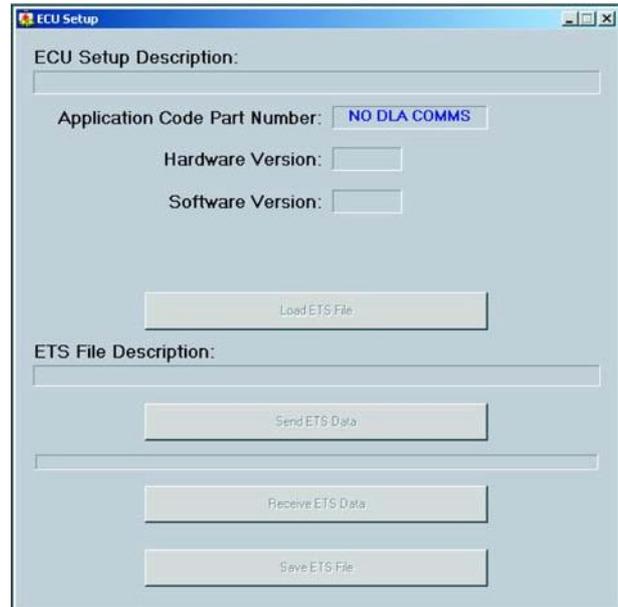
The PC Service Tools for example ShiftMaster Diagnostics indicate the existence of an ECU communication problem that can reside in two areas indicated in the type of displayed error message. The first message is generated when the problem exists between the PC and DLA then the 'Error Connecting to DLA' will be displayed. [⇒ Fig 34. \(□ M2-24\)](#)



**Fig 34.**

S404140-C1

Confirmation of this error can be found in the 'ECU Setup Page' with 'NO DLA COMMS' being displayed in the 'ECU Part Number' box. [⇒ Fig 35. \(□ M2-24\)](#)

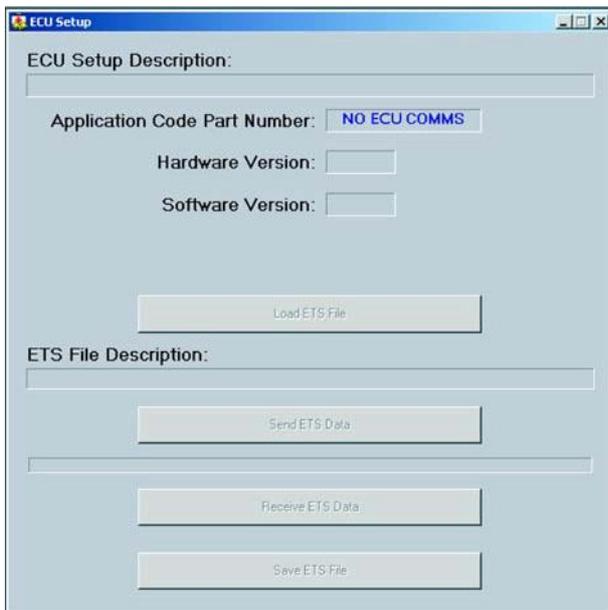


**Fig 35.**

C053020

The second is generated when no communications can be established with the DLA and the ECU usually through a hardware problem. No power supply from the machine, indicated by the DLA's power LED will display the 'NO ECU COMMS' message. [⇒ Fig 36. \(□ M2-25\)](#)

Another source could be related to resistance of the two data communication wires making up the machine's harness for the ECU's CAN connection to the Deutsch 9 way round diagnostic connector. The wiring must have two 120 Ohm resistors fitted to either end of this run of cable to give a 60 Ohm impedance. If the impedance is incorrect then 'NO ECU COMMS' message will displayed. [⇒ Fig 36. \(□ M2-25\)](#)



C053020-C1

**Fig 36.**

**Note:** The ECU must be powered for communications to work, i.e. the machine ignition must be ON (but the engine need not be running).

If a problem is experienced it can take one of three forms, a constant failure to establish communications, drop out during communications or intermittent communication connection. However, the source has a tendency to be of the 'NO DLA COMMS' type and thus related to the user's PC. Contributory factors to communication errors could be related to the following items:

- **DLA Drivers.** The DLA and PC are programmed with software 'drivers' which handle communications. Ensure the latest drivers are installed on the PC and DLA (contained in the latest version of Service Master).
- **PC Power Management.** Previous experiences have shown that some laptops' Power Management software can disrupt the COM ports. Turning off the power management software may resolve the problem.
- **IR Drivers.** If the PC has an InfraRed (IR) communications port then disabling the driver may help.
- **Modem Drivers.** Modem drivers could cause communication conflicts and temporary disabling to

establish if the software is conflicting with the port may establish this source.

If the aforementioned information fails to resolve the situation then the following contacts may be able to provide further assistance;

- Information Technology (IT) engineer.
- Authorised machine dealer or agent.
- Machine OEM. The Original Equipment Manufacturer (OEM) will make the relevant enquires.



### General Information

For all enquiries about the **ShiftMaster Diagnostics** tool please follow your normal channels of enquiry. This ensures that useful information can filter through to JCB personnel at all levels.

# Pulse Width Modulation Theory

## Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

Descriptions and procedures relate to the device and not related systems. For information about the systems refer to the relevant topics.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

[⇒ \*Related Topics\* \( !\[\]\(f97bbb84d3e14c71f5666b6875b81b2f\_img.jpg\) M3-2\)](#)

[⇒ \*Operation Overview\* \( !\[\]\(a21b01b47c6e0feceab2bddfd6461ab4\_img.jpg\) M3-3\)](#)

## Related Topics

Table 1. Related Topics in This Publication

The table lists other topics in the manual that contain information related to this topic. Where applicable the text in this section contains cross references to this page to help you find the correct information.		
Sections	Topic Titles	Sub Titles
2	ALL (Care and Safety) <sup>(1)</sup>	ALL

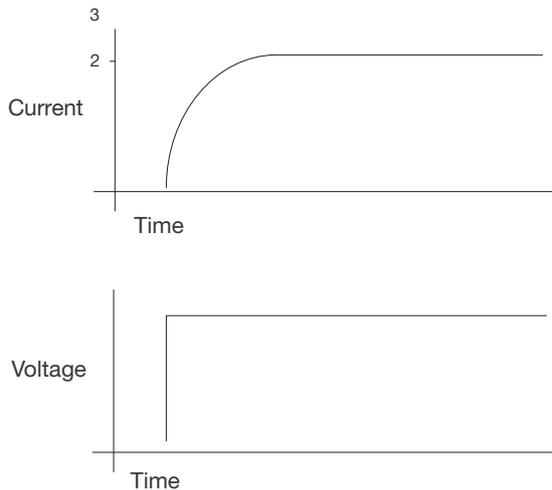
(1) You must obey all of the relevant care and safety procedures.

## Operation Overview

The machines use an electronic control unit (ECU) to provide a current signal output to operate proportional solenoid valves for some machine operations. Note that the ECU is a non serviceable part and is NOT programmable. For information on the ECU operation please refer to the relevant topic. See **Electronic Control Unit Theory**.

Ohms law states that, the amount of current flow in a circuit is determined by the voltage, and the resistance. A 12v circuit with a resistance of 6 ohms, would draw a current of 2 amps. This would be the case for a standard solenoid, which is either on or off.

Once the voltage is applied to the circuit, it is present 100% of the time. This would be known as a 100% duty cycle. Therefore the circuit will draw 2 amps constantly.



**Fig 1.**

C007260GB-C1

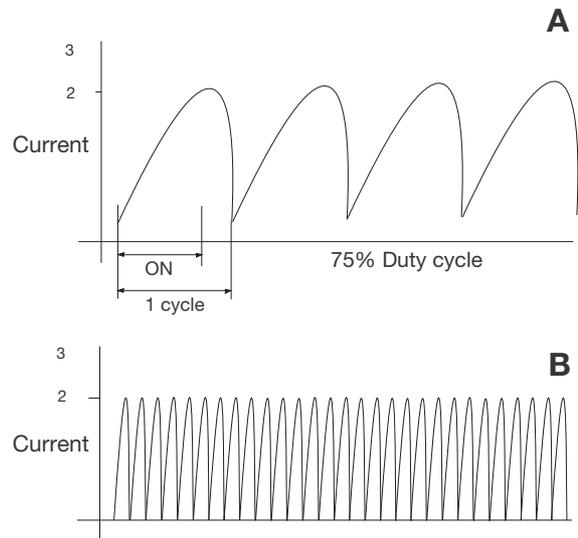
A proportional solenoid requires differing amounts of current, depending on its condition. As the coil has a fixed resistance, changing the current rating can be done in either of two ways,

- 1 Having lots of different resistors switched in and out of the circuit at different times to change the current flowing.
- 2 To change the duty cycle of the solenoid.

It is easier, more economical, and more reliable to change the duty cycle of the circuit, especially using today's computer - controller technology.

The duty cycle is the amount of time a component is switched on compared to the time it is switched off. If a solenoid is on for three seconds, then off for one second, on for three, off for one etc. this would be a 75% duty cycle.

The graph **A** although unstable would give a current rating of 1.5 amps. To stabilise the current in the circuit, the frequency would need to be increased. If the time scale on the graph **A** was one second, the frequency would be 4Hz (Hertz (cycles per second)). The graph **B** shows the same duty cycle, but at a higher frequency of 32 Hz. Note that the proportional solenoids can operate at a frequency of 250 Hz.



**Fig 2.**

C007270GB-C1



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# Electronic Control Unit Theory

## Introduction

This topic contains information about a machine DEVICE. Make sure you are referring to the correct device.

Descriptions and procedures relate to the device and not related systems. For information about the systems refer to the relevant topics.

This topic is intended to help you understand what the device does and how it works. Where applicable it also includes procedures such as removal and replacement and dismantle and assemble.

[⇒ \*Related Topics\* \( !\[\]\(ce61cd5b7d7b17ad4cb57fc0647cb1ce\_img.jpg\) M4-2\)](#)

[⇒ \*Operation Overview\* \( !\[\]\(ce7c5d6a792a8783ba1f4b0eeb0acbd0\_img.jpg\) M4-3\)](#)

## Related Topics

**Table 1. Related Topics in This Publication**

<b>The table lists other topics in the manual that contain information related to this topic. Where applicable the text in this section contains cross references to this page to help you find the correct information.</b>		
<b>Sections</b>	<b>Topic Titles</b>	<b>Sub Titles</b>
2	ALL (Care and Safety) <sup>(1)</sup>	ALL

(1) *You must obey all of the relevant care and safety procedures.*

### Operation Overview

The machines use an electronic control unit (ECU) to control machine operations. The ECU uses analog and digital signals from machine sensors, switches etc. and uses this data to supply a feed or a ground connection for other machine devices. The machines can have one or more ECU's depending on the model variant. For information on each ECU refer to the correct topic.

- Transmission ECU (PS760 Transmissions)
- Instrument ECU
- Steer Mode ECU

Some machine ECU's can be connected to JCB Servicemaster diagnostic software to check ECU version and operation. → [Related Topics \(□ M4-2\)](#)

## ECU Inputs

There are two main types of input, Digital and Analogue.

**1 Digital inputs (i.e. On-Off switch type inputs):** Digital type inputs are on-off type inputs (i.e. switches) and can be Low side inputs or High side inputs. Low side inputs are inputs that provide a ground to the ECU. High side inputs are inputs that provide a positive feed to the ECU.

**Low side input:** The low side input is the most frequently used input on an electrical system. The low side input can be in the form of rocker switches or pressure switches.

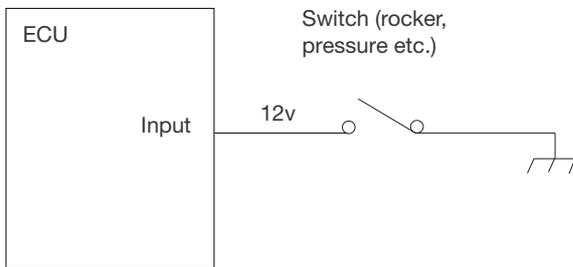


Fig 1.

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**High side input:** The high side input is used on circuits that require a positive feed when the ignition is switched off, e.g. sidelights or hazard lights.

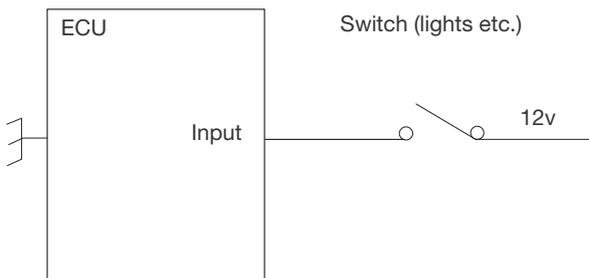


Fig 2.

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**2 Analogue inputs (i.e. sensor type inputs):** Analogue inputs are sensor type inputs that provide a varying type input to the ECU, this input could be a voltage, resistance or frequency type input.

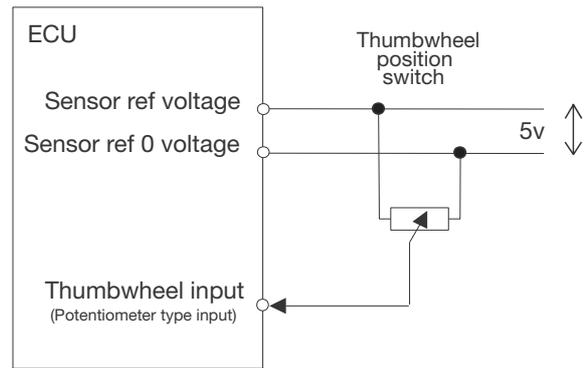


Fig 3.

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## ECU Outputs

There are three main types of outputs. Low side output, High side output and Modulated output.

- 1 **Low side output:** In the Low side output circuit the solenoid or relay which is being driven already has a positive feed available, the ECU then provides the ground side of the circuit.

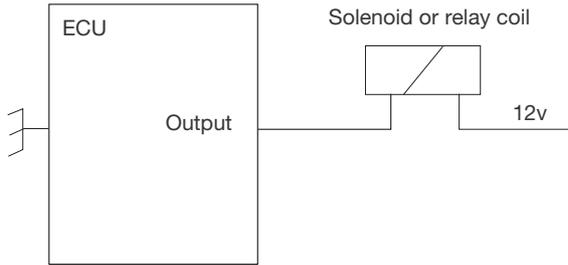


Fig 4.

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- 2 **High side output:** In the High side output circuit the solenoid or relay which is being driven already has a ground available, the ECU provides the positive side of the circuit.

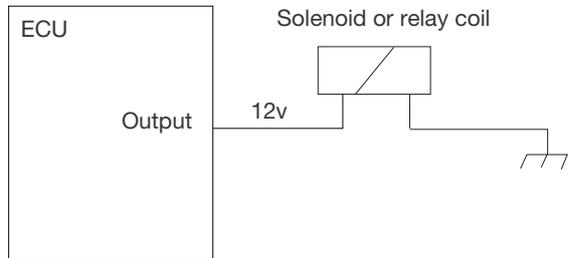


Fig 5.

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- 3 **Modulated outputs:** In the Modulated Output circuit the ECU provides a PWM (Pulse Width Modulation) signal to a proportional valve. As the ECU varies the duty cycle of the signal the proportional valve will select more or less depending on the change in duty cycle. See **Pulse Width Modulation Theory**.

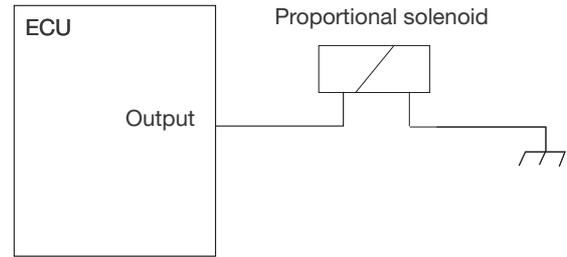


Fig 6.

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