DE&S Secretariat

DES SEC-PolSec LE-JSC-WPNS@mod.gov.uk

Defence Equipment & Support
Maple 0a, #2043
MOD Abbey Wood
Bristol BS34 8JH

22 November 2021
Our Reference: FOI2021/10943

Dear [redacted]

Further to my letter of 21 October 2021, I am writing to provide a substantive response to your request for the following information:

> *I have recently purchased an ex-military TRUCK UTY MED (HD) 6X6 PPV (PINZGAUER) VECTOR. In order to correctly repair and maintain this vehicle I require access to the various operating/repair manuals produced for this vehicle when in service.*
>
> *Therefore, I submit an FOI request for the electronic copies of the following operator/repair manuals:*
>
> *1) Failure Diagnosis 2320-D-503-512*
> *2) Maintenance Instructions 2320-D-503-522*

Your request has been handled as a request for information under the Freedom of Information (FOI) Act 2000.

Information in scope of your request is held by the Ministry of Defence (MOD); namely:

- AESP 2320-D-503-512 (1st Edition, March 2007) - TRUCK UTILITY MEDIUM (HEAVY DUTY) 6X6 PPV VECTOR – Failure Diagnosis

- AESP 2320-D-503-522 (1st Edition March 2007) - TRUCK UTILITY MEDIUM (HEAVY DUTY) 6X6 PPV VECTOR – Repair Instructions

Section 21(1) of the FOI Act provides that information is exempt if it is reasonably available by other means. AESP 2320-D-503-522 was released as part of a previous FOI request and can be accessed at the Government publications website, at the following link:

HTTPS://WWW.GOV.UK/GOVERNMENT/PUBLICATIONS/FOI-RESPONSES-RELEASED-BY-MOD-WEEK-COMMENCING-8-NOVEMBER-2021

AESP 2320-D-503-512 has not previously been published and some of the information falls within the scope of qualified exemptions of the FOI Act. It was necessary to undertake a Public Interest Test to determine whether the balance for withholding outweighs that for disclosure. That work has now concluded, and a copy of the document is included with this response.

However, it has proved necessary to withhold some information under qualified exemptions Section 26(1)(a) and (b) (Defence) and Section 38(1)(a) and (b) (Health and Safety) of the FOI Act. Section 26 applies to information that if disclosed would or would likely prejudice the defence of the British Islands or any colony; and/or the capability, effectiveness or security of the Armed Forces of the Crown or any forces cooperating with them. Section 38 applies to information that if disclosed would or would likely endanger the physical or mental health, or safety of any individual.

The Public Interest arguments for releasing AESP 2320-D-503-512 in its entirety were that it would demonstrate the MOD's commitment to openness and transparency; make Government more accountable to the electorate; and demonstrate that activities are conducted in an open and honest way. However, these arguments were outweighed by those for withholding information relating to vehicle protection schemes and specialist equipment which, if released, would compromise the ability of UK Armed Forces to carry out operations safely; by revealing information about capabilities and actions which could assist adversaries in planning attacks against Armed Forces personnel and equipment.

On balance, the weight of public interest lies in withholding some information under qualified exemptions Section 26(1) (Defence) and Section 38(1)(a) and (b) (Health and Safety) of the FOI Act. The level of prejudice against release of this exempted information has been set at the higher level of "would" rather than "would be likely to".

If you have any queries regarding the content of this letter, please contact this office in the first instance. If you wish to complain about the handling of your request, or the content of this response, you can request an independent internal review by contacting the Information Rights Compliance team, Ground Floor, MOD Main Building, Whitehall, SW1A 2HB (e-mail CIO-FOI-IR@mod.gov.uk). Please note that any request for an internal review should be made within 40 working days of the date of this response.

If you remain dissatisfied following an internal review, you may raise your complaint directly to the Information Commissioner under the provisions of Section 50 of the Freedom of Information Act. Please note that the Information Commissioner will not normally investigate your case until the MOD internal review process has been completed. The Information Commissioner can be contacted at: Information Commissioner's Office, Wycliffe House, Water Lane, Wilmslow, Cheshire, SK9 5AF. Further details of the role and powers of the Information Commissioner can be found on the Commissioner's website at https://ico.org.uk/.

Yours sincerely,

DE&S Policy Secretariat

CONDITIONS OF RELEASE

1 ~~This information is released by the UK Government for Defence purposes only.~~

2 ~~This information must be afforded the same degree of protection as that afforded to information of an equivalent security marking originated by the recipient Government or as required by the recipient Government's security regulations.~~

3 ~~This information may be disclosed only within the Defence Department of the recipient Government, except as otherwise authorized by the Ministry of Defence (Army).~~

4 ~~This information may be subject to privately owned rights.~~

TRUCK UTILITY MEDIUM (HEAVY DUTY), 6X6 PPV VECTOR

FAILURE DIAGNOSIS

~~THIS DOCUMENT IS THE PROPERTY OF HER BRITANNIC MAJESTY'S GOVERNMENT, and is issued for the information of such persons only as need to know its contents in the course of their official duties. Any person finding this document should hand it to a British forces unit or to a police station for its safe return to the MINISTRY OF DEFENCE (Dsy (Pol)), MAIN BUILDING, WHITEHALL, LONDON SW1A 2HB with particulars of how and where found. THE UNAUTHORIZED RETENTION OR DESTRUCTION OF THIS DOCUMENT MAY BE AN OFFENCE UNDER THE OFFICIAL SECRETS ACTS OF 1911-1989. (When released to persons outside Government service, this document is issued on a personal basis and the recipient to whom it may be entrusted in confidence, within the provision of the Official Secrets Acts 1911-1989, is personally responsible for its safe custody and for seeing that its contents are disclosed only to authorised persons).~~

BY COMMAND OF THE DEFENCE COUNCIL

Ministry of Defence
Issued by

DEFENCE LOGISTICS ORGANISATION

AMENDMENT RECORD

Amdt No.	Incorporated By (Signature)	Date
1	BAE Systems Land Systems Pinzgauer Limited	Apr 07
2	BAE Systems Land Systems Pinzgauer Limited	Aug 07
3	BAE Systems Land Systems Pinzgauer Limited	Nov 07
4	BAE Systems Land Systems Pinzgauer Limited	Dec 07
5	BAE Systems Land Systems Pinzgauer Limited	Sep 08
6	BAE Systems Global Combat Systems Pinzgauer Limited	Mar 09
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		

Amdt No.	Incorporated By (Signature)	Date
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		

CONTENTS

PRELIMINARY MATERIAL

Page

Title page ..... (i)/(ii)
Amendment record ..... (iii)/(iv)
Contents (this list) ..... (v)
PREFACE ..... (vi)
Introduction ..... (vi)
Equipment identity ..... (vi)
Related and associated publications ..... (vii)
Related publications ..... (vii)
Associated publications ..... (viii)
Comment on AESP ..... Final leaf

FAILURE DIAGNOSIS

Chapter

1 Engine
2 NTU
3 Gearbox
4 Transmission
5 Axles
6 NTU
7 Steering
8 Suspension
9 [redacted]
10 Antilock braking system
11 Fuel and exhaust
12 Cooling system
13 Electrical system
14 NTU
15 NTU
16 [redacted]
17 Hydraulic system
18 Environmental Control System (ECS)

PREFACE

Sponsor : DEC CSS

Publications Authority: DLO Andover

INTRODUCTION

1 Service users should forward any comments on this publication through the channels prescribed in AESP 0100-P-011-013. An AESP Form 10 is provided after the preliminary pages of this publication; it should be photocopied and used for forwarding comments on this AESP.

2 AESPs are issued under Defence Council authority and where AESPs specify action to be taken, the AESP will of itself be sufficient authority for such action and also for the demanding of the necessary stores, subject to the provisions of Para 3 below.

3 The subject matter of this publication may be affected by Defence Council Instructions (DCIs), by Standing Operating Procedures (SOPs) or by local regulations. When any such Instruction, Order or regulation contradicts any portion of this publication it is to be taken as the overriding authority.

4 The subject matter of this publication details information specific to Truck Utility Medium (Heavy Duty) 6x6 PPV VECTOR Pinzgauer variant.

5 For periods of servicing and lubricants to be used reference must be made to the Maintenance Schedule.

EQUIPMENT IDENTITY

6 The details are listed in Table 1

TABLE 1 EQUIPMENT IDENTITY

Serial (1)	Asset Code (2)	Designation (3)	UCE/ UCA
1	1774 3100	Truck Utility Medium (Heavy Duty) 6X6 PPV VECTOR	A
2		Truck Utility Medium (Heavy Duty) 6X6 PPV VECTOR 2	B
3	NB1045-3100	Ambulance Protected TUM (HD) 1 Stretcher 6x6 2.5 LTR DSL VECTOR	C
4	NB1045-3101	Ambulance Protected TUM (HD) 1 Stretcher 6x6 2.5 LTR DSL VECTOR 2	D

6.1 The Original Equipment Manufacturer (OEM) is as follows:

BAE Systems Land Systems Pinzgauer Limited
Midleton House
Midleton Industrial Estate
Guildford
Surrey
GU2 8XW
England

www.baesystems.com

6.2 Contract Nos:

SUVC1/0077

RELATED AND ASSOCIATED PUBLICATIONS

Related publications

7 The Octad for the subject equipment consists of the publications shown opposite. All are prefixed with the first eight digits of this publication. The availability of the publications can be checked by reference to the relevant Group Index (see AESP 0100-A-001-013).

Category/Sub-category			Information Level			
			1 User/ Operator	2 Unit Maintenance	3 Field Maintenance	4 Base Maintenance
1	0	Purpose and Planning	101	101	101	101
	1	Equipment Support Policy Directives	111	111	111	111
2	0	Operating Information	201	201	201	201
	1	Aide Memoire	*	*	*	*
	2	Training Aids	*	*	*	*
3		Technical Description	*	302	302	302
4	1	Installation Instructions	411	411	411	411
	2	Preparation for Special Environments	*	*	*	*
5	1	Failure Diagnosis	*	512	512	512
	2	Maintenance Instructions	201	522	522	522
	3	Inspection Standards	*	532	532	532
	4	Calibration Procedures	*	*	*	*
6		Maintenance Schedules	601	601	601	601
7	1	Illustrated Parts Catalogue	711	711	711	711
	2	Commercial Parts List	*	*	*	*
	3	Complete Equipment Schedule, Production	*	*	*	*
	4	Complete Equipment Schedule, Service Edition (Simple Equipment)	741	741	741	741
	5	Complete Equipment Schedule, Service Edition (Complex Equipment)	*	*	*	*
8	1	Modification Instructions	811	811	811	811
	2	General Instructions, Special Technical Instructions and Servicing Instructions	821	821	821	821
	3	Service Engineered Modification Instructions (RAF only)	*	*	*	*

* Category/Sub-category not published

NOTES

(1) Reference to AESP 0100-A-001-013 must be made to ensure the availability of the listed publications.

(2) Category 8 preliminary pages to be issued with the first Modification or General Instruction.

Associated publications

8	Reference	Title
	JSP 71	Joint Service Movement Diagrams
	JSP 341	Joint Service Road Transport Regulations
	JSP 800	Defence Movements and Transportation Regulations Volume 5 Road Transport

COMMENT(S) ON AESP*

To: DCCS
BFPO 794

From: .....
.....
.....
.....

Sender's Reference	BIN Number	Date
AESP* Title:		
Chapter(s)/Instruction	**Page(s)/Paragraph(s)**	
If you require more space, please use the reverse of this form or a separate piece of paper. **Comment(s):**		

Signed: ..... Telephone No.: .....

Name (Capitals): ..... Rank/Grade: .....Date: .....

✂ .....

FOR AESP* SPONSOR USE ONLY

To: .....
.....
.....
.....

From: DCCS
BFPO 794

Thank you for commenting on AESP*: .....

Your reference: ..... Dated: .....

Action is being taken to:	Tick		Tick
Issue a revised/amended AESP*		Under investigation	
Incorporate comment(s) in future amendments		No action required	
Remarks			

Signed: ..... Telephone No.: .....

Name (Capitals): ..... Rank/Grade: .....Date: .....

* AESP or EMER

CHAPTER 1

ENGINE FAILURE DIAGNOSIS

CONTENTS

Para

1 Introduction (WARNINGS)
2 Getting started
3 Main screen
4 Select control module screen
Open controller screen
5 Overview
6 Comm status
7 Controller info
8 Basic functions
9 Advanced functions (CAUTION)
10 Fault codes screen
11 Measuring blocks screen
12 Data logging
14 Single reading
Basic settings
15 General (CAUTIONS)
16 Basic settings in KWP-2000
17 Output tests
19 Recode (CAUTION)
Program options screen
21 General
22 Select COM port
23 Debug output
24 Colour scheme
25 Protocol options
About screen
26 General
27 Fault codes
28 SAE P fault codes
Final control diagnosis
29 Diagnosis of actuators
30 Procedure (CAUTION)
Measuring value blocks
31 Read measurement value block
32 Procedure
Evaluating measuring value blocks
33 General
34 Evaluation – display of idle running control
Evaluating measuring blocks at full load
38 General (WARNING)
Hand held EDC test box
39 General
41 Connecting the EDC test box (CAUTIONS)
42 Optimum Engine Mapping (OEM) module

Table Page

1 Fault codes 20
2 SAE P fault codes 27
3 Display group 000 at idling 37

(continued)

CONTENTS (continued)

Table		Page
4	Display group 001 injection quantity (at idling)	38
5	Display group 002 idle speed (at idling)	38
6	Display group 003 EGR (at idling)	39
7	Display group 004 commencement of injection (at idling)	40
8	Display group 005 starting conditions	40
9	Display group 006 switch positions (with ignition ON)	41
10	Display group 007 temperatures (cold, stationary engine)	42
11	Display group 009 injection quantity limitations	43
12	Display group 012 glow plug system	43
13	Display group 013 idle running control (at idle)	43
14	Display group 014 idling rest control (at idle)	44
15	Display group 015 fuel consumption	44
16	Display group 018 speed (at idling)	45
17	Display group 019 quantity adjuster (at idling)	45
18	Display group 000 at full load	46
19	Display group 004 commencement of injection (at full load)	47
20	Display group 008 injection quantity limitation (at full load)	48
21	Display group 010 Air values (at full load)	49
22	Display group 011 boost pressure control (at full load)	50
23	Lubricating oil related fault diagnosis	51

Fig		Page
1	Desktop icon	3
2	Port test	3
3	Main screen	4
4	Select control module screen	5
5	Select control module screen – less common modules	6
6	Open controller screen	7
7	Fault codes screen	9
8	Measuring blocks screen	10
9	Measuring blocks screen (data logging)	11
10	Data logging (stop button)	11
11	Data logging (resume button)	11
12	VAG-scope screen	12
13	Open controller screen (single reading)	13
14	Basic settings screens	14
15	Basic settings – VAG-scope and TDI-timing	15
16	Open controller screen (output tests)	16
17	Open controller screen (recode mode)	17
18	Program options screen	18
19	About screen	19

INTRODUCTION

1 This Chapter details the procedures for using the VAG-COM diagnosis software kit. This package allows the user to run a software diagnostic tool for the TDI 2.5 Euro 3 engine on a Windows-based PC connected to the vehicle diagnostic connector with the HEX-COM interface lead.

NOTE

The engine harness should be connected direct to the fuel injection pump prior to fault diagnosis using the diagnosis software. The Optimum Engine Mapping (OEM) module should not be connected.

WARNINGS

(1) PERSONAL INJURY. CARE MUST BE TAKEN WHEN USING THE DIAGNOSTIC TOOL WITH THE ENGINE COVER REMOVED AND THE ENGINE RUNNING IN THE EVENT THE FLEXIBLE FAN DUCT HAS BEEN REMOVED. THE MAINTENANCE FAN GUARD 8001560281 SHOULD BE FITTED.

(2) PERSONAL INJURY. DO NOT ALLOW ANY LOOSE ITEMS OF CLOTHING TO BECOME CAUGHT IN THE FAN BLADES OR ANY OTHER MOVING ENGINE PARTS. REMAIN ALERT TO THE LOCATION OF THE ROTATING FAN, PULLEYS, BELTS, ETC. WHEN WORKING ON A RUNNING ENGINE.

(3) ACCIDENT AVOIDANCE. IF USING THE VAG-COM SOFTWARE WITH THE VEHICLE IN MOTION, TWO PERSONS WILL BE REQUIRED; ONE TO DRIVE THE VEHICLE AND THE OTHER TO CARRY OUT THE DATA ANALYSIS.

GETTING STARTED

2 Initial set-up of the diagnostic tool is as follows:

2.1 Install the VAG-COM software on the PC using the CD-ROM provided (in accordance with the accompanying instructions) and follow the on-screen instructions.

2.2 Connect the serial end of the HEX-COM interface lead to the USB port of the PC.

2.3 Connect the other end of the HEX-COM interface lead to the vehicle diagnostic connector for the EDC control unit (J248). The diagnostic connector is located within the Vehicle Power Distribution Box (VPDB) situated on the rearward side of the vehicle bulkhead behind the passenger's seat, adjacent to the battery box. The connector is accessed by removing the uppermost panel of the VPDB that is secured with six captive screws.

2.4 Turn the vehicle ignition switch to the ON position. The engine may be running or stopped.

2.5 Start the VAG-COM program on the PC through either the Start menu or the icon on the desktop.

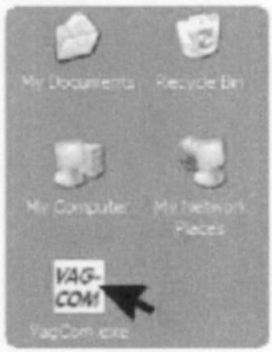


Fig 1 Desktop icon

2.6 From the main screen (see Fig 3) click the [Options] button to go to the options screen (see Fig 18).

2.7 Select the correct port for the PC's serial port (typically COM1 or COM2) and click the [Test] button. Ensure the VAG-COM software finds the interface. A test message will be displayed.

Fig 2 Port test

2.8 If the 'Adapter Status' is not 'Found!' check that the connections on the vehicle and PC are plugged in securely.

2.9 'Adapter Type' should always be "HEX-COM".

2.10 If 'K1' or 'K2 Status' are not "OK", there may be a short or open circuit in the diagnostic port.

2.11 Once the test is successful, click [Save] to apply this configuration and return to the main screen.

2.12 From the main screen click on [Select] button to view the select control module screen (see Fig 4). Select the appropriate control module (eg Engine).

NOTE

The vehicle does not have all the control modules shown in the VAG-COM software. The only modules available for interrogation are '01 Engine' and '25 Immobiliser'.

MAIN SCREEN

3 This screen appears when the VAG-COM software is started up. Six button options are available:

3.1 Select. Select control module.

3.2 Auto-scan. Not used in this installation. Performs an automatic scan of all controllers for fault codes.

3.3 Control module finder. Not used in this installation. Scan an address range for ISO 9141 compliant control modules.

3.4 OBD-II. Not used in this installation. Test for OBD-II functions.

3.5 Options. Program options.

3.6 About. Access about screen showing software license info etc.

3.7 Exit. Closes the VAG-COM software.

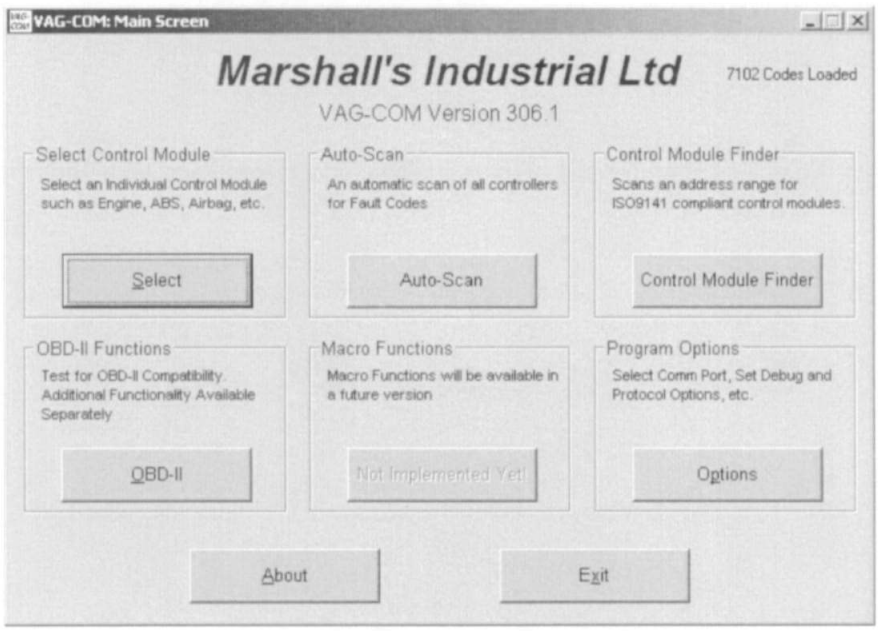


Fig 3 Main screen

SELECT CONTROL MODULE SCREEN

4 This screen is used to select which Control Module the user wishes to communicate with. In most cases '01 – Engine'. Clicking on any of the buttons for unavailable control modules will result in an error message stating no response from the EDC control unit (J248). Button options available are:

4.1 Common modules. To establish communications with a particular Control Module, eg 01 - Engine. Click on the appropriate button.

4.2 Direct entry. An address can be entered manually and selected by clicking [Go!].

4.3 Less common modules. To establish communications with less common control units, eg '25 - Immobiliser', click on [Display] button.

4.4 Go back. Return to the main screen.

NOTE

The vehicle does not have all the Control modules displayed on the VAG-COM software.

Fig 4 Select control module screen

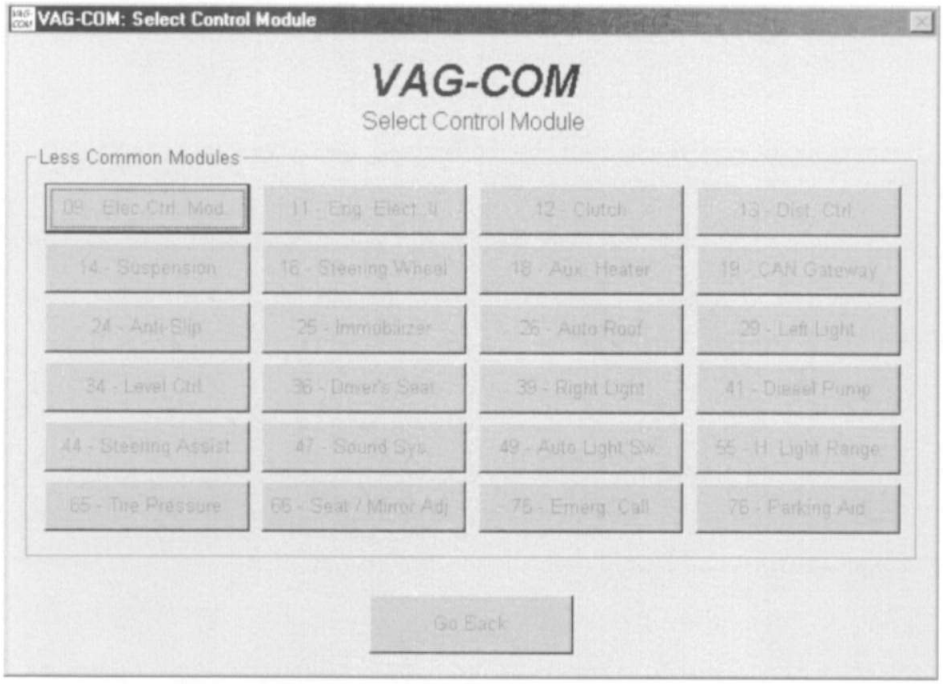


Fig 5 Select control module screen – less common modules

OPEN CONTROLLER SCREEN

Overview

5 This screen is displayed when the VAG-COM software is attempting to establish communications with any of the Control Modules shown on the Select Control Modules or Less Common Modules screen. Use the [Close Controller, Go Back – 06] to properly close the communications session and return to the Select Control Module screen.

Fig 6 Open controller screen

Comm status

6 Shows the status of the current communications session. A rotating cursor to the right of the 'Protocol' value indicates that communication is active. Once communications have been established:

6.1 IC=. Displays the number of times the session has been initialized. If IC increases beyond 1, communications are less than 100% reliable.

6.2 TE=. Counter for transmitter errors within individual packets and can indicate unreliable communication.

6.3 RE=. Counter for receive errors within individual packets and can indicate unreliable communication.

6.4 Protocol. Indicates whether the controller communicates using KWP-1281 or KWP-2000 protocol.

Controller info

7 Once communications have been established, all of the Control Module's 'Identification' data is presented here:

7.1 VAG Number. The VW/Audi part number for the controller selected.

7.2 Component. Contains more identification information about the controller and may contain a version number for the controller's internal firmware.

7.3 Soft. Coding. The software coding that determines various options for the controller.

7.4 Shop #. Identifies the Workshop code stored in the scan-tool that last recoded this control module.

7.5 Extra #. These fields can show VIN and immobiliser information or slave controller part numbers in some vehicles.

Basic functions

8 This grouping of 'safe' functions are used to read data from the control module. Greyed out buttons are functions that have not yet been implemented or are unavailable for the particular vehicle application.

Advanced functions

CAUTION

ENGINE OPERATION. It is possible to render the vehicle inoperable or damage components if the user makes changes using this option without the correct information and training.

9 These functions are capable of making various programming changes to the control module and should only be used by Original Equipment Manufacturer (OEM) technicians.

FAULT CODES SCREEN

10 This screen displays the fault codes, numbers and a meaningful text description of the fault. Button options available are:

10.1 Print codes. Prints a fault code report. If the PC is not connected to a printer when this button is pressed use the Windows program to ensure that the printer is set to 'Work off-line' first. Remember to un-check the 'Work off-line" option to print the report once the PC is connected to a suitable printer.

10.2 Copy codes. Copies the fault codes to the Windows clipboard. Once the [Copy Codes] button is pressed, the results may be pasted into a suitable application, such as MS Word or Notepad.

10.3 Clear codes - 05. Will erase the codes from the control module's memory. This does NOT fix the problem that caused the fault! Fault codes will only be erased after correcting the condition(s) that caused them in the first place.

NOTE

There is no way to erase individual fault codes whilst keeping others.

10.4 Go back. Return to the Control Module screen.

NOTE

The vehicle does not have all the Control modules displayed on the VAG-COM software.

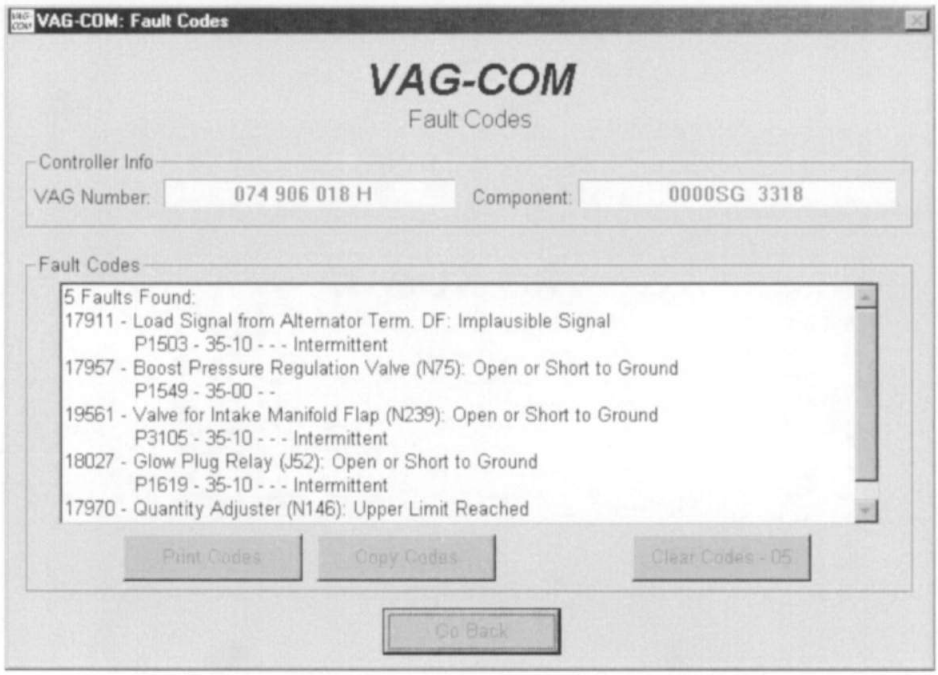


Fig 7 Fault codes screen

MEASURING BLOCKS SCREEN

11 This screen displays data from the control module in real-time. VAG-COM will scale the raw data where possible into standard metric units (degree C, km/h, etc.).

NOTE

Group 000 and any other group that displays ten fields instead of four are exceptions in that no units of scale are displayed because no data type information is provided by the EDC control unit (J248). Groups of this type can only be displayed in the top row of the screen.

11.1 Scroll groups. Using the [Up] and [Down] buttons the user can scroll through the available groups or enter a group number in the Group box and click the [Go] button.

NOTE

Some groups may be displayed as 'ERROR: Group xxx Not available' or some groups may contain only blank fields. This is a normal part of operation on some Control Units.

11.2 Log. Using the [Log] button the data from the measuring blocks may be logged (see Para 12).

11.3 Basic Settings. Using the [Switch to Basic Settings] the basic settings for the group currently displayed can be accessed, but this should only be done by properly trained/qualified persons using guidance documentation (see Para 15).

NOTE

Multiple groups are not permitted in basic settings. The [Switch to Basic Settings] button is intentionally disabled if groups are 'running' in the second and third rows. To stop a running group, click on the box that displays the group number (as though entering a new number).

11.4 Done, Go back. Return to the Controller Info / Select Function screen.

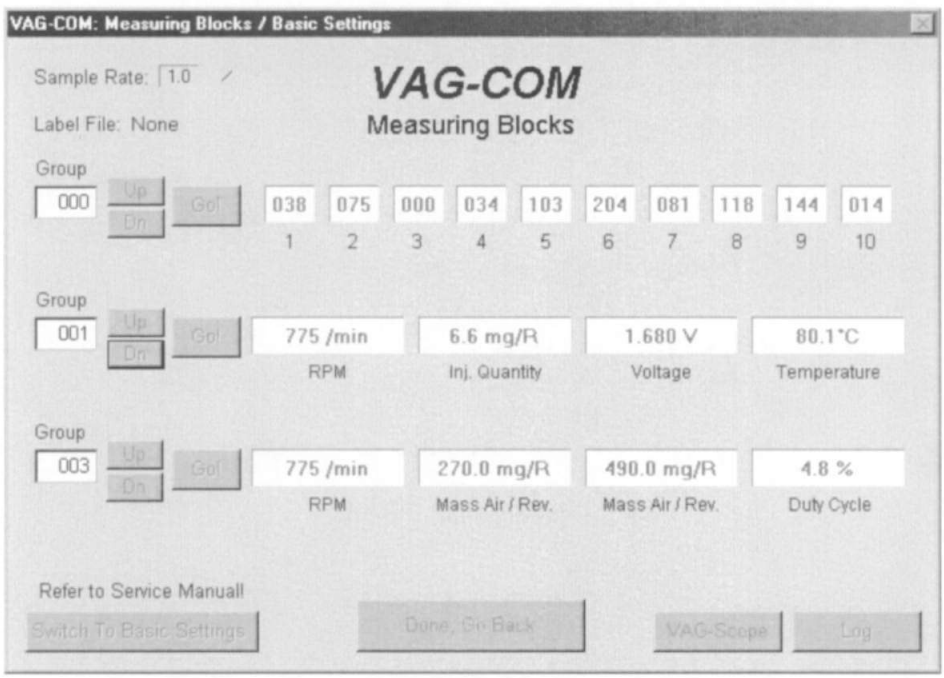


Fig 8 Measuring blocks screen

DATA LOGGING

NOTE

There is currently no support for logging groups that have ten display fields (eg Group 000). At present, no data will be logged for 'any' group if a group with ten display fields is on the screen.

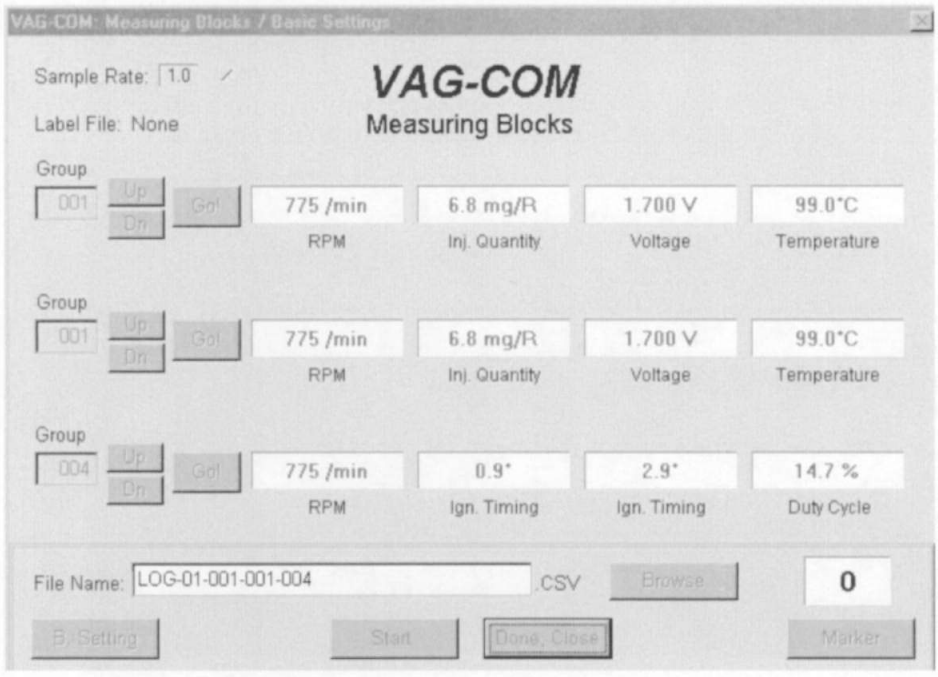


Fig 9 Measuring blocks screen (data logging)

12 While the Log Dialog is open [Start], [Stop] and [Resume] are all accessed from the same button:

12.1 Start. Using the [Start] button begins saving the data to a log file.

12.2 Stop. Using the [Stop] button discontinues saving of the data to a log file.

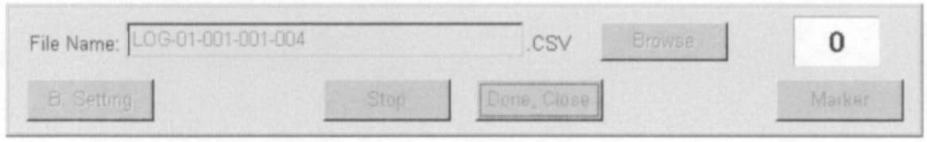


Fig 10 Data logging (stop button)

12.3 Resume. Using the [Resume] button continues saving the data to a log file.

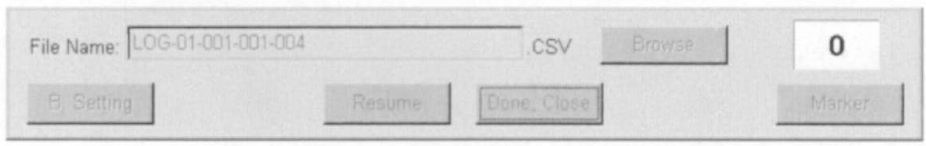


Fig 11 Data logging (resume button)

12.4 Marker. Using the [Marker] button places a sequential number in the file to help with data analysis.

12.5 Browse. This button is not currently implemented. All Log Files are saved in the LOGS sub-folder of the VAG-COM directory of the PC.

NOTE

By default, the name of the log file will be the controller number followed by the number of each group number being logged. Any filename may be used, but if a name is re-used the new data is appended to that file.

12.6 Switch to basic settings. The [B Setting] button is not currently available while data logging. It is possible, however, to start a log whilst in 'Basic Settings'. If an error message is displayed eg 'cannot open logs file', the LOGS sub-folder may be missing.

12.7 VAG-Scope. This plug in for the VAG-COM software may be used to replay LOG files if installed on the PC. The scope gives an active telemetry graph in real time.

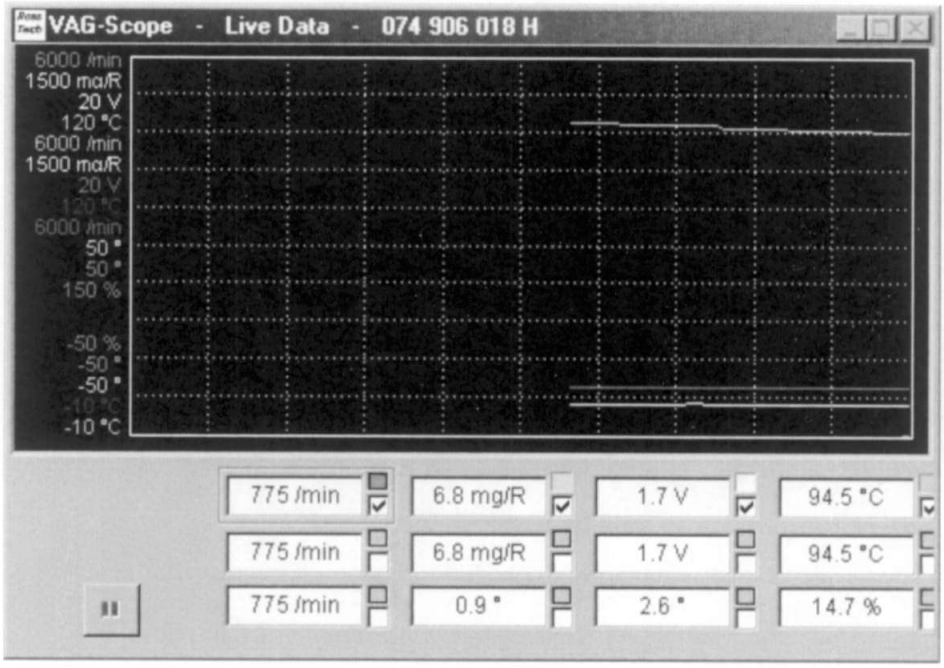


Fig 12 VAG-scope screen

13 Data from the Measuring Blocks screen can be logged to a '.csv' file. These files can be opened and analyzed with MS Excel or other compatible spreadsheet application. An example using Microsoft Excel is shown below:

(1) Select the data block to view.
(2) Click [Log] button.
(3) Use default file name if desired. The old file will be appended if a file name is re-used.
(4) Click [Done] button when data logging finished.
(5) Open Microsoft Excel.
(6) Click File > Open (change file type to all *.*).
(7) Select the columns of data required to be graphically represented.
(8) Click the Chart Wizard button.
(9) Select XY (Scatter) and click one of the formats with lines.
(10) The chart wizard will prompt you to name axes if required.

SINGLE READING

14 This function displays real-time data from control modules that support this feature. To interpret the values reference the relevant factory repair manual for the equipment. Click on [Done, Go Back] to return to the Controller Info / Select Function screen.

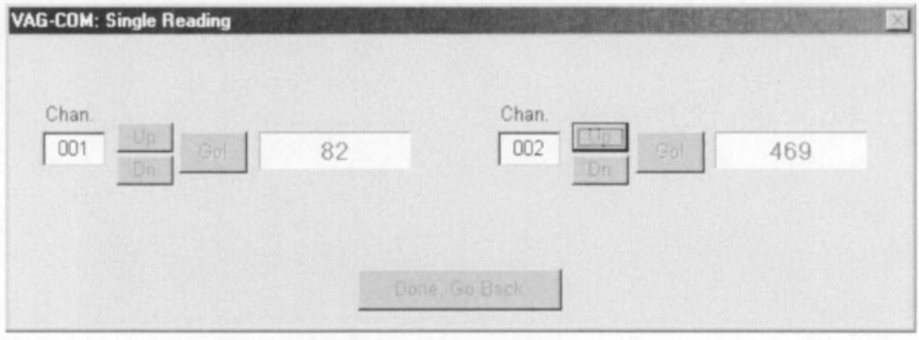


Fig 13 Open controller screen (single reading)

BASIC SETTINGS

General

CAUTIONS

(1) ENGINE OPERATION. It is possible to render the vehicle inoperable or damage components if the user makes changes to Basic Settings without the correct information and training.

(2) GROUPS. Although it is possible to use the [Up] and [Dn] buttons to scroll through the available groups like the Measuring Blocks screen, this is not recommended, because it may put the controller into Basic Settings for a Group that is not intended. It is recommended that the user enters a manual Group number directly and clicks on the [Go!] button.

15 Basic Settings mode is very similar to Measuring Blocks mode, the contents of each display is the same. The difference between the functions is that the Control Module will try to perform various calibrations while in Basic Settings mode.

15.1 Switch to Meas. Blocks. This option will switch back to the passive (and 'safe') Measuring Blocks mode.

NOTE

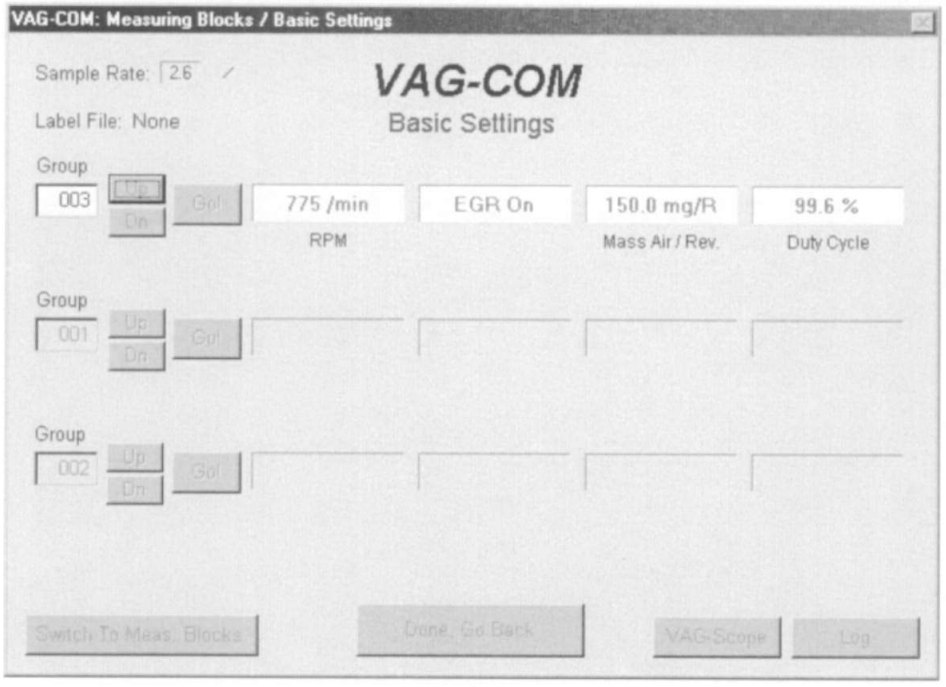
Multiple groups are not permitted in Basic Settings. The data presented in each Basic Settings group varies greatly dependent upon the Control Module.

15.2 Done, Go Back. Click on [Done, Go Back] to return to the Controller Info / Select Function screen.

15.3 VAG-Scope. Displays a 'live' data screen similar to Fig 15.

15.4 Log. Using the [Log] button the data from the basic settings may be logged (see Para 12).

15.5 TDI-Timing. Displays a 'live' timing screen similar to Fig 15.



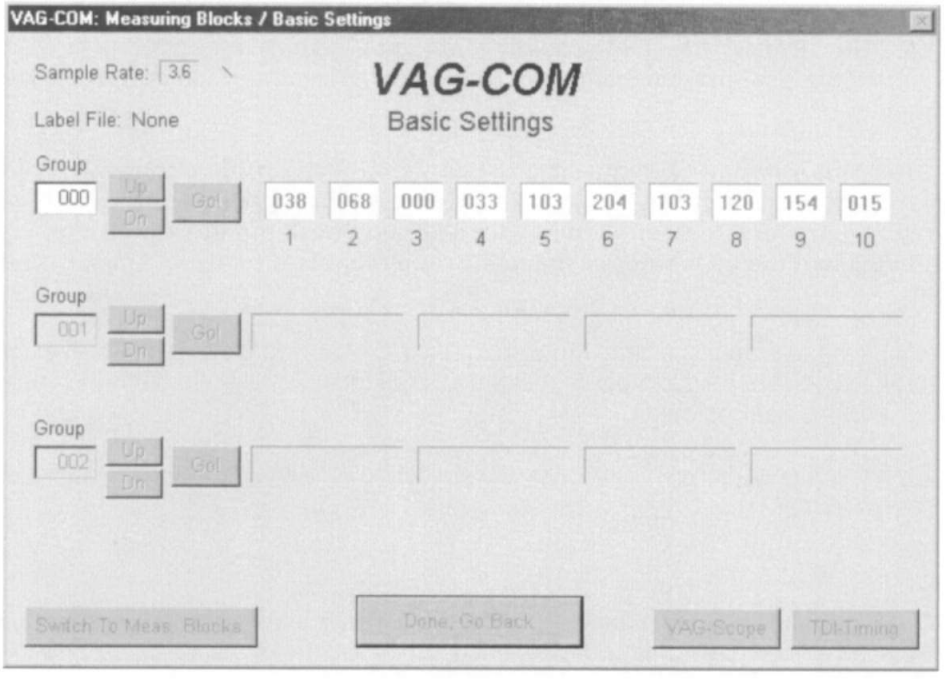


Fig 14 Basic settings screens

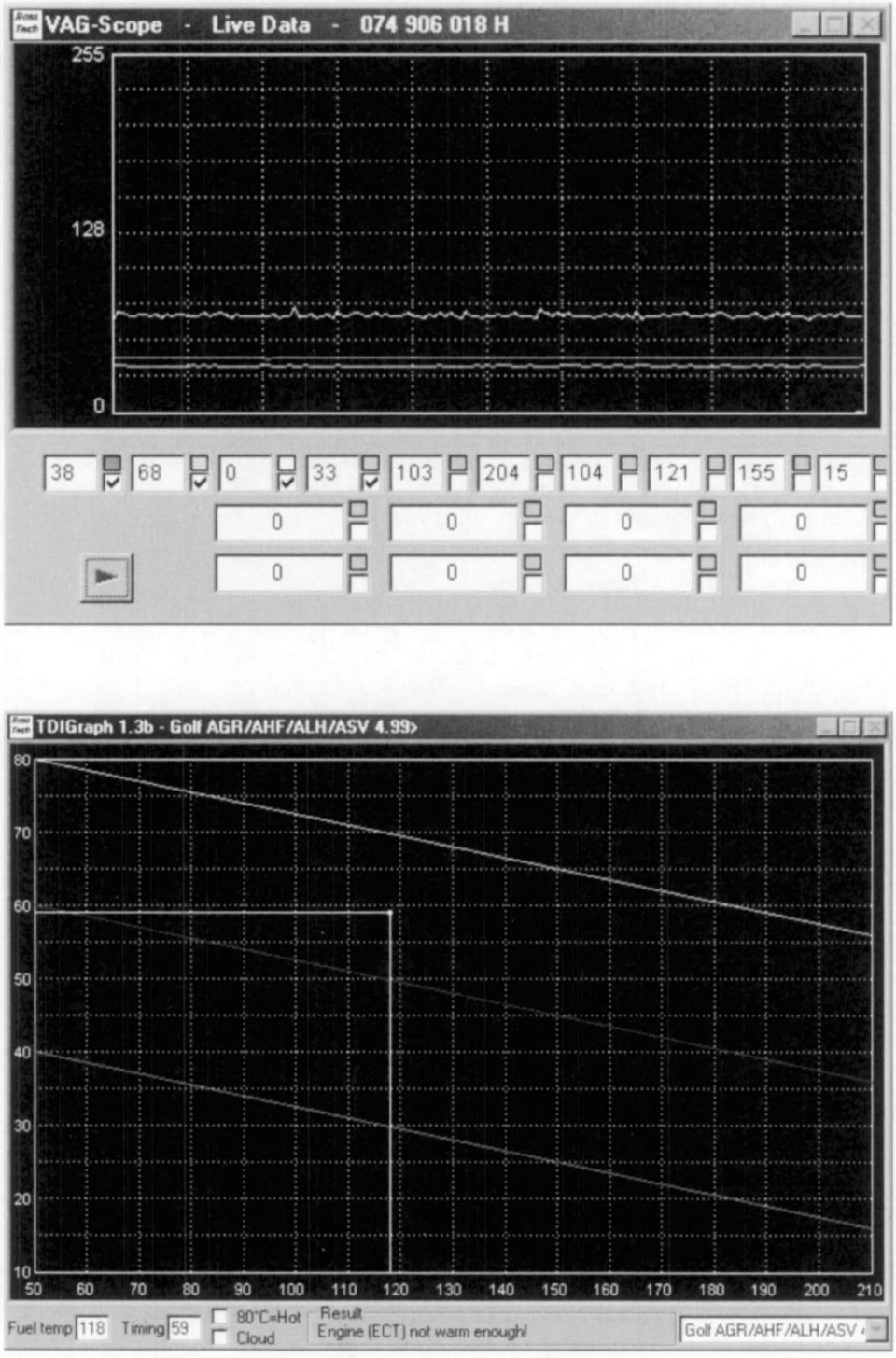


Fig 15 Basic settings – VAG-scope and TDI-timing

Basic settings in KWP-2000

16 On controllers using KWP-2000 protocol, there is an [ON/OFF/Next] button available that allows the user to initiate and exit Basic Settings whilst still being able to see the values in the measuring groups.

OUTPUT TESTS

17 This function is used to test a Control Module's electrical outputs (and the wiring that connects it to the various devices). To begin the output tests and to progress through each step click on the [Start/Next] button.

NOTES

(1) The outputs that can be tested and the sequence in which they become active is controlled strictly by the control module; this is not a function of the diagnostic tester. Refer to the relevant factory repair manual to ascertain what outputs can be tested and the sequence in which they become active.

(2) Most control modules will permit the output test sequence to be run only once per session. If the test sequence is run to completion, the VAG-COM software will allow the user to return to the previous screen without closing the session, but it may not be possible to run the Output Test sequence again. If this is desired, manually close the controller and re-start the session.

(3) The output test function is only available when the engine is not running.

18 Once the test sequence has been started, clicking on the [Done, Go Back] button will return to the Open Controller function screen. The test sequence will still be active!

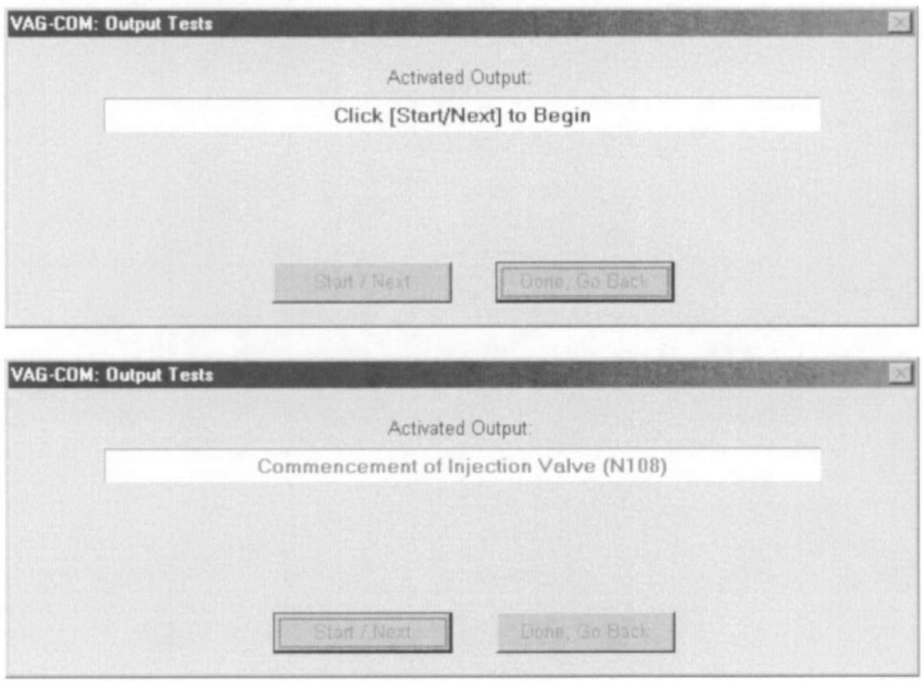


Fig 16 Open controller screen (output tests)

RECODE

19 This function is used to set various options in a control module.

CAUTION

ENGINE OPERATION. Refer to the factory repair manual before attempting to recode a control module. Write down the original values. There is no way to 'undo' or restore the original values if the wrong numbers are input by accident.

NOTES

(1) Some modules require a valid login before re-coding.

(2) The importer number is only relevant for recording controllers that use KWP-2000 protocol. By default, this will remain unchanged unless you have set up an importer number in the options screen.

20 Button options available are:

20.1 Do it! Saves the new Soft Coding to the controller and return to the Open Controller function.

20.2 Cancel. Return to the Open controller function screen without saving.

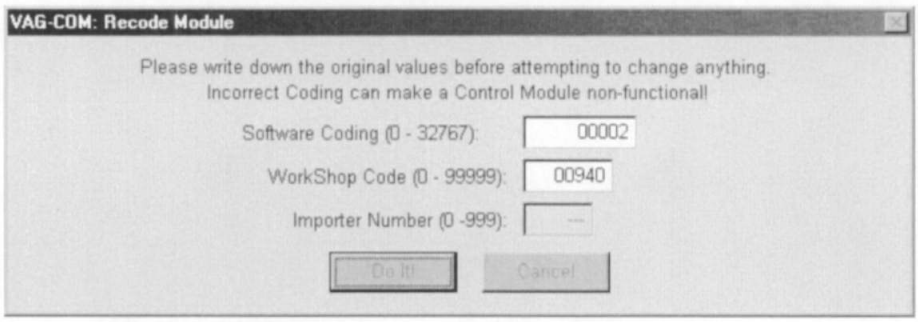


Fig 17 Open controller screen (recode module)

PROGRAM OPTIONS SCREEN

General

21 The standard on-screen options are:

21.1 Save. Click [Save] button to store the current options.

21.2 Apply. Click [Apply] button to use and test the options without storing them.

21.3 Cancel. Click [Cancel] button to return to the Main screen without any effecting changes.

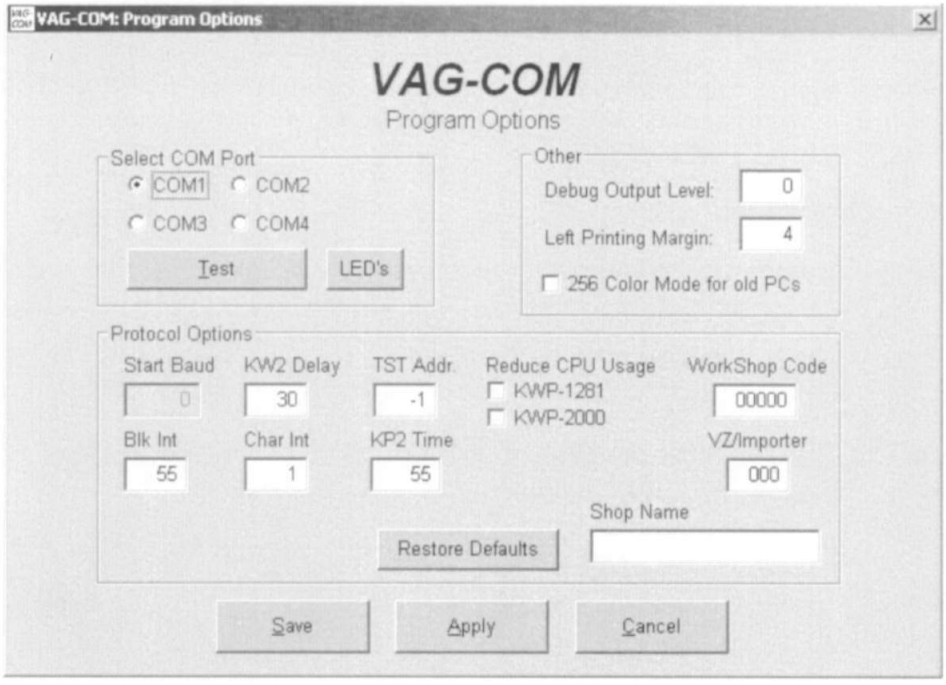


Fig 18 Program options screen

Select COM port

22 Set the COM Port to which the interface adapter in connected:

22.1 Test. Click [Test] button to check the connection. See also Getting Started Para 2.

22.2 LED's. Click [LED's] button to test a port's outputs with the communications interface.

Debug output

23 This option should be left at the default setting.

Colour scheme

24 Checking this option changes the display background colour from blue to white and looks better on some older monitors. The change will only take effect after the VAG-COM software is closed and re-started.

Protocol options

25 These options should be left at the default settings:

25.1 WorkShop code. Known as the WSC, default value is 00000.

25.2 VZ/Importer. Essentially a "region code" extension to the Work Shop Code, default value is 000.

25.3 Shop name. Displayed on reports such as the Fault Code report.

25.4 Restore Defaults. Clicking [Restore Defaults] button will reset all protocol options (except WorkShop Code and VZ/Importer number) to their 'as-delivered' settings.

ABOUT SCREEN

General

26 On this screen copyright notices, license information and contact details are displayed. If the PC is connected to the internet via a modem the web and e-mail links can be accessed automatically. To return to the Main screen click the [Go Back] button.

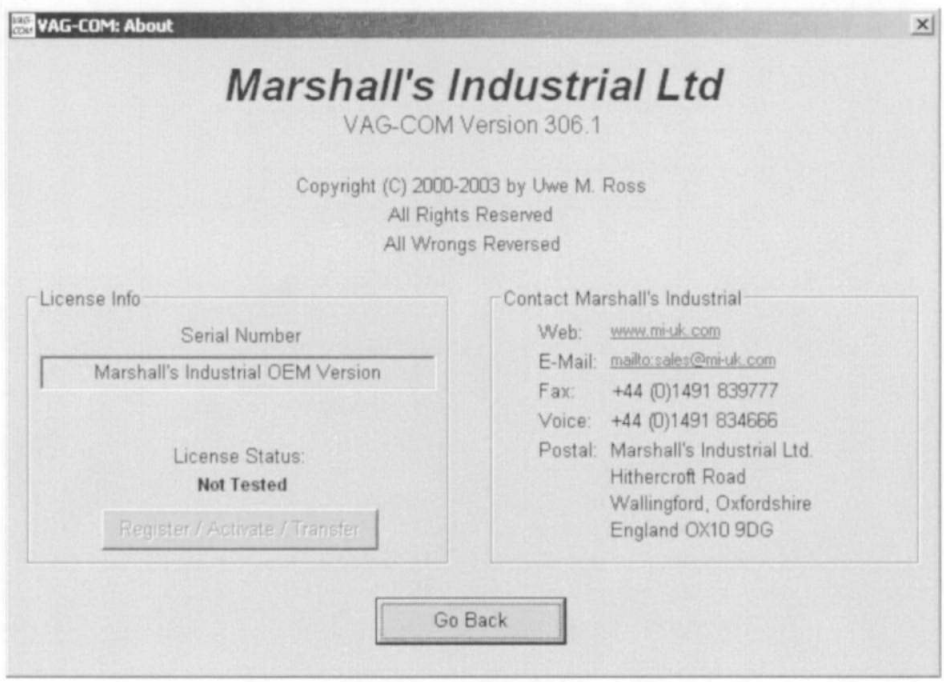


Fig 19 About screen

FAULT CODES

27 Table 1 details the various five-digit fault codes that are displayed by the diagnostic software. For ease of reference, the table is arranged in ascending numerical order and in a similar manner to that of the fault codes display (see Fig 7).

TABLE 1 FAULT CODES

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
00513 Engine speed sender – G28			
Implausible signal	• G28 defective • Distance between speed sender and sender wheel too large • Metal chips on G28 or retaining base loose	• Glow plug warning lamp flashes • Increased idling speed • Poor starting behaviour • Engine runs roughly • Reduced power • No display on rev. counter	Check G28
No signal	• G28 defective • Break in wiring or short circuit		
00519 Intake manifold pressure sender – G71			
Implausible signal	• Control unit defective • Hose connections interchanged or not connected	• Reduced power • Increased emissions	Check hose connections Check G71
Short to positive Short circuit to earth Power supply	• G71 in control unit J248 defective		Renew J248
00522 Coolant temperature sender – G62			
Short circuit to earth	• G62 defective • Wiring has short circuit to earth	• Black smoke during starting • Preheating is always carried out for approx. 20 sec.	Check G62 (0)
Short to positive	• G62 defective • Break in wiring or wiring has short circuit to positive		
Implausible signal	• G62 defective • Incorrect coolant temperature sender		
00527 Intake manifold temperature sender – G72			
Short circuit to earth	• G72 defective • Wiring has short circuit to earth	• Switches to default value 136.8 °C	Check G72
Short to positive	• G62 defective • Break in wiring or short circuit to positive		

(continued)

TABLE 1 FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
00528 Altitude sender – F96	**NOT APPLICABLE TO PINZGAUER**		
00532 Supply voltage Implausible signal	• Voltage supply relay terminal 30 (J317) defective	• Poor driveability and engine stops	Check power supply of the EDC control unit J248
00539 Fuel temperature sender – G81 Short circuit to earth Short to positive	• G81 defective • Wiring has short circuit to earth • G81 defective • Break in wiring or short circuit to positive	• Increased emissions	Check G81
00542 Needle lift sender – G80 Entrance open Short to positive Short circuit to earth Implausible signal	• G80 defective • Break in wiring or short circuit • G80 defective • Injection line to 5th cylinder not OK • Fuel shortage • Air in fuel system	• Glow plug warning lamp flashes • Engine runs roughly • Reduced power • Increased emissions	Check G80
00550 Commencement of injection control Control difference	• Commencement of injection valve (N108) defective • Needle lift sender (G80 defective • Fuel tank empty • Fuel supply not OK, fuel shortage • Point of injection not OK	• Engine runs roughly • Reduced power • Increased emissions • Poor cold starting behaviour	Check N108, Final control diagnosis. Check G80. Fuel filter or fuel line clogged. Check and adjust commencement of injection.

(continued)

TABLE 1 FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
00553 Air mass meter – G70			
Implausible signal	• G70 defective	• Reduced power • Black smoke	Checking air mass meter G70
Open circuit / Short to earth	• G70 defective • Break in wiring or short circuit to earth		
Short to positive	• G70 defective • Break in wiring or short circuit to positive		
Power supply	• Operating voltage too high or too low • Break in wiring		
00575 Intake manifold pressure			
Control difference	• Solenoid valve for boost pressure control (N75) defective • Hose connections interchanged or not connected	• Reduced power	Check N75, Final control diagnosis. Check boost pressure control
00625 Speed signal			
Implausible signal	• No signal from speedometer sender (G22)	• Speed display not OK • Vehicle shakes during shifting	Check signal from G22.
Signal too high	• G22 defective • Incorrect coding of switch panel insert.		Check coding of switch panel insert.
00626 Glow plug period warning lamp – K29			
Open circuit	• Break in wiring • Light bulb defective	• Glow plug warning lamp does not function	Check glow period warning lamp (K29)
	• Short circuit to earth	• Glow plug warning lamp lights up continuously	
Short to positive	• Short to positive	• Glow plug warning lamp does not function	

(continued)

TABLE 1 FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
00668 On-board voltage Terminal 30 Implausible signal	• Voltage supply relay defective	• Engine does not start • Poor driveability and engine stops	Check power supply of the EDC Control unit (J248)
00671 Switch for speed control system E45 Undefined switch condition	• E45 defective • Break in wiring or short circuit	• Speed control system is switched OFF	Check speed control system, wiring diagrams
00741 Brake pedal monitoring	**NOT APPLICABLE TO PINZGAUER**		
00765 Modulating piston movement sender – G149	• Injection pump defective • Break in wiring or short circuit	• Glow plug warning lamp flashes • Poor driveability • Engine stops	Check G149
00777 Accelerator pedal sender – G79 Implausible signal Short to positive Power supply	• G79 defective • G79 incorrectly set • G79 defective • Cable has short circuited to positive • Operating voltage too high or too low • Break in wiring	• Glow plug warning lamp flashes • Increased idling speed	Check and adjust G79.
01044 Control unit coded incorrectly No display Adaptation limit exceeded	• Invalid control unit coding		Coding control unit
01050 Glow plug monitoring No display	• Break in wiring or short circuit to earth • Fuse (S125) defective • Relay contact open	• Poor cold-starting properties • Glow period warning lamp (K29) flashes	Check cables and connectors using wiring diagrams Replace fuse / glow plugs if necessary.

(continued)

TABLE 1 FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
01117 Load signal for alternator terminal DF	**NOT APPLICABLE TO PINZGAUER**		
01208 Data record Changed	• Fault in data record • Data record manipulated	• Vehicle will lose official roadworthiness approval	Renew EDC control unit (J248)
01237 Fuel cutoff valve – N109 Mechanical fault Open circuit / short to earth	• N109 defective, leaky or sticking • N109 defective • Break in wiring or short circuit to earth	• Reduced power • Engine stops	Check N109
01242 Output stage in control unit Implausible signal Short to positive	• EGR valve (N18) defective • All the components activated during the diagnosis of actuators	• Increased emissions • Reduced power • Poor driveability • Engine stops	Check EGR Diagnosis of actuators, check cables. If actuators OK, EDC control unit (J248) defective
01262 Solenoid valve of boost pressure control – N75 Open circuit/ Short to earth Short to positive	• Break in wiring • Solenoid valve defective • Short circuit to earth • Short to positive	• Reduced power • Boost pressure too low • Reduced power • Boost pressure too high • Reduced power • Boost pressure too low	Check N75

(continued)

TABLE 1 FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
01265 EGR valve – N18			
Open circuit/	• Break in wiring • EGR valve defective	• No exhaust gas recirculation	Check (N18)
Short to earth	• Short circuit to earth	• Too much exhaust gas recirculation • Reduced power, black smoke	
Short to positive	• Short to positive	• No exhaust gas recirculation	
01266 Glow plug relay – J52			
Short to positive	• Wiring has short circuit to positive • J52 defective	• No preheating • Poor cold starting behaviour • Glow plug period warning lamp (K29) flashes	Check J52
Open circuit/ Short to earth	• Break in wiring or short circuit to earth • J52 defective		
01268 Quantity adjuster – N146			
Control difference	• Injection pump defective • Break in wiring or short circuit	• Glow plug warning lamp flashes • Poor driveability	Check N146
Upper stop value	• Quantity adjuster (N146) defective • Upper stop value reached	• Engine stops • Black smoke • Reduced power	
Lower stop value	• Quantity adjuster (N146) defective • Lower stop value reached	• Reduced power	
01269 Commencement of injection valve – N108			
Open circuit/	• Break in wiring • Commencement of injection valve defective	• Engine knocks in idle, as commencement of injection is constantly set to "advance"	Check N108
Short to earth	• Short circuit to earth	• Lack of power, as commencement of injection is constantly set to "retard"	
Short to positive	• Short to positive	• Engine knocks in idle, as commencement of injection is constantly set to "advance"	

(continued)

TABLE 1 FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
01575 Control switched off Control difference	• Auxiliary drive overloaded	• Engine speed is reduced to idling speed	Check auxiliary drive
17979 Engine control unit blocked	• Attempted tampering • Short circuit in communications wire • Wrong coding • Immobiliser control unit defective/missing	• Engine stops	Adapt engine control unit to electronic immobiliser. Check electronic immobiliser.
65535 EDC Control unit – J248 defective	• Internal defect in control unit	• Poor driveability • Engine stops	Renew J248

SAE P FAULT CODES

28 In addition to the standard five-digit fault codes, Table 2 details the SAE P fault codes that are displayed by the diagnostic software. These additional codes describe the fault causes more precisely. For ease of reference, the table is arranged in ascending alpha-numerical order and in a similar manner to that of the fault codes display (see Fig 7).

TABLE 2 SAE P FAULT CODES

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
16485P0101 Air mass meter – G70 Implausible signal	• G70 defective • Break in wiring or short circuit to earth	• Reduced power • Black smoke	Check Air Mass Meter
16500P0116 Coolant temperature sender – G62 Implausible signal	• G62 defective • Incorrect coolant temperature sender	• Black smoke during starting • Preheating is always carried out for 20 sec.	Check G62
16705P0321 Engine speed sender – G28 Implausible signal	• G28 defective • Distance between speed sender and sender wheel too large • Metal chips on G28 or retaining base loose	• Increased idling speed • Poor starting behaviour • Engine runs roughly • Reduced power • Engine does not start • Engine dies • Glow plug warning lamp flashes • No display on rev counter	Check G28
16706P0322 Engine speed sender – G28 No signal	• G28 defective • Break in wiring or short circuit	• Increased idling speed • Poor starting behaviour • Engine runs roughly • Reduced power • Engine does not start • Engine dies • Glow plug warning lamp flashes • No display on rev counter	Check G28
16885P0501 Vehicle speed signal Implausible signal	• No signal from speedometer sender (G22)	• Speed display not OK • Vehicle with maximum speed limitation runs in limp-home mode • Vehicle shakes during shifting	Check signal from G22
16955P0571 Brake light switch F	**NOT APPLICABLE TO PINZGAUER**		

(continued)

TABLE 2 SAE P FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
16989P0605 EDC Control unit – J248 defective	• Internal defect in control unit	• Poor driveability • Engine stops	Renew J248
17552P1144 Air mass meter – G70 Open circuit/ Short to earth	• G70 defective • Break in wiring or short circuit to earth	• Reduced power	Check G70
17553P1145 Air mass meter – G70 Short to positive	• G70 defective • Break in wiring or short circuit to positive	• Reduced power • Black smoke	Check G70
17554P1146 Air mass meter – G70 Supply voltage	• Operating voltage too high or too low • Break in wiring	• Reduced power • Black smoke	Check G70
17563P1155 Intake manifold pressure sender – G71 Short to positive	• G71 defective • Cable has short circuited to positive	• Reduced power • Increased emissions	Check G71
17564P1156 Intake manifold pressure sender – G71 Open circuit/ Short to earth	• G71 defective • Break in wiring or short circuit to positive	• Reduced power • Increased emissions	Check G71
17565P1157 Intake manifold pressure sender – G71 Supply voltage	• G71 defective • Break in wiring or short circuit	• Reduced power • Increased emissions	Check G71
17568P1160 Intake manifold temperature sender – G72 Short circuit to earth	• G72 defective • Wiring has short circuit to earth	• Switches to default value 136.8 °C	Check G72
17569P1161 Intake manifold temperature sender – G72 Open circuit/ Short to positive	• G72 defective • Break in wiring or short circuit to positive	• Switches to default value 136.8 °C	Check G72

(continued)

TABLE 2 SAE P FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
17570P1162 Fuel temperature sender – G81 Short circuit to earth	• G81 defective • Wiring has short circuit to earth	• Increased emissions	Check G81
17571P1163 Fuel temperature sender – G81 Open circuit/ Short to positive	• G81 defective • Break in wiring or short circuit to positive	• Increased emissions	Check G81
17653P1245 Needle lift sender – G80 Short circuit to earth	• G80 defective • Wiring as short circuit	• Glow plug warning lamp flashes • Engine runs roughly • Reduced power • Increased emissions	Check G80
17654P1246 Needle lift sender – G80 Implausible signal	• G80 defective • Injection line to 5th cylinder not OK • Fuel shortage • Air in fuel system	• Glow plug warning lamp flashes • Engine runs roughly • Reduced power • Increased emissions	Check G80
17655P1247 Needle lift sender – G80 Open circuit/ Short to positive	• G80 defective • Break in wiring or short circuit	• Glow plug warning lamp flashes • Engine runs roughly • Reduced power • Increased emissions	Check G80
17656P1248 Commencement of injection control Control difference	• Commencement of injection valve (N108) defective • Needle lift sender (G80) defective • Fuel tank empty • Fuel supply not OK, fuel shortage • Point of injection not OK	• Engine runs roughly • Reduced power • Increased emissions • Poor cold starting behaviour	Check N108. Check G80. Fuel filter or fuel line clogged. Check and adjust commencement of injection

(continued)

TABLE 2 SAE P FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
17659P1251 Commencement of injection valve – N108 Short to positive	• Short to positive	• Engine knocks in idle, as commencement of injection is constantly set to "advance"	Check N108
17660P1252 Commencement of injection valve – N108 Open circuit/ Short to earth	• Break in wiring • Commencement of injection valve defective • Short circuit to earth	• Engine knocks in idle, as commencement of injection is constantly set to "advance" • Lack of power, as commencement of injection is constantly set to "retard"	Check N108
17663P1255 Coolant temperature sender – G62 Short circuit to earth	• G62 defective • Wiring has short circuit to earth	• Black smoke during starting • Preheating is always carried out for approx. 20 sec.	Check G62
17664P1256 Coolant temperature sender – G62 Open circuit / Short to positive	• G62 defective • Break in wiring or wiring has short circuit to positive	• Black smoke during starting • Preheating is always carried out for approx. 20 sec.	Check G62
17762P1354 Modulating piston movement sender – G149 Electrical fault in circuit	• Injection pump defective • Break in wiring or short circuit	• Glow plug warning lamp flashes • Poor driveability • Engine stops	Check G149
17795P1387 EDC Control unit defective	• Internal defect in control unit	• Poor driveability • Engine stops	Renew J248

(continued)

TABLE 2 SAE P FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
17810P1402 EGR valve – N18 Short to positive	• Short to positive	• No exhaust gas recirculation	Check N18
17811P1403 Exhaust gas recirculation system Control difference	• Unmetered air • Hose connections interchanged or not connected • EGR valve defective (valve sticks, diaphragm rod does not move)	• Reduced power, black smoke • Too little or too much exhaust gas recirculation	Check exhaust gas recirculation system.
17849P1441 EGR valve – N18 Open circuit/ Short circuit to earth	• Break in wiring • EGR valve defective • Short circuit to earth	• No exhaust gas recirculation • Too much exhaust gas recirculation • Reduced power, black smoke	Check N18
17945P1537 Fuel cutoff valve – N109 Malfunction	• N109 defective, leaky or sticking	• Reduced power • Engine stops	Check N109 .
17946P1538 Fuel cutoff valve – N109 Open circuit / short to earth	• N109 defective • Break in wiring or short circuit to earth	• Reduced power • Engine stops	Check N109
17948P1540 Vehicle speed signal Signal too high	• Vehicle speed greater than 260 km/h • Dash panel insert defective	• Speed display not OK • Vehicle shakes during shifting	Check signal from G22
17954P1546 Solenoid valve of boost pressure control – N75 Short to positive	• Short to positive	• Reduced power • Boost pressure too low	Check N75 .

(continued)

TABLE 2 SAE P FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
17957P1549 Solenoid valve of boost pressure control – N75 Open circuit/ Short to earth	• Break in wiring • Solenoid valve defective • Short circuit to earth	• Reduced power • Boost pressure too low • Reduced power • Boost pressure too high	Check N75
17958P1550 Boost pressure Control difference	• Solenoid valve for boost pressure control (N75) defective • Hose connections interchanged or not connected • Leak between turbo charger and engine (charge air segment) • Turbocharger defective	• Reduced power	Check N75, Check boost pressure control.
17964P1556 Boost pressure control Control limit dropped below	• Solenoid valve for boost pressure control (N75) defective • Turbocharger defective • Leak between turbo-charger and engine (charge air segment	• Boost pressure too low • Reduced power	Check N75, Check boost pressure control.
17965P1557 Boost pressure control Control limit exceeded	• Hose connections	• Boost pressure too high • Reduced power	Check N75, Check boost pressure control.
17969P1561 Quantity adjuster – N146 Control difference	• Injection pump defective • Break in wiring or short circuit	• Glow plug warning lamp flashes • Poor driveability • Engine stops	Check N146

(continued)

TABLE 2 SAE P FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
17957P1562 Quantity adjuster – N146 Upper stop value	• Quantity adjuster (N146) defective/blocked • Upper stop value reached	• Reduced power • Shaking	Check N146
17971P1563 Quantity adjuster – N146 Lower stop value	• Quantity adjuster (N146) defective/blocked • Upper stop value reached	• Black smoke • Irregular idling	Check N146
17977P1569 Switch for speed control system – E45 Implausible signal	• E45 defective • Break in wiring or short circuit	• Speed control system is switched off	Check speed control system
17978P1570 Engine control unit blocked	• Immobiliser control unit defective/missing • Short circuit in communications wire • Wrong coding	• Engine stops	Adapt engine control unit to electronic immobiliser Check electronic immobiliser
18008P1600 Voltage supply Ter.15	• No voltage with ignition switched ON (Terminal 15)	• Poor driveability and engine stops	Check voltage supply to Terminal 15
18009P1601 Voltage supply relay – Terminal 30. – J317	• Voltage supply relay terminal 30 (J317) defective • Relay sticks (sporadic)	• Engine does not start • Poor driveability and engine stops	Check power supply of EDC control unit (J248)
18020P1612 Engine control unit incorrectly coded	• Invalid control unit coding	• Glow plug warning lamp flashes	Code control unit

(continued)

TABLE 2 SAE P FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
18024P1616 Glow period warning lamp – K29 Short to positive	• Short to positive	• Glow plug warning lamp does not function	Check glow period warning lamp (K29)
18025P1617 Glow period warning lamp – K29 Open circuit/ Short to earth	• Break in wiring • Light bulb defective	• Glow plug warning lamp does not function	Check glow period warning lamp (K29)
18026P1618 Glow plug relay – J52 Short to positive	• Wiring has short circuit to positive • J52 defective	• No preheating • Poor cold starting behaviour • Glow period warning lamp (K29) flashes	Check J52
18027P1619 Glow plug relay – J52 Short to positive	• Wiring has short circuit to positive • J52 defective	• No preheating • Poor cold starting behaviour • Glow period warning lamp (K29) flashes	Check J52
18039P1631 Accelerator pedal sender – G79 Signal too high	• G79 defective	• Increased idling speed	Check G79.
18039P1632 Accelerator pedal sender – G79 Supply voltage	• Operating voltage too high or too low • Break in wiring	• Glow plug warning lamp flashes • Increased idling speed	Check G79.
18047P1639 Accelerator pedal position ½ - G79 + G185* (*Correct display is: Implausible signal)	• G79 defective	• Increased idling speed	Check G79
18048P1640 EDC control unit – J248 defective	• Internal defect in control unit	• Poor driveability • Engine stops	Renew EDC control unit (J248).

(continued)

TABLE 2 SAE P FAULT CODES (continued)

Fault (1)	Possible cause(s) of fault(s) (2)	Possible effects (3)	Remedy (4)
19457P3001 Control difference	• Auxiliary drive overloaded	• Engine speed is reduced to idling speed	Check auxiliary drive
19560P3104 Switchover valve for intake manifold flap – N239 Short to positive	**NOT APPLICABLE TO PINZGAUER (N239 Disconnected)**		
19561P3105 Switchover valve for intake manifold flap – N239 Open circuit / Short to earth	**NOT APPLICABLE TO PINZGAUER (N239 Disconnected)**		

FINAL CONTROL DIAGNOSIS

Carry out diagnosis of actuators

29 With the diagnosis of actuators, the following components are activated in the order stated:

(1) Commencement of injection valve (N108)
(2) EGR valve (N18)
(3) Fuel cutoff valve (N109)
(4) Solenoid valve for boost pressure control (N75)
(5) Glow plug relay (J52)
(6) Glow plug warning lamp (K29)

NOTES

(1) The activation of the individual actuators is limited to 30 seconds, but it can be terminated at any time by clicking on the [Close Controller, Go Back – 06] button on the Open controller screen.

(2) Before the diagnosis of actuators is repeated, the ignition must be switched OFF.

Procedure

CAUTION

ENGINE OPERATION. It is possible to render the vehicle inoperable or damage components using advanced functions if the user makes changes without the correct information and training.

30 The procedure is as follows:

30.1 Remove both front seats and engine cover.

30.2 Fit maintenance fan guard 8001560281 to cover the fan blades at the front of the engine in the event that the flexible fan duct has been removed.

30.3 Start the engine and run at idle speed.

30.4 From the main screen of the VAG-COM software, click on the [Select] button to access the select control module screen, then select the engine control module by clicking on the [01 – Engine] button.

30.5 Observe the on-screen information whilst the tests are completed.

30.6 Click on the Diagnosis of actuators [Output Tests – 03] button. Tests are performed in the order shown in Para 29.

30.7 When the commencement of injection valve (N108) is activated there may be a clearly audible change in the sound of combustion (knocking). If this is the case the injection timing may require adjustment.

30.8 When the EGR valve (N18) is activated the valve must click. If it does not check the Exhaust Gas Recirculation (EGR) system.

NOTE

If the clicking of the valve cannot be heard it should be felt by directly touching the solenoid valve.

30.9 When the fuel cutoff valve (N109) is activated the engine must stop. If the engine does not stop, switch the ignition OFF, unscrew the fuel cutoff valve and clean it to remove any ingress of dirt or swarf. Repeat the diagnosis of actuators. If the engine still does not stop, replace the fuel cutoff valve (N109).

30.10 The remaining diagnosis of actuators is carried out with the engine stopped and the ignition switched ON.

30.11 When the solenoid valve of boost pressure control (N75) is activated the valve must click .If it does not, check the solenoid valve for boost pressure control (N75).

NOTE

If the clicking of the valve cannot be heard it should be felt by directly touching the solenoid valve.

30.12 When the glow plug relay (J52) is activated the relay must click. If it does not, check the glow plug relay (J52) .

30.13 When the glow period warning lamp (K29) is activated, the warning lamp on the dash must flash. If it does not check the lamp for electrical faults.

30.14 Once all the tests are complete, quit data interchange by clicking on the [Close Controller, Go Back – 06] button and switch the ignition OFF.

MEASURING VALUE BLOCKS

Read measurement value block

31 Before carrying out the procedure, the following conditions must be met:

(1) The coolant temperature must be at least 80 °C.
(2) All electrical consumers such as vehicle heater must be switched OFF.
(3) The automatic gearbox selector lever must be in 'P' or 'N'.
(4) No faults must be stored in the fault memory.
(5) The engine harness should be connected direct to the fuel injection pump (the Optimum Engine Mapping (OEM) module should not be connected).

Procedure

32 The procedure is as follows:

32.1 Remove both front seats and engine cover.

32.2 Fit maintenance fan guard 8001560281 to cover the fan blades at the front of the engine in the event that the flexible fan duct has been removed.

32.3 Start the engine and run at idle speed.

32.4 From the main screen of the VAG-COM software, click on the [Select] button to access the select control module screen, then select the engine control module by clicking on the [01 – Engine] button.

32.5 Read measurement value block, click on the [Meas. Blocks – 08] button. The measuring blocks screen is displayed.

32.6 As an example, enter "000" in the [Group] field and click the [Go] button. The 10 fields are displayed.

32.7 A different display group can be selected using either the [Up] and [Down] buttons or entering a value. To exit the procedure click the [Done, Go Back] button.

32.8 See Para 11 for further information on using this function.

EVALUATING MEASURING VALUE BLOCKS

General

33 The display group values accessible from the measuring blocks screen are detailed in the following Tables. The values are annotated on-screen, however, and these tables are provided as a supplement to aid evaluation of the on-screen information.

NOTE

All the display group values shown are with a warm engine and coolant temperature not below 80 °C unless otherwise stated.

TABLE 3 DISPLAY GROUP 000 AT IDLING

Read measuring block (1)		Setpoint value (2)	Corresponds to (3)
1	Engine speed	35 ... 39	740 ... 800 rpm
2	Commencement of injection	0 ... 98	3° after TDC ... 4.8° before TDC
3	Accelerator position	0	0 %
4	Injection quantity	11 ... 45	2.2 ... 9 mg/stroke
5	Intake manifold pressure	do not observe	---
6	Atmospheric pressure	do not observe	---
7	Coolant temperature	80 ... 37	80 ... 110 °C
8	Intake manifold temperature	182 ... 53	10 ... 100 °C
9	Fuel temperature	88 ... 198	20 ... 80 °C
10	Injection quantity	Display group 003	

TABLE 4 DISPLAY GROUP 001 INJECTION QUANTITY (AT IDLING)

	Read measuring block (1)	Setpoint value (2)	Evaluation (3)
1	Engine speed (rpm)	740 ... 800 rpm	---
2	Injection quantity (mg/stroke)	2.2 ... 9 mg/stroke	See (5)
3	Voltage from modulating piston movement sender (V)	1.25 ... 2.00 V	See (9)
4	Coolant temperature (°C)	80 ... 110 °C	---

Evaluation: Display of injection quantity (4)

Display value (5)	Possible cause(s) of fault(s) (6)	Remedy of fault (7)
Below 2.2 mg/stroke	• Injection pump too rich	Replace injection pump
Over 9 mg/stroke	• Engine too cold	Allow engine to run with increased speed and repeat test
	• Injection quantity too low	Replace injection pump

Evaluation: Display of voltage from modulating piston movement sender (8)

Display value (9)	Possible cause(s) of fault(s) (10)	Remedy of fault (11)
Below 1.25 V	• Injection pump too rich	Replace injection pump
Above 2.00 V	• Engine too cold	Allow engine to run with increased speed and repeat test
	• Injection quantity too low	Replace injection pump

TABLE 5 DISPLAY GROUP 002 IDLE SPEED (AT IDLING)

	Read measuring block (1)	Setpoint value (2)	Evaluation (3)
1	Engine speed (rpm)	740 ... 800 rpm	---
2	Accelerator position (%)	0 %	See (5)
3	Operating mode	010	See (9)
4	Coolant temperature (°C)	80 ... 110 °C	---

Evaluation: Display of accelerator position (4)

Display value (5)	Possible cause(s) of fault(s) (6)	Remedy of fault (7)
1 ... 100 %	• Accelerator pedal sender – G79 defective • Cable break to G79	Check G79

Evaluation: Display of operating mode (8)

Display value (9)	Operating mode (10)
001	Air-conditioner compressor switched on (not fitted on vehicle)
010	Idle switch closed
100	Of no significance

TABLE 6 DISPLAY GROUP 003 EGR (AT IDLING)

Read measuring block (1)		Setpoint value (2)	Evaluation (3)
1	Engine speed (rpm)	740 ... 800 rpm	---
2	Air mass intake – setpoint (mg/stroke) > 05.00 (see Note)	200 ... 380 mg/stroke	See (5)
3	Air mass intake - actual (mg/stroke) > 05.00 (see Note)	200 ... 380 mg/stroke	See (9)
4	Pulse duty factor from EGR (%)	25 ... 75 %	---

Evaluation: Display of air mass intake - setpoint (4)		
Display value (5)	**Possible cause(s) of fault(s) (6)**	**Remedy of fault (7)**
Over 380 mg/stroke	• Engine too cold	Allow engine to run with increased speed and repeat test

Evaluation: Display of air mass intake - actual (8)		
Display value (9)	**Possible cause(s) of fault(s) (10)**	**Remedy of fault (11)**
Below 200 mg/stroke	• Too much EGR	Check EGR
	• Unmetered air	Check intake system for leaks
Above 380 mg/stroke	• Engine too cold	Allow engine to run with increased speed and repeat test
	• Insufficient EGR	Run engine for 10 min. in Neutral, apply short bursts of throttle
	• Air mass meter G70 defective	Check G70. In the event of an error, the measurement value block displays a constant air mass value of approx 550 mg/stroke across the entire speed and load range.

NOTE

For Air Mass 06.00 >, the aspirated air mass is dependent upon the intake –air and fuel temperature. Checking is only possible in the basic setting for display group 3.

TABLE 7 DISPLAY GROUP 004 COMMENCEMENT OF INJECTION (AT IDLING)

Read measuring block (1)		Setpoint value (2)	Evaluation (3)
1	Engine speed (rpm)	740 ... 800 rpm	---
2	Commencement of injection – setpoint (before/after TDC)	3° aft TDC ... 4.8° bef TDC	See (5)
3	Commencement of injection – actual (before/after TDC)	3° aft TDC ... 4.8° bef TDC	See (9)
4	Pulse duty factor from commencement of injection valve (%)	15 ... 95 %	---

Evaluation: Display of commencement of injection – setpoint (4)

Display value (5)	Possible Cause(s) of Fault(s) (6)	Remedy of Fault (7)
Over 4.8° before TDC	• Engine too cold	Allow engine to run with increased speed and repeat test

Evaluation: Display of Commencement of Injection – actual (8)

Display Value (9)	Possible cause(s) of fault(s) (10)	Remedy of fault (11)
Over 4.8° before TDC	• Engine too cold	Allow engine to run with increased speed and repeat test
	• Injection pump stops too 'early'	Check commencement of injection dynamically and adjust
	• Commencement of injection valve (N108) defective	Check N108
Later 35° after TDC	• Injection pump stops too 'late'	Check commencement of injection dynamically and adjust
	• Injection timing device blocked	Check N108
	• Commencement of injection valve (N108) defective	

TABLE 8 DISPLAY GROUP 005 STARTING CONDITIONS

Read measuring block (1)		Setpoint value (2)	Evaluation (3)
1	Engine speed (rpm)	---	---
2	Starting quantity (mg/stroke)	---	---
3	Commencement of injection – actual (° before/after TDC)	---	---
4	Coolant temperature (°C)	---	---

NOTE

The displayed values of 005 are of no significance for trouble-shooting in service.

TABLE 9 DISPLAY GROUP 006 SWITCH POSITIONS (WITH IGNITION ON)

	Read measuring block (1)	Setpoint value (2)	Evaluation (3)
1	Speed (km/h)	(see Note 1)	---
2	Brake pedal monitoring (see Note 2)	---	---
3	Speed control system (see Note 3)	---	---
4	Speed control system	---	---

NOTES

(1) Value = 0 for vehicles fitted with speed control system. Value = 255 for vehicles without.

(2) Check signal from brake light switch and brake pedal switch.

(3) Check speed control system electrics. Function of speed control system.

TABLE 10 DISPLAY GROUP 007 TEMPERATURES (COLD, STATIONARY ENGINE)

Read measuring block (1)		Setpoint value (2)	Evaluation (3)
1	Fuel temperature (°C)	Approx ambient temperature (see Note)	See (5)
2	No display	---	---
3	Intake manifold temperature (°C)	Approx ambient temperature (see Note)	See (9)
4	Coolant temperature (°C)	Approx ambient temperature (see Note)	See (13)

NOTE

It is not possible to specify setpoint values for temperatures. With the engine cold, the temperature values of the fuel, intake air and coolant must naturally match the ambient temperature. If a value deviates to an obvious extent, the relevant sender must be checked.

Evaluation: Display of fuel temperature (4)

Display value (5)	Possible cause(s) of fault(s) (6)	Remedy of fault (7)
- 5.4 °C	• Short circuit or fuel temperature sender (G81) defective	Check G81. In a fault situation, the measurement value block shows a fuel temperature of - 5.4 °C

Evaluation: Display of intake manifold temperature (8)

Display value (9)	Possible cause(s) of fault(s) (10)	Remedy of fault (11)
Approx 136.8 °C	• Intake manifold temperature sender (G72) defective	Check G72. In a fault situation, the measurement value block shows a constant intake manifold temperature of approx – 136.8 °C

Evaluation: Display of coolant temperature (12)

Display value (13)	Possible cause(s) of fault(s) (14)	Remedy of fault (15)
Large deviation from ambient temperature	• Short circuit or coolant temperature sender (G62) defective	Check G62. In a fault situation, the fuel temperature is displayed instead.

TABLE 11 DISPLAY GROUP 009 INJECTION QUANTITY LIMITATIONS

	Read measuring block (1)	Setpoint value (2)	Evaluation (3)
1	Engine speed (rpm)	---	---
2	Injection quantity (mg/stroke)	---	---
3	Injection quantity limitation by automatic gearbox while changing gear (mg/stroke)	---	---
4	Voltage from modulating piston movement sender (V)	---	---

NOTE

The displayed values of 011 are of no significance for trouble-shooting in service.

TABLE 12 DISPLAY GROUP 012 GLOW PLUG SYSTEM

	Read measuring block (1)	Setpoint value (2)	Evaluation (3)
1	Of no significance	---	---
2	Glow period (sec.)	---	---
3	Supply voltage from control unit (V)	---	---
4	Coolant temperature (°C)	---	---

NOTE

The displayed values of 012 are of no significance for trouble-shooting in service.

TABLE 13 DISPLAY GROUP 013 IDLING REST CONTROL (AT IDLE)

	Read measuring block (1)	Setpoint value (2)	Evaluation (3)
1	Deviating injection quantity cyl 1 differs from average quantity (mg/stroke)	- 2.0 ... + 2.0 mg/stroke	(see Para 34)
2	Deviating injection quantity cyl 2 differs from average quantity (mg/stroke)	- 2.0 ... + 2.0 mg/stroke	(see Para 34)
3	Deviating injection quantity cyl 3 differs from average quantity (mg/stroke)	- 2.0 ... + 2.0 mg/stroke	(see Para 34)
4	Deviating injection quantity cyl 4 differs from average quantity (mg/stroke)	- 2.0 ... + 2.0 mg/stroke	(see Para 34)

TABLE 14 DISPLAY GROUP 014 IDLING REST CONTROL (AT IDLE)

	Read measuring block (1)	Setpoint value (2)	Evaluation (3)
1	Deviating injection quantity cyl 5 differs from average quantity (mg/stroke)	- 2.0 ... + 2.0 mg/stroke	(see Para 34)
2	No display	---	---
3	No display	---	---
4	No display	---	---

Evaluation – Display of Idle running control

34 The fuel injection system has an idle running control. Differences in performance between the individual cylinders (parts tolerances, nozzle flow rate, compression etc.) can be detected and balanced out by selective distribution of the injection quantity when idling.

35 The detection takes place when the engine is idling via the signal from the engine speed sender (G28), which supplies four signals per crankshaft revolution to the control unit. If the signals come in the same rhythm, all the cylinders have the same performance. If one cylinder has reduced performance, the crankshaft requires a longer interval for the next half crankshaft revolution. Conversely, a cylinder performing at a higher level accelerates the crankshaft to such an extent that it requires a very short interval.

36 If the control unit has detected a deviation, the cylinder in question is immediately supplied with a greater or smaller injection quantity, until the engine again runs 'smoothly'.

36.1 + ... mg/stroke. The respective cylinder is more powerful and is therefore supplied with less fuel.

36.2 – ... mg/stroke. The respective cylinder is less powerful and is therefore supplied with more fuel.

37 In measured value blocks 013 and 014, the injection quantity differences of the individual cylinders from the average injection quantity per cylinder at idle is displayed (display group 013 shows cylinders 1 through 4). A comparison with a reference cylinder is not carried out. The display for cylinder 5 appears in display group 014.

TABLE 15 DISPLAY GROUP 015 FUEL CONSUMPTION

	Read measuring block (1)	Setpoint value (2)	Evaluation (3)
1	Engine speed (rpm)	---	---
2	Injection quantity – actual (mg/stroke)	---	---
3	Fuel consumption (l/h)	---	---
4	Injection quantity required – specified by driver via accelerator (mg/stroke)	---	---

NOTE

The displayed values of 015 are of no significance for trouble-shooting in service.

TABLE 16 DISPLAY GROUP 018 SPEED (AT IDLING)

Read measuring block (1)		Setpoint value (2)	Evaluation (3)
1	Speed (km/h)	0	---
2	Status (CCS, speedometer)	01	---
3	Maximum speed – limitation (km/h)	100	See (5)
4	No meaning (km/h)	---	---

Evaluation: Display of commencement of maximum speed limitation (4)		
Display value (5)	**Possible cause(s) of fault(s) (6)**	**Remedy of fault (7)**
5 km/h	• Defective speed signal	Check signal from G22

TABLE 17 DISPLAY GROUP 019 QUANTITY ADJUSTER (AT IDLING)

Read measuring block (1)		Setpoint value (2)	Evaluation (3)
1	Lower stop value (V)	0.54 ... 0.88 V	See (5)
2	Upper stop value (V)	4.10 ... 4.80 V	See (9)
3			
4			

Evaluation: Display of lower stop value (4)		
Display value (5)	**Possible cause(s) of fault(s) (6)**	**Remedy of fault (7)**
Below 0.54 V or Above 0.88 V	• Quantity adjuster (N146) defective	Check N146

Evaluation: Display of upper stop value (8)		
Display value (9)	**Possible cause(s) of fault(s) (10)**	**Remedy of fault (11)**
Below 4.10 V or Above 4.80 V	• Quantity adjuster (N146) defective	Check N146

EVALUATING MEASURING VALUE BLOCKS AT FULL LOAD

General

WARNING

ACCIDENT AVOIDANCE. IF USING THE VAG-COM SOFTWARE WITH THE VEHICLE IN MOTION, TWO PERSONS WILL BE REQUIRED; ONE TO DRIVE THE VEHICLE AND THE OTHER TO CARRY OUT THE DATA ANALYSIS.

38 The display group values accessible from the measuring blocks screen are detailed in the following Tables. The values are annotated on-screen, however, and these tables are provided as a supplement to aid evaluation of the on-screen information.

NOTES

(1) All the display group values shown are during a test drive in 2nd gear and coolant temperature not below 80 °C unless otherwise stated.

(2) For the tests accelerate at full throttle. When an engine speed of 3000 rpm is reached, the measurement values have to be printed out or read off by a second person.

(3) The engine harness should be connected direct to the fuel injection pump prior to fault diagnosis using the diagnosis software. The Optimum Engine Mapping (OEM) module should not be connected.

TABLE 18 DISPLAY GROUP 000 AT FULL LOAD

	Read measuring block (1)	Setpoint value (2)	Corresponds to (3)
1	Engine speed	142 ... 152	2900 ... 3100 rpm
2	Commencement of injection	162 ... 214	10 ° ... 14 °before TDC
3	Accelerator position	255	100 %
4	Injection quantity	170 ... 210	34 ... 42 mg/stroke
5	Intake manifold pressure	171 ... 191	1780 ... 1970 mbar
6	Atmospheric pressure	do not observe	---
7	Coolant temperature	80 ... 37	80 ... 110 °C
8	Intake manifold temperature	182 ... 53	10 ... 100 °C
9	Fuel temperature	88 ... 198	20 ... 80 °C
10	Air mass	Display group 010	

TABLE 19 DISPLAY GROUP 004 COMMENCEMENT OF INJECTION (AT FULL LOAD)

Read measuring block (1)		Setpoint value (2)	Evaluation (3)
1	Engine speed (rpm)	2900 ... 3100 rpm	---
2	Commencement of injection – setpoint (°before/after TDC)	10 ° ... 14 °before TDC	---
3	Commencement of injection – actual (° before/after TDC)	Approx. commencement of injection (setpoint)	See (5)
4	Pulse duty factor from commencement of injection valve (%)	15 ... 95 %	See (9)

Evaluation: Display of commencement of injection – actual (4)		
Display value (5)	**Possible cause(s) of fault(s) (6)**	**Remedy of fault (7)**
In the event of too large a deviation from the setpoint value (approx. 55)	• Commencement of injection valve (N108) defective	Check N108
	• Injection pump stops incorrectly	Check commencement of injection dynamically and adjust
	• Air in fuel system	

Evaluation: Display of pulse duty factor from commencement of injection valve (8)		
Display value (9)	**Possible cause(s) of fault(s) (10)**	**Remedy of fault (11)**
Below 15 % or Above 95 %	• Commencement of injection valve (N108) defective	Check N108 Check commencement of injection dynamically and adjust Check fuel supply

TABLE 20 DISPLAY GROUP 008 INJECTION QUANTITY LIMITATION (AT FULL LOAD)

Read measuring block (1)		Setpoint value (2)	Evaluation (3)
1	Engine speed (rpm)	2900 ... 3100 rpm	---
2	Injection quantity - specified by driver (mg/stroke)	39 ... 46 mg/stroke	See (5)
3	Injection quantity – limitation by speed – torque (mg/stroke)	34 ... 42 mg/stroke	See (9)
4	Injection quantity – limitation due to air mass intake – smoke avoidance (mg/stroke)	39 ... 46 mg/stroke	See (13)

Evaluation: Display of commencement of injection – actual (4)		
Display value (5)	**Possible cause(s) of fault(s) (6)**	**Remedy of fault (7)**
Below 39 mg/stroke	• No Full throttle	Repeat test at full throttle
	• Accelerator position sender G79 incorrectly set or defective	Check G79 and adjust if necessary

Evaluation: Display of pulse duty factor from commencement of injection valve (8)		
Display value (9)	**Possible cause(s) of fault(s) (10)**	**Remedy of fault (11)**
Below 34 mg/stroke	• Engine speed too high or too low	Read off setpoint at 3000 rpm

Evaluation: Display of pulse duty factor from commencement of injection valve (12)		
Display value (13)	**Possible cause(s) of fault(s) (14)**	**Remedy of fault (15)**
Below 30 mg/stroke	• Air mass intake too low	Check air volume sensor
	• EGR quantity too high	Check EGR

TABLE 21 DISPLAY GROUP 010 AIR VALUES (AT FULL LOAD)

Read measuring block (1)		Setpoint value (2)	Evaluation (3)
1	Air mass intake (mg/stroke)	700 ... 950 mg/stroke	See (5)
2	Atmospheric (air) pressure (mbar)	No setpoint value	---
3	Intake manifold (boost) pressure (mbar)	1780 ... 1970 mbar	See (9)
4	Accelerator position (%)	100 %	See (13)

Evaluation: Display of air mass intake (4)		
Display value (5)	**Possible cause(s) of fault(s) (6)**	**Remedy of fault (7)**
Below 700 mg/stroke	• Engine speed too high or low	Read off setpoint value at 3000 rpm
	• Boost pressure too low	Check boost pressure control
	• Air mass meter G70 defective	Check air mass meter G70. In the event of an error, the measurement value block displays a constant air mass value of approx. 550 mg/stroke across the entire speed and load range.

Evaluation: Display of pulse duty factor from commencement of injection valve (8)		
Display value (9)	**Possible cause(s) of fault(s) (10)**	**Remedy of fault (11)**
Below 1780 mbar Above 1970 mbar	• Boost pressure control defective • Turbocharger defective	Check boost pressure control

Evaluation: Display of pulse duty factor from commencement of injection valve (12)		
Display value (13)	**Possible cause(s) of fault(s) (14)**	**Remedy of fault (15)**
Below 100 %	• No full throttle	Repeat test at full throttle
	• Accelerator position sender G79 incorrectly set or defective	Check G79 and adjust if necessary.

TABLE 22 DISPLAY GROUP 011 BOOST PRESSURE CONTROL (AT FULL LOAD)

Read measuring block (1)		Setpoint value (2)	Evaluation (3)
1	Engine speed (rpm)	2900 ... 3100 rpm	---
2	Boost pressure – setpoint (mbar)	1780 ... 1970 mbar	---
3	Boost pressure – actual (mbar)	1780 ... 1970 mbar	See (5)
4	Pulse duty factor from valve for boost pressure control (%)	5 ... 90 %	---

Evaluation: Display of commencement of injection – actual (4)		
Display value (5)	**Possible cause(s) of fault(s) (6)**	**Remedy of fault (7)**
Below 1780 mbar	• Boost pressure control defective	Check boost pressure control.
	• Turbocharger defective	
	• Charge air hose not connected to control unit	Connect charge air hose
Above 1970 mbar	• Turbocharger defective	Check boost pressure control

TABLE 23 LUBRICATING OIL RELATED FAULT DIAGNOSIS

Indicator/symptom (1)	Possible cause(s) of fault(s) (2)	Remedy of fault (3)
Excessive oil consumption	• Turbocharger defective	Replace turbocharger,
	• Engine oil level too high	Check level and drain excess oil if necessary
	• External/internal oil leaks	Examine engine for external oil leaks and oil dilution. Ensure engine oil is maintained at an acceptable level
	• Incorrect oil viscosity for ambient weather conditions	Replace engine oil with correct specification oil
	• Cylinder head gasket failure	Replace gasket,
	• Worn or damaged piston rings or cylinder liners	Replace engine,
	• Valve stem guides worn	Replace cylinder head,
	• Valve stem seals worn	Replace cylinder head,
Low oil pressure	• Oil pressure switch defective	Replace switch,
	• Obstructed oil cooler	Check/clean oil cooler. Replace if necessary,
	• Low engine oil level	Check level and top up if required
	• External/internal oil leaks	Examine engine for external oil leaks and oil dilution. Rectify if necessary; ensure engine oil is maintained at an acceptable level.
	• Incorrect oil viscosity for ambient weather conditions	Replace engine oil with correct specification oil
	• Contaminated/restricted oil filter	Replace filter
	• Defective oil pump or oil pressure relief valve	Replace valve. Replace oil pump if necessary,
	• Obstructed oil pump suction pipe or strainer	Check/clear pipe and strainer
	• Main/connecting rod bearings damaged or worn	Replace crankshaft oil seals,
	• Cylinder head cracked	Replace cylinder head,
	• Cylinder block cracked	Replace engine,
	• Crankshaft worn	Replace engine,

HAND HELD EDC TEST BOX

General

39 For in-depth fault diagnosis that requires interrogation of the engine wiring looms a hand held test box (8001560161) is required. The test box acts a break out facility and is connected between the EDC control unit (J248) and the engine loom and allows individual engine loom connectors/wires to be checked.

40 The final steps in many of the procedures detailed in 2320-D-503-522 Chapter 11 and Chapter 12 concerning checks of engine management systems senders and actuators require the use of the test box.

Connecting the EDC test box

CAUTIONS

(1) DAMAGE TO ENGINE MANAGEMENT SYSTEM – AUTOMOTIVE BATTERIES. If the 12 V dc positive (+ve) wire is not disconnected first and the 24 V dc negative (-ve) cable is removed first, the 12 V dc wire could act as a negative (-ve) wire for the 24 V dc system and could cause system damage.

(2) DAMAGE TO ELECTRICS. The main cover of the VPDB must only be removed if absolutely necessary, ie when using the EDC test box. Extreme care must be taken not to cause damage to components housed within the VPDB.

NOTE

Ensure that the HEX-COM diagnostic interface lead has been disconnected from the VPDB prior to connecting the EDC test box.

41 To connect the EDC test box 8001560161 proceed as follows:

41.1 Isolate the electrical system. Turn the battery isolation switch in the vehicle cab, behind the passenger's seat to the OFF position.

41.2 Disconnect the yellow (or white and orange) wire from the 12 V dc positive (+ve) terminal of the automotive batteries and ensure that it is safely placed, ie cannot reconnect with any terminal unintentionally.

41.3 For both automotive and FFR batteries:

41.3.1 Disconnect the 24 V dc negative (-ve) battery terminal and ensure that this is isolated and safely placed, ie cannot reconnect with the terminal unintentionally.

41.3.2 Disconnect the 24 V dc positive (+ve) battery terminal and ensure that this is isolated and safely placed, ie cannot reconnect with the terminal unintentionally.

WARNING

INJURY TO PERSONNEL. INSTALLATION/REMOVAL OF THE SEATS IS ONLY TO BE CARRIED OUT BY A QUALIFIED VEHICLE MECHANIC. THE GENERAL CONDITION OF THE SEAT FIXINGS AND MOUNTINGS SHOULD BE INSPECTED PRIOR TO THE INSTALLATION.

41.4 Remove the passenger seats in the vehicle cab. The seat is held in place with four M10 fixings (toque to 49 Nm) and also has an earth strap to be disconnected, which is held in place by M6 fixings.

41.5 Remove the upper VPDB panel (held in place by six captive screws).

41.6 Remove the screws securing the main lid of the VPDB and carefully pull the lid forward.

NOTE

There is no need to disconnect the loom from the glow plug relay attached to the front of the VPDB lid.

41.7 Disconnect the 16-pin diagnostic plug from the printed circuit board and move the VPDB lid across to the near side of the vehicle, ensuring that the glow plug loom is not twisted or strained.

41.8 Unfold the EDC ECU retainers and extract the ECU from its stowed position.

41.9 Disconnect the ECU from the VPDB loom.

41.10 Connect test box ground clip to a body earth point.

41.11 Connect test box between VPDB loom and ECU.

41.12 Reconnect batteries in the reverse procedure to Paras 41.2 to 41.3.2.

NOTE

To prevent incorrect installation of the radio batteries an audible cross polarity alarm is provided in the VPDB. The alarm activates in the event an attempt is made to connect the radio batteries incorrectly. A test button is provided on the VPDB. Pushing the button sounds the alarm when the radio batteries are connected correctly.

41.13 Commence fault diagnosis routine in accordance with the procedure in hand.

41.14 Upon completion of the fault diagnosis procedure disconnect the test box and return the VPDB to its original condition by following the reverse procedure to the above.

OPTIMUM ENGINE MAPPING MODULE

42 To improve performance when operating the vehicle on AVTUR, an Optimum Engine Mapping (OEM) module is provided. The OEM module **should only be connected** when it is necessary to operate the vehicle on AVTUR and is designed to achieve enhanced performance by modifying the fuel injection parameters. The OEM operates independently of the EDC engine management system and is installed in-line between the fuel injection pump and the engine harness.

CAUTION

ENGINE DAMAGE. Operating the vehicle on regular diesel will damage the engine if the OEM module is fitted. Always remove the OEM module prior to operating on diesel.

43 The OEM module is operating correctly when:

43.1 The green light illuminates with the ignition switched to position '2'.

43.2 The green light is replaced by flashing red when the engine is started and revved.

44 If the green light does not illuminate when the ignition is switched to position '2':

44.1 Switch off the ignition, isolate the electrical system (turn the battery isolation switch in the vehicle cab, behind the passenger's seat to the OFF position) and check the connection of the OEM module and the integrity of the associated wiring,

45 If are no green or red lights illuminated when the engine is running, the OEM module is faulty. In this event:

45.1 Switch off the ignition, isolate the electrical system (turn the battery isolation switch in the vehicle cab, behind the passenger's seat to the OFF position).
45.2 Disconnect and replace the OEM module.

NOTE

If the OEM module is faulty, the vehicle may not start. In the event a replacement module is not immediately available, connect the engine harness directly to the fuel injection pump. Subject to any other fault condition being present, the vehicle will be operable without the OEM module, but with reduced performance.

CHAPTER 3

GEARBOX FAILURE DIAGNOSIS

CONTENTS

Para

1 General information

Table Page

1 Control unit gear shifting problems 2
2 Gearbox gear shifting problems 4
3 Oil leaks 8
4 Running noise 9

GENERAL INFORMATION

1 When diagnosing gearbox failure, check the list of possible causes. All headings contain some serious and some minor faults. It is advisable to check each of the possible causes in order of increasing severity. This will prevent removal of the gearbox unless it is to be replaced.

TABLE 1 CONTROL UNIT GEAR SHIFTING PROBLEMS

Indicator/symptom (1)	Possible cause (2)	Action (3)
Position 'R'		
1 Position 'R' does not engage	1) Damper function B disorder	Replace gearbox
	2) Locking valve R gear sticking	Replace gearbox
2 Position 'R' and forward gears do not engage	1) Main pressure valve sticking	Replace gearbox
	2) Main pressure valve spring broken	Replace gearbox
3 Faulty power transmission	1) Pressure in clutch B or E or in brake D too low	Replace gearbox
4 Hard jolt when engaging 'R'	1) Damper function B disorder	Replace gearbox
	2) Modulation pressure too high	Replace gearbox
Position D		
5 Position 'D' does not engage	1) Main pressure valve sticking	Replace gearbox
	2) Main pressure valve spring broken	Replace gearbox
6 Faulty power transmission	1) Pressure in clutch A too low	Replace gearbox
7 Does not shift up or down	1) Governor malfunction	Check and clean governor, replace if necessary
	2) Shift valves sticking	Replace gearbox
8 No neutral shifts	1) Shift valves sticking	Replace gearbox
	2) Governor malfunction	Check and clean governor, replace if necessary
9 Kick down gear shift too low	1) Throttle pressure too low	Replace gearbox
10 No 4-3 kick down gearshift	1) 4-3 kick down valve sticking	Replace gearbox
11 Hard jolt when engaging D	1) Damper A sticking	Replace gearbox
12 Hard gearshifts (all gears)	1) Modulation pressure too high	Replace gearbox
13 Hard gearshifts (1-2 only)	1) Damper C disorder	Replace gearbox
14 Hard gearshifts (2-3 only)	1) Damper B disorder	Replace gearbox
15 Hard gearshifts (3-4 only)	1) Damper F disorder	Replace gearbox
16 Hard gearshifts 4-3	1) Screen F disorder	Replace gearbox

(continued)

TABLE 1 CONTROL UNIT GEAR SHIFTING PROBLEMS (continued)

Indicator/symptom (1)	Possible cause (2)	Action (3)
17 No lockup clutch actuation	1) Lockup clutch hysteresis valve sticking	Replace gearbox
	2) Converter pressure valve sticking	Replace gearbox
	3) Control valve lockup clutch sticking	Replace gearbox
	4) Lockup clutch damper disorder	Replace gearbox
18 Lockup clutch shift point incorrect	1) Governor malfunction	Check and clean governor, replace if necessary
	2) Lockup clutch hysteresis valve sticking	Replace gearbox
Position 3		
19 No gearshift from 4-3	1) Shift valve 3-4 sticking	Replace gearbox
Position 2		
20 Manual gearshift from 3-2 does not engage	1) Locking valve 2 sticking	Replace gearbox
	2) Governor malfunction	Check and clean governor, replace if necessary
21 Manual gearshift from 3-2 difficult	1) Damper function C' disorder	Replace gearbox
	2) Clutch valve C' sticking	Replace gearbox
Position 1		
22 Manual gearshift from 2-1 does not engage	1) Locking valve 1 sticking	Replace gearbox
	2) Governor malfunction	Check and clean governor, replace if necessary
23 Manual gearshift from 2-1 difficult	1) Damper function D disorder	Replace gearbox
24 Main pressure too high in all positions	1) Main pressure valve sticking	Replace gearbox
	2) Shift throttle pressure or modulation pressure too high	Replace gearbox

(continued)

TABLE 2 GEARBOX GEAR SHIFTING PROBLEMS

Indicator/symptom (1)	Possible cause (2)	Action (3)
Position 'P'		
1 Position 'P' does not engage	1) Wrong setting of gear change rods between control lever and gearbox	Adjust setting
	2) Excessive friction in parking lock mechanism	Replace gearbox
2 Vehicle creeps	1) Wrong setting of gear change rods between control lever and gearbox	Adjust setting
3 Engine does not start	1) Starter inhibitor switch faulty	Replace switch
	2) Selector lever incorrectly set	Adjust setting
	3) Selection system faulty	Check system, replace as necessary
Position 'R'		
4 Position 'R' does not engage	1) Wrong setting of gear change rods between control lever and gearbox	Adjust setting
	2) Oil filter screen dirty	Clean or replace screen
	3) Clutch B damaged (if so, there will be no 3rd or 4th gear either)	Replace gearbox
	4) Clutch D damaged (if so, there will be no engine braking in Position '1')	Replace gearbox
	5) Clutch E damaged (if so, there will be no engine braking in 1st, 2nd and 3rd gears)	Replace gearbox
	6) Reverse gear safety valve faulty	Replace gearbox
5 Slipping or stuttering	1) Clutch B or E, or brake D damaged	Replace gearbox
6 Hard jolt (double impact) when changing from P-R or N-R	1) Damper B faulty (if so, shifting from 2-3 will also be affected)	Replace gearbox
7 Reversing lamp does not illuminate	1) Starter inhibitor switch faulty	Replace switch
	2) Selector lever incorrectly set	Adjust setting
	3) Selection system faulty	Check system, replace as necessary

(continued)

TABLE 2 GEARBOX GEAR SHIFTING PROBLEMS (continued)

Indicator/symptom (1)	Possible cause (2)	Action (3)
Position 'N'		
8 Engine does not start	1) Starter inhibitor switch faulty	Replace switch
	2) Selector lever incorrectly set	Adjust setting
	3) Selection system faulty	Check system, replace as necessary
9 Vehicle creeps	1) Wrong setting of gear change rods between control lever and gearbox	Adjust setting
	2) Clutch A faulty	Replace gearbox
Position 'D'		
10 No power output	1) Oil filter screen dirty	Clean/replace screen
	2) Clutch A faulty	Replace gearbox
	3) One way clutch 1st gear slips	Replace gearbox
	4) Wrong setting of gear change rods between control lever and gearbox	Adjust setting
11 Slipping or stuttering	1) Clutch A damaged	Replace gearbox
12 Hard jolt (double impact) when changing from N-D	1) Clutch A damaged	Replace gearbox
	2) Damper A faulty	Replace gearbox
13 Cannot shift from 1-2 or 2-1	1) Governor dirty	Replace governor
	2) Shift valve 1-2 sticking	Replace gearbox
14 Cannot shift from 1-2	1) Brakes C' and/or C faulty	Replace gearbox
15 Cannot shift from 2-3 or 3-2	1) Governor dirty	Replace governor
	2) Shift valve 2-3 sticking	Replace gearbox
16. Cannot shift from 2-3	1) Clutch B faulty	Replace gearbox
17 Cannot shift from 3-4 or 4-3	1) Governor dirty	Replace governor
	2) Shift valve 3-4 sticking	Replace gearbox
18 Cannot shift from 3-4	1) Brake F faulty	Replace gearbox

(continued)

TABLE 2 GEARBOX GEAR SHIFTING PROBLEMS (continued)

Indicator/symptom (1)	Possible cause (2)	Action (3)
19 Vehicle starts in 2nd gear	1) Governor sleeve sticking	Replace governor
	2) Shift valve 1-2 sticking	Replace gearbox
20 Vehicle starts in 3rd gear	1) Governor sleeve sticking	Replace governor
	2) Shift valve 1-2 and 2-3 sticking	Replace gearbox
21 Vehicle shifts from 1-3	1) Shift valve 2-3 sticking	Replace gearbox
Position 3		
22 No engine braking	1) Clutch E damaged	Replace gearbox
Position 2		
23 Manual shift 3-2 faulty	1) Locking valve sticking	Replace gearbox
	2) Governor sticking	Replace governor
24 No engine braking	1) Brake C' or clutch E damaged	Replace gearbox
Position 1		
25 Manual shift 2-1 faulty	1) Locking valve sticking	Replace gearbox
	2) Governor sticking	Replace governor
26 No engine braking	1) Brake D or clutch E damaged	Replace gearbox
Shifting speeds		
27 No change at light throttle	1) Governor dirty	Replace governor
	2) Shift valve sticking	Replace gearbox
28 Full throttle switching point incorrect	1) Throttle cable incorrectly set	Adjust setting
29 No kick down shift from 2-1	1) Throttle cable incorrectly set	Adjust setting
30 No kick down shift from 3-2	1) Throttle cable incorrectly set	Adjust setting
31 No kick down shift from 4-3	1) Kick down valve sticking	Replace gearbox
32 No load shift harsh	1) Damper faulty	Replace gearbox
	2) Modulation pressure too high	Replace gearbox
	3) Discs damaged	Replace gearbox

(continued)

TABLE 2 GEARBOX GEAR SHIFTING PROBLEMS (continued)

Indicator/symptom (1)	Possible cause (2)	Action (3)
Shifting transitions		
33 Full throttle and kick down shifts too slow	1) Damper faulty	Replace gearbox
	2) Modulation pressure too low	Replace gearbox
	3) Discs damaged	Replace gearbox
34 Full throttle and kick down shifts harsh	1) Modulation pressure incorrect	Replace gearbox
	2) Damper faulty	Replace gearbox
Lockup clutch		
35 Shift speed incorrect	1) Lockup clutch hysteresis valve sticking	Replace gearbox
	2) No 4th gear	Replace gearbox
	3) Governor pressure incorrect	Replace governor
36 Shift transition harsh	1) Lockup clutch damper defective	Replace gearbox
	2) Converter damaged	Replace converter
37 No gearshift	1) Control unit damaged	Replace gearbox
	2) Lockup clutch faulty	Replace converter
	3) No 4th gear	Replace gearbox
General		
38 Throttle cable sticks	1) Nipple in throttle cams detached	Change throttle cable
	2) Excessive friction in throttle cable cover	Change throttle cable
	3) Throttle pressure piston sticking	Replace gearbox
39 Noisy and no drive after long journey	1) Oil filter screen on control unit dirty	If burnt clutch coating in oil pan, replace gearbox. If not, renew oil filter screen
40 Loud noise and no drive	1) Drive plate between engine and gearbox broken	Replace plate/converter
	2) Pump driving pin broken	Replace gearbox

(continued)

TABLE 3 OIL LEAKS

Indicator/symptom (1)	Possible cause (2)	Action (3)
1 Oil leaking from the converter housing	1) Sealing ring in pump casing damaged	Replace sealing ring
	2) Pump casing leaking	Replace gearbox
	3) Converter leaking at welded seam	Replace converter
2 Leak between gearbox housing and oil pan	1) Retaining screws on oil pan not properly tightened	Tighten screws
	2) Oil pan seal damaged	Replace seal
3 Leak between intermediate plate and gearbox housing (especially around pump pressure bore)	1) Retaining screws on converter housing not properly tightened	Tighten screws
4 Oil loss at throttle cable connector	1) O-ring on connector damaged	Replace O-ring or throttle cable complete
5 Oil loss at drive pinion	1) Shaft seal on drive pinion damaged	Replace shaft seal
6 Oil loss through or on breather	1) Oil level too high	Correct level
	2) Wrong oil (excessive foaming)	Change oil, if necessary remove gearbox and empty with converter
	3) Breather pipe missing	Install breather pipe
	4) O-ring on breather damaged	Replace O-ring
	5) Pre-load of tab washer too low	Replace washer
7 Oil loss on cooler pipe	1) Screws loose	Tighten screws
	2) Cooler pipe damaged	Replace cooler pipe
	3) Cooler leaking	Replace cooler
8 Oil loss on intermediate plate	1) Plug on intermediate plate leaking	Tighten plug or replace sealing rings
9 Leak between gearbox housing and extension	1) Retaining screws loose	Tighten screws
	2) Seal damaged	Replace seal

(continued)

TABLE 4 RUNNING NOISE

Indicator/symptom (1)	Possible cause (2)	Action (3)
1 High pitched noise in all positions, especially when oil is cold	1) Oil level too low	Correct oil level
	2) Control unit leaking	Replace gearbox
2 High pitched noise in all positions, especially when oil is warm and on long journeys. Occasional interruptions of adherence	1) Oil filter screen dirty	If burnt clutch coating in oil pan, replace gearbox. If not, renew oil filter screen
3 Load noise when lockup clutch closed	1) Torsional absorber defect	Replace converter
4 Loud engine humming when lockup clutch closed	1) Lockup clutch shift point incorrect	Replace gearbox

CHAPTER 4

TRANSMISSION FAILURE DIAGNOSIS

CONTENTS

Para

1 General information

Table Page

1 Transfer gearbox trouble 2
2 Propshaft noise 3

GENERAL INFORMATION

1 When diagnosing transfer box failure, it is advisable to check through the list of possible causes in order of severity. Start by checking failures that are easy to diagnose and remedy. This will prevent removal of the transfer box unless it is to be replaced.

2 When diagnosing propshaft failure, first check that the markings are aligned and in the top position. If they are not, the propshaft will have to be re-aligned.

TABLE 1 TRANSFER GEARBOX TROUBLE

Indicator/symptom (1)	Possible cause (2)	Action (3)
1 Transfer gearbox cannot be shifted.	a) Gearshift cable of remote control detached.	Check cable.
	b) Gearshift cable of remote control wrongly adjusted.	Check adjustment of gearshift cable.
	c) Transfer gearbox remote control defective.	Replace remote control unit.
	d) Transfer gearbox selector lever defective.	Check/ replace lever.
	e) Selector unit defective.	Replace transfer gearbox.
	f) Sliding sleeve defective.	Replace transfer gearbox.
	g) Synchronizer defective.	Replace transfer gearbox.
	h) Incorrect specification oil.	Drain and refill with correct specification oil.
2 Noises during gearshift.	a) Synchronizer defective.	Replace transfer gearbox.
	b) Sliding sleeve defective.	Replace transfer gearbox.
	c) Incorrect specification oil.	Drain and refill with correct specification oil.
3 Gear disengages by itself.	a) Locking damaged.	Check/replace locking parts if necessary.
	b) Retaining teeth of speed change gear damaged.	Replace transfer gearbox.
	c) Incorrect adjustment of gearshift cable.	Check gearshift cable adjustment.
	d) Sliding sleeve defective.	Replace transfer gearbox.
	e) Synchronizer defective.	Replace transfer gearbox.
4 Running noise in transfer gearbox.	a) Bearings defective.	Replace transfer gearbox.
	b) Gear wheels defective.	Replace transfer gearbox.
	c) Drive shaft distorted.	Replace transfer gearbox.
	d) Incorrect specification oil.	Drain and refill with correct specification oil.

TABLE 2 PROPSHAFT NOISE

Indicator/symptom (1)	Possible cause (2)	Action (3)
1 Speed related noises when driving.	a) Propshaft unbalanced.	Replace shaft.
	b) Worn joints of propshaft.	Replace shaft.
	c) Propshaft marking staggered.	Reset propshaft with the marking arrows facing each other.
	d) Marking arrows are not in top position.	Loosen propshaft, turn shaft so that marking arrows are on top and tighten in this position.
	e) Spline end worn.	Replace shaft.

CHAPTER 5

AXLE FAILURE DIAGNOSIS

CONTENTS

Para

1 General information

Table Page

1 Axle trouble 2
2 Engaging/disengaging all wheel drive 3
3 Engaging/disengaging differential locks 4

Fig Page

1 All wheel drive pneumatic system 6
2 Differential locks pneumatic system 8

GENERAL INFORMATION

1 When diagnosing axle failure, first determine whether the cause is due to electrical or lubrication problems.

2 In order to find the cause of all wheel drive or differential lock failure, first determine whether the defect is electrical, mechanical or pneumatic.

TABLE 1 AXLE TROUBLE

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Oil in hand brake.	a) Axle journal housing leakage.	Replace rotary shaft seal at axle journal or sealing at differential lock cylinder.
2 Oil leakage at axle.	a) Axle sleeve broken.	Check/replace axle sleeve.
	b) Axle breather inoperative.	Ensure that breather pipe is not obstructed, clean/renew breather. Rectify oil leak.
3 Abnormal noises during driving.	**Lubrication Fault**	
	a) Oil level too low.	Find and repair leaks. Top up oil to correct level.
	Mechanical Fault	
	a) Tyres have different diameters.	Check tyre type and dimension, replace if necessary.
	b) Wheel bearing defective.	Replace bearing
	c) Distortion during cornering on dry, paved road.	All wheel drive engaged. Disengage all wheel drive.
	d) Central tube drive shaft unbalanced.	Remove and balance shaft, replace if necessary.
	e) Knocking noise during load alternation.	Check tube shaft teeth and replace shaft if necessary. If excessive play of pinion or crown wheel bearing, replace axle.
	f) Crushing noise.	Check axle journal bearing. Replace if defective.
	g) Crown wheel and pinion or differential bevel gears damaged.	Replace axle.
	h) Driving off only possible with differential lock engaged.	Axle drive shaft broken, replace axle shaft (in case of accident check axle tube for distortion).

TABLE 2 ENGAGING/DISENGAGING ALL WHEEL DRIVE

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 All wheel drive lamp does not light up when switch is depressed.	**Electrical Fault**	Note: For circuit diagrams see sub chapter 13-1 for 6 cylinder engine variants or 13-2 for 5 cylinder Euro 3 engine variants
	a) Fuse fault.	Check fuses. Replace if necessary.
	b) Wiring worn.	Check wiring. Replace if necessary.
	c) Electro-pneumatic valve for all wheel drive defective.	Check valve, replace if necessary.
	d) Bulb defective.	Replace bulb.
	e) Contact switch defective.	Check/replace switch.
	f) Faulty/incorrect connection at switch.	Check/rectify wiring connection switch.
	Pneumatic Fault	
	a) Filter of dryer clogged.	Check/clean/replace filter and dryer.
	b) Pneumatic hoses disconnected at electro-pneumatic valve, pneumatic reservoir or gearshift cylinder return valve.	Check connections at hoses, replace if necessary.
	c) Vacuum pump defective.	Check/replace pump.
	d) Gearshift cylinder defective.	Check/replace cylinder.
2 All wheel drive lamp lights up when switch is off (transfer gear shift lever in high range).	**Electrical Fault**	Note: For circuit diagrams see sub chapter 13-1 for 6 cylinder engine variants or 13-2 for 5 cylinder Euro 3 engine variants
	a) Defective electro-pneumatic valve for all wheel drive.	Replace valve.
	b) Switch at transfer shift lever defective or wiring from contact switch to switch has ground contact.	Check/replace switch. Check/repair wiring.
	c) Switch defective.	Check/replace switch.
	d) Fuse blown.	Check fuse. Replace if necessary.
	e) Wiring fault.	Check/repair wiring.

(continued)

TABLE 2 ENGAGING/DISENGAGING ALL WHEEL DRIVE (continued)

Indicator/symptom (1)	Possible cause (2)	Action (3)
	Pneumatic Fault	
	a) Defective electro-pneumatic valve for all wheel drive.	Change valve.
	b) Filter or dryer clogged.	Check/change filter and dryer as necessary.
	c) Gearshift cylinder defective.	Check/clean/replace cylinder.
3 All wheel drive lamp lights up when all wheel drive is disengaged.	a) Gear fork or sliding sleeve defective.	Check/replace gear fork or sliding sleeve.
	b) Different diameter/dimension tyres.	Check diameter and dimension of tyres, replace tyres if necessary.

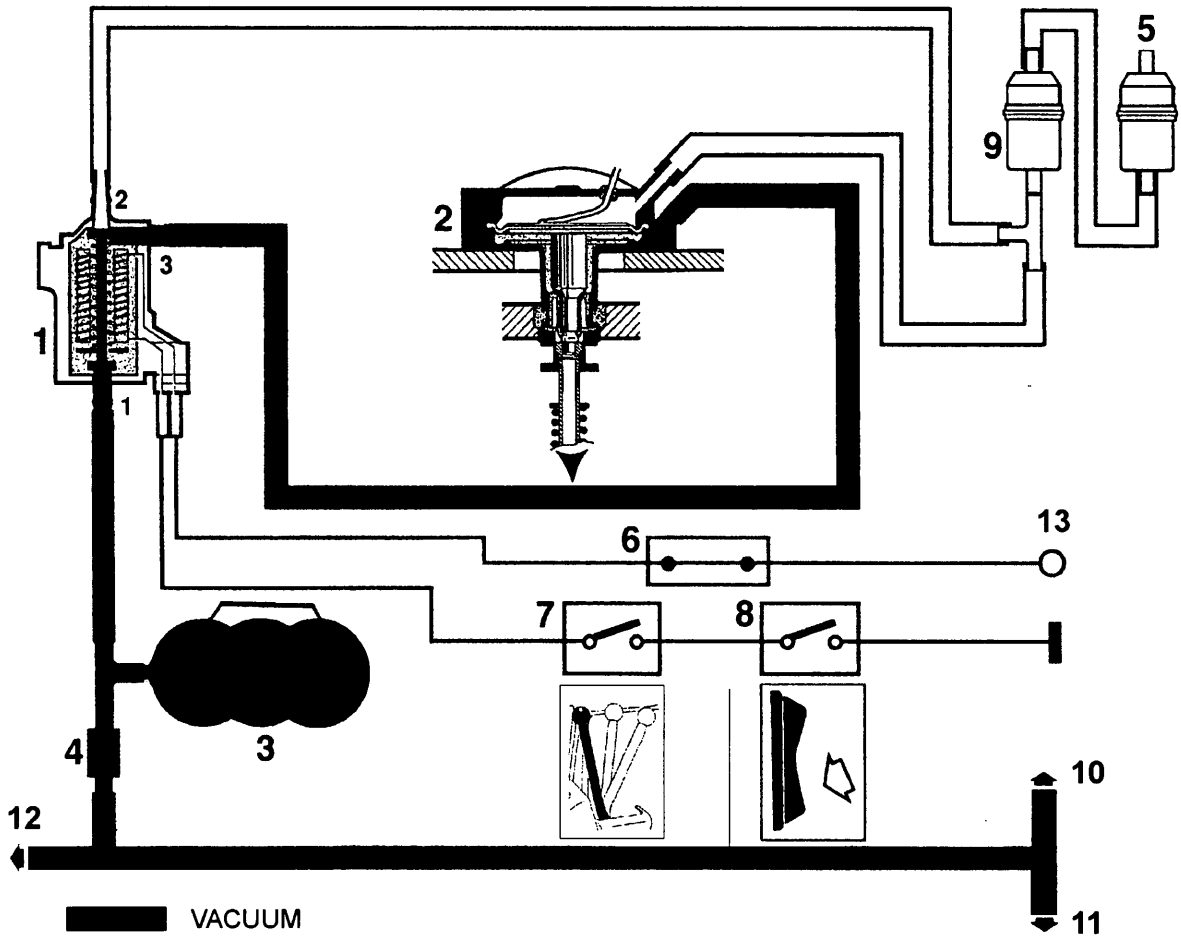
TABLE 3 ENGAGING/DISENGAGING DIFFERENTIAL LOCK

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Differential lock lamp does not light up when switch is on.	**Electrical Fault**	Note: For circuit diagrams see sub chapter 13-1 for 6 cylinder engine variants or 13-2 for 5 cylinder Euro 3 engine variants
	a) Fuse fault.	Check fuses. Replace if necessary.
	b) Bulb defective.	Replace bulb.
	c) Electro-pneumatic valve defective.	Check/replace valve.
	d) Contact switch defective.	Check/replace switch.
	e) Faulty/incorrect wiring connection at switch.	Check/repair wiring connection at switch.
	f) Wiring worn.	Check/replace worn wires.
	g) Diode defective (only rear axle lock)	Check/replace diode.
	h) Pneumatic hoses disconnected at electro-pneumatic drive, pneumatic reservoir, gearshift cylinder or return valve.	Check/replace hose connections.
	i) Vacuum pump defective.	Check/replace pump.
	j) Gearshift cylinder defective.	Check/replace cylinder.

(continued)

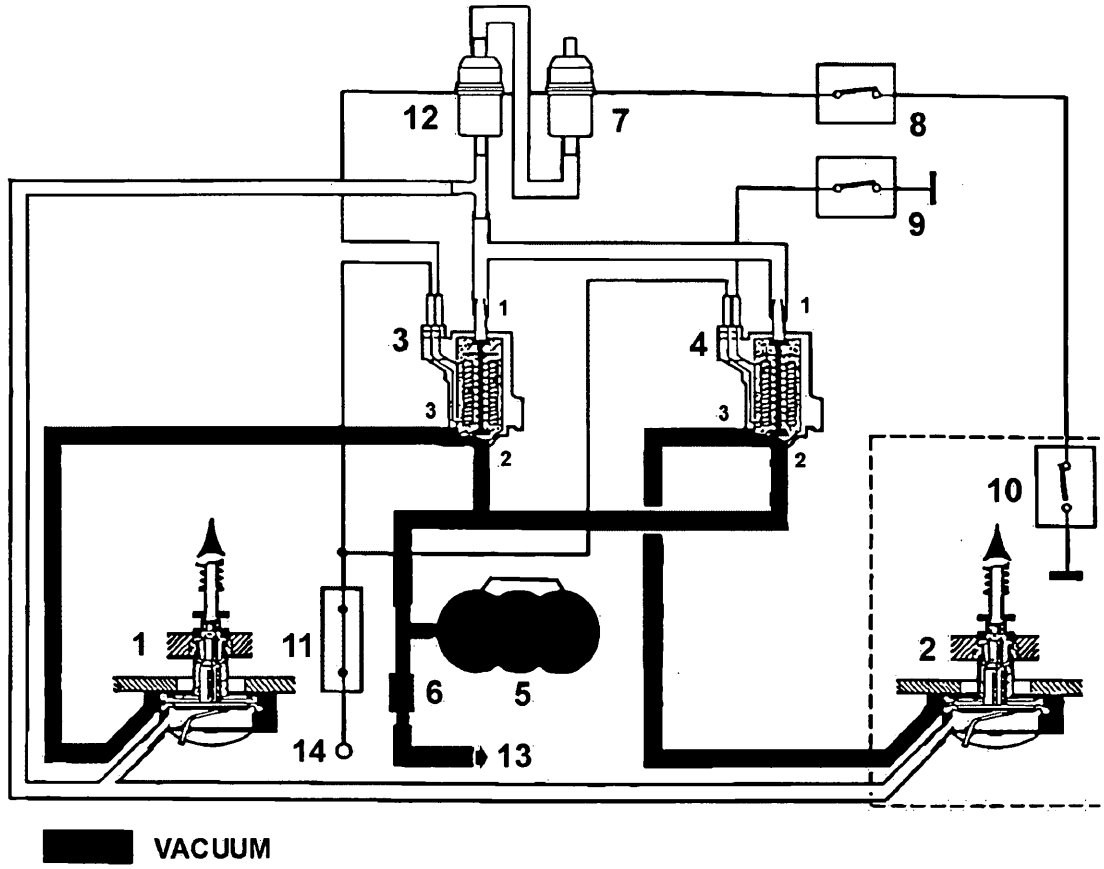
TABLE 3 ENGAGING/DISENGAGING DIFFERENTIAL LOCK (continued)

Indicator/symptom (1)	Possible cause (2)	Action (3)
2 Differential lock lamp does not light up when switch is on.	a) Filter or dryer clogged.	Check/clean/replace filter or dryer.
3 Differential lock function lamp lights up when switch is off.	**Electrical Fault**	Note: For circuit diagrams see sub chapter 13-1 for 6 cylinder engine variants or 13-2 for 5 cylinder Euro 3 engine variants
	a) Defective electro-pneumatic valve for rear differential lock.	Replace valve.
	b) Switch at transfer gearshift lever defective or wiring from contact switch to switch has ground contact.	Check/replace switch. Check/rectify wiring.
	c) Switch defective.	Check/replace switch.
	d) Fuse blown.	Check fuses. Replace if necessary.
	e) Wiring fault.	Check/repair wiring.
	Pneumatic Fault	
	a) Electro-pneumatic valve for differential lock defective.	Replace valve.
	b) Filter or dryer clogged.	Check/clean/replace filter or dryer.
	c) Gearshift cylinder defective.	Check/replace cylinder.
4 Differential lock lamp lights up when differential lock is disengaged.	a) Gear fork sliding sleeve defective.	Check/replace gear fork and sliding sleeve.



1 Solenoid valve
2 Actuator
3 Vacuum reservoir
4 Non-return valve
5 Dryer
6 Fuse 8A
7 Switch at auxiliary gearbox shift lever
8 Toggle switch actuated
9 Air filter
10 Vacuum – from vacuum pump
11 Vacuum - to servo
12 Diff. lock system (vacuum supply)
13 Ignition switch

Fig 1 All wheel drive pneumatic system



1 Actuator front axle
2 Actuator rear axle
3 Solenoid valve front axle
4 Solenoid valve rear axle
5 Vacuum reservoir
6 Non-return valve
7 Dryer
8 Toggle switch front axle
9 Toggle switch rear axle
10 Microswitch rear axle
11 Fuse
12 Air filter
13 To vacuum pump
14 Ignition switch

Fig 2 Differential locks pneumatic system

CHAPTER 7

STEERING SYSTEM FAILURE DIAGNOSIS

CONTENTS

Para

1 General information

Table Page

1 Steering problems 2

Fig Page

1 Steering System 4

GENERAL INFORMATION

1 When diagnosing a steering system failure, try to determine exactly what the symptoms are. Then work through the relevant list of possible causes checking the easiest to rectify (or most likely) failures first.

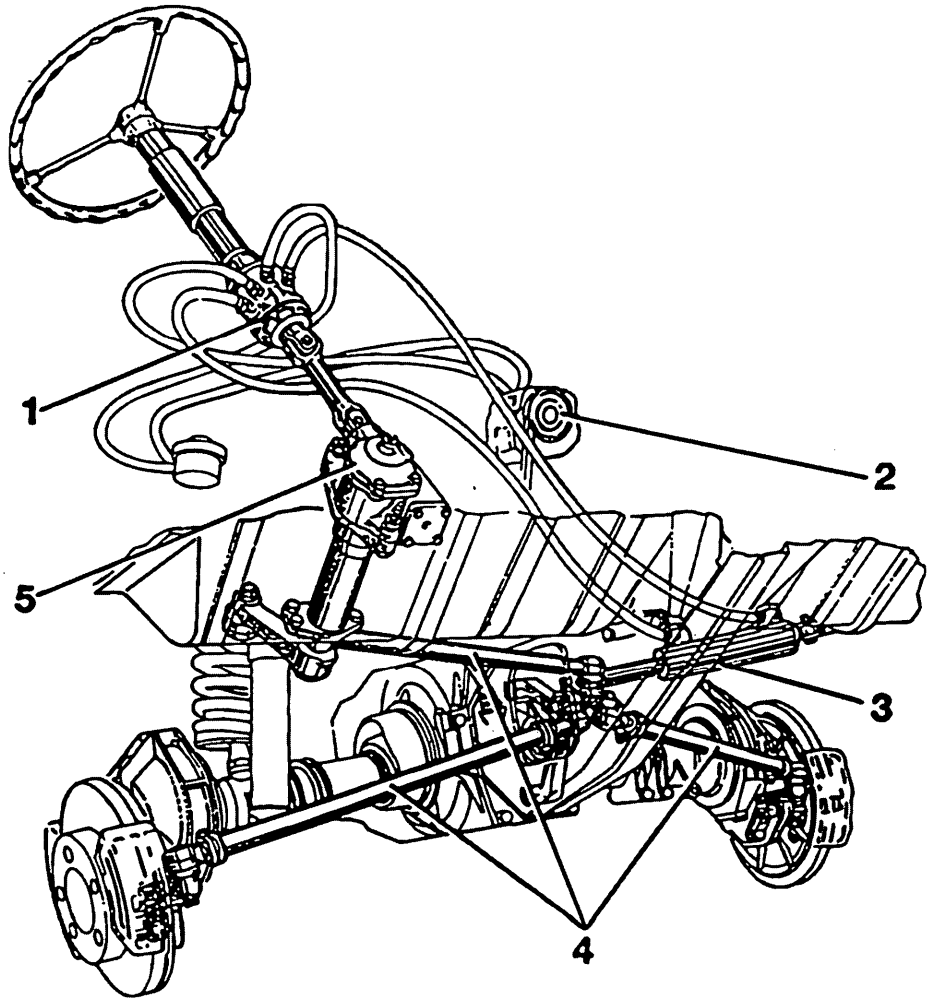
TABLE 1 STEERING PROBLEMS

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Steering hard to move when turning.	a) V-belt loose/broken.	Check belt tension, replace if necessary.
	b) Insufficient oil delivered by pump.	Check V-belt tension, replace if necessary. Replace hydraulic power pump.
	c) Steering oil filter clogged.	Replace filter.
	d) Leakage inside working cylinder.	Replace working cylinder.
	e) Leakage inside rotary piston valve.	Replace valve.
	f) Servo pump defective	Replace pump.
	g) Insufficient oil in steering unit.	Check steering oil level, top up if necessary.
	h) Steering gear defective.	Replace steering gear.
	i) Engine idling speed too low.	Try steering at faster idle. If necessary, reset idle speed.
	j) Insufficient air pressure in tyres.	Check tyre pressure, correct if necessary.
	k) Air in steering system	Bleed system, check oil level, top up if necessary.
	l) Swivel pin not correctly adjusted or hard to move.	Check swivel pin. Adjust/replace if necessary.
	m) Upper and lower relay lever hard to move.	Check lever, replace bearing bush or levers if necessary.
2 Steering wheel is slow to return to central position.	a) Swivel pin or steering transmission stiff.	Loosen/ replace transmission. Check swivel pin.
	b) Upper and lower relay lever stiff to move.	Check lever, replace bearing bush or lever if necessary.
3 Steering wheel vibrates.	a) Wheels unbalanced.	Balance wheels.
	b) Steering geometry (track alignment) misaligned.	Check/adjust track alignment.
	c) Wheels or rims dirty after driving cross county.	Clean wheels and rims.
4 Excessive play in steering wheel.	a) Steering fastening screws loose.	Tighten screws.

(continued)

TABLE 1 STEERING PROBLEMS (continued)

Indicator/symptom (1)	Possible cause (2)	Action (3)
	b) Incorrect steering gear adjustment.	Adjust steering gear. At limit of adjustment, replace gear.
	c) Excessive play in ball joints of track rod.	Replace track rods.
	d) Defective wheel bearings.	Check bearings, replace if necessary.
	e) Incorrect adjustment of swivel pin.	Check swivel pin, adjust/replace if necessary.
	f) Excessive clearance of upper and lower relay lever.	Check lever and bush, replace/adjust if necessary.
	g) Rotary piston valve defective.	Check valve, replace if necessary.
5 Steering rattles during turning.	a) Insufficient oil in steering system.	Check oil level, top up if necessary.
	b) Air in steering system.	Bleed steering system.
	c) Oil filter clogged.	Replace filter.
6 Different wheel angle or irregular /excessive front tyre wear.	a) Incorrect alignment of steering.	Adjust alignment.
	b) Incorrect basic adjustment when toe-in is correct.	Check toe-in.
	c) Distortion in front axle.	Check/replace or repair axle as required.
	d) Weak or damaged coil spring.	Check/replace springs (in pair).
	e) Defective dampers.	Check/replace dampers (in pairs).



1 Cylindrical rotary valve
2 Servo-steering pump
3 Hydraulic ram
4 Track rods
5 Steering gear

Fig 1 Steering system

CHAPTER 8

SUSPENSION FAILURE DIAGNOSIS

CONTENTS

Para

1 General information

Table Page

1 Front suspension problems 2
2 Rear suspension problems 3

GENERAL INFORMATION

1 When diagnosing a suspension system failure, first determine whether the defect is on the front or rear suspension. If the suspension rattles or squeaks, the problem is spring or damper related.

TABLE 1 FRONT SUSPENSION PROBLEMS

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1. Noise from front suspension	1) Spring not seated correctly	Use spring compressor to compress and re-seat.
	2) Broken coil spring	Replace springs (in pairs).
	3) Spring pan locating pin dry	Remove spring and spring pan re-grease pin.
	4) Badly worn spring pan locating pin	Replace pin.
	5) Damper touching coil spring, fitted incorrectly	Remove damper, refit correctly.
2. Rattle from front suspension	1) Defective damper	Replace dampers (in pairs).
	2) Damaged damper bush	Replace dampers (in pairs).
3. Ride over cross-country is hard and uncomfortable	1) Tyres over/under inflated	Set to correct tyre pressure.
	2) Weak or worn coil spring	Replace coil springs (in pairs).
	3) Worn rubber hollow spring	Replace rubber hollow springs.
	4) Defective damper	Replace dampers (in pairs)
4. Excessive body roll	1) Defective damper	Replace dampers (in pairs).
	2) Weak coil spring	Replace springs (in pairs)
5. Vehicle not level	1) Vehicle loaded unevenly	Check load, redistribute if necessary
	2) Flat tyre	Change tyre
	3) Broken or weak coil spring	Replace coil springs (in pairs)
	4) Defective damper	Replace dampers (in pairs)

TABLE 2 REAR SUSPENSION PROBLEMS

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1. Noise from rear suspension	1) Spring not seated correctly	Use spring compressor to compress and re-seat.
	2) Broken leaf spring	Replace springs (in pairs).
	3) Spring pan locating pin dry	Remove spring and spring pan re-grease pin.
	4) Badly worn spring pan locating pin	Replace pin.
	5) Dampers touching coil springs, fitted incorrectly	Remove dampers, refit correctly.
2. Rattle from rear suspension	1) Defective damper	Replace dampers (in pairs).
	2) Damaged damper bush	Replace dampers (in pairs).
	3) Loose leaf spring U-bolt	Tighten bolts
3. Ride over cross-country is hard and uncomfortable	1) Tyres over/under inflated	Set to correct tyre pressure.
	2) Worn rubber hollow spring	Replace rubber hollow springs.
	3) Weak or worn leaf spring	Replace leaf springs (in pairs).
	4) Defective damper	Replace dampers (in pairs)
	5) Incorrect air shock absorber pressure (where fitted)	Set to correct pressure.
4. Excessive body roll	1) Defective damper	Replace dampers (in pairs).
	2) Weak leaf spring	Replace springs (in pairs)
	3) Incorrect air shock absorber pressure (where fitted)	Set to correct pressure.
5. Vehicle not level	1) Flat tyre	Change tyre
	2) Vehicle loaded unevenly	Check load, redistribute if necessary
	3) Broken or weak leaf spring	Replace leaf springs (in pairs)
	4) Defective damper	Replace dampers (in pairs)
	3) Incorrect air shock absorber pressure (where fitted)	Set to correct pressure.

CHAPTER 9

[redacted] TYRES FAILURE DIAGNOSIS

CONTENTS

Para

1 General information

Table

1 Tyre wear/damage 2
1 [redacted] 2

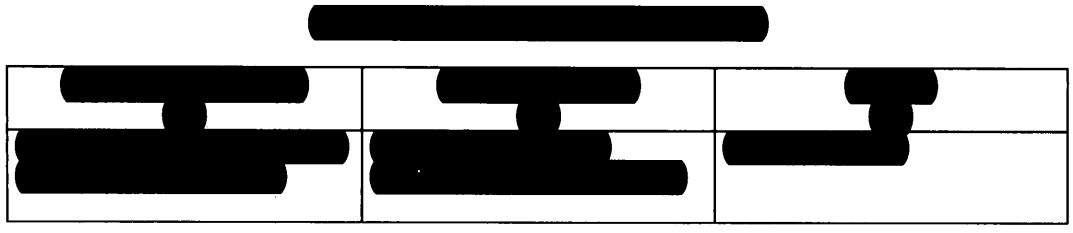
GENERAL INFORMATION

1. When diagnosing tyre failure, check all tyres for irregular wear or cuts. The location of the damage makes diagnosis and remedy very simple.

2. [redacted]

TABLE 1 TYRE WEAR/DAMAGE

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1. Tyres heavily worn out in tread centre	1) Excessive air pressure in tyres	Adjust pressure, replace tyres if necessary.
2. Tyres heavily worn out at tread outside edges	1) Insufficient air pressure in tyres	Adjust pressure, replace tyres if necessary.
	2) Incorrect track alignment	Check/adjust alignment.
3. Saw tooth formation at front wheel tread	1) Incorrect track alignment	Check/adjust alignment.
	2) Shock absorbers defective	Replace shock absorbers.
4. Saw tooth formation at rear wheel tread	1) Shock absorbers defective	Replace shock absorbers.
5. Rear tyres tread badly damaged and cut	1) Driving off road in 2 wheel drive	Select all wheel drive for off road use.
6. High level of wear on front tyres	1) Driving on paved surface in all wheel drive	Select 2 wheel drive for on road use.
7. Saw tooth formation on outside edge only of front tyres	1) Excessive cornering speed on paved surface	Reduce speed when cornering.
	2) Incorrect track alignment	Check/adjust alignment.



CHAPTER 10

ANTILOCK BRAKING SYSTEM FAILURE DIAGNOSIS

CONTENTS

Para

1 General information
2 Brake system warning lamps
3 Hand brake and low brake fluid level
4 ABS
6 EBD
7 ETC
8 Fault recording
10 Using the diagnostic controller with program card 446 300 783 0
13 Connecting the diagnostic controller to the vehicle diagnostic socket
14 Operation of the diagnostic controller (CAUTION)
20 Program card menu structure
21 ECU and modulator pin numbers and locations
22 Standard diagnosis procedures
24 Diagnostic memory
26 Component actuate (WARNING)
27 Measuring values
28 ECU data
29 System Check (WARNING)
32 Multimeter
34 Options
35 Advanced diagnosis procedures using program card 446 300 604 0
38 Program card menu structure
39 Connecting the diagnostic controller for the sensor probe test (WARNING) (CAUTIONS)
Diagnosis procedures using the program card
44 Pole wheel check
55 Test results
56 Speed test
58 Tooth counter
59 Multimeter
60 Options
61 Fault Diagnosis

Table Page

1 Multimeter measuring ranges 12
2 Generic braking problems 19
3 Hand brake problems 21
4 ABS problems 22
5 Typical diagnostic controller fault messages (446 300 783 0 program card) 23
6 Typical sensor probe test diagnostic controller fault messages (446 300 604 0 program card) 24
7 Functional faults in the diagnostic system 25

Fig Page

1 ABS hydraulic circuit 3
2 Diagnostic controller 5
3 Initial display screen 4
4 Diagnostic controller menu structure (446 300 783 0 program card) 4
5 ECU pin numbers, locations and inputs/outputs 6

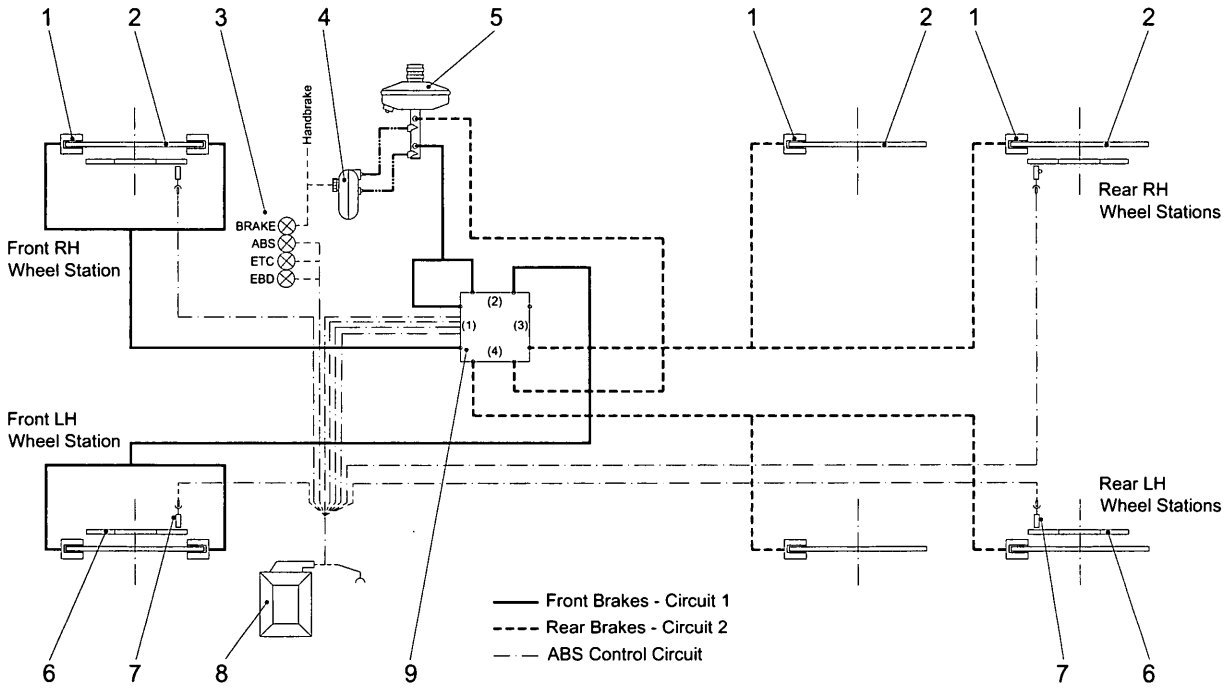
(continued)

CONTENTS (continued)

Fig		Page
6	Modulator pin numbers and locations	8
7	Diagnostic controller main menu	8
8	Diagnostic controller diagnosis menu	19
9	Diagnostic controller multimeter menu	11
10	Diagnostic controller menu structure (446 300 604 0 program card)	13
11	Sensor probe main menu	14
12	Pole wheel check menu	14
13	Pole wheel check service menu	15
14	Pole wheel check system menu	15
15	Pole wheel parameter menu (1)	15
16	Pole wheel parameter menu (2)	15
17	Pole wheel diameter menu	16
18	Commence pole wheel check display	16
19	Commence pole wheel check countdown display	16
20	Pole wheel check activity display	16
21	Pole wheel check evaluation display	17

GENERAL INFORMATION

1 This Chapter details the procedures for using the ABS fault diagnosis equipment in addition to traditional fault finding procedures on the vacuum, hydraulic and mechanical elements of the braking system. When diagnosing brake system failure, first determine whether the cause is vacuum, hydraulic, mechanical or electrical. Fault diagnosis tables are provided later in this chapter. Check all possible causes under the relevant heading before trying the most likely (or simplest to rectify) ones first.



1	Brake calliper	6	Pole wheel
2	Brake disc	7	Sensor
3	Brake system warning lamps	8	Electronic Control Unit
4	Fluid reservoir with loss indicator	9	Modulator
5	Servo unit and tandem master brake cylinder		

Fig 1 ABS hydraulic circuit

BRAKE SYSTEM WARNING LAMPS

2 The majority of faults will first be presented via the four warning lamps located in the drivers display panel.

Hand Brake And Low Brake Fluid Level

3 As fitted on a non-ABS Pinzgauer, a combined red warning lamp is provided. The purpose of the lamp is to indicate that the hand brake is "ON" or the brake fluid is low.

ABS

4 The purpose of the amber ABS warning lamp is to display a malfunction of the electronic or electrical ABS components or of the entire system. A self-test of the ECU and the connected electrical circuits is performed when the ignition is switched on.

5 The lamp comes on when the ignition is switched on. It then goes out for about 2 seconds and comes back on until all wheels with sensors have exceeded a road speed of 7 km/h for the first time. This

provides an optical indicator that the system self-test has been performed successfully. If the 1 second lamp off phase does not take place, this means a fault has been detected first and stored in the ECU memory. If a fault is currently present, the lamp remains continuously lit even when the vehicle is driving.

EBD

6 The purpose of the red EBD warning lamp is to display a malfunction of the electronic or electrical ABS components or that a fluid error has occurred. If a serious fault occurs, both the EBD and the ABS warning lamp come on.

ETC

7 The ETC function is available between 0 and 50 km/h, as soon as the ignition is switched on and the ECU has completed its self-test. An amber display lamp indicates when the ETC function is operating. If a fault occurs, both the ETC and the ABS warning lamp come on.

FAULT RECORDING

8 The ECU signals to the driver via the warning lamps if there are any messages and, if necessary, switches off the control of one wheel, both diagonally opposed wheels or, in certain circumstances, the entire ABS system. The brake system remains fully functional in this case, it is merely that the anti-lock function is partially or fully unserviceable – in this event the EBD function will not operate and the vehicle should be driven with care. The ETC function is unavailable whenever a fault is detected in the wiring or system components (but there may still be partial anti lock functionality).

9 Messages are permanently saved in the electronic control unit for diagnostic purposes. It is possible to read out and delete the message memory using the diagnostic connection and diagnostic controller.

USING THE DIAGNOSTIC CONTROLLER WITH PROGRAM CARD 446 300 783 0

10 The diagnostic controller is a computer which can exchange data with the ABS ECU. Data exchanged includes stored fault messages in the ECU and commands sent by the controller to the ECU which trigger certain procedures. A special program is needed in order to communicate with an ECU. The program is stored on the corresponding program card. The program card must match the ECU!

11 In addition to the corresponding program card the diagnostic controller must be used with a diagnostic cable and, for sensor fault diagnosis (see para. 35), a sensor probe, diagnostic cable and diagnostic sensor probe program card.

12 Although users of the diagnostic equipment should react to the program prompts, typical problems, cause and action arising from the diagnostic controller interrogation of the ABS are provided in Table 6.

Connecting The Diagnostic Controller To The Vehicle Diagnostic Socket

13 The diagnostic connector is located on the ABS control board which is situated on the forward side of the vehicle cab rear bulkhead, behind the passenger's seat. To access the control board, remove the front cover. Attach one end of the connection cable (8001370170) to the diagnostic controller and the other end to the diagnostic connection in the vehicle. The connection cable provides both the diagnostic connection and power supply to the diagnostic controller. The vehicle ignition does not need to be switched on.

Operation of the Diagnostic Controller

14 The diagnostic controller is operated by pressing the three operating push-buttons on the front of the unit (Fig 2/1). The function of the buttons depends on the instructions appearing in the display above the push-buttons (Fig 2/2).

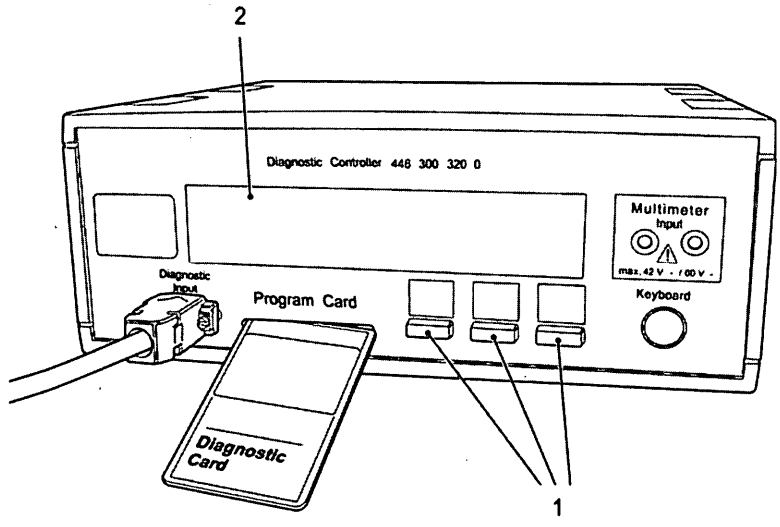


Fig 2 Diagnostic Controller

15 Examples of the different push button functions are shown below:

START	Initiate program
EXIT	The display will return to the last main menu
↓	Select an item from the main menu. Scroll forward one item at a time by pressing the push-button. The item selected will flash.
CONT(INUE)	The menu item selected is triggered, (i.e. activated).
ACTIVATE	While pressing the push-button the component will be activated.
ON/OFF	While pressing the push-button the component will be switched on/off.
YES/NO	Activating the push-button will answer a question
REPEAT	Repeat a function once more.

16 When the diagnostic controller is connected to the vehicle black bars will appear on the display.

17 Insert the program card into the slot provided for it (Fig 2). The contact side of the card must face upwards. The program card should be handled with care to avoid damage to the contact surface.

CAUTION.

PROGRAM CARD DAMAGE. Do not pull the card hard to remove it. If a resistance is felt, push the end of the card upwards lightly with the thumb, whilst pressing downwards lightly with the index and middle fingers

18 Switch on the vehicle ignition to position 2.

19 The following display (or similar) appears. If this is not the case refer to Functional Faults in the Diagnostic System (Table 7).

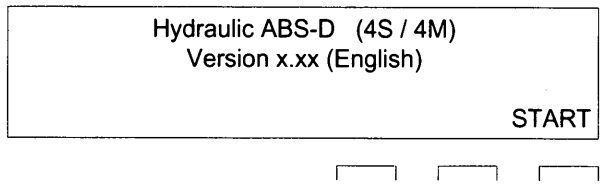


Fig 3 Initial Display Screen

Program Card Menu Structure

20 The menu structure for the standard program card is provided below.

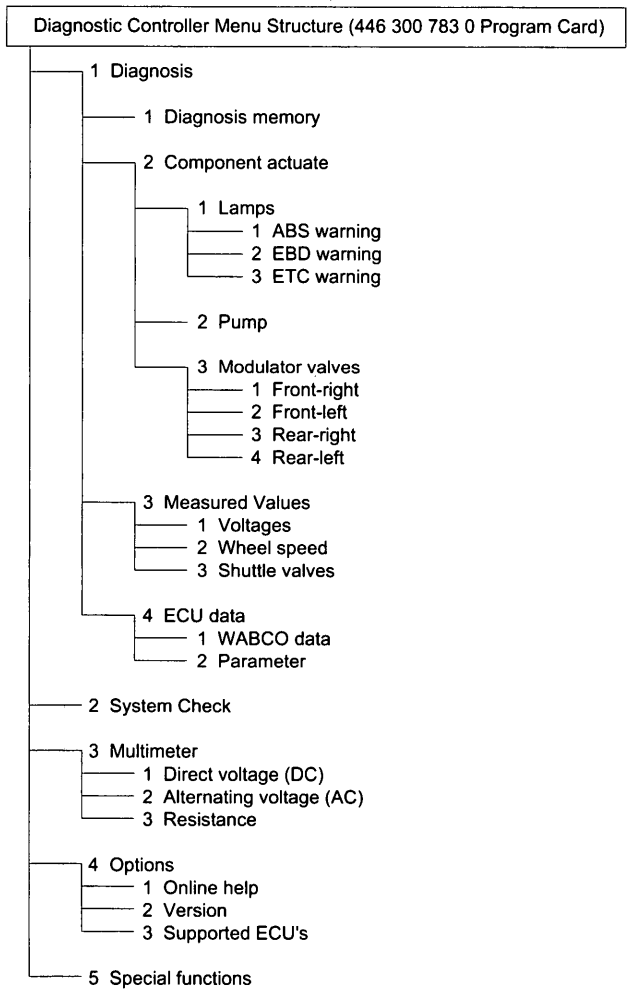
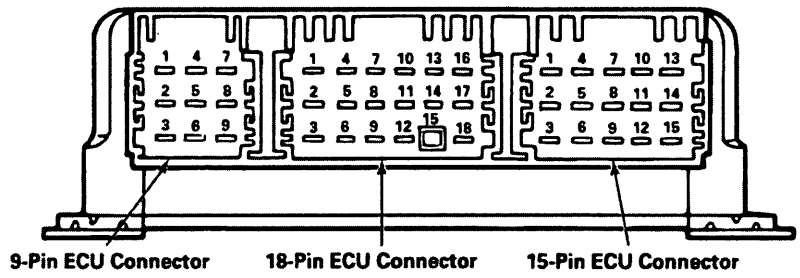


Fig 4 Diagnostic Controller Menu Structure (446 300 783 0 Program Card)

ECU and Modulator Pin Numbers and Locations

21 ECU and modulator pin references referred to in the remainder of this document are provided in Fig 5 and Fig 6.



9 Pin ECU Connector (X1)

Pin No.	Circuit Description
1	Left Front Sensor
2	Left Front Sensor
3	Right Rear Sensor
4	Right Front Sensor
5	Right Front Sensor
6	Right Rear Sensor
7	Left Rear Sensor
8	Left Rear Sensor
9	Not Used

18 Pin ECU Connector (X2)

Pin No.	Circuit Description
1	+12v Battery
2	+12v Ignition
3	Not Used
4	Not Used
5	K Line
6	Not Used
7	Not Used
8	Modulator Pump Monitor
9	EBD Warning Lamp
10	Not Used
11	Not Used
12	Ground
13	ETC Warning Lamp
14	Not Used
15	Jumper
16	Not Used
17	Not Used
18	ABS Warning Lamp

15 Pin ECU Connector (X3)

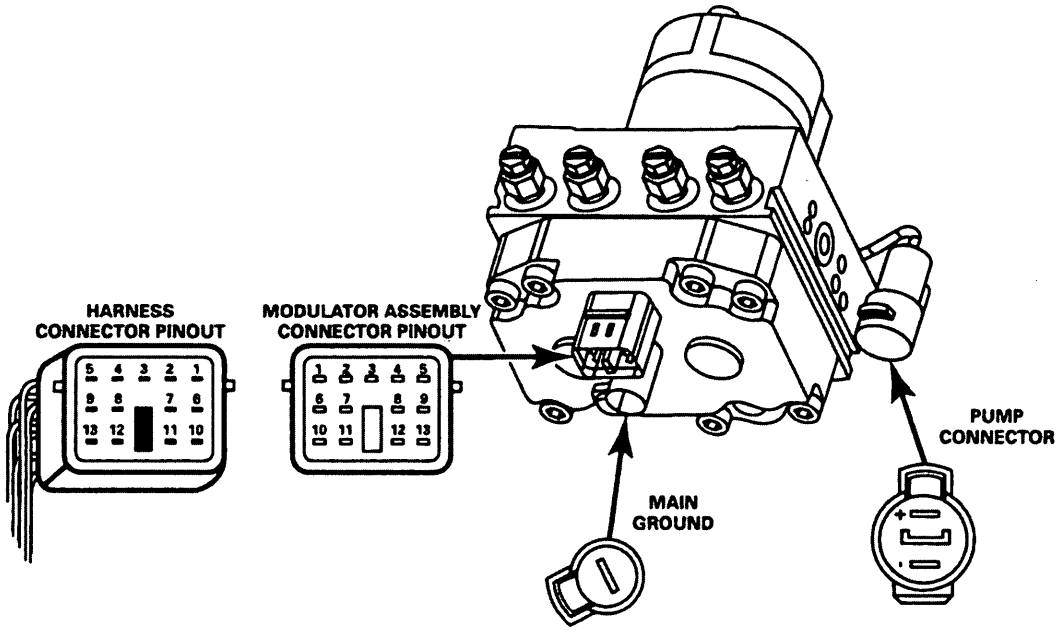
Pin No.	Circuit Description
1	Left Front Outlet Valve
2	Left Front Inlet Valve
3	Ground
4	Right Front Outlet Valve
5	Right Front Inlet Valve
6	Shuttle Valve Switch
7	Left Rear Outlet Valve
8	Left Rear Inlet Valve
9	Not Used
10	Right Rear Outlet Valve
11	Right Rear Inlet Valve
12	Not Used
13	Not Used
14	Not used
15	Modulator Pump Relay

ECU Inputs and Outputs

Inputs	Pin No.	Outputs	Pin No.
Wheel speed sensor front left	X 1 pin 1, X 1 pin 2	EBD warning light	X 2 pin 9
Wheel speed sensor front right	X 1 pin 4, X 1 pin 5	ABS warning light	X 2 pin 18
Wheel speed sensor rear left	X 1 pin 7, X 1 pin 8	Outlet valve front left	X 3 pin 1
Wheel speed sensor rear right	X 1 pin 3, X 1 pin 6	Inlet valve front left	X 3 pin 2
Battery voltage supply	X 2 pin 1	Outlet valve front right	X 3 pin 4
Ignition voltage supply	X 2 pin 2	Inlet valve front right	X 3 pin 5
Reference earth	X 3 pin 3	Outlet valve rear left	X 3 pin 7
Switch for shutoff valve	X 3 pin 6	Inlet valve rear left	X 3 pin 8
Modulator pump monitoring	X 2 pin 8	Outlet valve rear right	X 3 pin 10
Electronics earth	X 2 pin 12	Inlet valve rear right	X 3 pin 11
		ETC warning light	X 3 pin 13
		Pump relay	X 3 pin 15

Fault number	Pin No.
K-line	X 2 pin 5

Fig 5 ECU Pin Numbers, Locations and Inputs/Outputs



Pin No.	Circuit Description	Pin No.	Circuit Description
1	Outlet Valve Front Left	8	Reference Ground
2	Inlet Valve Front Left	9	-----
3	-----	10	Outlet Valve Front Right
4	Inlet Valve Rear Right	11	Inlet Valve Front Right
5	Outlet Valve Rear Right	12	Inlet Valve Rear Left
6	-----	13	Outlet Valve Rear Left
7	-----		

Fig 6 Modulator Pin Numbers and Locations

Standard Diagnosis Procedures

22 Let the cursor flash on "1" and press the start key (see Fig 7).

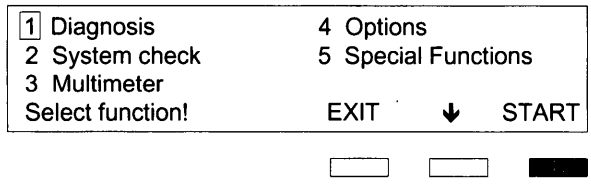


Fig 7 Diagnostic Controller Main Menu

23 When selecting the diagnostic function, communication with the ABS ECU is established. When this has been achieved, the data of the ABS ECU is shown on the display. When ready press CONT to continue in the diagnostic mode. 4 diagnostic functions are now available for selection (see Fig 8).

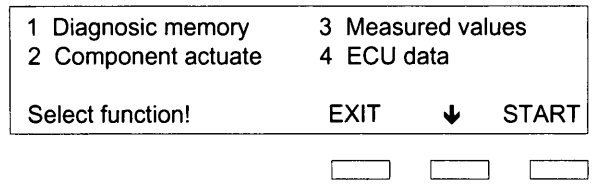


Fig 8 Diagnostic Controller Diagnosis Menu

Diagnostic Memory

24 If the ABS ECU has recognised a fault in the system, this function helps locate the fault. The following appears on the display:

24.1 Display of the error in plain text

24.2 Information on whether the error currently exists or not. If not, the display shows how often it occurred.

24.3 To assist in repairs, repair information may be selected and displayed.

25 If the repair button has been pushed for all errors, the error memory is deleted automatically. Following this, the ignition has to be switched off and on again to allow the ECU to recognise any errors present. The error memory will be read again and any errors still stored displayed and resolved.

Component Actuate

WARNING

DANGER TO LIFE AND LIMB – HIGH PRESSURE BRAKE FLUID. ENSURE THAT THE FLOOR PLATE AND MODULATOR COVER IN THE DRIVERS FOOT WELL (SEE 2320-D-503-522 CHAPTER 10) ARE IN PLACE AND SECURE PRIOR TO PERFORMING THE COMPONENT ACTUATE TESTS.

26 "Actuate" is used to interrogate and make sure that certain components within the ABS system and wiring are in good working order. This function may be used to test the operation of a current or replaced component. The following components may be tested:

Warning Lamps

26.1 The function of the ABS, EBD and ETC warning lamps is checked.

NOTE

The function of the combined hand brake and low brake fluid warning lamp is not checked by this function.

26.2 When entering the menu point, the warning lamps are on. After the selection of one lamp the buttons "ON" and "OFF" are available in order to switch this lamp. Finally the warning lamp is illuminated again.

Pump

26.3 The pump should only be activated after the system has been charged with fluid. The hydraulic pump should be activated for no longer than 12 seconds. The sound of the pump operating will be heard. At the same time, the voltage at the return (X2 Pin 8) is measured. If this voltage is too low, the pump is switched off immediately (<10V after 30 milliseconds) and an error message will be returned.

Solenoid Valves

26.4 By means of a pulse program the function of all four solenoid valves (within the modulator assembly) can be tested. The correct assignment as well as the hydraulic and electrical connections are checked. The procedure for testing the solenoid valves is provided in following paragraphs.

26.4.1 The test must be performed on a brake test rig with individual wheel control, or with the aid of an assistant and vehicle on axle stands at a sufficient height to permit free rotation of each wheel station.

26.4.2 During the test the diagnostic controller will display prompts when to apply hold the foot brake on or release, and when to turn a particular wheel station.

Test Sequence

26.4.3 Test Step T1. The pump is started after the brake is applied.

26.4.4 Test Step T2. The inlet solenoid valve is closed 5 seconds later and user is prompted to attempt to rotate the appropriate wheel, which should be braked. The program cancels the test if the user does not confirm this within 10 seconds.

26.4.5 Test Step T3. The outlet valve is opened and the user is prompted to rotate the wheel, which should be free. The program cancels the test if the user does not confirm this within 10 seconds.

NOTE

The test result is a fail if no speed > 1.9 km/h was detected at the wheel station being tested during Test Step T3.

26.5 Problems and action arising from the solenoid valve test are included in Table 4.

Measuring Values

27 In this part of the diagnostic program, various measuring values provide by the ECU can be displayed.

Voltages

27.1 The voltages on the reference ground pin (X3 Pin 3) and the supply voltages of the ECU (X2 Pin 2) and of the valves (X2 Pin 1) are displayed. The voltages are measured on the terminals of the ECU.

Wheel speeds

27.2 All four wheel speeds picked up by the speed sensors (mph) are displayed. Speeds are not displayed until a speed of 1.7 km/h has been reached.

Shuttle valve switches

27.3 The functionality of the shuttle valve switches can be checked. The brake pedal must be applied until both switches are actuated during this test. The status of the shuttle valve switches is displayed.

ECU Data

28 Various ECU data is displayed by this part of the diagnostic program including ECU series numbers

NOTE

The testing procedures are identical for both "Service" and "System Check". However if "System Check" is selected the program takes into account that tolerances are smaller for new components, and more stringent testing criteria is applied.

46 After selecting item No. 1 or 2, one of the following two displays will appear.

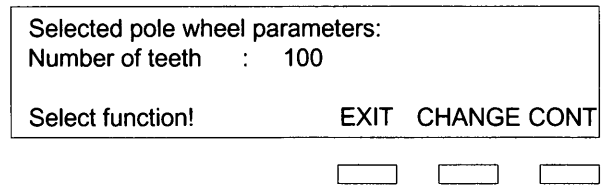


Fig 13 Pole Wheel Check Service Menu

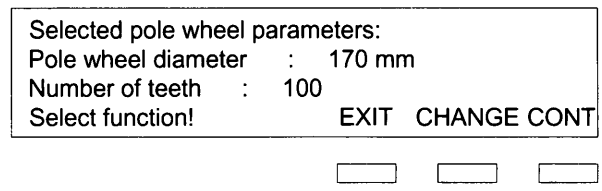


Fig 14 Pole Wheel Check System Menu

47 Due to the more stringent "System Check testing criteria it is necessary to enter the pole wheel diameter. To obtain accurate results, the number of teeth must always be entered.

NOTE

If a program request for a Pulse Duty Factor is made, always use the default value of 0.55.

48 On either menu, if the pole wheel parameters are right, press the "CONT" key in order to initiate or continue the pole wheel check, otherwise push the "CHANGE" button to change to one of the following menus.

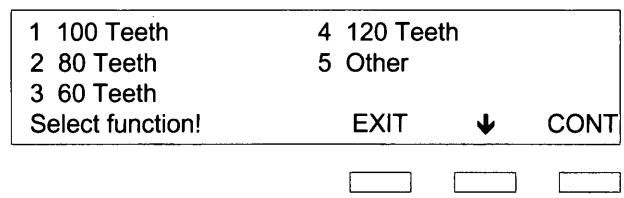


Fig 15 Pole Wheel Parameter Menu (1)

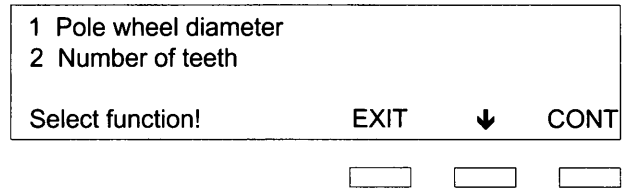


Fig 16 Pole Wheel Parameter Menu (2)

49 If item 1 of the pole wheel parameter menu (2), (Fig 16) is selected, the display may, for example, show the following:

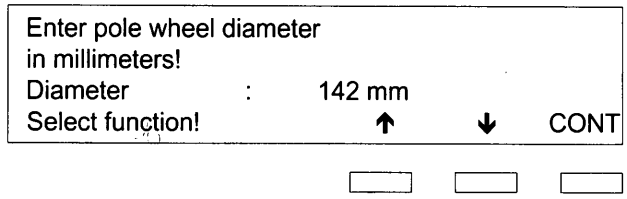


Fig 17 Pole Wheel Diameter Menu (2)

50 The Pinzgauer pole wheel diameter is 161 mm. By pressing the left hand or centre key, the correct diameter can be selected. When the correct diameter is displayed, press the "CONT" key to proceed.

51 If item 2 of the pole wheel parameter menu (2), (Fig 16) is selected, the number of teeth for the pole wheel can be selected. The Pinzgauer pole wheel has 100 teeth, which can be entered directly by selecting item 1 on the menu.

52 Once the pole wheel diameter or number of teeth have been selected press the "EXIT" key in order to begin or continue the pole wheel check. Follow all the instructions appearing in the display and then press the "CONT" key. The following display (Fig 18) will appear.

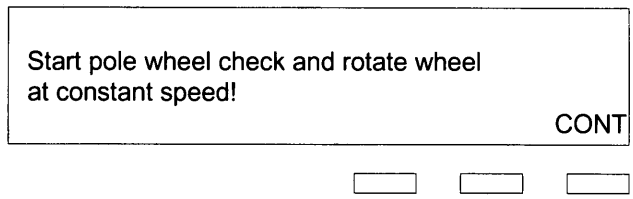


Fig 18 Commence Pole Wheel Check Display

53 After pressing the "CONT" key, the following display (Fig 19) will appear and a countdown of 5 seconds begins prior to the check being started. In order to achieve optimum test results, the wheel should be turned at as constant a speed as possible. The check will take approximately 2 to 6 seconds during which the activity display (Fig 20) will be shown.

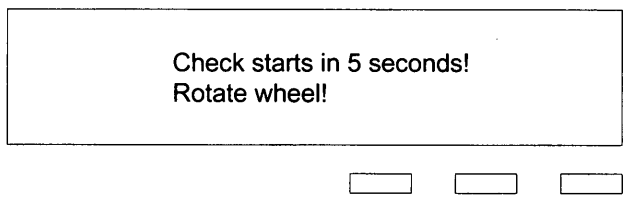


Fig 19 Commence Pole Wheel Check Countdown Display

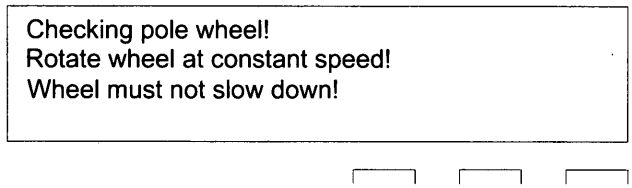


Fig 20 Pole Wheel Check Activity Display

54 When sufficient data has been collected the concluding display (Fig 21) will appear. When this display appears wheel rotation can stop. The evaluation of data collected will require a few seconds, and

then the result of the pole wheel check will then appear on the display in written form. Although users of the diagnostic equipment should react to the program prompts, typical problems, cause and action arising from the diagnostic controller interrogation of the sensor/pole wheel are provided in Table 6.

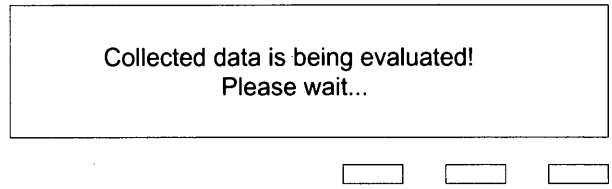


Fig 21 Pole Wheel Check Evaluation Display

Test Results

55 The findings of the pole wheel check can be either displayed or printed (see para 31 for printer requirements) by following the on-screen prompts. Select No.2 from the main menu (Fig 10) to display check results.

Displaying Results

55.1 The results of the pole wheel check will be shown on the display of the diagnostic controller. To proceed through the test results available, press the "CONT" key.

Speed Test

56 Select No.3 from the main menu (Fig 10) to commence the Speed test. This is suitable for testing proper connection of the ABS sensor. If the ABS sensor is too weak, or not present at all the message "Sensor Voltage Too Low" will be displayed (see table 6).

57 The speed at which the pole wheel turns during the test will be displayed in rpm. The test must be performed with the wheel being rotated at a constant speed corresponding to between 5 and 20 kph. Any deviation outside the tolerance band will result in the pole wheel number of teeth being displayed.

Tooth Counter

58 Menu item No. 4 (Fig 10) is selected when the number of the teeth is unknown and the information is required to support other tests. The Pinzgauer pole wheel has 100 teeth and therefore use of this menu item should not be necessary.

Multimeter

59 The sensor check program card 446 300 604 0 includes an integrated multimeter function (menu item No. 5 (Fig 10)) that permits electric measurements on the vehicle in the same way as the function on the standard diagnostic controller program card 446 300 783 0. Para 32 refers.

Options

60 The sensor check program card is also provided with the following options (menu item No. 6 (Fig 10)).

Online Help

60.1 This function enables the user to obtain additional information on the diagnostic controller program. When the function is switched on, more detailed information will appear where appropriate.

Version

60.2 This operation displays the version of the diagnostic controller and program card being used.

FAULT DIAGNOSIS

61 When diagnosing brake system failure, first determine whether the cause is vacuum, hydraulic, mechanical or electrical. Check all possible causes under the relevant heading before trying the most likely (or simplest to rectify) ones first.

62 Fault diagnosis of the braking system is provided in the following tables:

62.1 Table 2. Generic Braking Problems

62.2 Table 3. Hand Brake Problems

62.3 Table 4. ABS Problems

62.4 Table 5. Typical Diagnostic Controller Fault Messages (446 300 783 0 Program Card)

62.5 Table 6. Typical Diagnostic Controller Fault Messages (446 300 604 0 Program Card)

62.6 Table 7. Functional Faults in the Diagnostic System

TABLE 2 GENERIC BRAKING PROBLEMS

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Hand brake and low brake fluid level illuminates.	a) Hand brake not entirely released.	Push hand brake lever down fully.
	b) Insufficient brake fluid in compensation reservoir.	Check brake system and repair if necessary. Top up brake fluid.
	c) Switch for hand brake release defective.	Replace switch.
	d) Brake pads worn.	Replace brake pads as necessary.
	e) Brake fluid compensation reservoir switch defective.	Check switch, replace if necessary.
2 Insufficient braking effect.	**Vacuum Fault**	
	a) Insufficient vacuum in brake system.	Check vacuum, find leak and replace defective section.
	b) Vacuum pump defective.	Replace pump.
	c) Pipe between vacuum pump and brake unit crushed or leaking.	Replace pipe.
	d) Non-return valve clogged.	Replace valve.
	e) Diaphragm torn.	Replace brake unit.
	Hydraulic Fault	
	a) Air in brake hydraulic system.	Bleed system.
	b) Brake pads oiled or worn.	Check brake system for leakage, replace brake pads/ discs if necessary.
	c) Master cylinder defective.	Check master cylinder, overhaul/replace if necessary
	d) Brake calliper defective.	Check brake calliper, overhaul/replace if necessary.

(continued)

TABLE 2 GENERIC BRAKING PROBLEMS (continued)

Indicator/symptom (1)	Possible cause (2)	Action (3)
3 Irregular braking effect.	a) Piston of one brake calliper sticks.	Replace/overhaul defective brake calliper.
	b) Brake pads oiled or glazed on one side of wheel brakes.	Replace brake pads.
	c) Tyres worn unequally.	Replace tyres.
	d) Unequal tyre pressure.	Correct tyre pressure.
	e) Master cylinder defective.	Check master cylinder, overhaul/replace if necessary.
	f) Brake calliper defective.	Check brake calliper, overhaul/replace if necessary.
	g) Brake pipes/hoses leaking.	Check brake pipes and hoses for leakage. Repair/ replace if necessary.
4 Insufficient braking effect and long pedal travel.	a) Brake pipe of one brake circuit damaged.	Replace brake pipe and bleed system.
	b) Master cylinder defective.	Check master cylinder, overhaul/replace if necessary.
	c) Brake calliper defective.	Check brake calliper, overhaul/replace if necessary.
	d) Brake pads worn.	Check/replace pads.
5 No braking effect, free travel of brake pedal until stop.	a) Brake master cylinder sleeves leaking.	Replace master cylinder.
	b) Brake calliper leakage.	Replace brake calliper.
	c) Brake pipes or brake hoses.	Replace brake pipes or hoses.
	e) Brake fluid compensation reservoir leakage.	Replace reservoir.
7 Brake squeaks.	a) Worn brake pads or brake disc.	Check/replace brake pads or discs.
	b) Stones trapped in brake calliper.	Clean/replace calliper.
8 Loss of brake fluid.	a) Brake system leakage.	Check/replace leaking pipes and hoses. Bleed system.
9 Brake lights do not light up when actuating brake pedal or light permanently.	a) Brake light switch defective.	Replace switch.
	b) Short circuit in electric system.	Check brake light electrical system. Replace faulty wires.

(continued)

TABLE 2 GENERIC BRAKING PROBLEMS (continued)

Indicator/symptom (1)	Possible cause (2)	Action (3)
10 Brake lights do not light up when brake pedal actuated.	a) Brake light switch defective.	Replace switch.
	b) Fuse defective.	Check/replace fuse.
	c) Lamps defective.	Check/replace lamps.

TABLE 3 HAND BRAKE PROBLEMS

Indicator/symptom (1)	Possible cause (2)	Action (3)
1 Hand brake does not release.	a) Hand brake cable sticking.	Replace cable.
2 Hand brake does not work.	a) Lining discs oiled/worn or burned.	Replace sealing ring in rear axle journal. Replace lining discs.
3 Vehicle driven with hand brake on.	a) Linings burnt. Casing and discs cracked.	Replace sealing ring in rear axle journal. Replace casing discs.
4 Hand brake lever travel too far.	a) Lining discs worn.	Replace lining discs.
	b) Hand brake incorrectly set.	Adjust hand brake.

TABLE 4 ABS PROBLEMS

Indicator/symptom (1)	Possible cause (2)	Action (3)
1 Brake pulsing noted at brake pedal.	a) ABS control active	No action required.
2 ABS warning lamp illuminates.	a) Malfunction of ABS components.	Connect diagnostic controller and interrogate system.
3 EBD warning lamp illuminates.	a) Malfunction of ABS components.	Connect diagnostic controller and interrogate system.
4 ETC warning lamp permanently illuminated.	a) Malfunction of ABS components.	Connect diagnostic controller and interrogate system.
5 Wheels lock during braking although ABS warning lamp is out.	a) ABS warning lamp defective	Connect diagnostic controller and interrogate system. Replace bulb as necessary
	b) System fault	Connect diagnostic controller and interrogate system.
6 Wheels spin under throttle conditions although ETC warning lamp is out.	a) ETC warning lamp defective	Connect diagnostic controller and interrogate system. Replace bulb as necessary
	b) System fault	Connect diagnostic controller and interrogate system.
7 Rear wheels lock during braking although EBD warning lamp is out.	a) EBD warning lamp defective	Connect diagnostic controller and interrogate system. Replace bulb as necessary
	b) System fault	Connect diagnostic controller and interrogate system
8 Modulator pump runs continuously.	a) System fault	Connect diagnostic controller and interrogate system
9 During solenoid valve test, activation has no effect on the activated valve, and/or there are deviations from the pulse program.	a) Electrical connection of two solenoid valves incorrect	Check connections
	b) Connection of cables for inlet valve and outlet of a particular solenoid valve incorrect	Check cable connections.
	c) Hydraulic connections incorrect	Check hydraulic connections
	d) Defective solenoid valve	Replace ECU

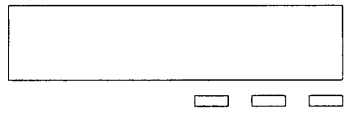
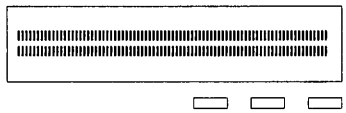
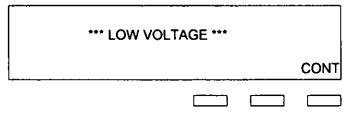
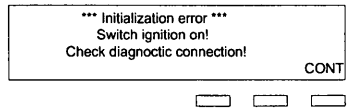
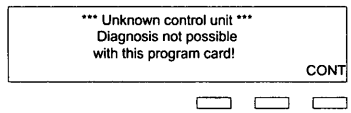
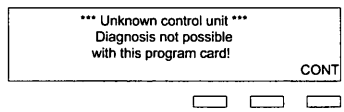
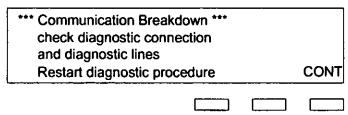
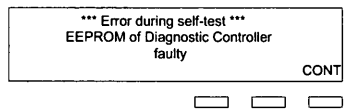
TABLE 5 TYPICAL DIAGNOSTIC CONTROLLER FAULT MESSAGES (446 300 783 0 PROGRAM CARD)

System Area (1)	Possible cause (2)	Action (3)
1 ECU	a) Electrical wiring fault	Check cabling and connections.
	b) System fault	Replace ECU if fault reoccurs after error memory has been cleared
2 Modulator	a) There is a permanent or temporary disconnection / short to battery + or earth in the inlet valve or outlet or a shared cable.	Check cabling and connections.
3 Modulator earth connection	a) There is a permanent or temporary disconnection / short to positive in the earth connection.	Check cabling and connections.
4 Sensor air gap	a) Amplitude of the signal is too low.	Check the bearing play and run out of the pole wheel. Check condition of pole wheel and sensors and sensor gap. Check cables. If inconclusive, perform full sensor test using sensor check probe. Replace faulty items as necessary.
5 Sensor short circuit/open circuit	a) An open circuit, short to battery + or earth or between the sensor cables is detected.	Check cables. Check condition of pole wheel and sensors and sensor gap. If inconclusive, perform full sensor test using sensor check probe. Replace faulty items as necessary.
6 Modulator pump monitoring defective	a) Pump or cabling faulty.	Check pump operation and cables. Replace faulty items as necessary.
7 Modulator pump will not switch off	a) Pump or cabling faulty.	Check pump operation and cables. Replace faulty items as necessary.
8 Modulator pump sticking	a) Pump faulty.	Check pump operation and cables.
9 Modulator pump relay fault (sticking)	a) Relay faulty.	Check the pump relay. Replace faulty items as necessary.
10 Internal ECU error	a) System fault.	Replace ECU if the fault reoccurs after error memory has been cleared.

TABLE 6 TYPICAL SENSOR PROBE TEST DIAGNOSTIC CONTROLLER FAULT MESSAGES (446 300 604 0 PROGRAM CARD)

System Area (1)	Possible cause (2)	Action (3)
1 ABS sensor voltage too low	a) Sensor is not connected to sensor probe.	Check sensor/probe connection and re-run test.
	b) Sensor or pole wheel is not fitted at wheel station	Check sensor/pole wheel installation and re-run test.
	c) During test, wheel is being turned too slowly or not at all.	Re-run test at correct wheel speed.
	d) Air gap between sensor and pole wheel probably too large.	Check air gap. Adjust as necessary.
	e) Sensor faulty.	Replace sensor.
2 Pole wheel failure detected	a) Air gap between pole and sensor varies too much. Maximum, minimum and average root mean square voltages (Vrms) will be displayed. The ratio of maximum and minimum voltage (bottom line of the display) is an indication of variance in the ABS sensor air gap in the course of one revolution of the wheel. If the air gap is constant, this value will be exactly 1.0.	Check the bearing play and run out of the pole wheel. Check condition of pole wheel and sensors and sensor gap. Check cables. Replace faulty items as necessary.
3 Pole wheel failure detected	a) Defect in pole wheel tooth form has occurred.	Replace pole wheel.

TABLE 7 FUNCTIONAL FAULTS IN THE DIAGNOSTIC SYSTEM

Diagnostic Display (1)	Possible cause (2)	Action (3)
	a) No voltage supply.	Check all plugs and connections.
	b) Under voltage (less than about 7 volts).	Check supply voltage. Ensure adequate supply.
	a) Program card not inserted.	Insert / check insertion of program card
	a) Supply voltage too low (only during diagnostic operation)	Check supply voltage. Ensure adequate supply.
	a) Insufficient supply voltage (< 8 volts)	Check supply voltage. Ensure adequate supply.
	b) No supply voltage (ignition off)	Switch on ignition.
	c) Diagnostic line switched or disconnected	Check lines and connections for function and proper allocation.
	a) Wrong ECU connected.	Check ECU part number.
	b) Wrong data in ECU or ECU defective.	Change ECU.
	a) Wrong ECU/program card combination	Check program card and compatibility with ECU (in Options menu). Change program card.
	a) Data transmission disconnected during test.	Check all connections and restart diagnostic procedure.
	b) Diagnostic line or voltage disconnection during diagnosis.	Check diagnostic supply voltage. Ensure adequate supply. Turn off and vehicle ignition to position 2 and restart diagnostic procedure.
	c) Critical error in diagnostic operation.	Restart diagnostic procedure.
	a) Memory of diagnostic controller faulty.	Replace diagnostic controller

CHAPTER 11

FUEL AND EXHAUST SYSTEM FAILURE DIAGNOSIS

CONTENTS

Para

1 General Information

GENERAL INFORMATION

1 Fuel and exhaust system failure diagnosis is provided in Chapter 1.

CHAPTER 12

COOLING SYSTEM FAILURE DIAGNOSIS

CONTENTS

Para

1 Introduction

Table Page

1 Cooling system faults 2
2 Electromagnetic fan clutch system faults 5

Fig Page

1 Cooling system 6

INTRODUCTION

1 When diagnosing a cooling system failure, establish the symptoms and find the relevant section of the table. Check all the possibilities in order of simplicity until the cause is found.

TABLE 1 COOLING SYSTEM FAULTS

Indicator/symptom (1)	Possible Cause (2)	Action (3)
1 Loss of coolant	a) Coolant system leaks	Check hoses and pipes for leakage, rectify as necessary
	b) Water pump leakage	Check/replace gasket or water pump
	c) Heat exchanger or heater valve leakage	Check/replace heat exchanger or heater valve
	d) Thermostat housing leakage	Check/replace housing
	e) Oil cooler leakage	Check/replace cooler
	f) Radiator leakage	Check/replace radiator
	g) Filler cap of expansion reservoir defective	Replace filler cap
	h) Cracks on cylinder head	Remove and check cylinder head Replace if necessary
	i) Cylinder head gasket failure	Replace gasket
	j) Core plugs on engine block leaking or displaced	Replace core plugs
	k) Cracks on engine block	Replace engine block
	l) Expansion reservoir leakage	Change reservoir
2 Excessive pressure in cooling system	a) Expansion reservoir filler cap defective	Check/replace filler cap
	b) Cylinder head gasket leakage	Remove cylinder head and replace gasket
	c) Cracks on cylinder head	Check cylinder head for cracks Replace if necessary
	d) Cracks on engine block	Replace engine block
3 Insufficient pressure in cooling system.	a) Filler cap leaking or defective	Replace filler cap
	b) Insufficient operating temperature	Check/replace thermostat
	c) Bypass valve open	Close valve

(continued)

TABLE 1 COOLING SYSTEM FAULTS (continued)

Indicator/symptom (1)	Possible cause (2)	Action (3)
4 High coolant temperature	a) Low coolant level or restricted radiator matrix	Check/top up coolant level, clean radiator matrix If necessary, flush engine cooling system
	b) Defective water pump	Replace pump
	c) Defective thermostat	Test thermostat and replace if necessary
	d) Broken or insufficiently tensioned fan (FEAD) belt	Replace/tension fan belt
	e) Defective electromagnetic fan clutch system	Investigate electromagnetic fan clutch/controller/sender unit Replace faulty unit as necessary See Table 2
	f) External coolant leaks/air in cooling system	Examine system for leakage, repair/ replace if necessary
	g) Sediment in radiator	Clean out lime and scale from radiator and heat exchanger with suitable agent (follow manufacturer's instructions) Observe correct ratio of coolant/water mix
	h) Excessive towing weight (trailer operation)	Observe maximum towing weight
	i) Excessive load	Observe maximum total weight
	j) Driving in wrong gear	Select correct gear
	k) Intercooler matrix obstructed	Clean/replace intercooler
	l) Fuel injection pump timing incorrect	Check/adjust pump timing
	m) Damaged fan blades	Replace fan blades as necessary
	Lubrication System Fault	
	n) Low engine oil level	Check/top up engine with correct specification oil
	Mechanical Fault	
	o) Cylinder head gasket failure	Replace gasket
	p) Cylinder head damaged	Replace cylinder head

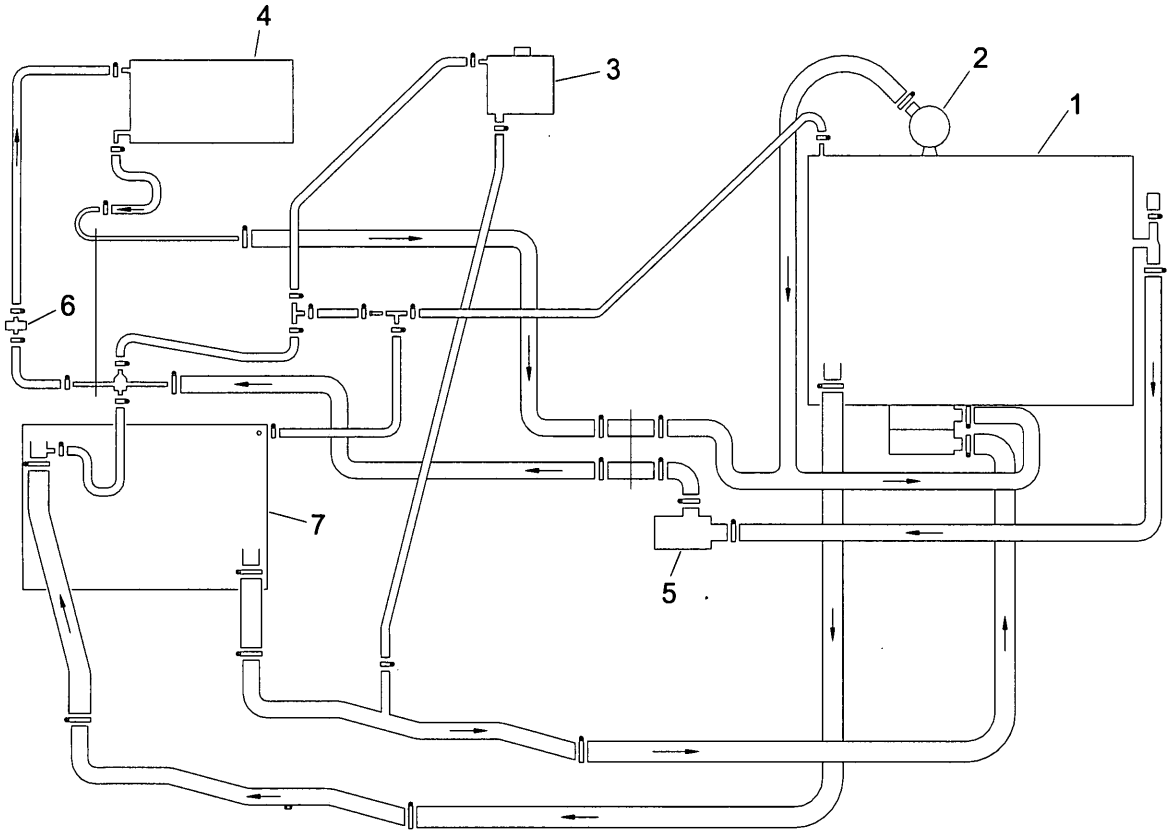
(continued)

TABLE 1 COOLING SYSTEM FAULTS (continued)

Indicator/symptom (1)	Possible cause (2)	Action (3)
5 Low coolant temperature	a) Defective thermostat	Test thermostat and replace if necessary
	b) Defective electromagnetic fan clutch system	Investigate electromagnetic fan clutch/controller/sender unit Replace faulty unit as necessary See Table 2
	c) Bypass valve at thermostat open	Check/ close bypass valve
	d) Temperature indicator defective	Check temperature control sender
6 Oil in cooling water.	a) Oil cooler leaking	Replace cooler
	b) Cylinder head gasket failure	Remove cylinder head, replace gasket
	c) Cylinder head cracked	Check/replace cylinder head
	d) Cylinder block cracked	Check/replace cylinder block

TABLE 2 ELECTROMAGNETIC FAN CLUTCH SYSTEM FAULTS

Indicator/symptom (1)	Possible Cause (2)	Action (3)
1 Cooling fan does not operate	a) Wading switch has been depressed	Wading switch illuminates when fan operation is disabled. Depress the wading switch again to permit fan operation Fan operation is also re-instigated after the vehicle ignition is switched off and on
	b) Broken or insufficiently tensioned fan (FEAD) belt	Replace/tension belt
	c) Loose connections or failed wiring	Check all electromagnetic fan clutch system connections and wiring continuity Replace faulty wiring as necessary
	d) Failed radiator or oil cooler temperature sensor unit	Check operation of radiator or oil cooler temperature sensor units Sensor is serviceable if a resistance is noted between a) sensor pins b) each pin and sensor body Replace faulty sensor as necessary
	e) Failed electromagnetic fan clutch	Check operation of electromagnetic fan clutch Unplug electromagnetic fan clutch fly lead from main loom and with engine running apply 24 V power source across fly lead connector pins Replace fan clutch if fan does not operate
	f) Failed clutch control unit	Replace clutch control unit



1	Engine
2	Oil cooler
3	Expansion tank
4	Heater matrix
5	Recirculating pump (not applicable to Vector PPV)
6	Heater cab control
7	Radiator

Fig 1 Cooling system

CHAPTER 13

ELECTRICAL SYSTEM FAILURE DIAGNOSIS

CONTENTS

Para

1 Introduction
2 VPDB failure diagnosis
9 Variant specific failure diagnosis
10 Vector Ambulance
11 Circuit protection
13 Variant specific circuit protection
14 Vehicle light bulbs

Table Page

1 Starter motor 4
2 Alternator 5
3 Battery 6
4 Lighting 7
5 Control and warning lights 8
6 Indicator system 9
7 Reversing lights 9
8 Rear fog light 9
9 Convoy light 10
10 Windscreen wiper 10
11 All wheel drive 11
12 Differential lock 12
13 Pre-heating system 13
14 Cooling/heating box 14
15 Cooling/freezing box 14
16 Siren system 15
17 Fuse box 1 – instrument panel (bullet fuses) 16
18 Fuse box 2 – instrument panel (bullet fuses) 16
19 Fused within vehicle power distribution box (blade fuses) 17
20 ABS control board fuses (blade fuses) 17
21 Environmental Control System (ECS) fuses (blade fuses) 18
22 FFR box circuit breakers 18
23 Miscellaneous fuses 18
24 Vector ambulance – blade fuses 19
25 Vehicle light bulbs 20

Fig		Page
1	VPDB Failure diagnosis part 1 – fuses and lamps	21/22
2	VPDB Failure diagnosis part 2 – power components	23/24
3	VPDB Failure diagnosis part 3 – passive components	25/26
4	Sheet 1 - References for wiring diagrams	27/28
4	Sheet 2 - Power distribution, starting and charging	29/30
4	Sheet 3 - Engine management system	31/32
4	Sheet 4 - Exterior lighting	33/34
4	Sheet 5 - Instrument & illumination, heater system	35/36
4	Sheet 6 - Wiper system and horn	37/38
4	Sheet 7 - Differential lock – front & rear, all wheel drive system, cigar lighter	39/40
4	Sheet 8 - ABS	41/42
4	Sheet 9 - FFR power distribution and charging	43/44
4	Sheet 10 - Cooling fan clutch control	45/46
4	Sheet 11 - Interior and tactical lighting	47/48
4	Sheet 12 - Environmental Control System (ECS)	49/50
4	Sheet 13 – Ambulance variant specific	51/52

INTRODUCTION

1 When diagnosing the failure of a component in this section, first check all contacts, bulbs and fuses. If the defect proves difficult to locate, either replace the component (eg starter, alternator or battery) or check the electrical system with the aid of the diagnosis tables and circuit diagrams.

VPDB FAILURE DIAGNOSIS

2 The VPDB contains circuitry relating to a number of functions that may be treated as separate circuits for the purposes of failure diagnosis, although many are carried on the same printed circuit board. For a description of the electrical circuits managed by the VPDB, refer to 2320-D-503-302 Chapter 13.

3 The VPDB is a line-replaceable unit that contains no user-serviceable parts with the exception of fuses located behind the small removable panel in the upper forward face of the unit; see 2320-D-503-201 Chapter 4. Access to the engine Electronic Diesel Control (EDC) diagnostic port is also via this panel. When necessary, the engine EDC test box (8001560161) is connected directly between the EDC and the connection within the VPDB. This is the only reason for the main cover of the VPDB being removed.

4 The initial stage in identification of a fault within the VPDB is to determine which of the electrical circuit groups the problem relates to, from the following 'active' and 'passive' functions.

Active functions

5 Active functions are:

(1) Engine EDC unit
(2) Gearbox start inhibitor

Passive functions

6 Passive functions are:

(1) Engine EDC unit interconnections
(2) Vehicle rear circuits
(3) Front cab systems

7 In the event that the EDC system is considered faulty, the engine failure diagnosis procedure should be followed, see Chapter 1.

8 If the fault is considered to be associated with any of the other VPDB functions, the procedures in the flowcharts, see Figs 1 through 3, should be followed.

TABLE 1 STARTER MOTOR

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Starter does not turn when ignition key is operated.	a) Battery main switch in OFF position.	Turn switch to ON.
	b) Battery discharged.	Check/charge battery.
	c) Battery terminals loose or oxidized.	Clean terminals, smear with acid-proof grease and tighten.
	d) Ignition switch defective.	Check/replace switch.
	e) No voltage at Solenoid +Ve terminal.	Check/repair wiring.
	f) Starter solenoid switch defective.	Check/replace switch.
	g) No voltage at Starter +Ve terminal.	Check battery cable and connection.
	h) Starter ring gear defective.	Change ring gear.
	i) Starter defective.	Replace starter.
2 Starter turns too slowly.	a) Battery insufficiently charged.	Check/charge battery.
	b) Voltage loss between battery and starter.	Repair oxidized spots.
	c) Starter defective.	Replace starter.
	d) Incorrect specification oil for engine.	Drain and refill with correct specification oil (engine).
	e) Excitation windings short circuited.	Replace starter.
	f) Soiled carbon brushes.	Replace brushes.
3 Starter does not turn when ignition switched on, but starter solenoid clicks.	a) Batteries discharged.	Check/charge batteries. Check connections.
		Check starter solenoid battery cable connections.
		Remove starter and check drive gear for condition and freedom of movement. Clean/replace if necessary.
	b) Solenoid switch worn.	Replace switch.
4 Starter does not turn when ignition key is switched on. Rapid clicking is heard from starter solenoid.	a) Solenoid switch held in winding open circuit.	Replace switch assembly.
5 Harsh grating sound when starter is operated.	a) Bush defective.	Remove starter and examine drive and ring gear. Check/replace planetary gear.

TABLE 2 ALTERNATOR

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Charge warning light does not illuminate when ignition key is in position 1.	a) Charge warning light bulb faulty.	Check/replace charge warning light bulb. Check alternator, battery and battery main switch connections.
2 Charge warning light glows dimly when ignition key is in position 1.	a) Rectifier diodes or regulator pack defective.	Overhaul/replace alternator.
	b) Excitation feed poor.	Check for resistance in field circuit to battery main switch. If necessary, replace alternator.
3 Batteries insufficiently charged.	a) Batteries defective.	Check/replace batteries.
	b) Carbon brushes worn.	Change brushes.
	c) VPDB charging circuit defective	Check/replace VPDB in accordance with Figs 1, 2 and 3
4 Charge warning light lights up permanently.	a) Regulator defective.	Replace regulator.
	b) Relay battery main switch defective.	Check/replace VPDB in accordance with Figs 1, 2 and 3
	c) Rectifier diodes defective, collector rings soiled. Short circuit in rotor direction.	Overhaul/replace alternator.
	d) Hydraulic system drive belt loose/worn.	Check belt condition and tension at hydraulic pump and motor. Replace if necessary.
	e) Current path (D+) has ground connection.	Check current path charging control.
	f) Heavy contamination of connections causing shorts.	Clean all connections. Spray with water displacement fluid. Re-apply silicone grease.
	g) Hydraulic system fault	See Chapter 17.
5 Charge warning light glows dimly when the engine is running.	a) Rectifier diodes defective.	Overhaul/replace alternator.
	b) Regulator defective.	Overhaul/replace alternator.
	c) Hydraulic system drive belt loose/worn.	Check belt condition and tension at hydraulic pump and motor. Replace if necessary.
	d) Rotor defective.	Overhaul/replace alternator.

TABLE 3 BATTERY

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Battery discharges itself.	a) Surface leakage current in damaged cables.	Replace cables if ammeter reading between battery negative terminal and disconnected earthing strap is above 3 mA.
2 Oxidized pole terminals.	a) Insufficient current transition	Clean terminals and connections and grease with acid-proof grease.
3 Battery is repeatedly found to be in discharged condition.	a) Hydraulic system drive belt loose	Check alternator, regulator, battery and battery main switch connections. Check belt condition and tension at hydraulic pump and motor. Replace if necessary. Check alternator output voltage is between 27.5 V and 28 V. If not, replace alternator.
	b) Alternator defective	
	c) Plus diodes defective.	Overhaul/replace alternator.
	d) VPDB charging circuit defective	Check/replace VPDB in accordance with Figs 1, 2 and 3
	e) ABS power supply defective	Check fuses and relays, replace as necessary. Check wiring terminals and connections. Check 24 V input and 12 V output. If output is not present when input is satisfactory change power supply.
	f) Battery in poor condition	Check terminal voltage of battery. Change battery if either voltage less than 10.5 V.

TABLE 4 LIGHTING

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Lamps light weak.	a) Voltage drop in cables, fuses, earth and terminal connections.	Check/replace cables, fuses, earth and terminal connections.
2 Roadway badly illuminated.	a) Headlights set wrongly.	Adjust headlights.
	b) Reflector defective.	Change headlights.
	c) Blown bulb.	Change bulb.
3 Position lights do not light.	a) Blown bulb.	Change bulb.
	b) Blown fuse.	Change fuse.
	c) Switch defective.	Change switch.
	d) Terminals oxidised.	Clean terminals.
	e) Line interrupted.	Repair/replace line.

TABLE 5 CONTROL AND WARNING LIGHTS

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Charging control light.	a) Insufficient charging, hydraulic system drive belt loose/worn.	Check belt condition and tension at hydraulic pump and motor. Replace if necessary.
	b) Regulator/alternator defective.	Replace regulator/alternator.
	c) Hydraulic system fault (depicted by hydraulic system light)	See Chapter 17.
2 Brake fluid level, ABS, EBD, ETC lights	Refer to Chapter 13.	Refer to Chapter 13.
3 Engine oil pressure light.	a) Insufficient engine oil pressure.	Stop engine immediately. Check oil level and check for leakage.
	b) Oil pressure switch defective.	Replace switch.
4 Hydraulic system light.	Refer to Chapter 17.	Refer to Chapter 17.
5 Glow plug/Mil LED does not light up.	a) LED burnt out.	Renew LED.
	b) Cable connection interrupted.	Check connections.
		Check/replace pre-heating relay using VW diagnostic tool
6 Lights do not function.	a) Sender unit defective.	Change sender unit.
	b) Blown bulbs.	Replace bulbs and eliminate cable defects.

TABLE 6 INDICATOR SYSTEM

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Indicator does not work.	a) Blown bulb.	Replace bulb.
	b) Blown fuse.	Replace fuse.
	c) Relay defective.	Replace relay.
	d) Multi-function stalk defective.	Replace multi-function stalk.
	e) Hazard warning switch defective.	Replace hazard warning switch.
	f) Terminals oxidised or loose.	Check/clean terminals.
	g) Broken cable.	Repair cable.

TABLE 7 REVERSING LIGHTS

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Reversing lights do not work.	a) Blown bulb.	Replace bulb.
	b) Blown fuse.	Replace fuse.
	c) Switch defective.	Replace switch.
	d) Terminals oxidised or loose.	Clean terminals.
	e) Broken cable.	Repair cable.
2 Lights are on permanently.	a) Switch defective.	Replace switch.

TABLE 8 REAR FOG LIGHT

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Lights do not function.	a) Blown bulb.	Replace bulb.
	b) Blown fuse.	Replace fuse.
	c) Switch defective.	Replace switch.
	d) Terminals oxidised or loose.	Check/clean terminals.
	e) Broken cable.	Repair cable.

TABLE 9 CONVOY LIGHT

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Lights do not function.	a) Blown bulb.	Replace bulb.
	b) Blown fuse.	Replace fuse.
	c) Convoy switch defective.	Replace switch.
	d) Terminals oxidised or loose.	Check/clean terminals.
	e) Broken cable.	Repair cable.

TABLE 10 WINDSCREEN WIPER

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Wipers do not function.	a) Blown fuse.	Replace fuse.
	b) Multi-function stalk defective.	Replace stalk.
	c) Pulse generator defective.	Replace generator.
	d) Wiper motor defective.	Replace motor.
	e) Wiper linkage detached.	Repair linkage.
2 No retraction.	a) Wiper arms loose.	Replace arms.
	b) Pulse generator defective.	Replace generator.
	c) Wiper motor defective.	Replace motor.

TABLE 11 ALL WHEEL DRIVE

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 All wheel drive lamp does not light up when switch is depressed.	a) Blown fuse.	Check fuses Nos. 11, 12 and dimmer unit. Replace if necessary.
	b) Wiring damaged.	Check wiring. Replace if necessary.
	c) Electro-pneumatic valve for all wheel drive defective.	Check valve, replace if necessary.
	d) Blown bulb.	Replace bulb.
	e) Contact switch defective.	Check/replace switch.
	f) Faulty/incorrect connection at switch.	Check/rectify wiring connection switch.
2 All wheel drive lamp lights up when switch is off (transfer gear shift lever in high range).	a) Defective electro-pneumatic valve for all wheel drive.	Replace valve.
	b) Switch at transfer shift lever defective or wiring from contact switch to switch has ground contact.	Check/replace switch. Check/repair wiring.
	c) Switch defective.	Check/replace switch.
	d) Blown fuse.	Check fuses Nos. 11, 12 and dimmer unit. Replace if necessary.
	e) Broken cable.	Repair cable.

TABLE 12 DIFFERENTIAL LOCK

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Differential lock lamp does not light up when switch is on.	a) Blown fuse.	Check/replace fuses Nos. 12, 12a and dimmer switch.
	b) Blown bulb	Replace bulb.
	c) Electro-pneumatic valve defective.	Check/replace valve.
	d) Contact switch defective.	Check/replace switch.
	e) Faulty/incorrect wiring connection at switch.	Check/repair wiring connection at switch.
	f) Wiring worn.	Check/replace worn wires.
	g) Diode defective (only rear axle lock).	Check/replace diode.
	h) Pneumatic hoses disconnected at electro-pneumatic drive, pneumatic reservoir, gearshift cylinder or return valve.	Check/replace hose connections.
	i) Vacuum pump defective.	Check/replace pump.
	j) Gearshift cylinder defective.	Check/replace cylinder.
2 Differential lock lamp does not light up when switch is on.	a) Filter or dryer clogged.	Check/clean/replace filter or dryer.
3 Differential lock function lamp lights up when switch is off.	a) Defective electro-pneumatic valve for rear differential lock.	Replace valve.
	b) Switch at transfer gearshift lever defective or wiring from contact switch to switch has ground contact.	Check/replace switch. Check/rectify wiring.
	c) Switch defective.	Check/replace switch.
	d) Blown fuse.	Check/replace fuses and dimmer unit.
	e) Broken cable.	Repair cable

TABLE 13 PRE-HEATING SYSTEM

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Pre-heating indicator lamp does not light up when ignition is switched on and water temperature lower than 50° C.	a) Blown bulb.	Check/replace bulb.
	b) Pre-heating relay defective.	Replace relay.
	c) Wiring harness defective.	Check/repair wiring.
	d) Blown fuse	Check/replace fuse.
	e) Dimmer unit or dimmer switch defective.	Check/replace dimmer unit or dimmer switch.
2 Difficult starting or failure to start at low temperature.	a) Blown fuse.	Check/replace fuse at relay.
	b) One or more heater plugs defective.	Check/replace heater plugs.
	c) Cable fault.	Check/repair cables.
	d) No voltage at plug connections	Check/repair connections and electrical lines.
	e) Pre-heating relay defective	Replace relay.
3 Pre-heating time incorrect.	a) Pre-heating relay defective.	Replace relay.
	b) Temperature sender unit defective.	Check/replace sender unit and wiring to the sender unit.

VARIANT SPECIFIC FAILURE DIAGNOSIS

9 The following tables are provided for failure diagnosis of variant specific equipment installed in some Vector variants.

Vector Ambulance

10 Failure diagnosis for variant specific equipment installed in the Vector Ambulance is limited to the refrigeration and siren equipment. The maintenance/repair of the ambulance specialist medical equipment is the responsibility of the Unit medical staff

TABLE 14 COOLING/HEATING BOX

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Cooling/Heating box does not function (and the ventilation fan impeller visible at the front of the unit does not rotate).	a) Unit not connected to power source.	Connect unit lead to FFR box. Note that the power lead is hard wired into the unit.
	b) FFR battery main switch "OFF".	Turn "ON" FFR battery main switch.
	c) Circuit isolated by circuit breaker.	Check circuit breaker FFR box / identify fault / reset circuit breaker.
	d) Unit defective.	Replace unit.
2 Cooling/Heating box does not function satisfactorily.	a) Ventilation fan obstructed.	Check fan/ventilation slots are not block.
	b) Unit defective.	Replace unit.

TABLE 15 COOLING/FREEZING BOX

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Cooling/Freezing box does not function (and the LED does not glow).	a) Unit not connected to power source.	Connect unit lead to FFR box. Note that the power lead is hard wired into the unit.
	b) FFR battery main switch "OFF".	Turn "ON" FFR battery main switch..
	c) Circuit isolated by circuit breaker.	Check circuit breaker FFR box / identify fault / reset circuit breaker.
	d) Unit defective.	Replace unit.
2 The unit does not cool satisfactorily (and the POWER LED is illuminated).	a) Unit defective.	Replace unit.
3 The unit does not cool satisfactorily (and the ERROR LED flashes).	a) Battery supply too low.	Run vehicle to recharge batteries / recharge batteries off vehicle.
	b) Unit defective.	Replace unit.

TABLE 16 SIREN SYSTEM

Indicator/Symptom / Possible Cause / Action (1)
The siren power amplifier (located on the lower cab side wall to the left of the Commanders seat) is protected against overheating or short circuits on the output. In the event of either, the amplifier will shutdown and the fault lamp on the front on the power amplifier housing will illuminate. To continue operation the amplifier selector switch on the control unit (at the vehicle dashboard) should be first switched to the Standby position or the Power switch to "OFF". In the event of overheating the amplifier must have cooled sufficiently before operation of the siren can recommence. NOTES (1) A short circuit is lost likely due to a loud speaker that has shorted or is starting to short. To confirm this disconnect the loudspeaker wire then turn the amplifier ON. If the fault lamp does not illuminate when the siren is operated the loudspeaker circuit is at fault. If the fault lamp remains illuminated then the amplifier is faulty and should be replaced. In the case of a short circuit the fault lamp may be cancelled immediately whereas for overheating the amplifier must have cooled sufficiently first. A barely distinguishable quick flashing simply indicates that the control unit is disconnect or turned "OFF". (2) The siren is powered by the FFR battery circuit. The FFR battery main switch must be switched "ON" to permit siren operation.

CIRCUIT PROTECTION

11 Circuit protection is provided by two fuse boxes located under the dashboard instrument panel, fuses located within the VPDB (behind removable panel at the upper forward face) and fuses located on the ABS control board in support of the ABS and its power supply. A number of other in line and system specific fuses also provide circuit protection.

12 Fuse ratings and applications are provided in Tables 17 through 23.

TABLE 17 FUSE BOX 1 – INSTRUMENT PANEL (BULLET FUSES)

Fuse No. (1)	Fuse rating (amps) (2)	Consumer (3)
1	8	Tail light left, tail light right, lighting for heating and cooling, instrument lighting, switch lighting, licence plate lighting
2	8	Side light left, side light right
3	8	High beam left, high beam control lamp
4	8	High beam right
5	8	Low beam left
6	8	Low beam right, rear fog light
7	8	Spare
8	8	Cigar lighter/plug, interior light
9	8	Horn, stop lights, reversing light
10	8	Fan for heating and cooling, windscreen wiper and washer, horn
11	8	Circulation pump, level control valve (where fitted) electro-pneumatic valve for all wheel drive
12	8	Horn, stop lights, reversing light, charging control light, oil pressure control light, pre-heating control light, fuel level indicator, high beam control light, indicator light turn signal, brake fluid level control, coolant temperature gauge, electro-pneumatic valve for differential lock

TABLE 18 FUSE BOX 2 – INSTRUMENT PANEL (BULLET FUSES)

Fuse No. (1)	Fuse rating (amps) (2)	Consumer (3)
1	8	Convoy light
2	16	Compressor engine, level lift system (where fitted)

TABLE 19 FUSES WITHIN VEHICLE POWER DISTRIBUTION BOX (BLADE FUSES)

Fuse No. (1)	Fuse rating (amps) (2)	Consumer (3)
1	5	Immobiliser/diagnostics
2	25	Main EDC fuse
3	10	G81/N75/N239/N18 power feeds and EDC
4	5	Air suspension power (where fitted) *1
5	10	Ignition to immobiliser/diagnostics
6	7.5	Equaliser circuit
7	5	G70/EDC power feed
8	5	Crank EDC
9	25	Starter motor
10	N/A	**NEVER USE** *2
11	15	Power feed
12	10	Hazard flasher
13	25	FFR power feed 1 *1
14	25	FFR power feed 2 *1
15	7.5	Air suspension system (where fitted) *1

*1 *Not applicable to Vector PPV.*
*2 *To ensure optimal performance of force protection equipment never fit a fuse to position 10.*

TABLE 20 ABS CONTROL BOARD FUSES (BLADE FUSES)

Fuse No. (1)	Fuse rating (amps) (2)	Consumer (3)
1	15	24 V power supply input
2	25	12 V power supply output
3	5	ABS diagnostic
4	25	ABS ECU
5	30	ABS modulator
6	5	Ignition feed to power supply
7	1	Power supply

A selection of spare blade fuses is also provided in ABS control board fuse housing.

TABLE 21 ENVIRONMENTAL CONTROL SYSTEM (ECS) FUSES (BLADE FUSES)
(located adjacent to the ABS Control Board)

Fuse No. (1)	Fuse rating (amps) (2)	Consumer (3)
C	7.5	Clutch
E	20	Condenser fan C2
F	20	Condenser fan C1
I	20	Evaporator fan

TABLE 22 FFR BOX CIRCUIT BREAKERS

CB No. (1)	Fuse rating (amps) (2)	Consumer (3)
1	40	STX
2	10	Locksmith
3	10	Locksmith
4	10	Locksmith
5	10	Locksmith
6	10	Locksmith
7	25	Bowman

NOTE: Vector Ambulance Variant. 10 A FFR circuit breakers 2, 3, 4, 5, 6 protect the following ambulance variant consumers: cooling/freezing box; cooling/heating box, a/c booster fans circuit; interior rear compartment lighting circuits; siren/exterior blue lights citrcuits.

TABLE 23 MISCELLANEOUS FUSES

Fuse No. (1)	Fuse rating (amps) (2)	Consumer (3)
1	5	Searchlight (blade fuse in line to searchlight)
2	50	Import/Export socket (Maxi fuse in line to socket)
3	10	12v Power outlet (blade fuse in line to outlet)
4	30	Hydraulic system module (blade fuse in line to cooling fan)
5	10	Interior lighting circuit (in-line blade fuse adjacent to instrument panel fuses)

Variant specific fuses/circuit breakers

13 The following tables depict additional fuses/circuit protection in support of variant specific equipment installed in some Vector variants.

TABLE 24 VECTOR AMBULANCE - BLADE FUSES

Fuse No. (1)	Fuse rating (amps) (2)	Consumer (3)
1	10	Siren amp circuit
2	1	Siren control circuit

VEHICLE LIGHT BULBS

14 Electrical data on the vehicle light bulbs is provided in Table 24.

TABLE 21 VEHICLE LIGHT BULBS

Use (1)	Category (2)	Voltage (3)	Output (4)
Exterior lamps:			
High beam	H4	24 V	75/70 W
Parking Light	T8/4	24 V	4 W
Turn signal front	P 25-1	24 V	21 W
Turn signal side	P21W	24 V	21 W
Licence plate light	R 19/10	24 V	10 W
Convoy light	R 5 W	24 V	5 W
Searchlight	H3	24 V	70 W
Tail light cluster:			
Turn signal rear	P 25-1	24 V	21 W
Rear fog light	P 25-1	24 V	21 W
Reversing light	P 25-1	24 V	21 W
Stop light	R 19/10	24 V	10 W
Rear light	R 19/5	24 V	5 W
Interior lamps:			
Interior light	K	24 V	10 W
Instrument lamps:			
Speedometer	W2,1 x 9.5d	24 V	2 W
Fuel level indicator	W2,1 x 9.5d	24 V	2 W
Coolant temperature indicator	W2,1 x 9.5d	24 V	2 W
Indicator lamps:			
High beam	W 5/1,2	24 V	1,2 W
Turn signals	W 5/1,2	24 V	1,2 W
Fuel reserve	W 5/1,2	24 V	1,2 W
Oil pressure	W 5/1,2	24 V	1,2 W
Charging current	W 5/1,2	24 V	1,2 W
Pre-heating	W 5/1,2	24 V	1,2 W
Brakes	W 5/1,2	24 V	1,2 W
Signal/trailer	W 5/1,2	24 V	1,2 W
Toggle switches	W 5/1,2	24 V	1,2 W
Glow plug/EDC warning lamp	LED	2 V	20 mW
Lighting of ventilation/heater control	W 5/1,2	24 V	1,2 W

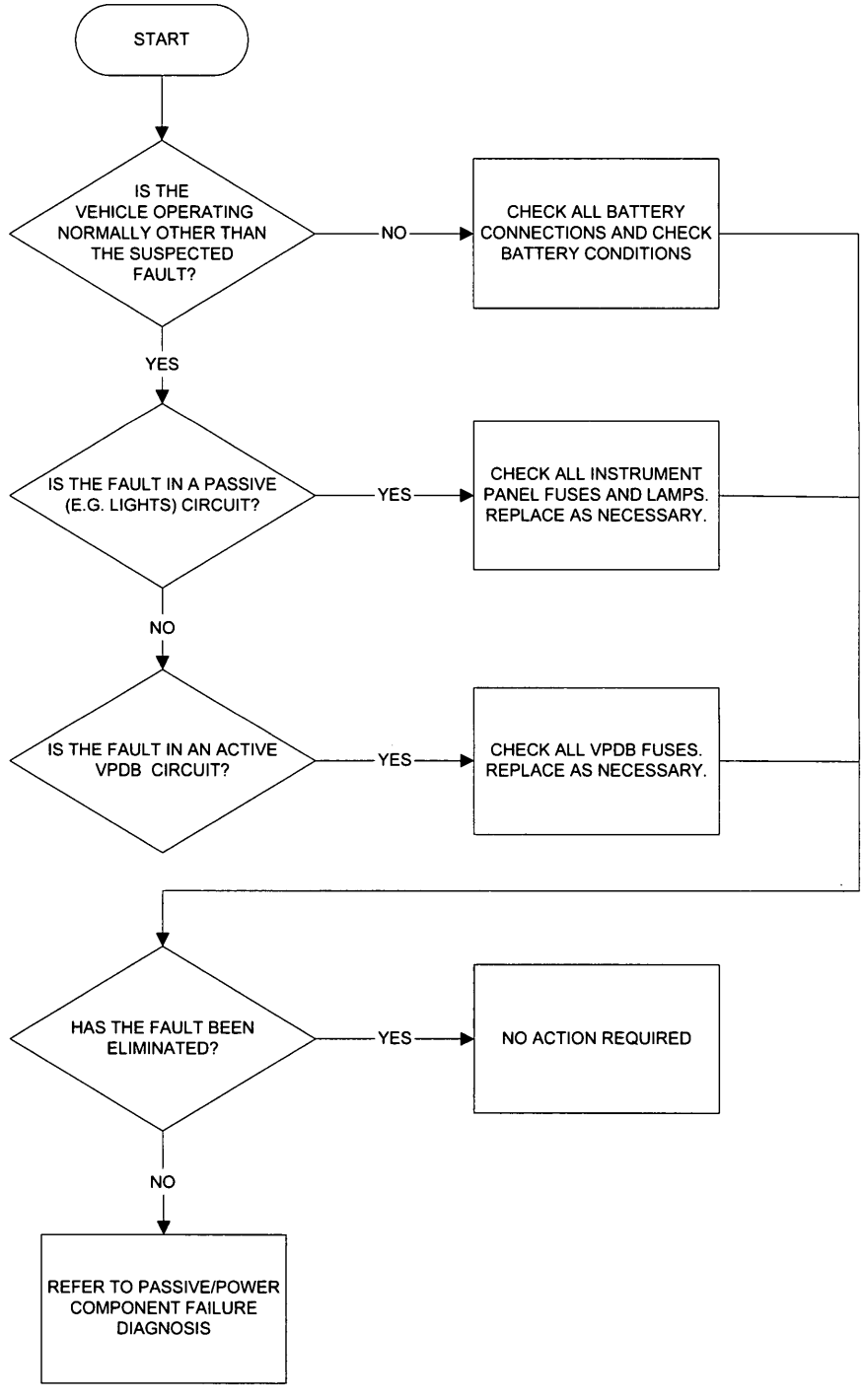


Fig 1 VPDB Failure diagnosis part 1 – fuses and lamps

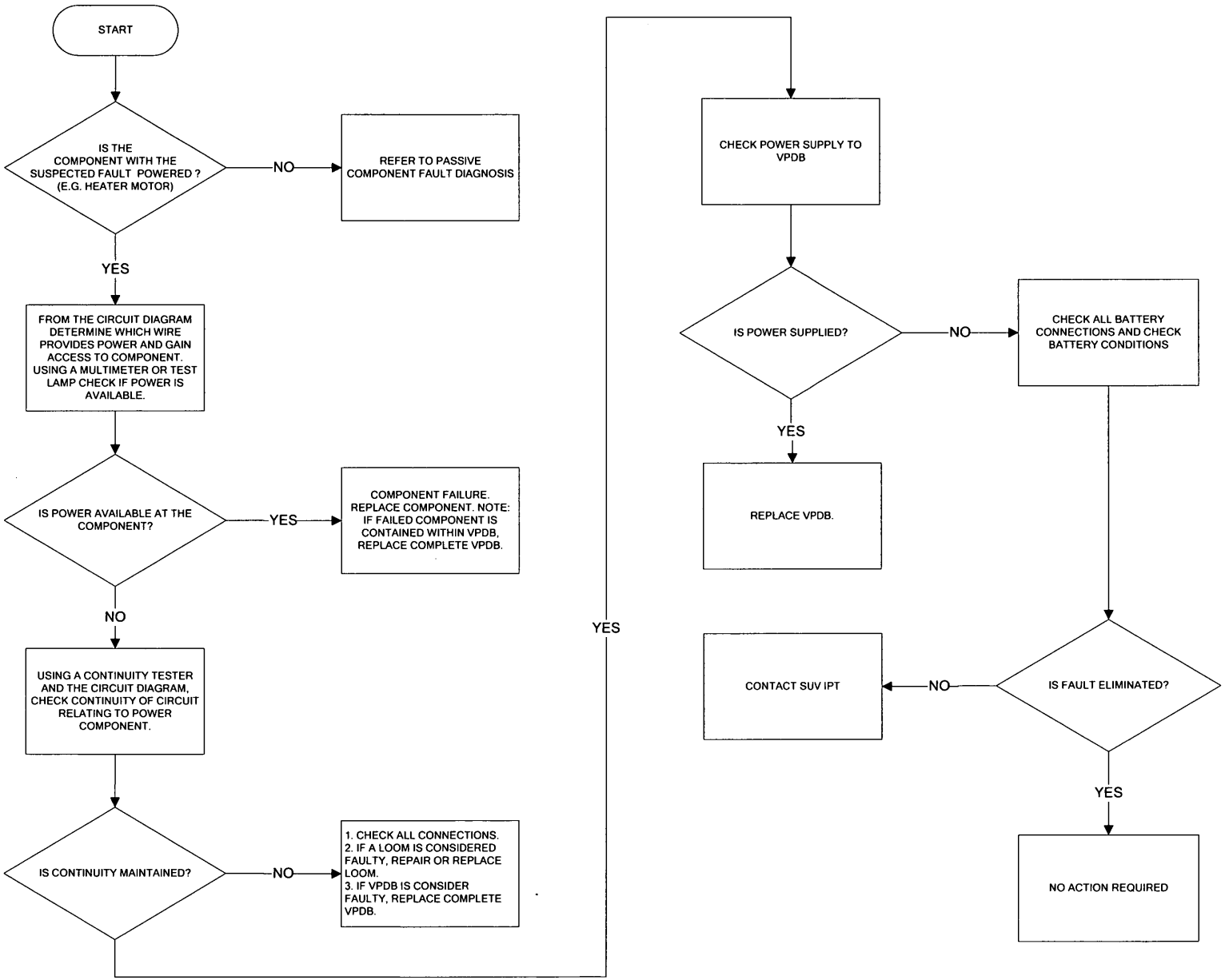


Fig 2 VPDB Failure diagnosis part 2 – power components

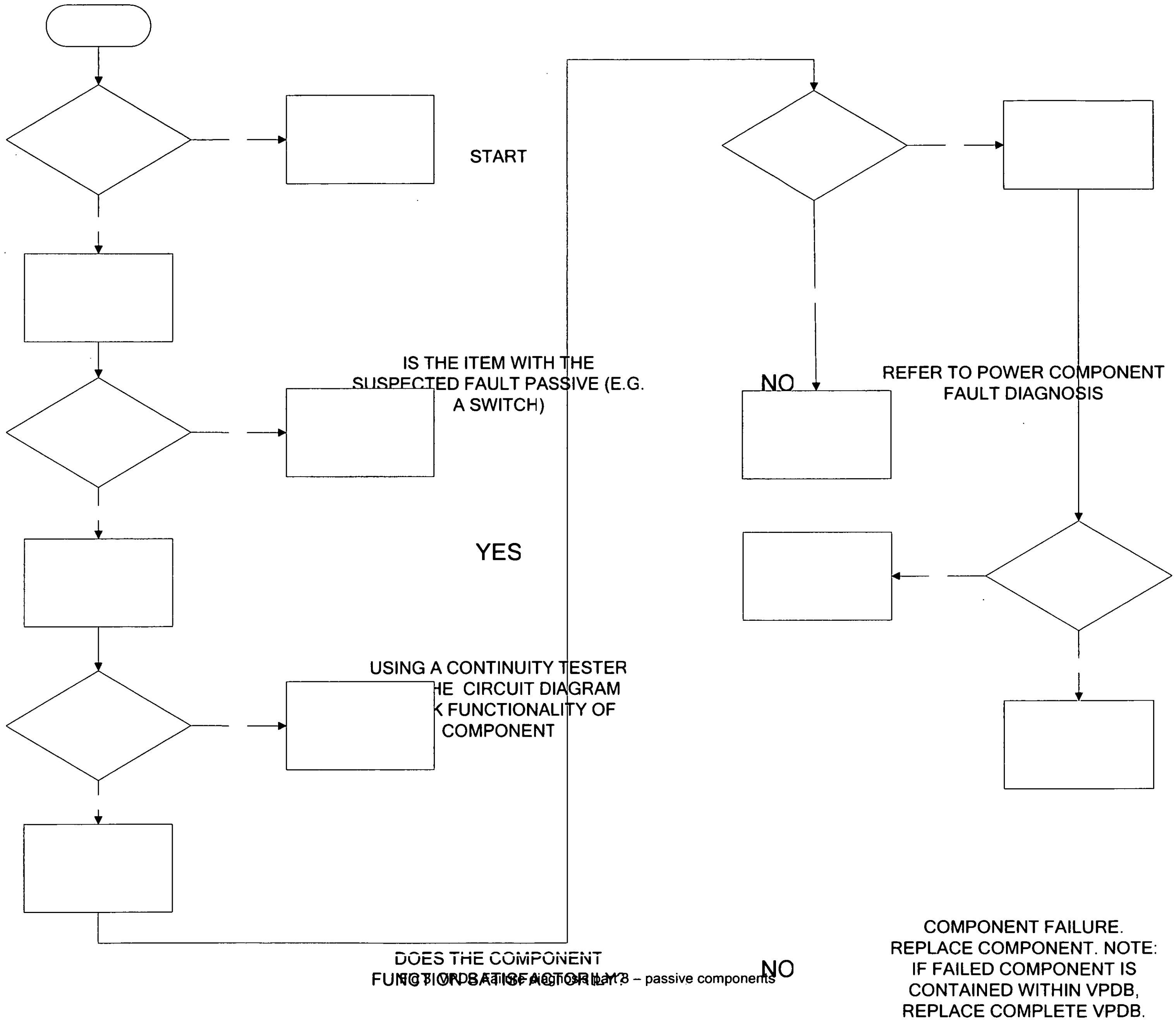


Fig 3 VPDB Failure diagnosis part 3 – passive components

WIRE COLOURS FOR DIAGRAMS

Colour Code (1)	Wire Colour (2)
BK	Black
BN	Brown
BL	Blue
GN	Green
GY	Grey
RD	Red
VT	Violet
WH	White
YE	Yellow

All wire sizes quoted on drawings indicate cross sectional area of conductor in mm^2, unless otherwise specified.

Wiring Diagram: 8251850708 – Issue D (13/12/07)

Fig 4 Sheet 1 – References for wiring diagram

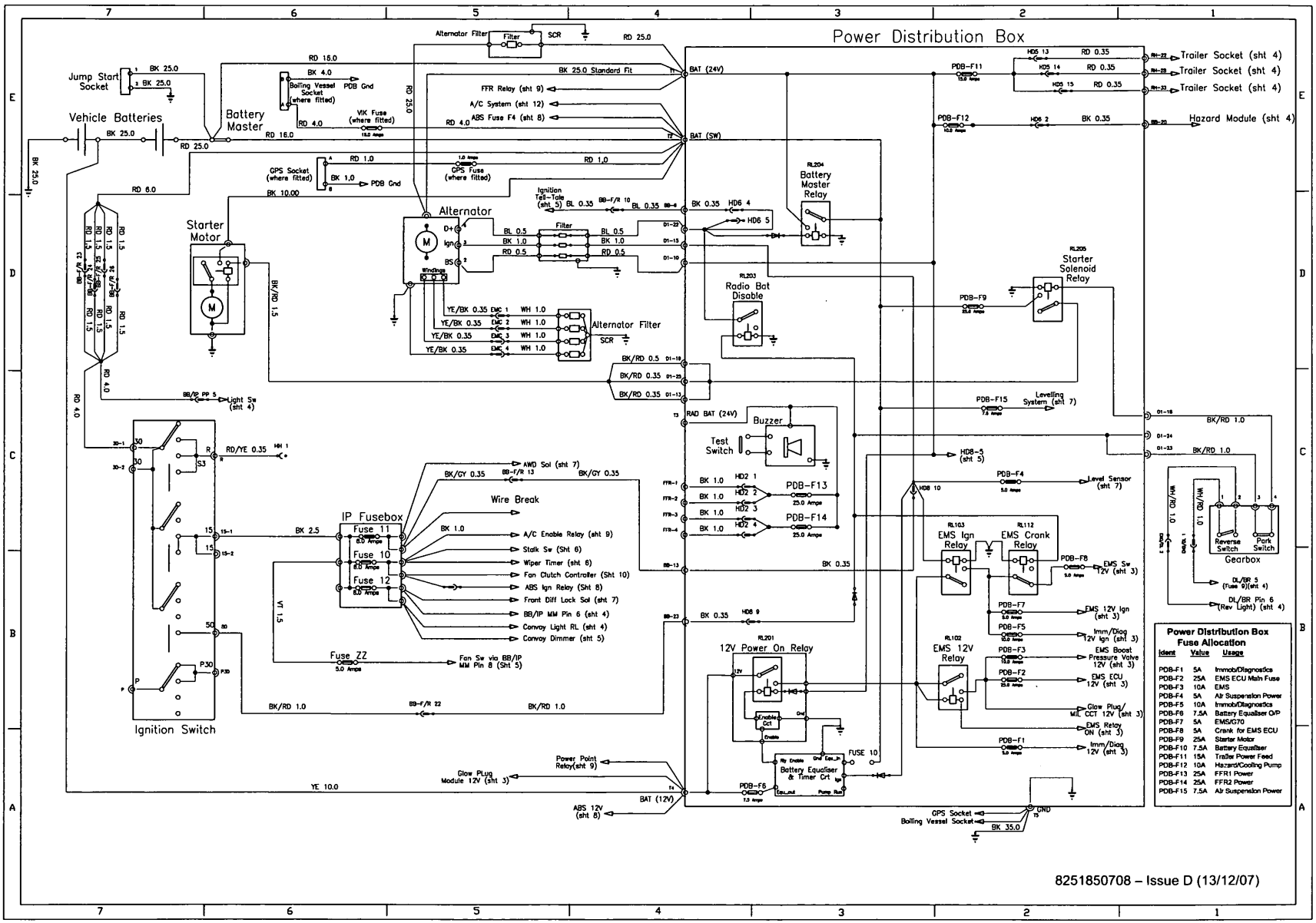


Fig 4 Sheet 2 - Power distribution, starting and charging

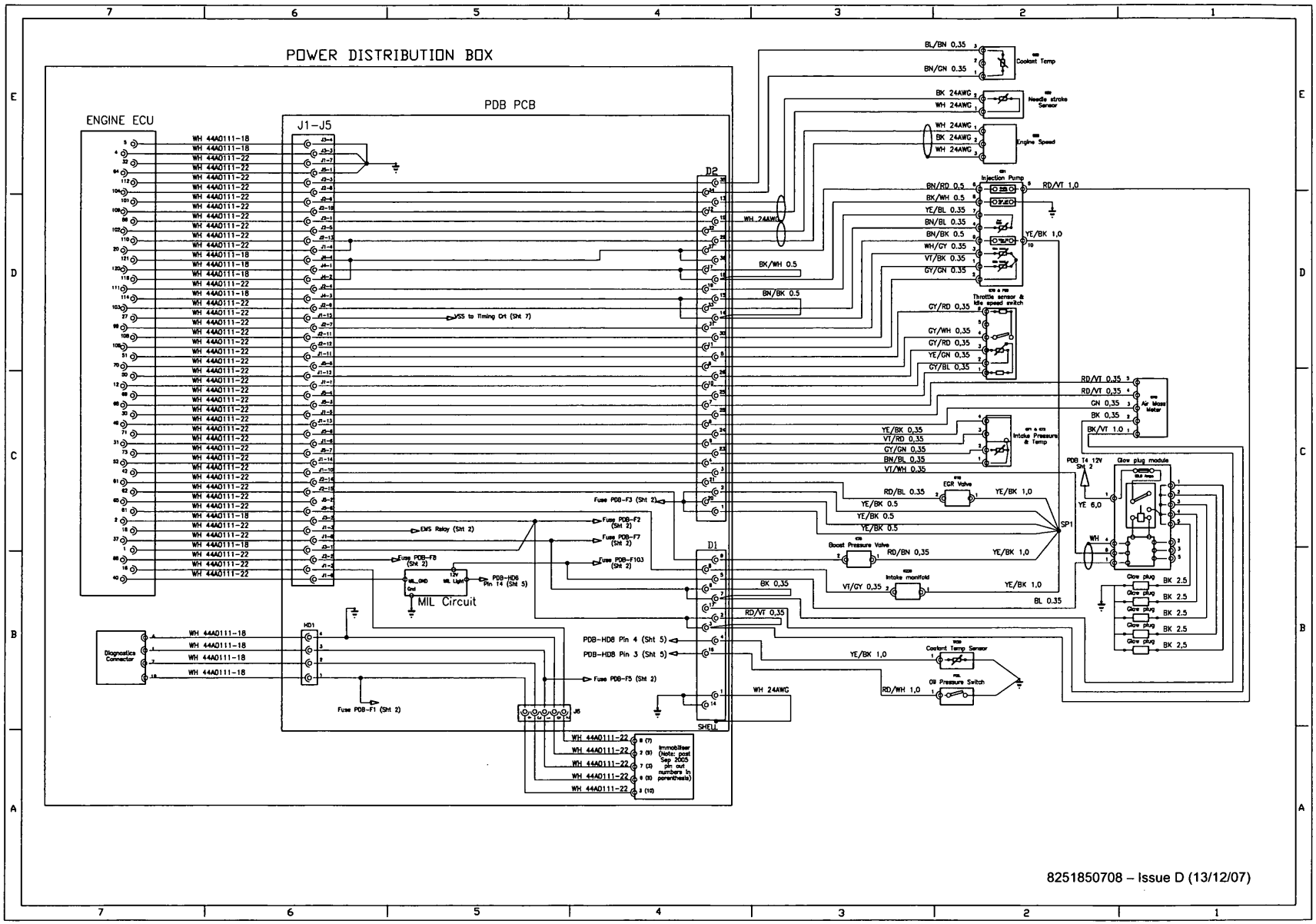


Fig 4 Sheet 3 - Engine management system

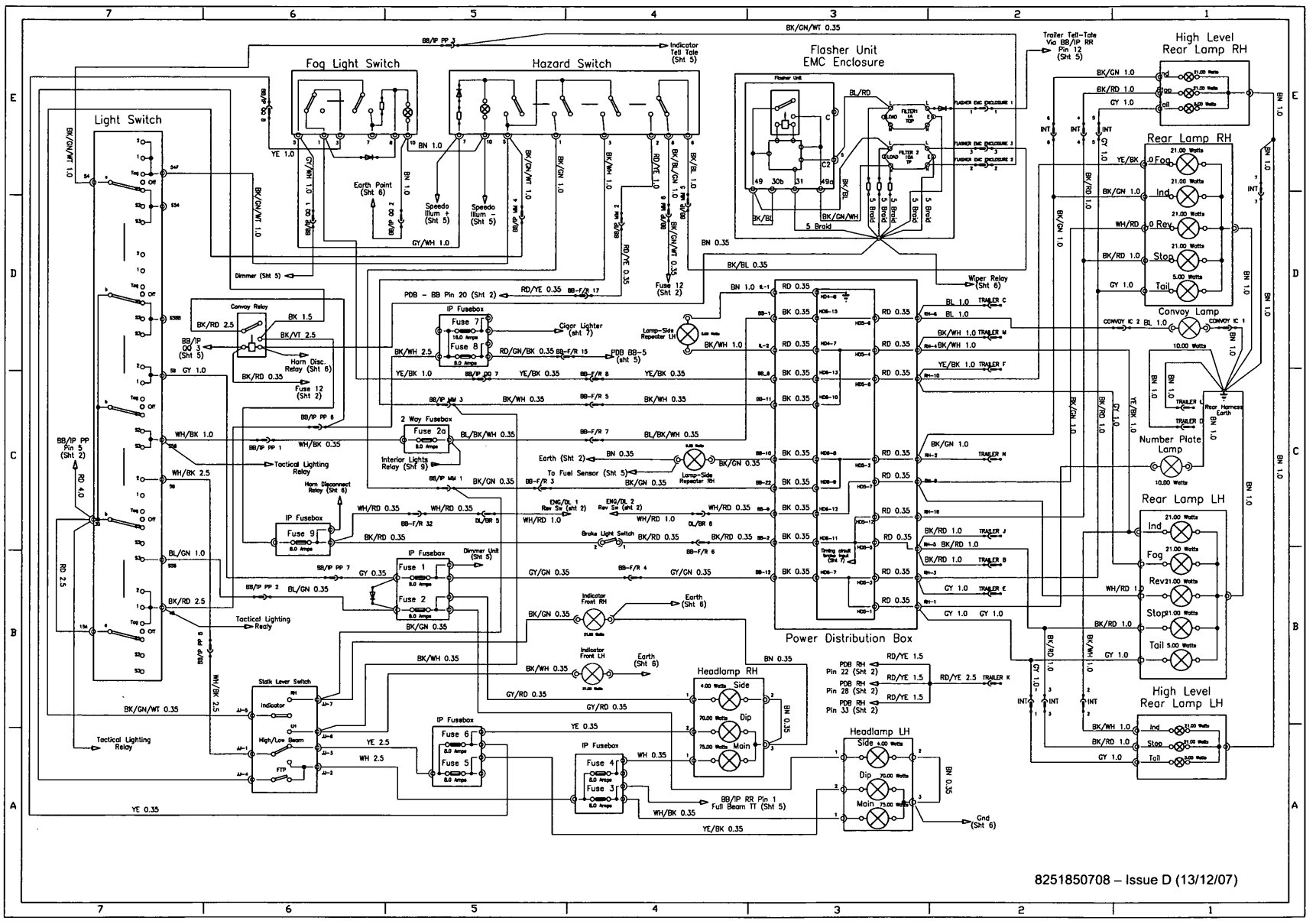


Fig 1 Sheet 1 - Exterior lighting

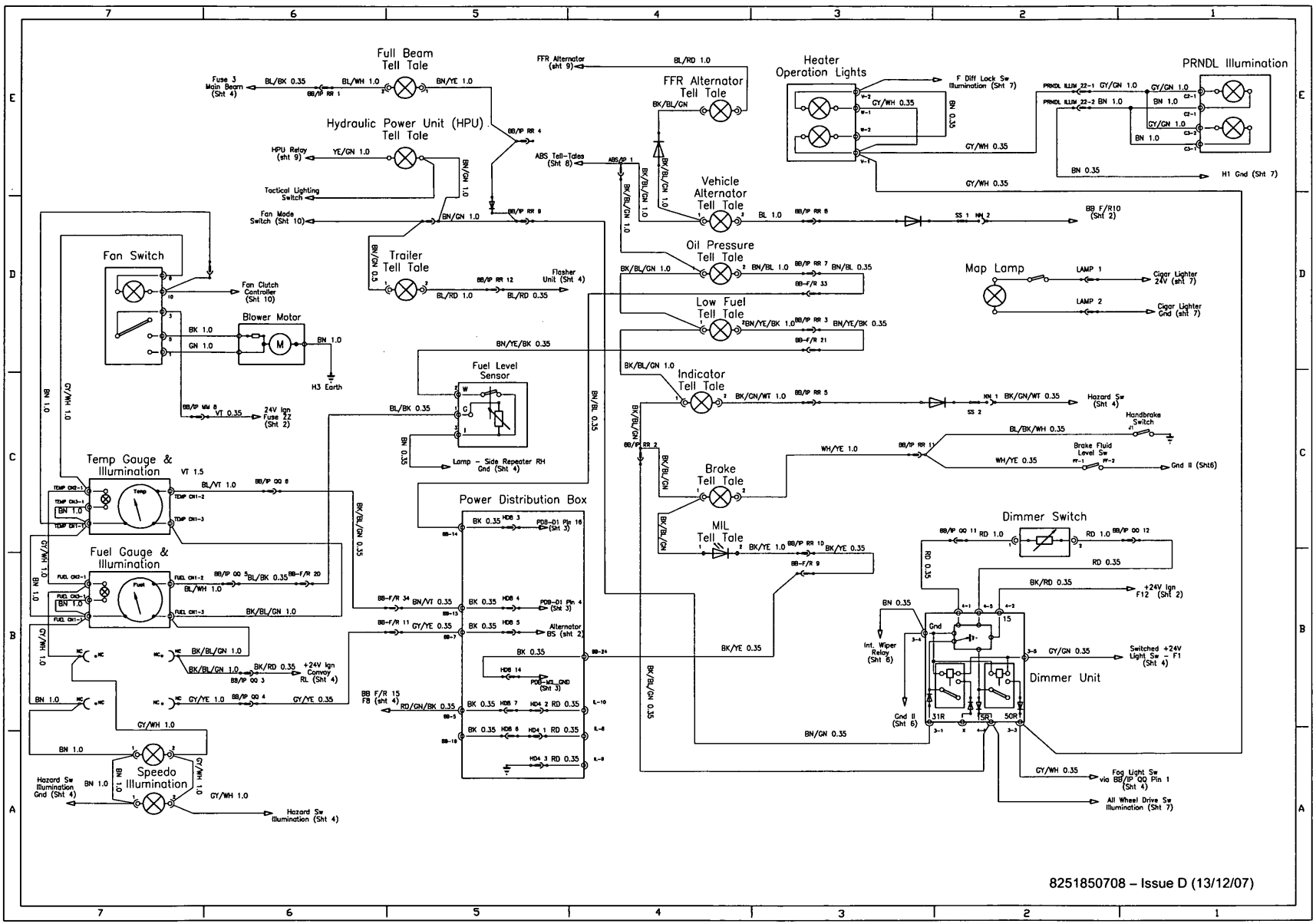


Fig 1 Sheet 5 - Instrument & illumination, heater system

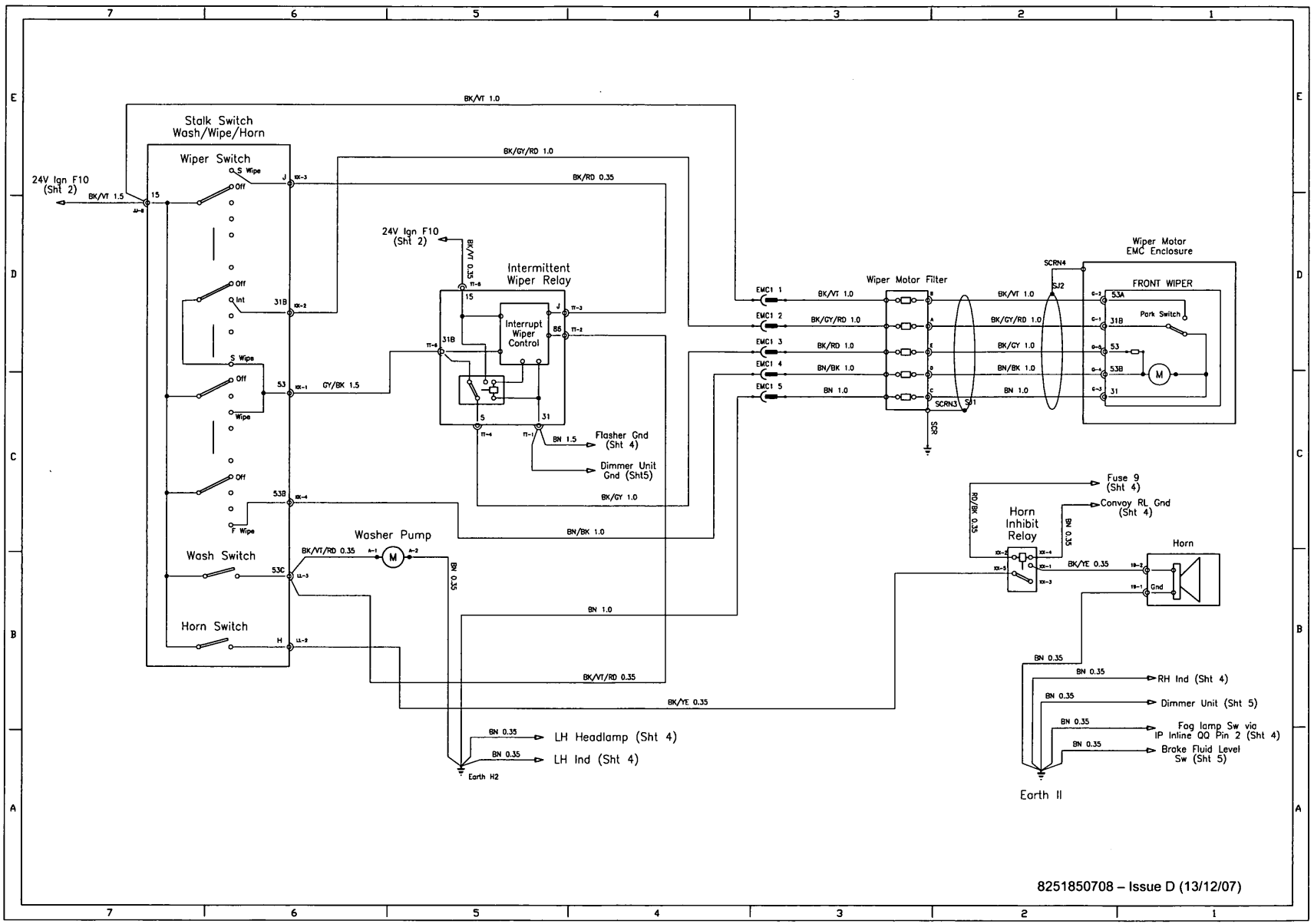


Fig 1 Sheet 6 - Wiper system and horn

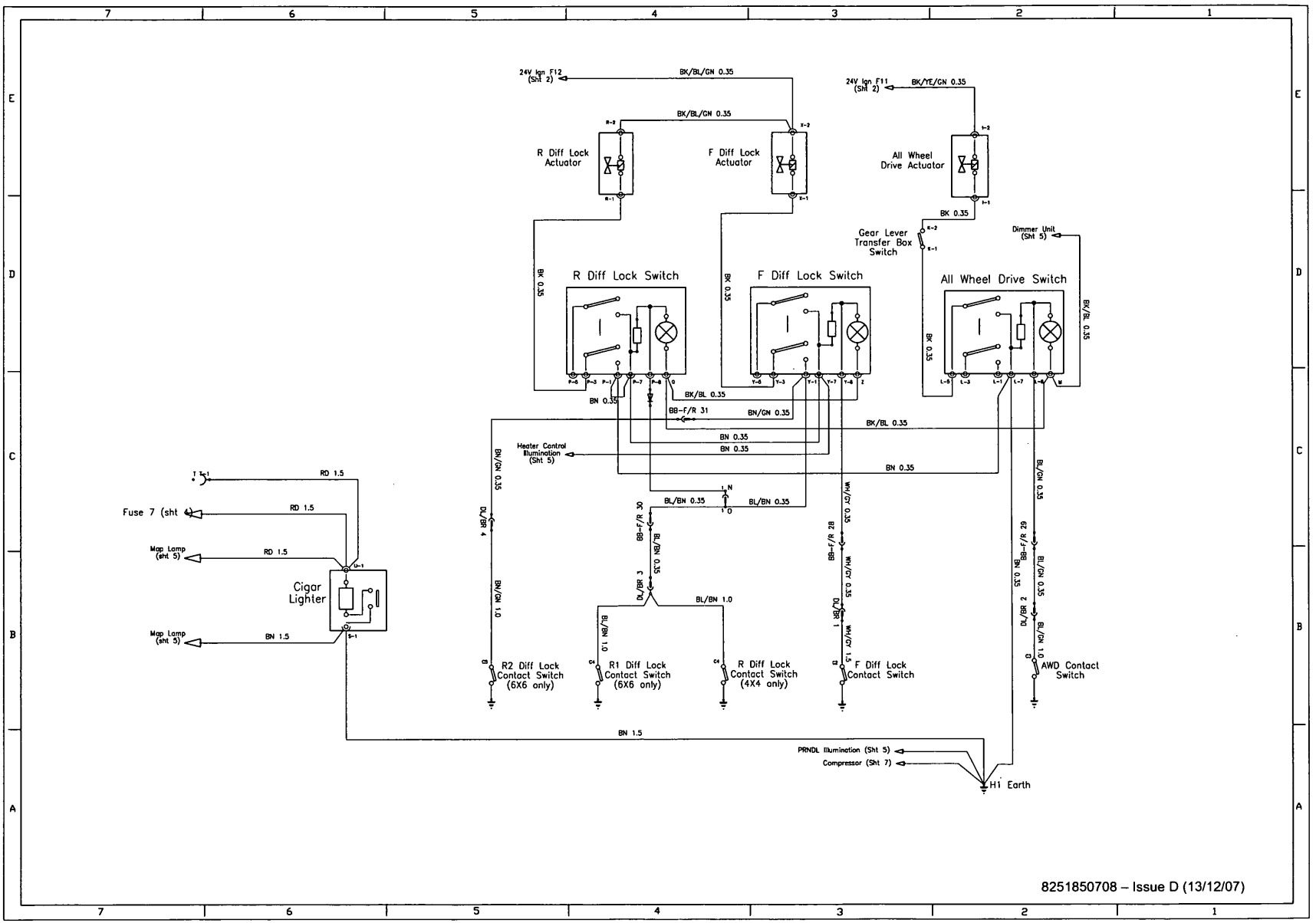


Fig 1 Sheet 7 - Differential lock – front & rear, all wheel system, cigar lighter

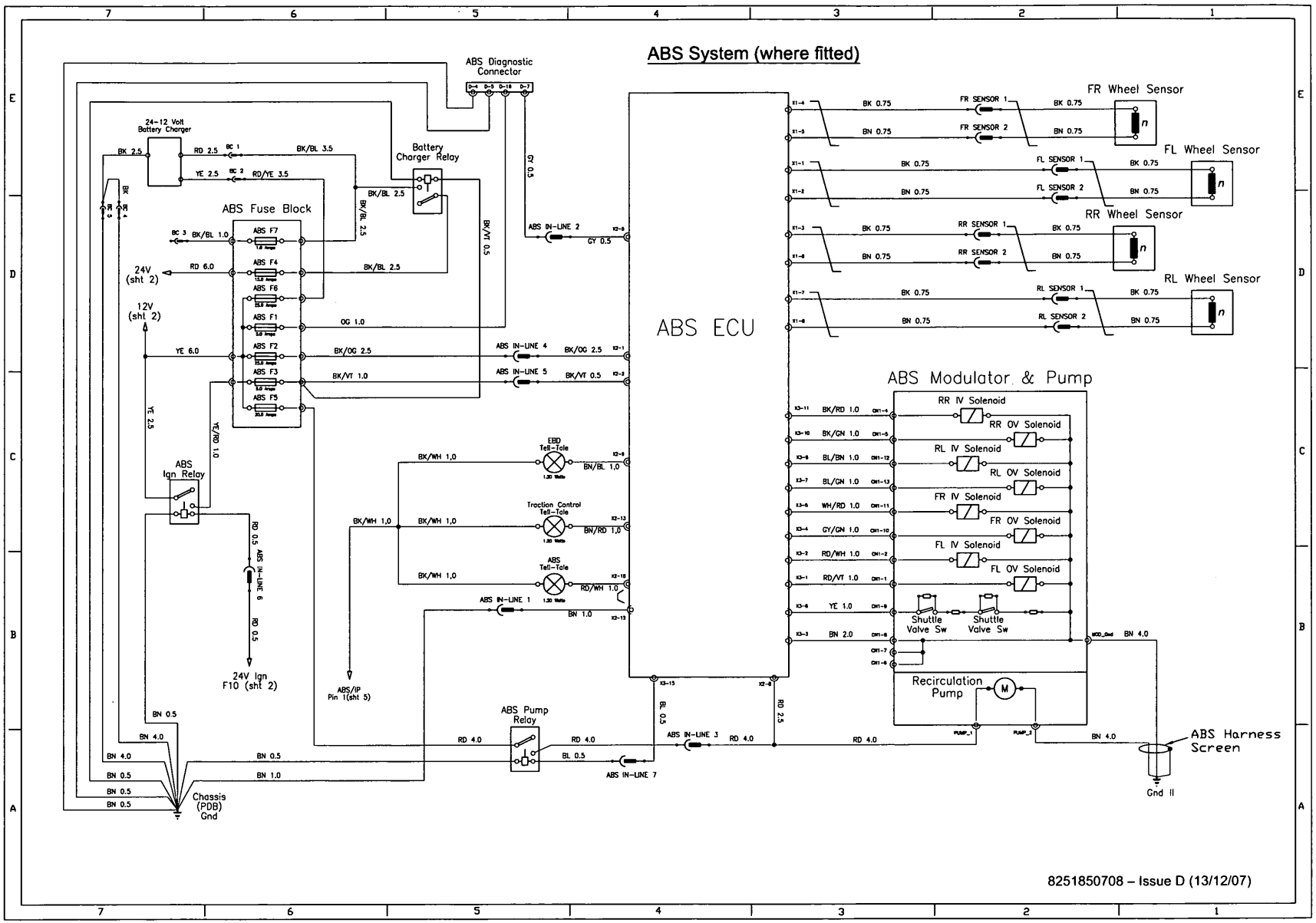


Fig 1 Sheet 8 – ABS

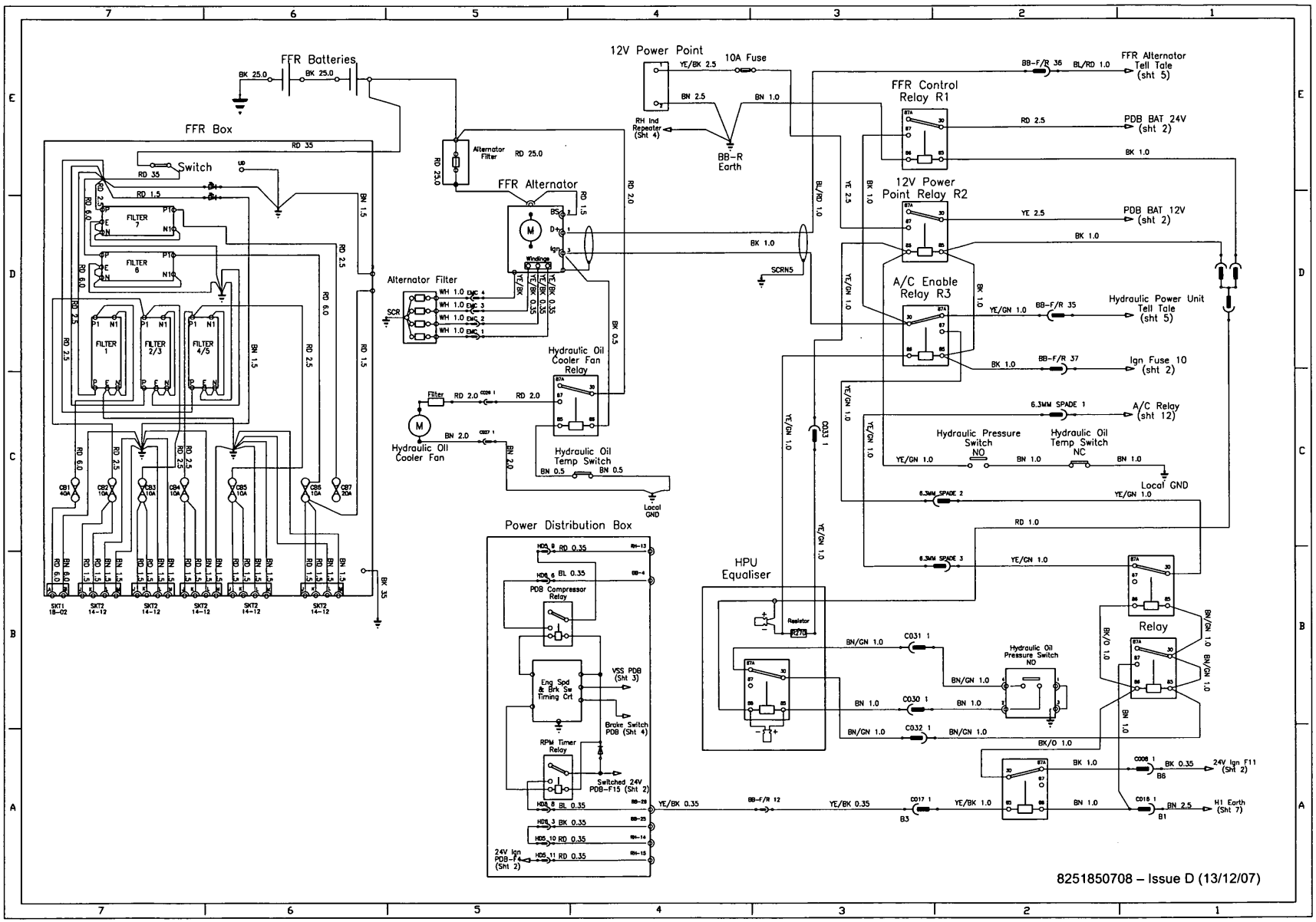


Fig 4 Sheet 9 – FFR power distribution and charging

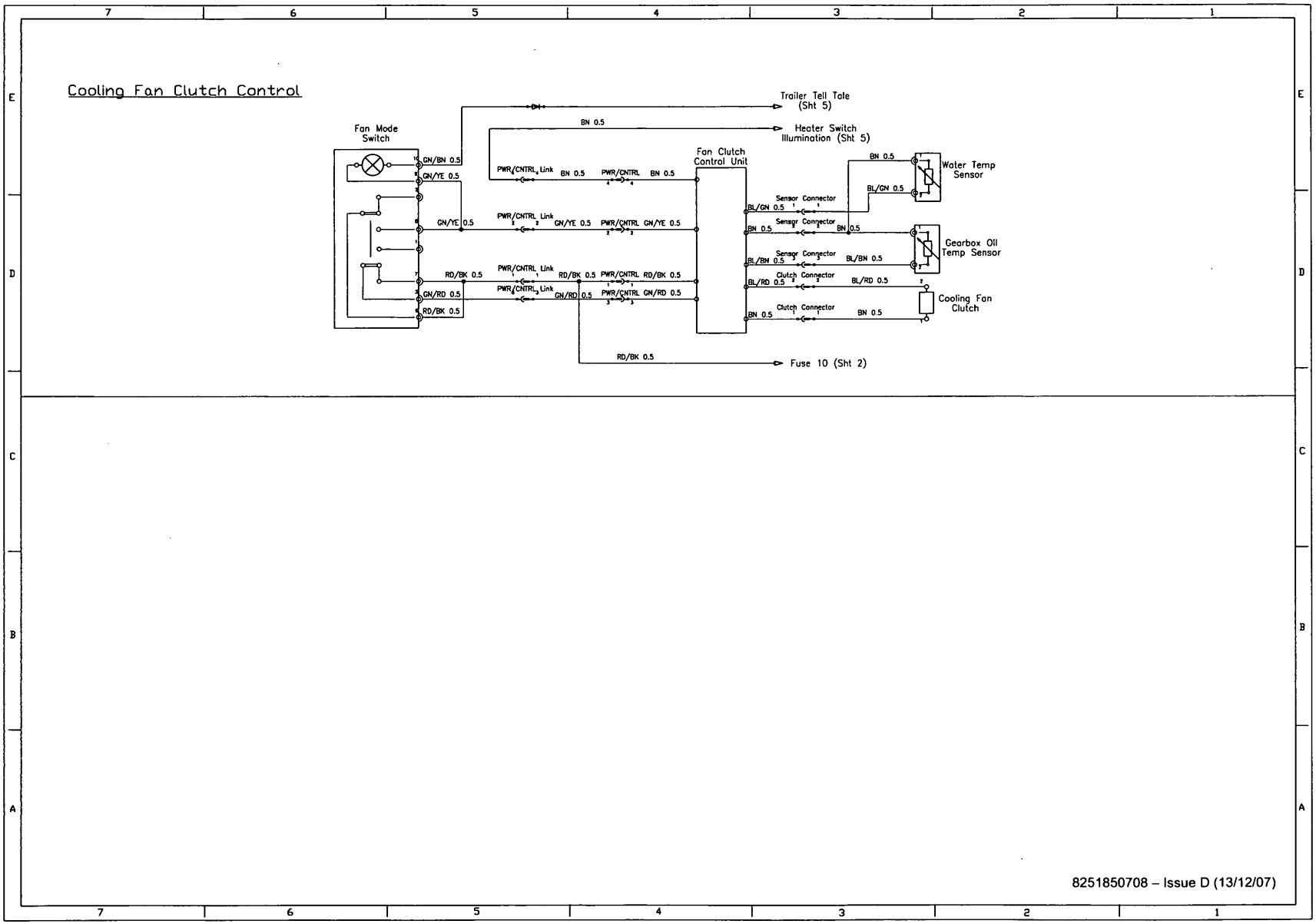


Fig 4 Sheet 10 – Cooling fan clutch control

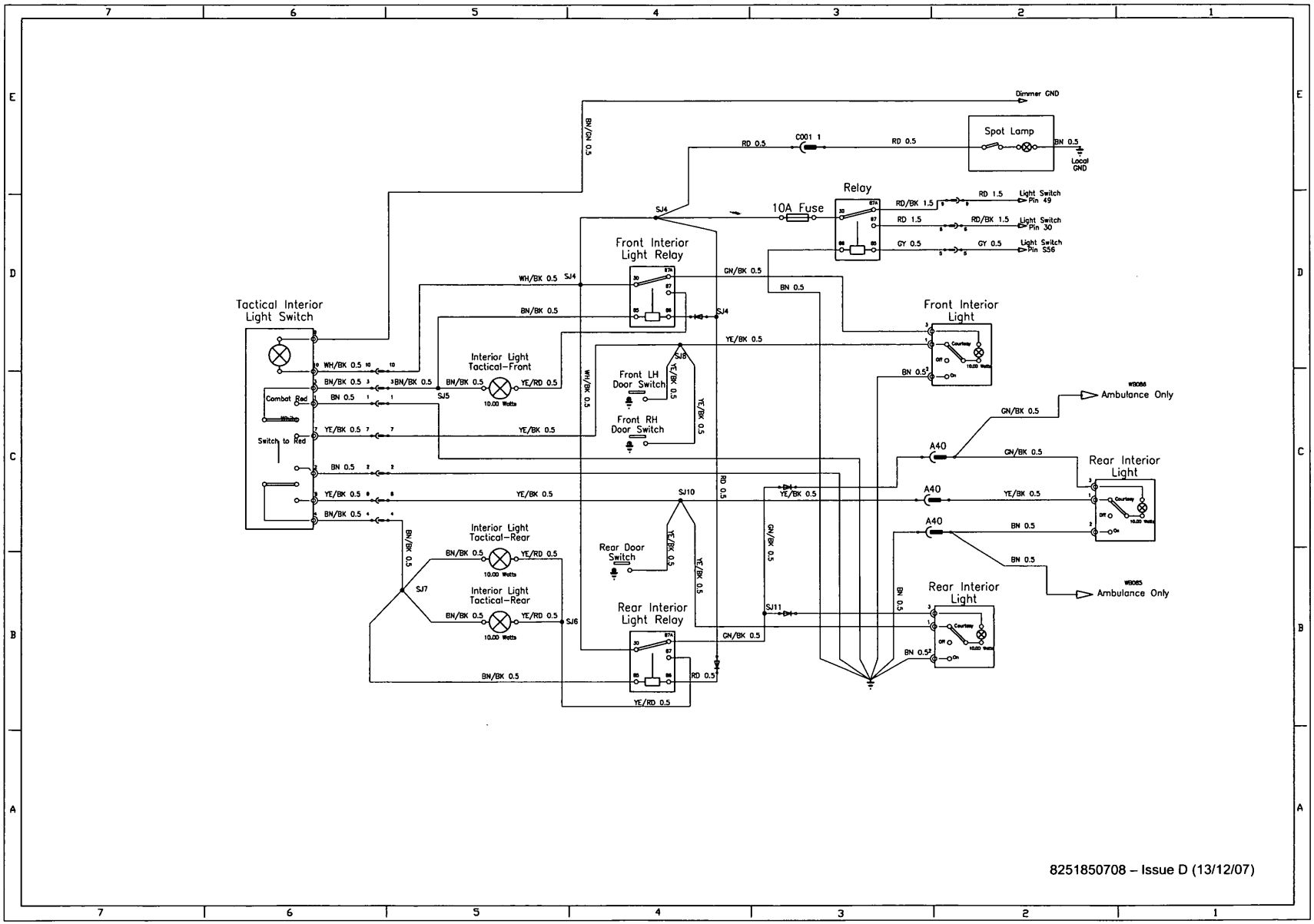


Fig 4 Sheet 11 – Interior and tactical lighting

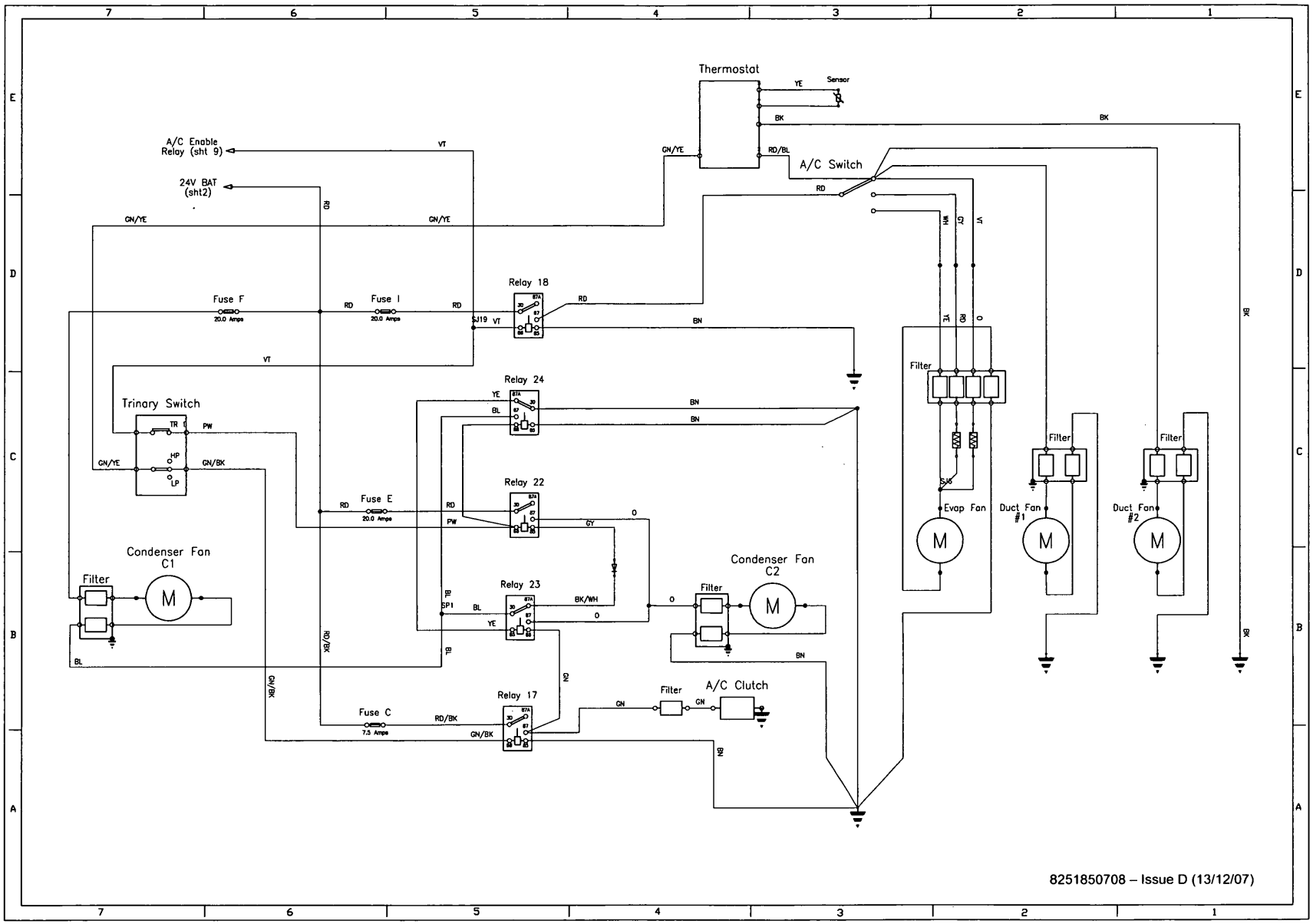


Fig 4 Sheet 12 – Environmental Control System (ECS)

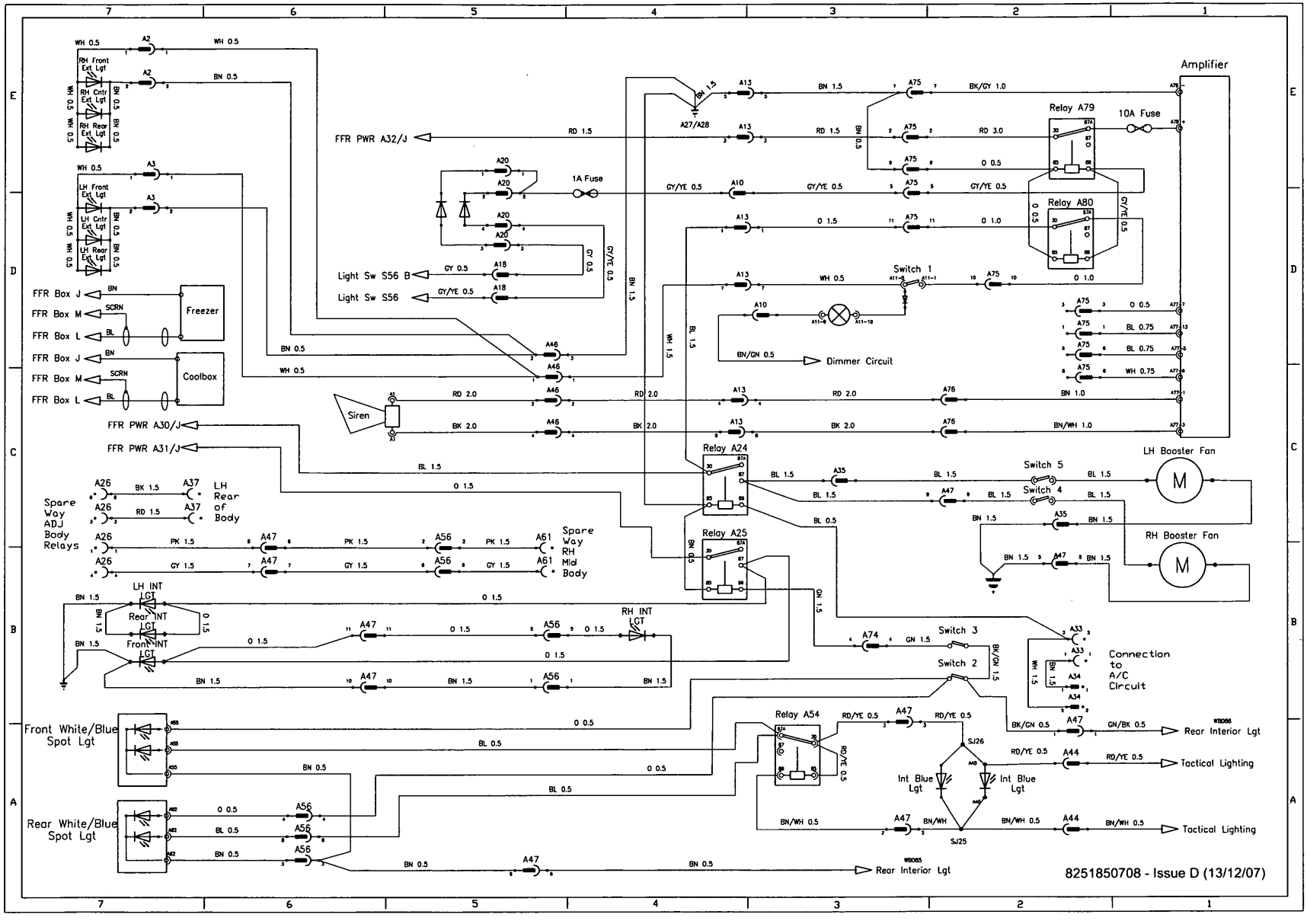


Fig 4 Sheet 13 – Ambulance Variant Specific

CHAPTER 16

[redacted]

[redacted]

CHAPTER 17

HYDRAULIC SYSTEM FAILURE DIAGNOSIS

CONTENTS

Para

1 General information (WARNINGS)(CAUTIONS)

Table Page

1 Indicative system RPM 2
2 Hydraulic system 3

Fig Page

1 Hydraulic system circuit 4

GENERAL INFORMATION

WARNINGS

(1) HAZARDOUS SUBSTANCES. THE HANDLING OF FUELS, LUBRICANTS AND ASSOCIATED PRODUCTS IS HAZARDOUS. REFER TO LOCAL SAFETY PROCEDURES, INSTRUCTIONS AND WARNINGS ON PACKAGING AND OTHER RELEVANT REGULATIONS FOR HANDLING. MINIMUM ACTION AFTER SKIN CONTACT IS TO WASH THE AFFECTED AREAS WITH SOAP AND WATER. THE USE OF BARRIER CREAM IS RECOMMENDED. PROTECTIVE CLOTHING SHOULD BE WORN.

(2) BURN HAZARD. PRIOR TO PERFORMING ANY MAINTENANCE ENSURE THAT THE HYDRAULIC SYSTEM HAS COOLED SUFFICIENTLY TO PREVENT PERSONAL INJURY.

(3) DANGER TO LIFE AND LIMB – PRESSURISED HYDRAULIC OIL. PRIOR TO PERFORMING ANY SCHEDULED OR UNSCHEDULED MAINTENANCE ENSURE THAT THE VEHICLE ELECTRICAL SYSTEM IS SWITCHED OFF.

CAUTIONS

(1) FLUID SPILLS. Spilt oils, lubricants, fluids etc should be contained immediately with spill absorbent materials.

(2) EQUIPMENT DAMAGE. Absolute cleanliness is necessary when working on hydraulic systems and components. All ports and orifices must be capped off immediately a component is removed or a pipe is disconnected.

1 When diagnosing a hydraulic system failure, establish the symptoms and check all the possibilities in order of simplicity until the cause is found

2 The hydraulic system operates whenever the vehicle engine is running as the engine directly drives the hydraulic pump. System pressure depends on the following factors:

2.1 **Electrical load**. As the electrical load on the alternators increases then the pressure in the system increases.

2.2 **Environmental Control System (ECS) load.** As the ECS increases the pressure in the system increases. This is usually when the ECS is switched on as the loading is at it's highest as the system reduces crew compartment temperature.

2.3 **Engine Speed.** As the engine speed increase then the pressure in the system decreases as the flow increases.

2.4 **Ambient temperature**. As a rule in a hydraulic system the pressure decreases as the ambient temperature increases. This will not be the case in this application as with increasing ambient temperature the ECS load increases.

2.5 In general with the ECS operating the hydraulic system pressure will be between 120 and 240 bar once the system has stabilised after start up.

3 Indicative operating speeds (engine v pump/motor v ECS compressor) are provided in Table 3. The speed of the motor is proportional to the speed of the hydraulic pump and therefore the speed of the engine.

TABLE 1 INDICATIVE SYSTEM RPM

Engine RPM	Hydraulic Pump / Motor RPM	ECS Compressor RPM
777	1165	1192
1750	2625	2686
3400	5100	5219
4300	6450	6600

4 The majority of faults will first be presented via the hydraulic system warning light or charge control warning lights located in the drivers display panel.

5 Fault finding on the hydraulic system is mainly carried out by establishing pressure at test point TP2 on the rearward face of the manifold assembly using a suitable test gauge. The test point is fitted with a M16 x 2 thread.

TABLE 2 HYDRAULIC SYSTEM

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 Charging control light.	a) Insufficient charging, hydraulic system drive belt loose/worn.	Check condition and tension of belts at hydraulic pump motor. Replace if necessary.
	b) Regulator/alternator defective.	Replace regulator/alternator.
	c) Hydraulic system fault (depicted by hydraulic system light)	See Ser. 2.
2 Hydraulic system light.	a) Hydraulic system drive belt loose/worn.	Check condition and tension of belts at hydraulic pump and motor. Replace if necessary.

continued

TABLE 2 HYDRAULIC SYSTEM - CONTINUED

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
	b) Insufficient hydraulic oil pressure.	Stop immediately. Check oil level. Check for oil leakage / rectify as necessary. Check system pressure and pressure relief valve setting.
	c) Hydraulic system over temperature Note: The ECS compressor is automatically taken off line when the oil temperature exceeds normal operating conditions.	Check system temperature on sight level temperature gauge (max operating temperature 90°C) / allow system to cool for 15 minutes and check warning light. Check the cooler matrix is clean and clear from any obstructions. Check operation of cooler temperature switch (located in rearward face of hydraulic tank). Normally open switch operates when oil temperature reaches 45°C. Check operation of cooler. Check system pressure and pressure relief valve setting.
	d) High temperature switch faulty.	Check operation of high temperature switch (located in forward face of hydraulic tank). Normally closed switch goes open circuit when oil temperature reaches 75°C.
	d) Low pressure switch faulty	Check operation of low pressure switch (located in rearward face of manifold). Normally open switch closes when the pressure in the system reaches 0.5 bar.
	c) Hydraulic pump or motor faulty or motor jammed.	Check speed of pump and motor in relation to engine. If the motor is not operating at the correct speed in relation to the main engine speed check the setting of the relief valve. If this is incorrect the flow will pass over this valve and therefore by pass the hydraulic motor. If the hydraulic motor is not able to spin then the system pressure measured will be the relief valve setting (350 bar).
3 Filter blocked indicator red.	a) Filter blocked.	Change filter.

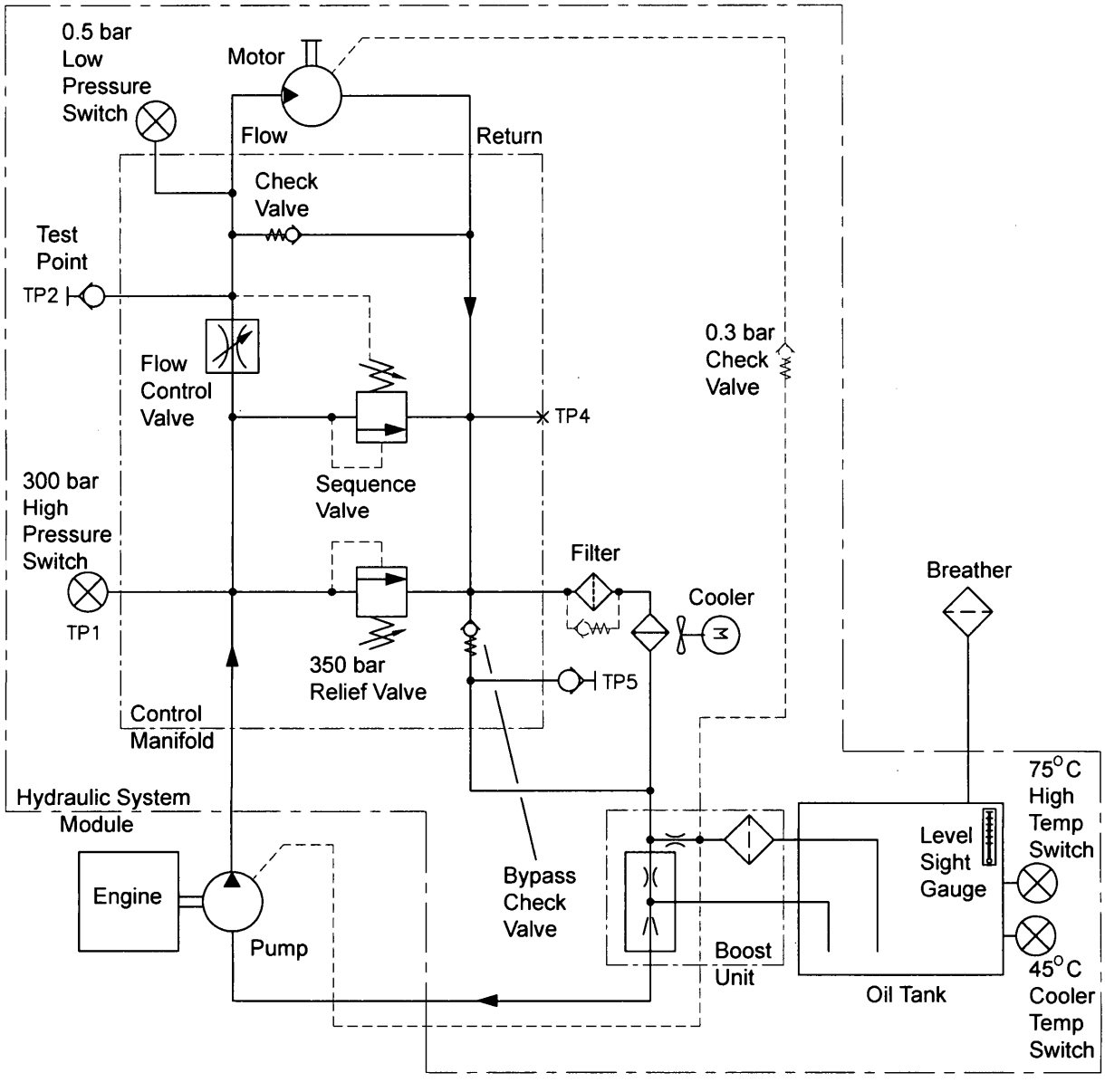


Fig 1 Hydraulic system circuit

CHAPTER 18

ENVIRONMENTAL CONTROL SYSTEM (ECS) FAILURE DIAGNOSIS

CONTENTS

Para

1 General information

Table Page

1 ECS/vehicle interface 1

2 HVAC/vehicle interface 2

GENERAL INFORMATION

1 Commercial standard failure diagnosis and repair information for the Eberspacher Environmental Control System (ECS) is provided at 2320-D-503-522 Chapter 18.

2 ECS/vehicle interface fault diagnosis is provided in the following table:

TABLE 1 ECS/VEHICLE INTERFACE

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
1 ECS failure	a) Insufficient drive, hydraulic system drive belt loose/worn (probably also denoted by automotive charge control light illumination).	Check condition and tension of belt at hydraulic motor/compressor/alternator. Replace if necessary.
	b) Hydraulic system high pressure switch faulty	Check operation of high pressure switch (located in the underside face of the hydraulic system manifold). The switch has change over contacts set to 300 bar. When the switch operates it unloads the air conditioning compressor.
	c) Hydraulic power system equaliser failure (probably denoted by intermittent function of ECS or heavy engine loading).	Change equaliser.
	d) Hydraulic system fault (depicted by hydraulic system light).	See Chapter 17.

TABLE 2 HVAC/VEHICLE INTERFACE

Indicator/Symptom (1)	Possible Cause (2)	Action (3)
2 HVAC failure	a) Insufficient coolant in HVAC system.	Check for coolant leak on engine and HVAC system.
	b) Bleed valve left open	Check for coolant leaks on bleed valve port
	c) Heater valve defective	Check heater valve operation (see 522 Chap 18-2)
3 Poor heating performance	a) Secondary pump failure	Check operation of secondary pump (see 522 Chap 18-2)
	b) Unable operate/ adjust heater temperature control	Check heater control cable , micro switch and spring (see 522 Chap 18-2
	c) ESC system is switched on	Check operating instructions (See 201 Chap ??)
	d) Blockage in cooling system	Check cooling system for operation (see 522 Chap 18-2)
	e) Blower fan not working	Check operation of blower fan (see 522 Chap 18-2)