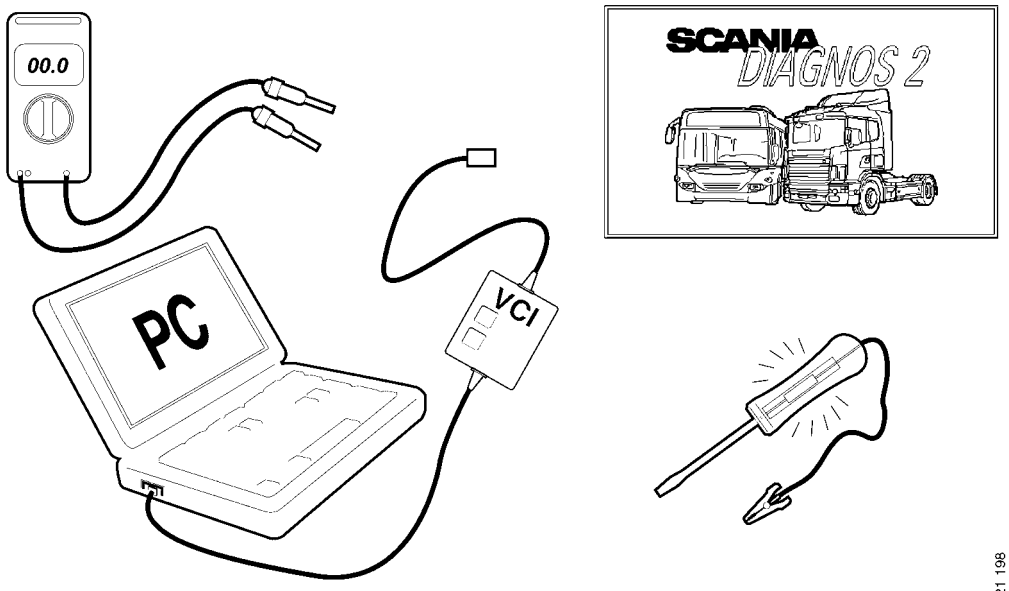
SCANIA

16:07-00

Issue 2 **en**

General troubleshooting in electrical systems and electronic control systems



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Contents

General troubleshooting

If you study the specific fault and carry out methodical troubleshooting using the wiring diagram, test lamp, multimeter and in some cases also a PC and Scania Diagnos you will find that troubleshooting in the electrical systems of modern vehicles and in their electronic control systems is not especially difficult.

Some basic knowledge of electrical systems and computer usage is however required.

This booklet should help you to find a suitable procedure when troubleshooting traditional electrical systems and electronic control systems.

You will find the basic electrical system on both the wiring and circuit diagrams.

Specific equipment which is not standard on all vehicles, e g a tag axle lift, has its own wiring diagram.

Electronic control systems communicate frequently with their components using digital signals and varying voltage analogue signals. This makes it impossible to use a test lamp as a tool when troubleshooting.

When faults occur in electronic control systems, fault codes are generally generated, which can be read off with a PC and Scania Diagnos.

A fault in one control system can produce a subsequent fault in other control systems. Sometimes the subsequent faults are more obvious than the original fault.

Example:

A customer comes in and complains that the vehicle retarder is not operating correctly. It cannot be controlled via the brake pedal and the downhill speed control is not operating either. Nor has any warning lamp come on and according to the customer all the fuses are intact.

The vehicle is equipped with an ABS brake system and it appears that the ABS system warning lamp is defective. The retarder and ABS system communicate with each other and the retarder uses a test signal via the ABS system warning lamp. If the signal is not present, the retarder control unit disconnects the retarder operation via the brake pedal and downhill speed control.

It is therefore important to be familiar with the design of different electronic control systems and their communication with each other.

Cable marking

Some basic information

Numeral mark

15	Voltage with key in drive position*
30	Constant voltage
31	Earth connection

*The circuit is supplied with voltage when the key is in the drive position. When measuring a component, it is necessary to know how it is connected, e g there may be a switch that must also be switched on for voltage to be supplied to the component.

Colour mark*

BK	black	YE	yellow
BN	brown	RD	red
OG	orange	GN	green
BU	blue	VT	violet
GY	grey	WH	white
PK	pink		

*The abbreviation relates to the name in English, BlacK, YEllow etc.

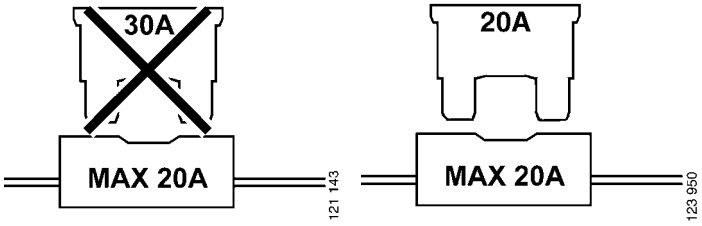
Example:

15HB.RD-2.5+C8-3

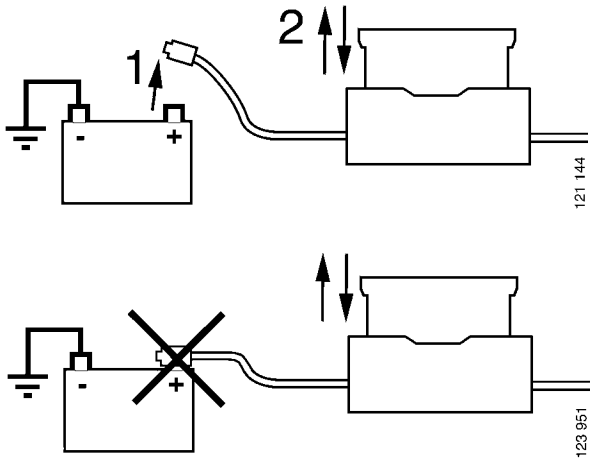
15HB.	Function (15 = Voltage with key in start position, HB = ABS circuit)
RD	Colour
-2.5	Cable area, mm² (2.5mm²)
+C8-3	Address, other end C8 = connector -3 = Connection 3

To be considered ...

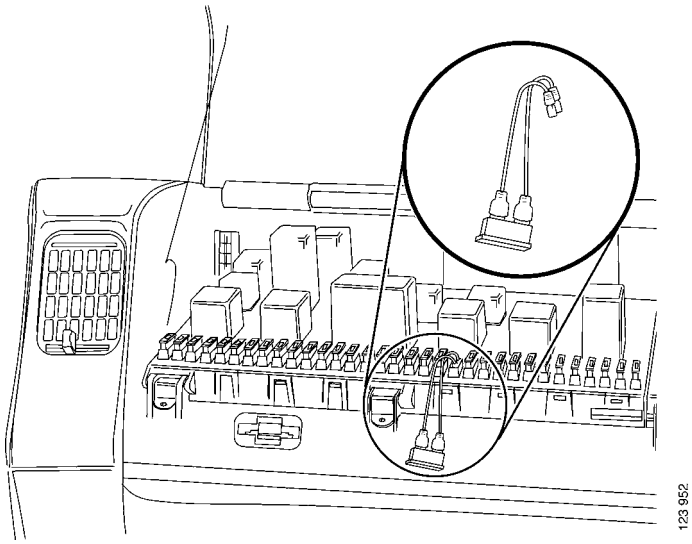
- You should never fit a fuse with a higher amperage than permitted. The fuse is designed to suit the electrical system and its components.



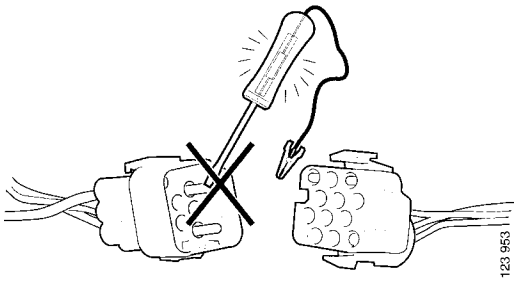
- Avoid changing a fuse when the power supply is still connected to it. This is to avoid burns in the fuse holder.



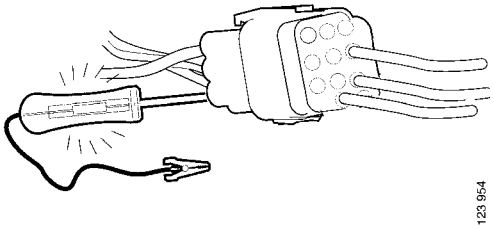
Sometimes it may not be appropriate to disconnect the power supply to the vehicle during troubleshooting, e g if the customer has some equipment in the vehicle which is dependent on a constant power supply for memory functions etc. If this is the case, you should remove the fuse from the fuse holder during troubleshooting. You can do this with a couple of self-made cables. Refer to the illustration.



- Always try to carry out voltage tests on a connector from the rear of the connector. This avoids damaging the pin and you do not need to disconnect the connector unnecessarily. A connector which has been frequently disconnected can, in time, give rise to a loose contact.

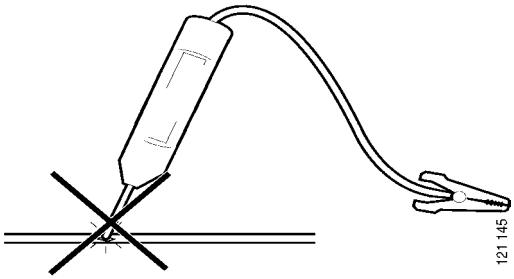


IMPORTANT! If a connector to a currently active electronic control system is disconnected, fault codes are often generated. Therefore remember to check that no new and misleading fault codes have been generated after troubleshooting and repair.



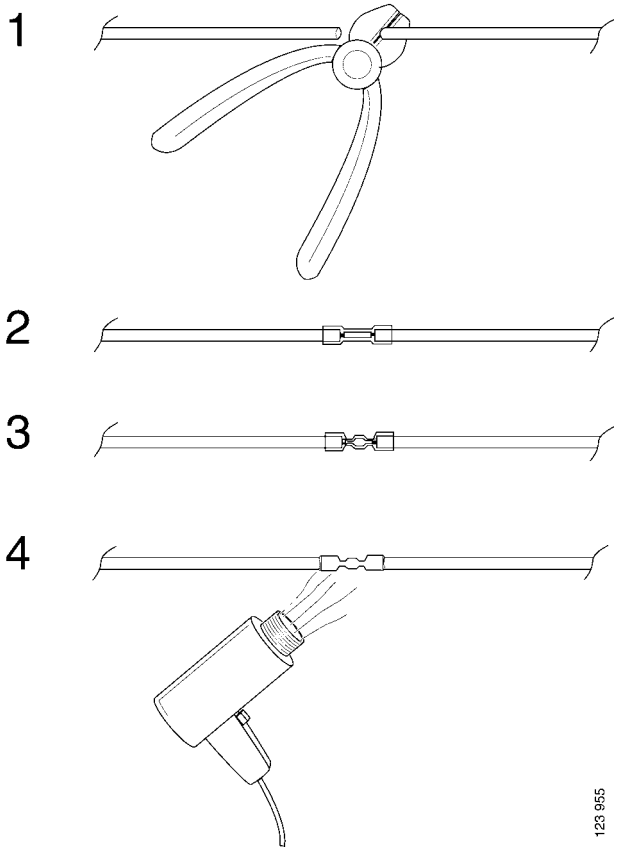
- When you are searching for a **open circuit between connectors**, the following applies:

  You should never make a hole in a cable which is located outside the cab to check whether it is live. Moisture and salt can penetrate even a very small hole and in time the cable will form verdigris within the insulation. Such an open circuit is almost impossible to see. It is better then to cut the cable and make a waterproof joint afterwards.

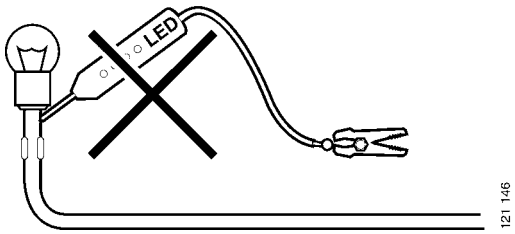


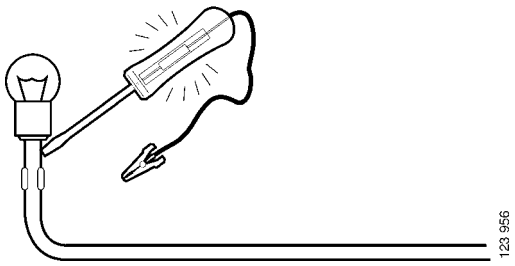
WARNING!

Never cut a cable with several internal leads when it is live. There is a risk of a short circuit which can result in personal injuries and costly consequential damage.

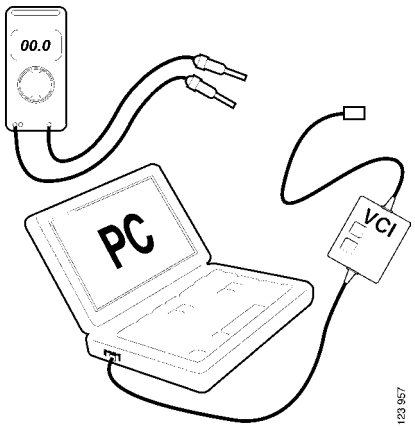


- Do not use a test lamp with an LED to check whether there is a power supply to components such as lamps, magnets, motors, etc which are operated with 24 volts. A bad earth connection to the circuit concerned is enough to switch on an LED which then gives an incorrect result. A test lamp fails to come on or comes on at a very much reduced output in such a test.





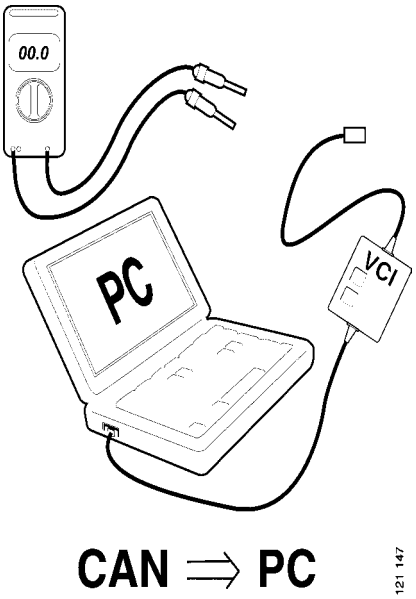
- Troubleshooting in electronic control systems requires access to a multimeter and/ or PC with the Scania Diagnos program.
- Electronic control systems generally store a fault code in their control unit. The fault code can be read off using Scania Diagnos. It is generally possible to locate faults and test various components relatively easily using Scania Diagnos.



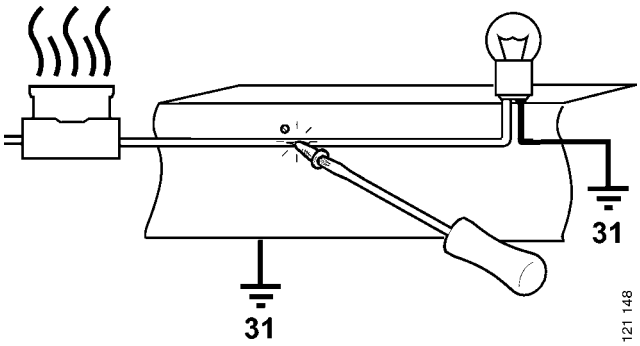
- Control Area Network, CAN

  Certain electronic control systems operate in networks with other control units and components, CAN communication.

  It is not possible to carry out troubleshooting with a test lamp in electronic control systems which use CAN communication. In these control systems you troubleshoot with a PC and the Scania Diagnos and Scania Programmer programs. Cables which form part of CAN communication controlled circuits are marked with the letters CAN on their connections.



Short circuit



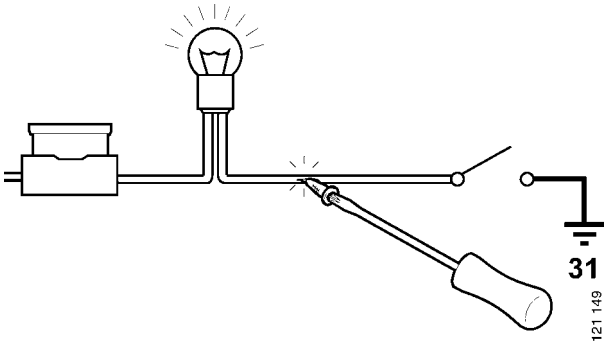
There are different types of short circuits:

- Short circuit to earth on live cables.

  This often results in a fuse blowing or a function being absent and a fault code is generated in an electronic control system.

- Short circuit to earth on an earth circuit.

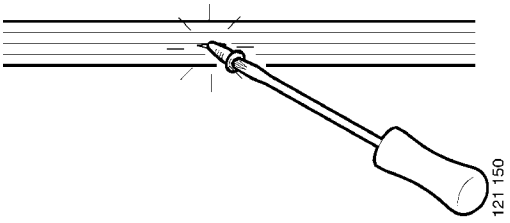
  E g the cable to the brake lamp switch is earthed because a screw is screwed through the cable. Normally that cable is earthed via the brake lamp switch. The short circuit does not cause any fuse to blow in this case, but fault codes can be generated in an electronic control system. Also different electronic control systems can lose functions since several functions are required at the same time. These faults are more difficult to find and it is necessary to understand how the electronic system operates.



- Short circuit from one live circuit to another circuit which is not currently live.

  These types of short circuits may be that a screw is screwed into a cable with several leads, or that there is a touch condition between two pins in a trailer connection, so that normal lighting turns on the direction indicator, activates the tilt function on a connected tipper, etc.

  These short circuits do not necessarily cause any fuse to blow, but fault codes can be generated in an electronic control system.



Open circuit

When there are open circuits, the fuses do not generally blow. What is known as a current spike may be generated by this if the cable or lead is loaded just when it is pulled, torn or cut off. Then a fuse may blow but when a new fuse is fitted it will hold, since there is no longer any load there.

Fault codes are however often generated in electronic control systems when there is an open circuit on their cables. This is because electronic control systems often keep watch and communicate with their components.

Voltage drop

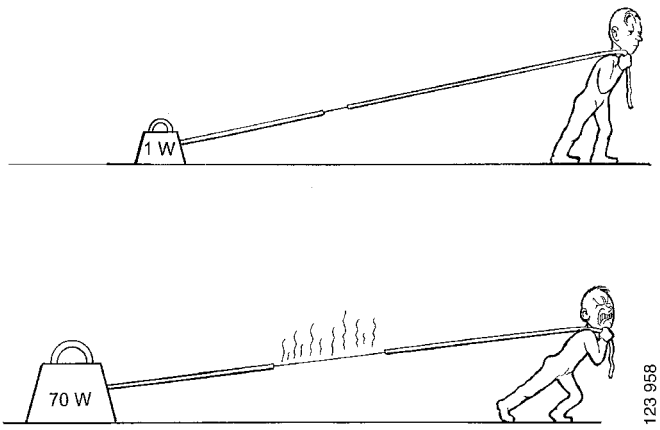
When resistance testing the cable in a currently load-free circuit, you can obtain a misleading measurement result which indicates that the cable and its connections are undamaged.

Example:

A work lamp is not working. You remove the bulb and measure directly in the bulb holder. There you obtain a value of 24 volts and think that it was the bulb that was defective. But it still does not work with a new bulb.

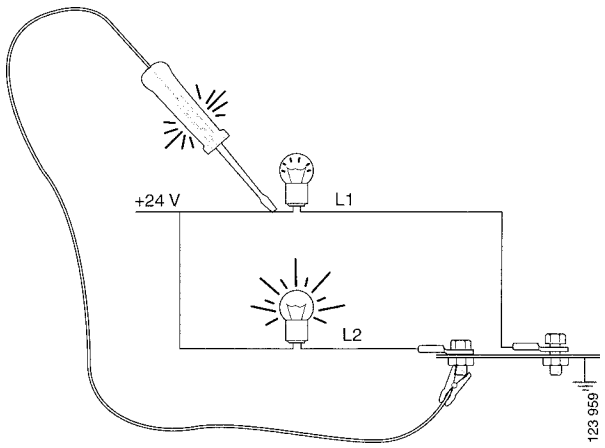
You remove the new bulb and resistance test the cables and obtain a measurement result which shows that the cables and their connections are undamaged.

This is a misleading measurement result. With such a measurement, the load on a cable is so low that it is sufficient if just one copper wire in the cable is intact or the connection is quite poor to obtain a correct measurement result. Under load, however, the conductivity becomes much too poor and the bad cable or connection then functions as a large resistance and a voltage drop occurs. The greater the load the greater the heat released at the voltage drop point.

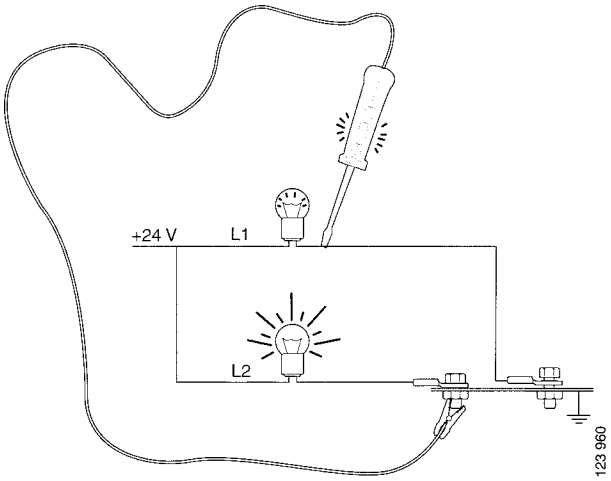


Earth fault

Earth faults in the light circuits or circuits with warning lamps are frequently recognised because the lamps do not come on at full output.

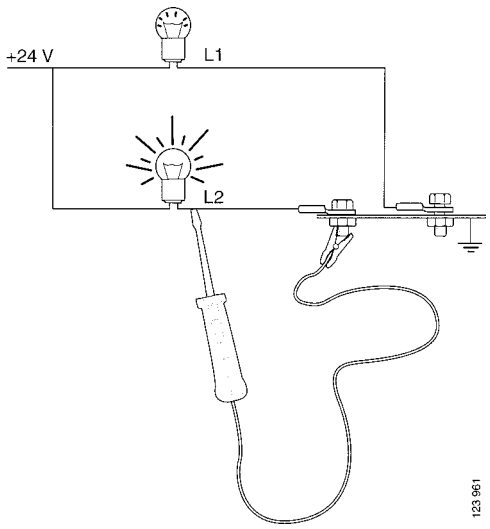


Good earth connection to the test lamp. Correct voltage to L1, but the lamp is glowing.

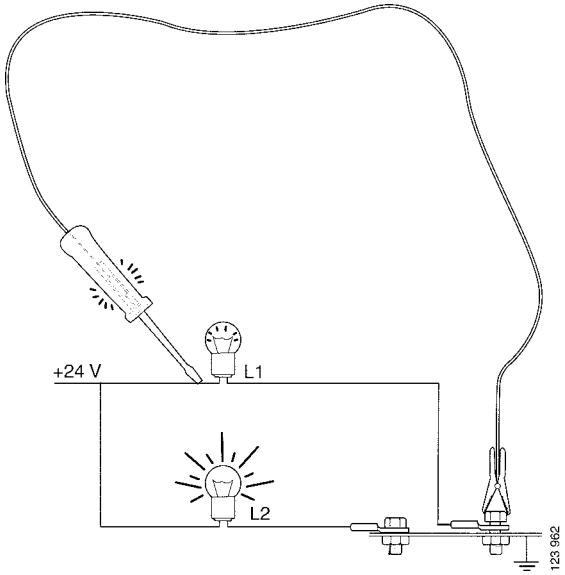


Good earth connection to the test lamp. Faulty earth connection to L1 and both the test lamp and L1 are glowing.

A good earth connection is always dead. Always make sure that there is a good earth connection to the test equipment.



Good earth connection to the test lamp and L2. The test lamp does not come on.



Faulty earth connection to L1 and the test lamp. L1 is glowing and the test lamp comes on faintly. This gives a misleading voltage value for L1.

Earth faults often result in circuits, which have no common connection apart from the earth connection, quite suddenly having an effect on each other.

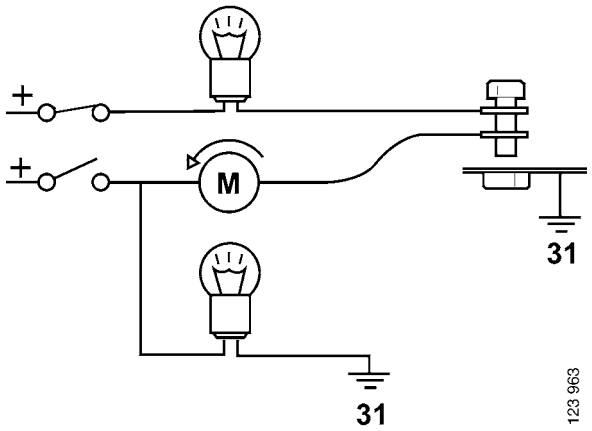
If a common earth point for several different components comes loose, e g from a chassis, the current will be conducted to the nearest earth point.

Earth faults in electronic control systems do not always generate fault codes.

Examples 1 and 2:

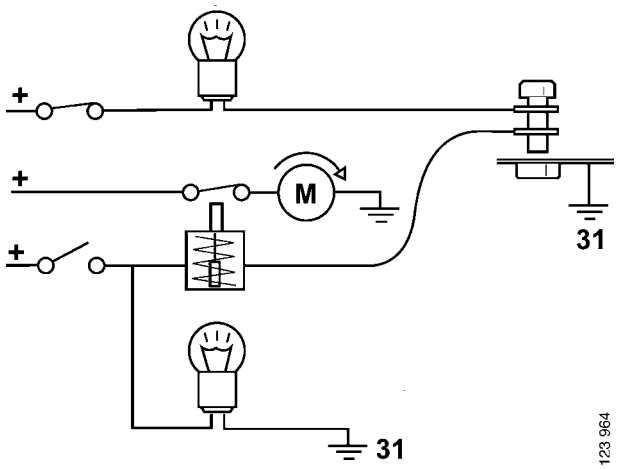
An earth bolt comes loose but is still held in the ring cable terminal connectors of other circuits. Now the current cannot be conducted to earth as intended but the current is conducted to another earth point. Then the current is conducted back into another circuit and in this way circuits are affected by each other, which they normally are not.

Example 1



1. Current via switch, through lamp, to earth point, faulty earth point, on to motor, back through the motor, to output on switch, on to lamp and earths through the lamp and its earth point. This means that the lamps are glowing and the motor runs slowly and in the wrong direction.

Example 2



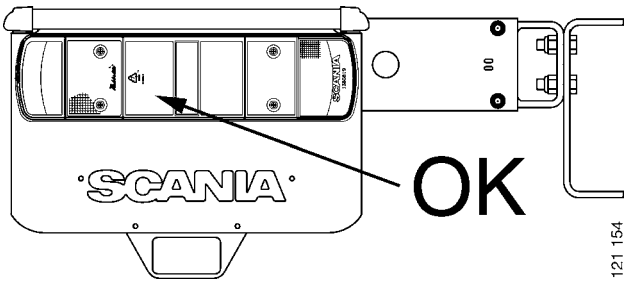
2. Current via switch, through lamp, to earth point, faulty earth point, on to relay, back through the relay, to output on switch, on to lamp and earths through the lamp and its earth point. This means that the relay operates and the engine is running at full output, but the lamps are glowing.

Troubleshooting in the basic electrical system

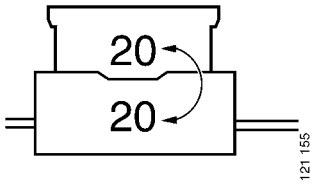
Example

A customer comes in and says that the brake light fuse is defective.

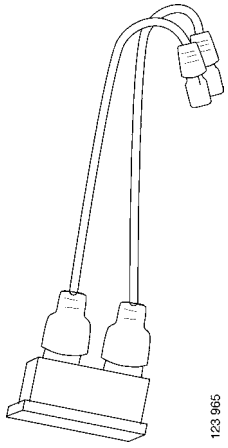
1 An initial inspection of the brake lights shows no visible damage.



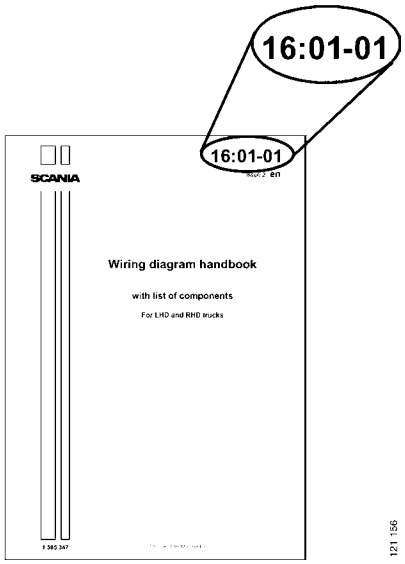
2 Check that a fuse with the correct amperage is fitted. If a fuse with too low an amperage is fitted, it may be enough to fit one with the correct amperage for it to operate.



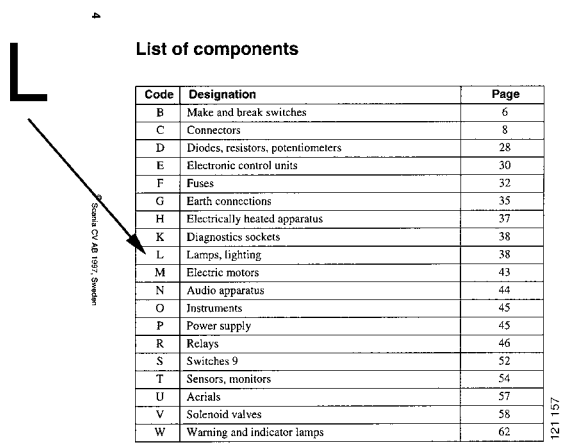
Note: Make sure that the power supply is disconnected to avoid burns to the fuse holder, or remove the fuse holder.



3 If the fault remains it is now advisable to refer to *16:01-01 Wiring diagram handbook* to find the various connection points for the brake lamp.



4 At the beginning of the manual there is a list of components with explanations. Select section L in this case and look for brake light.



List of components

Code	Designation	Page
B	Make and break switches	6
C	Connectors	8
D	Diodes, resistors, potentiometers	28
E	Electronic control units	30
F	Fuses	32
G	Earth connections	35
H	Electrically heated apparatus	37
K	Diagnostics sockets	38
L	Lamps, lighting	38
M	Electric motors	43
N	Audio apparatus	44
O	Instruments	45
P	Power supply	45
R	Relays	46
S	Switches 9	52
T	Sensors, monitors	54
U	Aerials	57
V	Solenoid valves	58
W	Warning and indicator lamps	62

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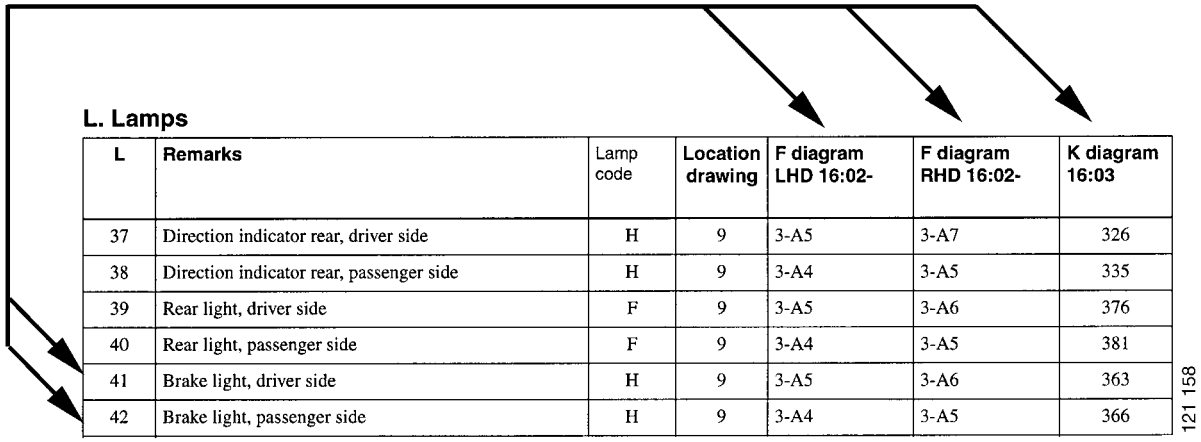

L. Lamps

L	Remarks	Lamp code	Location drawing	F diagram LHD 16:02-	F diagram RHD 16:02-	K diagram 16:03
37	Direction indicator rear, driver side	H	9	3-A5	3-A7	326
38	Direction indicator rear, passenger side	H	9	3-A4	3-A5	335
39	Rear light, driver side	F	9	3-A5	3-A6	376
40	Rear light, passenger side	F	9	3-A4	3-A5	381
41	Brake light, driver side	H	9	3-A5	3-A6	363
42	Brake light, passenger side	H	9	3-A4	3-A5	366

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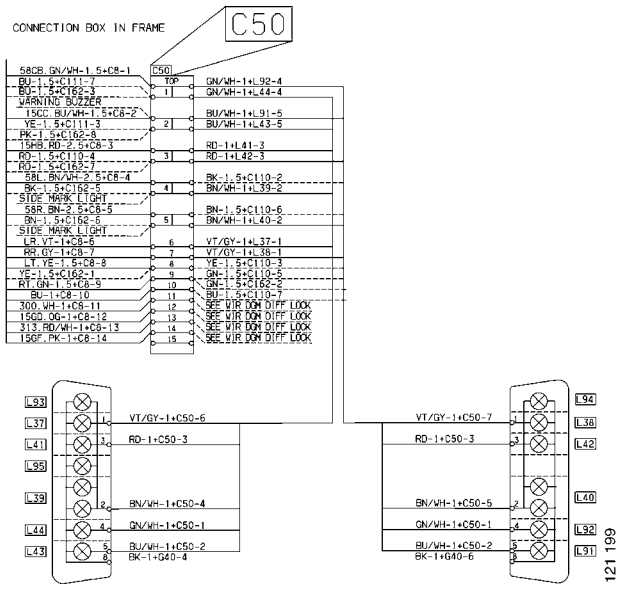
5 You will now find a reference to the appropriate wiring diagram. When troubleshooting in the basic electrical system, and if you are unfamiliar with it, it may be advisable to choose the circuit diagram where you can follow **one** line which corresponds to **one** cable.

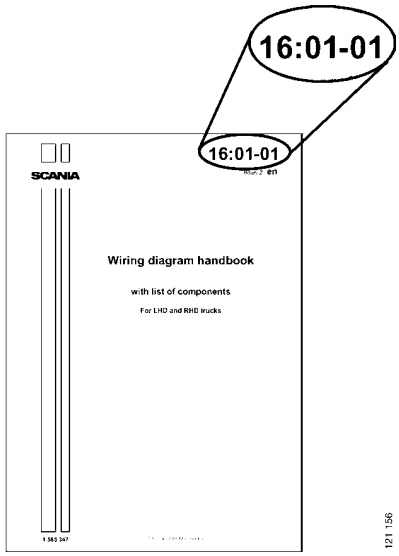
If you have learned how to interpret the cable markings and addresses on the wiring diagram you will obtain an overview of the system by using the connection diagram.

6 In the wiring diagram you will see which different components and connection points that belong to the brake light circuit.

In this case C50 is the nearest component to the brake light. But what is C50 and where is it located?



7 Go back to *16:01-01 Wiring Diagram handbook.*



8 Refer to section C, C50. There it is specified that this is a "junction box in rear crossmember" and is found in location drawing 9.

C. Connectors

C	No. of pins	Remarks	Location drawing
43	2	Air conditioning, shifting motor	5
44	2	Air conditioning, magnetic clutch	
45	1	TC	
46	2	Clutch pedal lower position	5
47	3	Clutch pedal upper position	2, 5
48	3	Brake pedal	2, 5
49	3	Power take-off 2	
50	15	Junction box in rear crossmember	9

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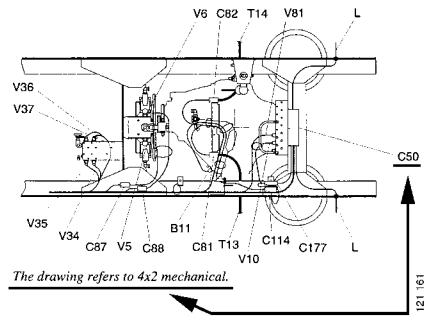
9 Go to the "Location drawings" section in the booklet and select the configuration which corresponds to the chassis you are working on.

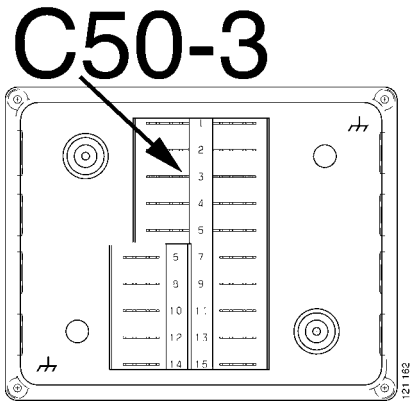
Location drawings

9a.



10 Now it is advisable to disconnect the brake light cable terminal on connection 3 in the junction box and either resistance test the wiring to the respective brake light or fit a new fuse and check its function. If it is now free from defects the fault has been located to one of the brake light circuits after the junction box. If the fault remains, continue using the same method until the fault is located.

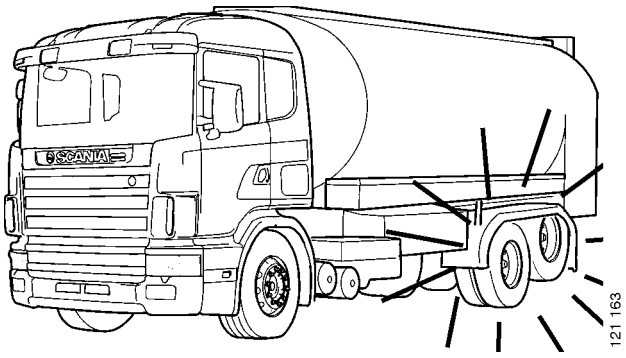
Study the whole system and what the vehicle looks like with a view to possible damage points, e g where the wiring runs around the cab, etc.



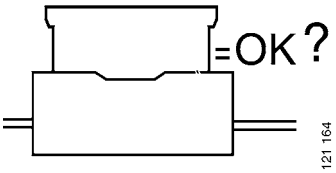
Troubleshooting in systems specific to the chassis

Example

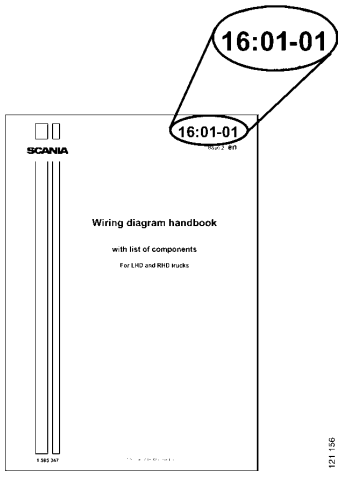
1 A customer comes in and has problems with the tag axle lift on his leaf sprung vehicle. The tag axle lift cannot be lowered.

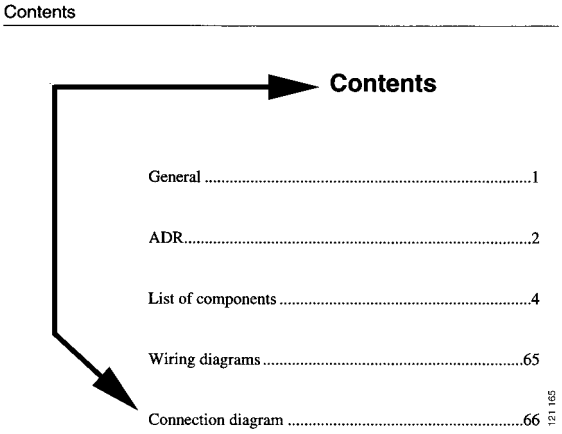


2 First check the fuse in the cab central electric unit. Even if the customer says that the fuse is intact, you should check that this is the case yourself.

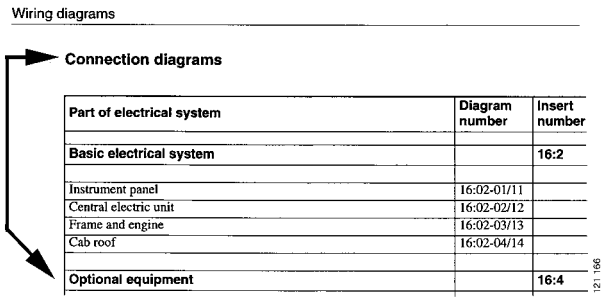


3 The next step is to find the tag axle lift on the wiring diagram and study the whole system. Also check what the vehicle looks like with a view to possible damage points, e g where the wiring runs around the cab, connection points, etc. Refer to *16:01-01, Wiring Diagram handbook* Connection Diagram section.

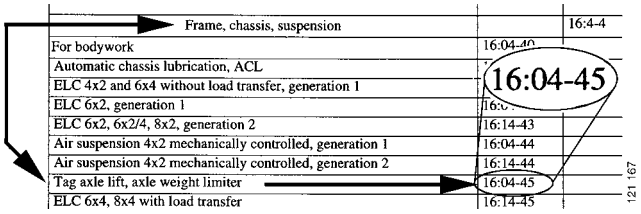




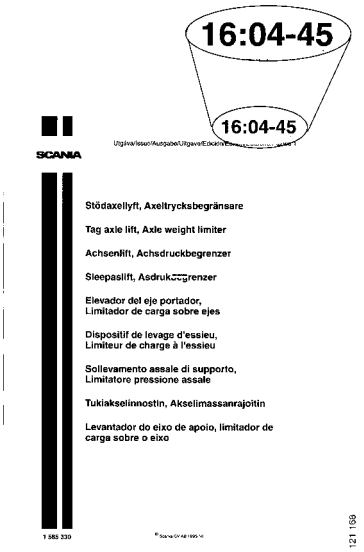
4 Go on to "Optional equipment" since the tag axle lift is not part of the basic electrical system.



5 In the subgroup "Frame, chassis, suspension" you will find tag axle lift, axle weight limiter and will find a reference there to diagram No. 16:04-45. Look for the diagram in the Workshop Manual, group 16.



6 Now you have the diagram which relates to the tag axle lift and its components.



7 Each component has its code and designation on the wiring diagram in English. If you require the designation in your own language you should refer to 16:01-01, Wiring Diagram handbook, List of components.

Des.	Pos.	Description	
C73	D6	Connector	17-pole
C75	D4		3-pole
C76	D4		4-pole
C108	D3		1-pole
E21	D8	Control unit	
F10	E3	Fuse holder	2-pole
G5	C8	Ground	instr panel
G9	D8		
G36	C3		Frame
G42	C3		
M11	D3	Motor hydraulic	tag axel lift
P1	C3	Battery	
P2	F8	Central electric unit	
R44	D3	Relay	hydraulic pump
S14	E8	Switch	tag axle lift M
S40	B3		battery master switch
T34	B3	Sensor	load limiter
T45	E3	Monitor	high oil pressure
V49	F3	Solenoid valve	tag axle down
V50	F3		tag axle up

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8 You will find solenoid valve V49 on the wiring diagram which should be activated when lowering the tag axle lift.

9 One of the cable designations at the connection to the V49 is:

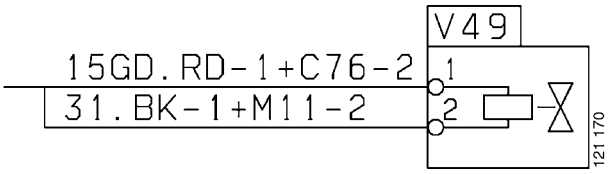
15GD. RD-1 +C76-2

The designation then gives you the following important information in three stages:

15GD = 15 means that the circuit must have starting voltage in order to be activated by switches, etc.

RD-1 = The cable is red (RD) and has 1 mm² cable area

+C76-2 = The other end of the cable is found on component C76, connection 2



121 170

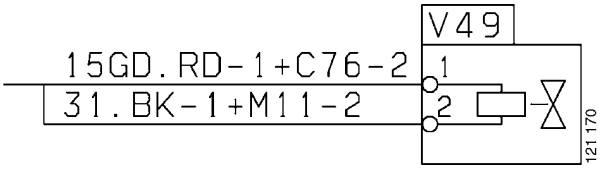
10 The designation of the other cable on the connection to the V49 is:

31.BK-1 +M11-2

31 = Earth connection

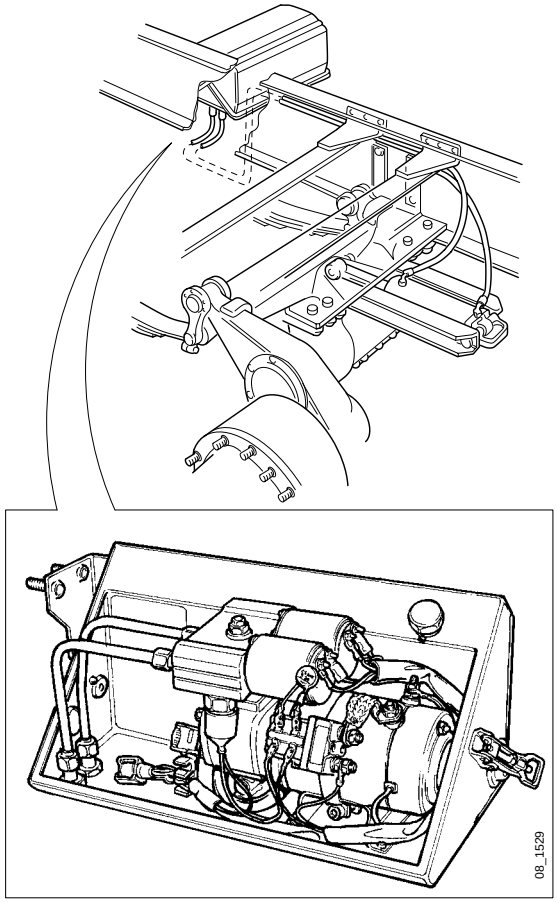
BK-1 = The cable is black (BK) and has 1 mm² cable area

+M11-2 = The other end of the cable is found on component M11, connection 2

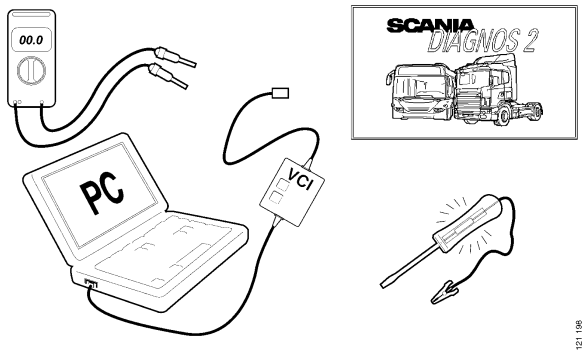


11 So now you can look for the tag axle lift machine box on the vehicle and check using a test lamp whether there is voltage between the red and black connections on the V49 when the switch is pressed. By reading the wiring diagram and looking at the cable colour you can now figure out which components you should test. Particularly if there are several similar components side by side.

12 Continue to troubleshoot calmly and methodically in the same way. Then the fault will be located and the correct action will be taken so that components are not replaced unnecessarily.



Troubleshooting in the electronic system



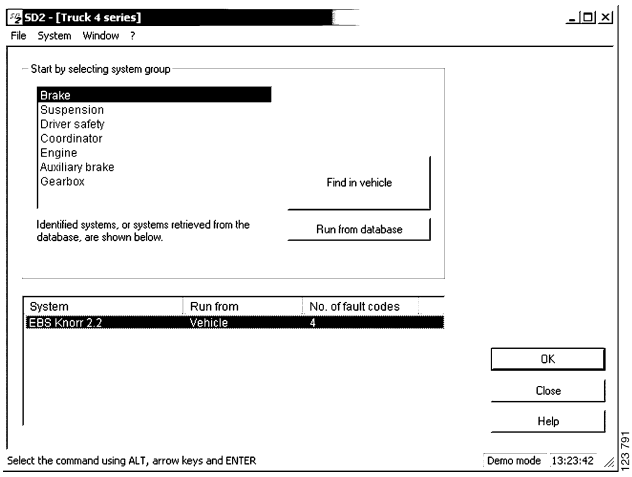
When troubleshooting in electronic control systems, it is important to think in system terms and to consider how different systems communicate with each other.

A fault in one control system can produce a subsequent fault in other control systems. Sometimes the subsequent faults are more obvious than the original fault.

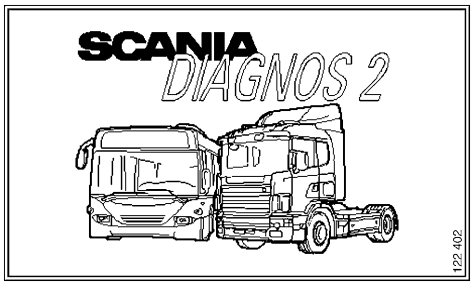
When troubleshooting it is advisable to connect the control system to a PC with the program Scania Diagnos 2, SD2.

Faults can be read off as flashing codes via the diagnostics lamp in the vehicle but if you connect the computer it will read off the control systems that are located in the vehicle and any fault codes at the same time. At the same time you can troubleshoot and obtain the wiring diagram, component location diagrams, proposed remedies, etc using Scania Diagnos.

Scania Diagnos is therefore an extremely effective tool with which to carry out troubleshooting. As long as you work calmly and methodically and read what appears on the screen, you will resolve most faults. The risk of replacing undamaged components is reduced and at the same time unnecessary complaint disputes are avoided.



Scania Diagnos, SD 2

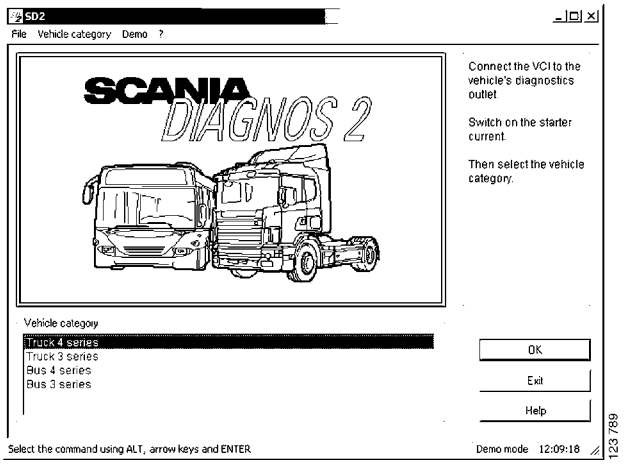


You can troubleshoot in the various electronic control systems with the Scania Diagnos program. The program is sometimes called just SD or SD2.

Scania Diagnos contains a number of windows, three of which are main windows.

A detailed explanation about the program is provided under the ? symbol found in the menu bar.

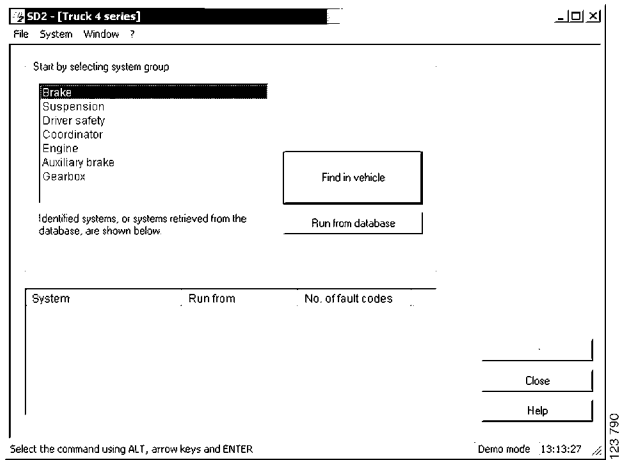
There is a Help button in each window. This provides information about all the functions and buttons in the current window.



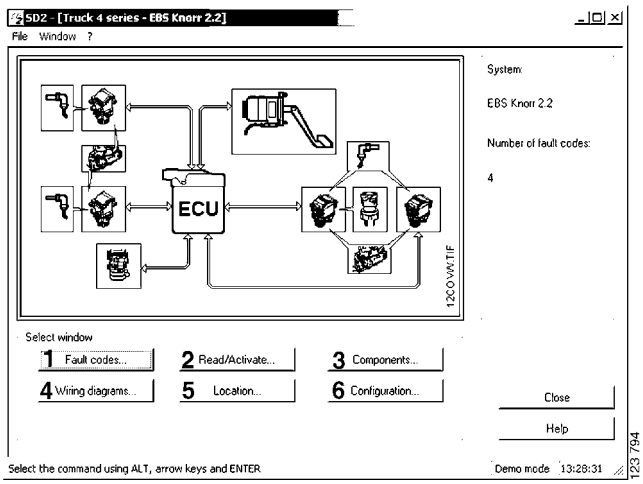
1 In the first window you select the vehicle category you wish to work with.

   In this window you can also opt to run Scania Diagnos in demo mode. This option is available in the Demo menu bar. The choice of control systems which you can run in demo mode is set out under File.

2 In the second window you select the system group that you wish to work with.



3 When you come to the third window you are inside the control system and can start to carry out active troubleshooting by clicking on the different buttons.



1. Fault codes: *Here there are explanations, causes and proposed remedies for the specific faults. In addition there is an option to delete fault codes and obtain direct information about selected components and the wiring diagram which is related to the fault code.*

2. Read/Activate: *Here you can read off and activate signals and functions in the current system.*

3. Components: *When you know a component designation, you can select this button directly to obtain information on the component.*

4. Wiring diagrams: *Here you can study the control system wiring diagram.*

5. Location: *Here you obtain the component location diagrams for the control system.*

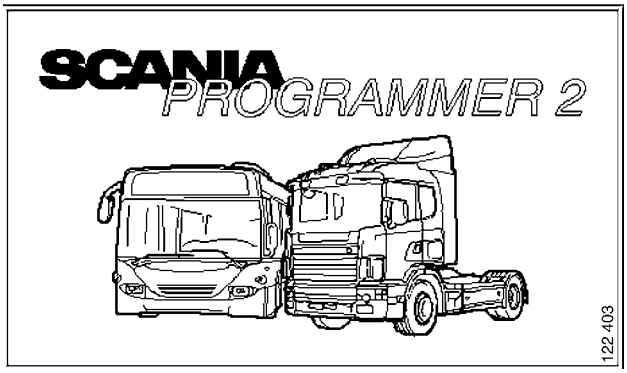
6. Configuration: *Here you can see how the control unit is configured. The configuration can also provide information about how the present control system communicates with other control systems. However, sometimes you must use Scania Programmer to see further configuration information. Refer to the section Scania Programmer.*

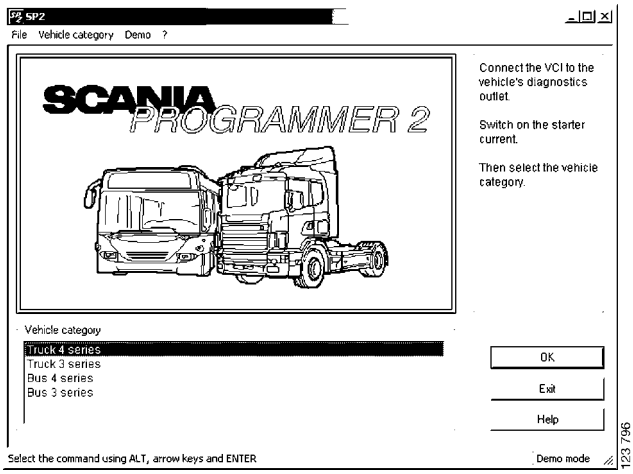
Scania Programmer, SP2

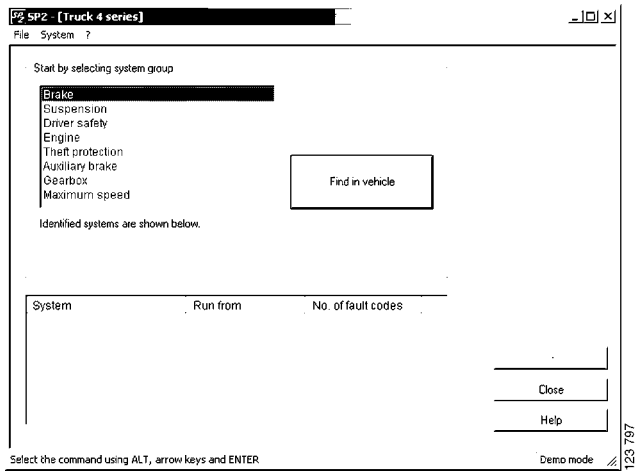
You can reprogram and configure control units in the various electronic control systems with the Scania Programmer program. The program is sometimes called just SP or SP2.

You navigate through the Scania Programmer program in the same way as through the Scania Diagnos program.

IMPORTANT! Remember that reprogramming a control unit is only possible if the specified control unit does not have any fault codes stored. Fault codes are remedied and deleted with Scania Diagnos.





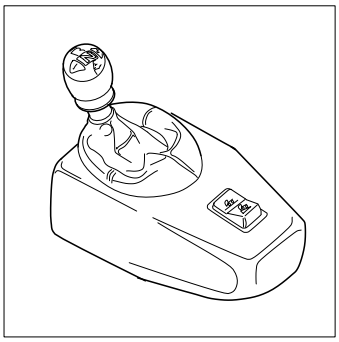


Perceptible faults which do not give any fault warning or fault codes

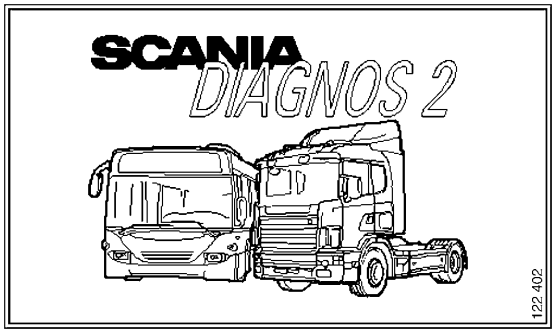
When one of several voltage supplies is missing from an electronic control system, faults may arise which do not give a fault warning or fault codes in Scania Diagnos.

Example:

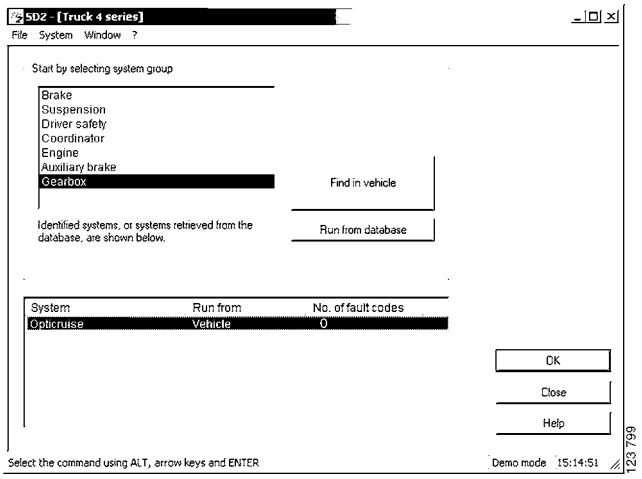
1 A customer says that it is not possible to program the starting gear on his Opticruise-equipped vehicle.



2 No fault codes are found when Scania Diagnos is connected and attempts to program another starting gear are successful.

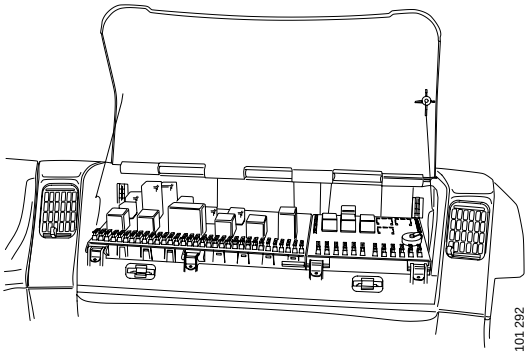


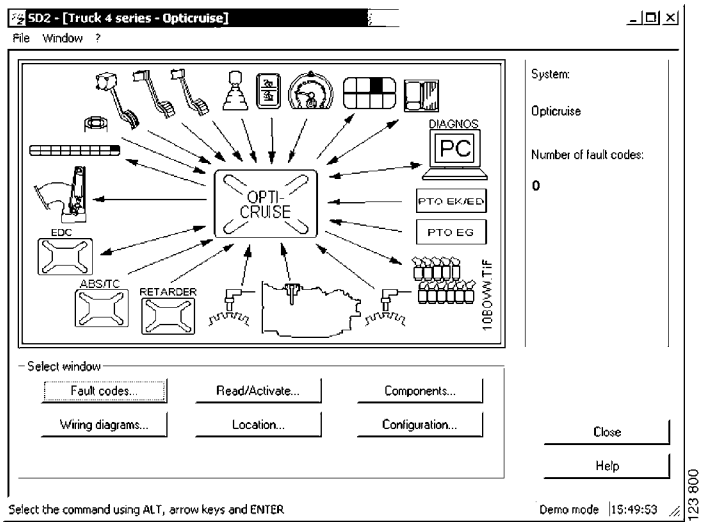
3 It is easy then to believe that everything is working, but when the power is turned on with the key next time, the newly programmed starting gear is not stored.



4 A far too common hasty conclusion is that there may be a fault on the control unit. Make a habit of always checking the voltage supplies to the control system concerned. In this case there are two fuses for the Opticruise. One fuse that protects the ignition on supply (pin 15) and one that protects the permanent supply (pin 30).

Either look directly at the label on the central electric unit cover or use Scania Diagnos/Opticruise/Components or the Wiring diagram to see which fuses belong to the control system.





5 In this case fuse No. 41 was defective. This fuse provides a permanent supply (pin 30) to the control unit. When the permanent supply (pin 30) is missing, neither fault codes nor previous settings are stored.

Conclusion: Always check first that all voltage supplies are present in the specific control system you wish to work with.

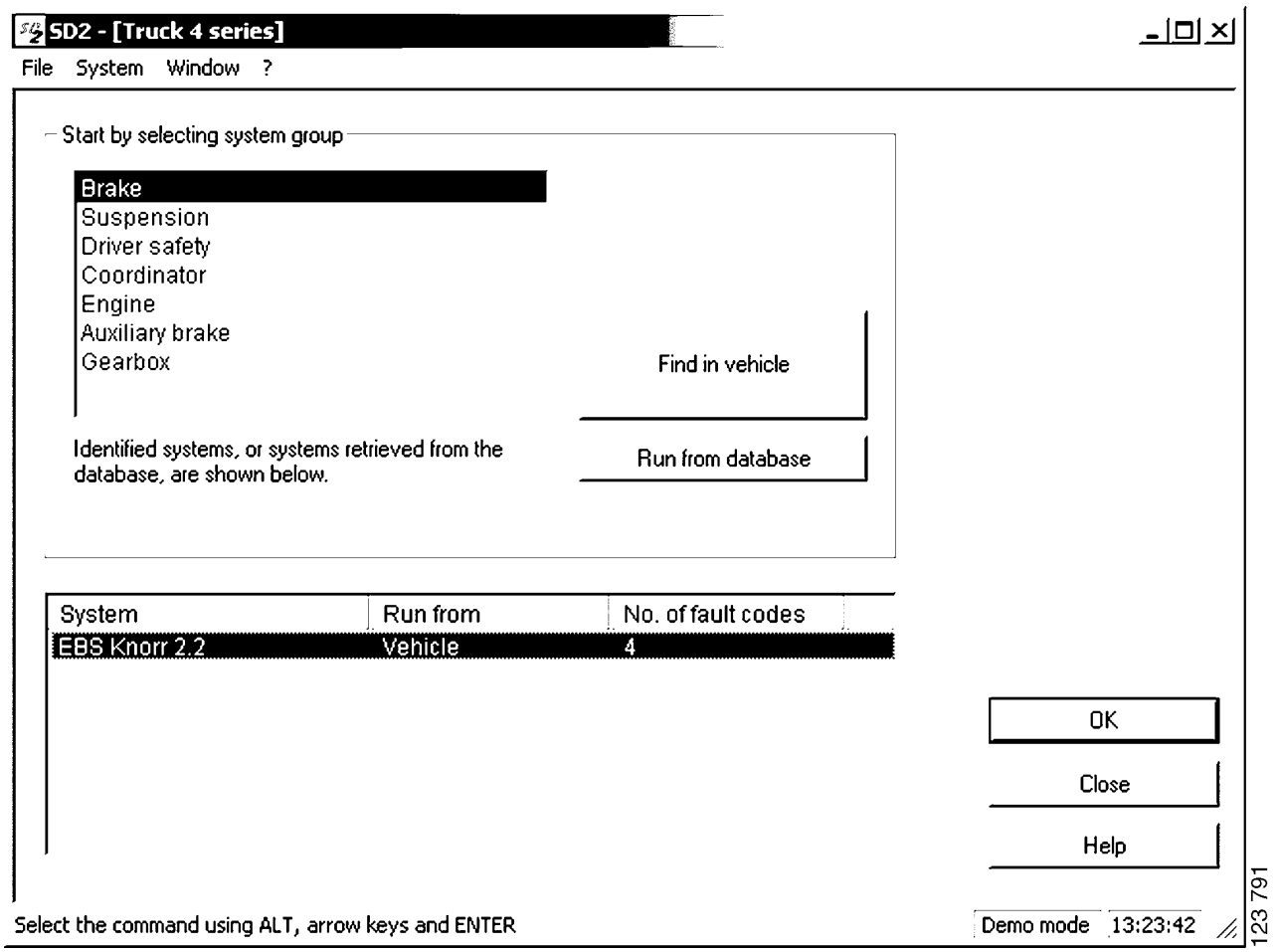
Perceptible faults which give a fault warning and/or fault codes

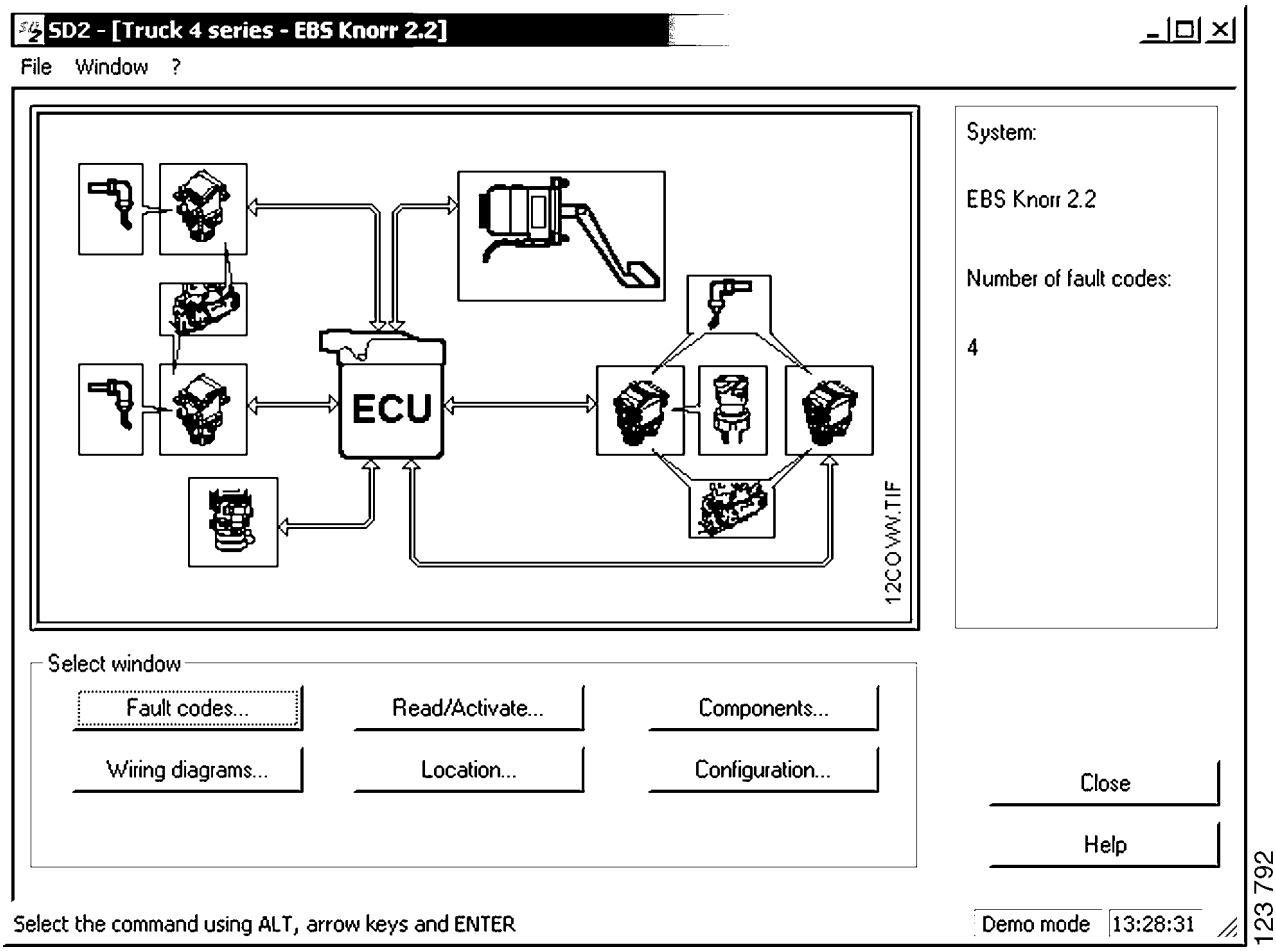
Example:

1 A customer comes in and has problems with the ABS system on his vehicle. The ABS system warning lamp has come on.

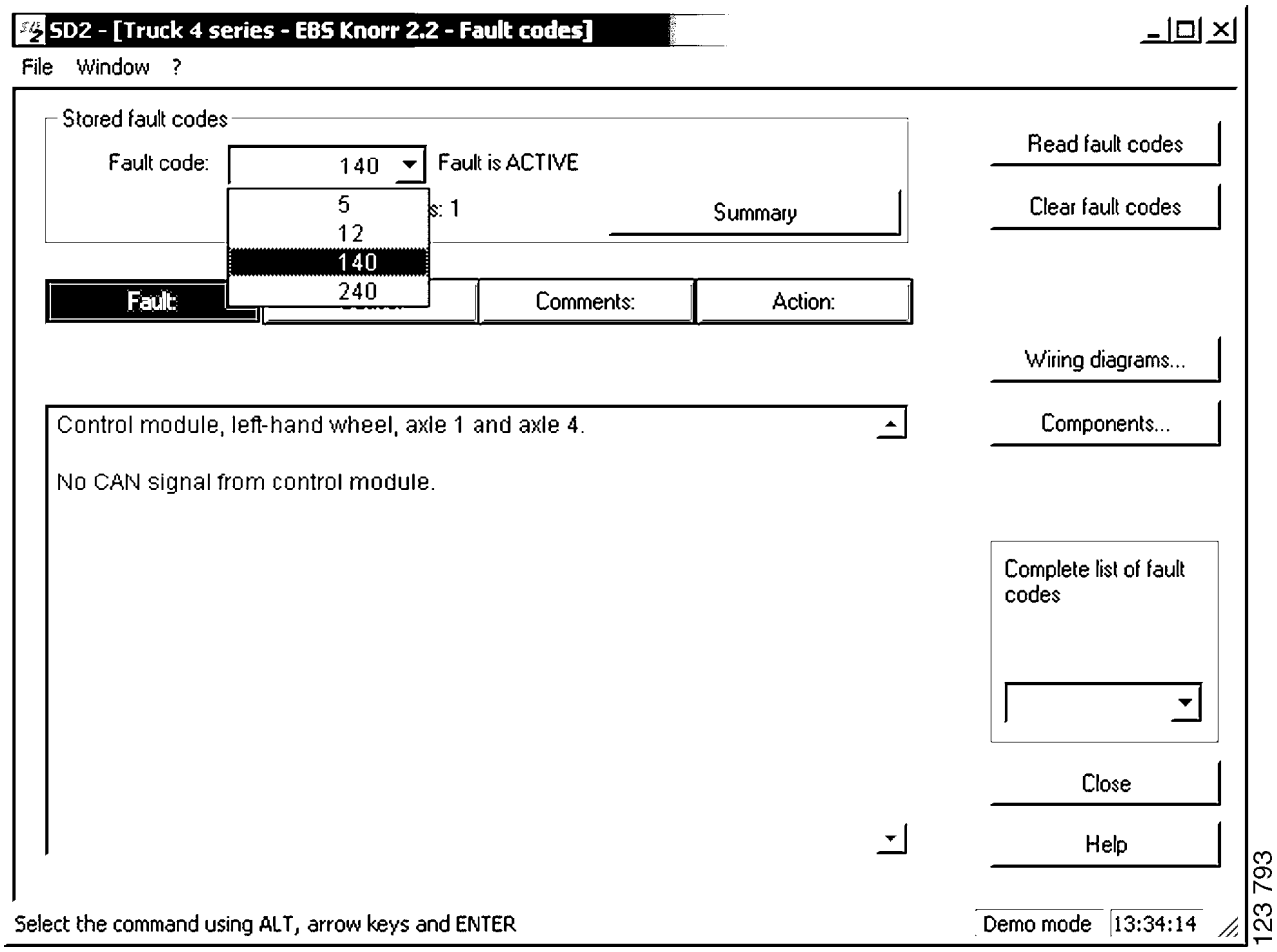
2 Connect the computer and start Scania Diagnos. Follow the instructions on the screen.

3 When you have selected the vehicle category and system group, the system you are working on and the number of fault codes will be displayed. Click on OK.





4 In the next window you have an overview of the system and a number of function windows. At this point select *Fault codes*.



5 At the top of the next window there is a scroll bar with stored fault codes, the marked fault code is explained in the large screen. Fault code 140....

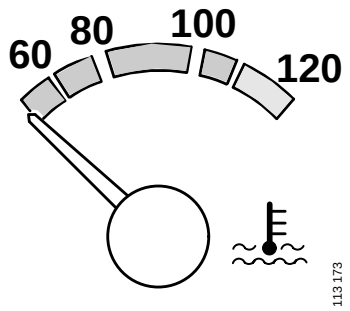
Alongside the scroll bar a display indicates whether the fault is ACTIVE or INACTIVE.

In this window you can then obtain information on the respective fault code with Cause, Comments and Action for the fault. This is a great help when troubleshooting in electronic control systems.

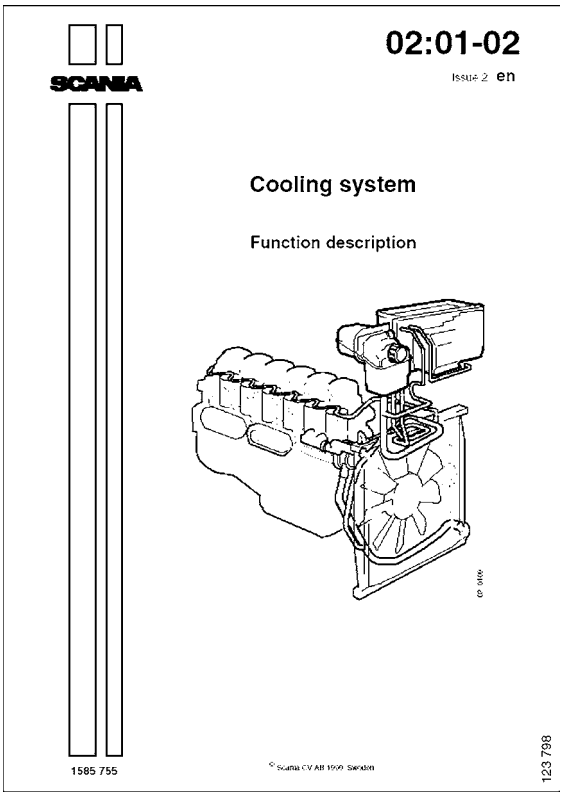
Perceptible faults which do not at first appear to be faults in electronic control systems

Example:

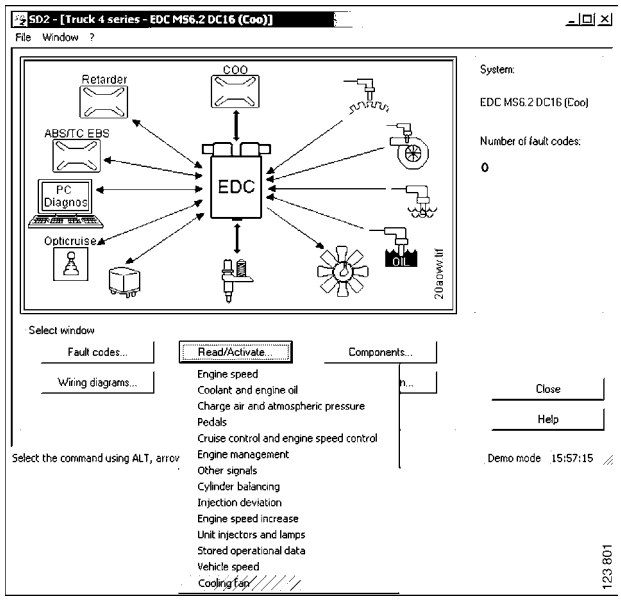
1 A customer complains that his vehicle has difficulty in reaching its working temperature. It is then easy to think that there is a fault on the engine thermostat or a fault in the cooling fan.



2 During troubleshooting, the cooling fan appears to run permanently. The engine is a 16 litre engine. When checking in the Workshop Manual, cooling system, you note that there are engines which are equipped with electronically controlled cooling fans.

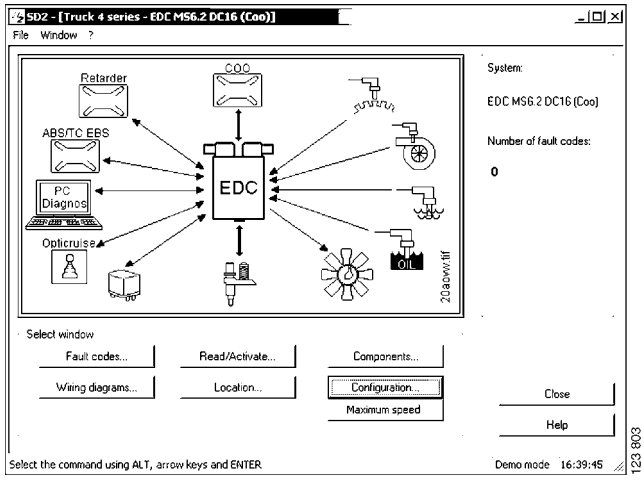


3 When Scania Diagnos is connected, you note that the engine control system is EDC MS6.2 DC16 with a coordinator. As you noted earlier, this engine should be equipped with an electronically controlled cooling fan, but in Scania Diagnos you see no option to check the cooling fan. You should be able to do this under the Read/ Activate button.



4 Now you may start to suspect that the vehicle control system is configured incorrectly. You look under the Configuration button but do not obtain enough information there. The next step is then to exit Scania Diagnos and start the Scania Programmer program instead.

Note: If the system has fault codes stored you must rectify these before it is possible to program a new configuration.



5 Select Programming/View configuration or Fan control in Scania Programmer. You can obtain information about the current setting under the option Fan control and can reprogram it at the same time.

In this case it was the setting Mechanically controlled which caused the cooling fan on the vehicle to be connected the whole time. The cooling fan control operates in such a way that cooling fan is fully connected if it does not receive any signal from the EDC control unit. This is done to ensure that the engine is cooled even if there is a fault with fan control.

After reprogramming the Cooling fan option is then also displayed under Read/ Activate in Scania Diagnos.

In this way an incorrectly configured control unit can generate a subsequent fault which does not leave any fault codes and which also gives fault symptoms which do not even appear to be electrical faults.

It is therefore important to study faults and fault symptoms and at the same time think in system terms and consider how components and systems communicate with each other.