

SCANIA

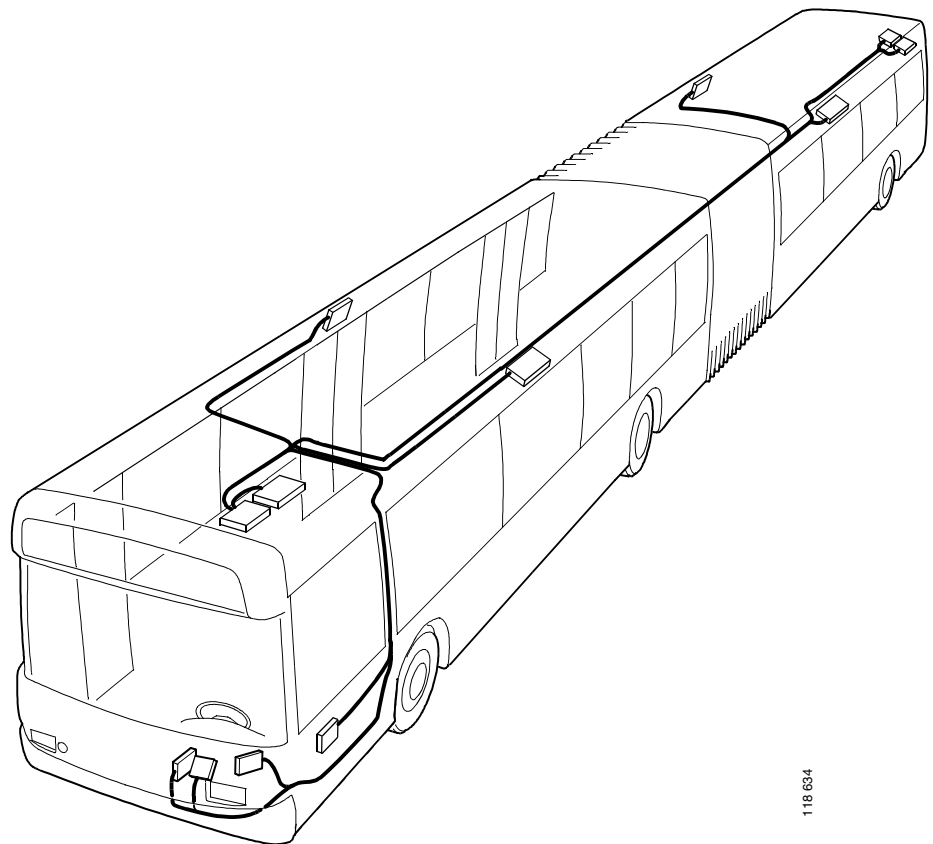
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Issue 1 **en**

BNS

Body Node System

Function description



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General description

Differences and advantages

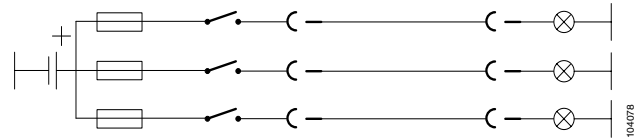
Scania BNS (Body Node System) is an electrical system designed for bus bodies. It is a *multiplexed* electrical system, with significant differences to a conventional electrical system. The multiplex technology enables groups of components to be linked by a single cable.

One of the aims of BNS is to reduce the number of cables and connectors, so increasing the reliability. The system also replaces relays, safety fuses and control units for various functions.

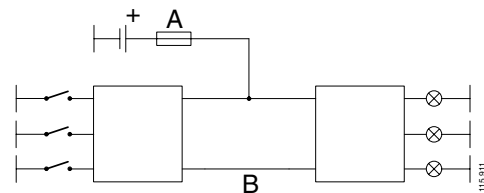
The advantages are numerous. The ease of adding new functions and modifying the system logic makes it very versatile in terms of adaptation to customers' requirements. It is reliable and easy to troubleshoot using the diagnostic tool. It also weighs less than a conventional electrical system.

BNS controls such functions as doors, heating, exterior and interior lighting as well as lesser functions such as the driver's gate and the immobiliser.

The nodes (the control units forming the framework of the system) are located in the vehicle for best possible service accessibility and depending on the electrical components they will control.



A conventional electrical system has separate wiring and fuses for each circuit.



BNS enables groups of components to be linked by a single cable. The total number of cables and connectors is reduced. The two squares in the illustration are nodes.

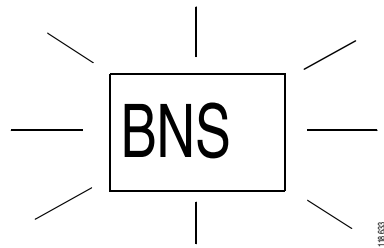
A. Fuse

B. Communication lead between two nodes

BNS warning lamp

A warning lamp for the BNS system is located in the instrument cluster. This will light in the event of a major fault, e.g. if communication with a node is interrupted. It will then be impossible to activate those components connected to the node with which communication is interrupted.

The lamp also lights if a node is replaced with another node that has not been correctly programmed.



Warning lamp that lights in the event of a major system fault.

Versions and generations of BNS

Since the BNS system was introduced, it has been updated and modified a number of times. Modifications are made continuously and every time something new is introduced, the system designation is also changed.

The designations are based on a very simple numerical system. The first generation is simply called BNS 1, the second BNS 2, etc. As BNS systems are different for rigid and articulated buses, they are also distinguished by different designations. A simple rule of thumb is that, starting from BNS 2, even numbers represent rigid buses and odd numbers articulated buses.

Versions

When minor improvements or adjustments to the software itself are made (rather than physically to the vehicle), the system retains its generation designation, but an extra digit is added to the regular designation. For example, BNS 4.1 is an updated *version* of BNS 4, and BNS 4.2 is an updated *version* of BNS 4.1, etc.

If the reason for the creation of a new version is that a fault was rectified in the old version, the new version should ideally completely *replace* the old. In other words, the aim would be to update the BNS system in all vehicles already sold. However, if the improvements to a function are only minor, the old version is *not* replaced.

Generations

A completely new *generation* is created when greater modifications are made, e.g. when a completely new function is added to the vehicle. The new generation always receives a higher number in its designation.

The new generation is not to be considered as a replacement, as the previous generation is continued.

BNS 1	Rigid bus
BNS 2	Rigid bus
BNS 3.1	Articulated bus
BNS 4.1	Rigid bus
BNS 4.2	Rigid bus
BNS 5.1	Articulated bus
BNS 5.2	Articulated bus
BNS 6	Rigid bus
BNS 7	Articulated bus

Different generations and versions of the BNS system may be available on the market simultaneously. Note that both BNS 4.1 and 4.2 may be available simultaneously. Note also that as modifications are made often, this list cannot always be considered as being up to date.

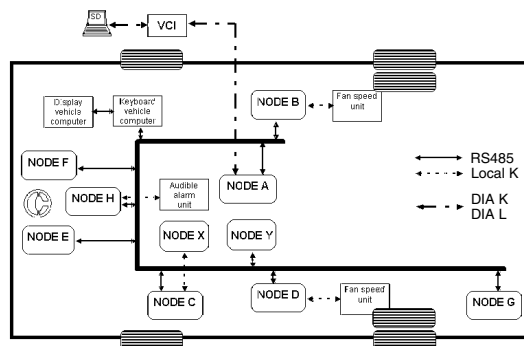
System design

BNS is based on a number of control units known as nodes. The nodes are star-connected in a network. They are designated by letters starting from A. A complete BNS system is composed of around ten nodes.

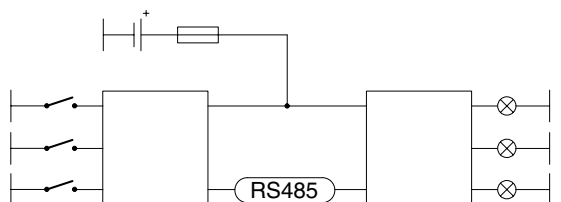
The nodes operate according to the sender/receiver principle. Communication between the nodes takes place via a wound cable that carries all the information between the nodes. Such a cable is known as a *communication bus*; in the case of BNS this communication bus is of the type RS485.

Each node is connected to a number of components that it controls and gathers information from. These components are of conventional type (e.g. switches and lamps) and are also connected to the nodes in the conventional way with wires for plus and minus. The nodes can also send data to other control systems in the vehicle (e.g. for the suspension), or to a connected PC.

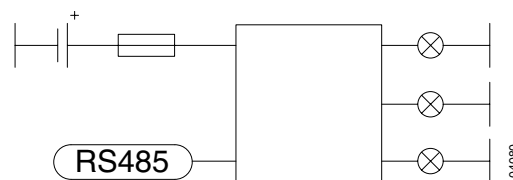
In a node system, not every current consumer is fused individually, but is protected automatically within the node the component is connected to. In a node system, only the respective nodes need to be protected, reducing the number of fuses required.



All nodes are linked together via the communication bus (RS485). Communication with the other electrical systems in the vehicle takes place via Local K. DIA K / DIA L in the illustration are the designations for the diagnostic socket



The RS485 alone carries all the information between the nodes.

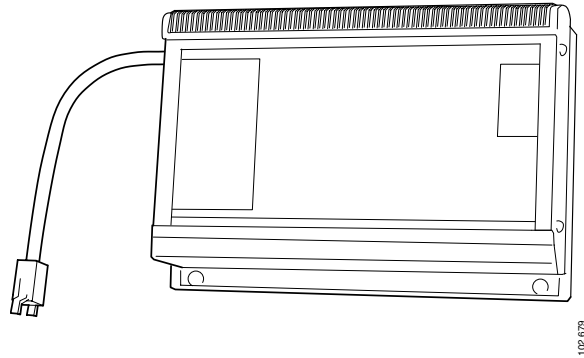


The current consumers in the node system do not need to be fused individually, but it is sufficient to protect the nodes with fuses.

Nodes

In a vehicle equipped with the BNS system, all the nodes are identical, both with regard to the hardware and the software. The behaviour of a node depends on its location in the vehicle, in other words which components it is connected to.

All nodes have a 37-pin connector for connections to components, one connector for supply voltage and one for the communication bus.



In a vehicle with BNS, all the nodes are identical.

Communication between nodes

Put simply, the communication could be said to resemble radio technology. The data signals passing through the communication bus can be compared to radio waves passing through the air.

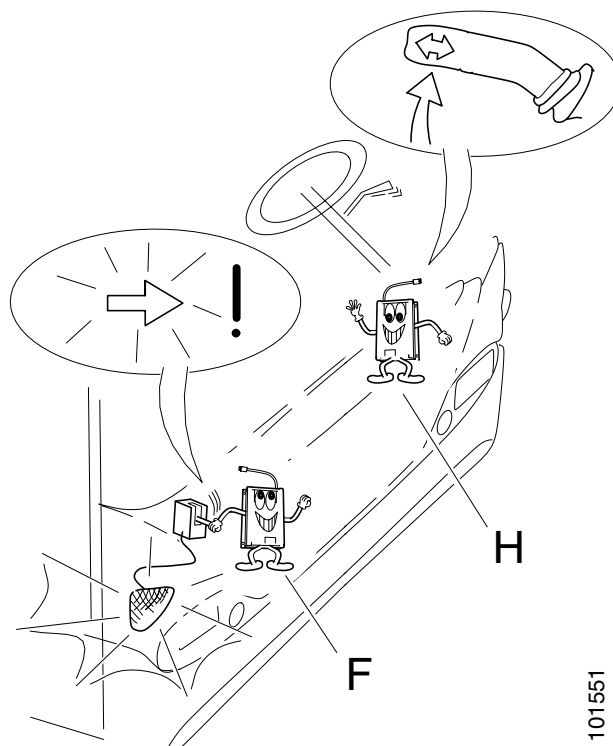
When listening to the radio, the receiver is set to pick up only one radio station at a time. Only one station is heard, even though many other radio stations are transmitting simultaneously.

A function in a node performs roughly the same task with the data passing through the communication bus as a radio receiver does with radio waves. It listens e.g. for information on vehicle speed, receives this value and uses it in calculations.

The node receives all signals sent through the communication bus in a separate memory. This memory may be compared to a number of radio receivers that are all on but set to different radio stations to listen to several radio programmes simultaneously. In this way, the node knows continuously what is happening in the vehicle.

Communication bus activity cannot be monitored using a multimeter. However, it is still possible to take measurements at each current consumer that is connected to the nodes. However, in this case it is important to realise that the voltage level can vary considerably as a result of the amplification or resistance that may occur at certain node outputs. A component may be connected in such a way that a value of, for example, 11 volts is OK even though the function in question is not activated.

The BNS system therefore differs from a conventional electrical system even in terms of those components connected in the conventional way.



Example: When a node (in this case node H) senses that the direction indicator switch is set for indicating to the right, it sends the message to the communication bus. Another node (in this case node F) interprets the message and lights the lamp.

Note that node F does not know if the bus will turn to the right or if the hazard warning lights are on. Node F only knows that the lamp should be lit, but not why.

However, node H knows that the signal originates from the right direction indicator switch.

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Node software

The nodes contain electronics that could otherwise be described as hardware with logic. In the factory, before the nodes are installed into a vehicle, they are programmed with a basic program. This is called *application program* and consists of a set of logic conditions. Finally in the vehicle manufacturing process, when all the nodes have been installed, they are programmed with a parameter file specific to every vehicle.

Logic conditions

When a node operates, it receives *input signals* and generates *output signals*. The *input signals* originate from various switches that change position depending on which function is required to be activated. The *output signals* is the information the node sends to the components that are to be activated. However, several nodes always need to interact when a function is to be activated. The information sent via the communication bus between the nodes is known as *messages*.

The logic conditions dictate which input signals and messages are required and how they should interdepend in order to activate a particular function. Therefore the logic conditions dictate the requirements to generate an output signal.

If a fault occurs, for example if a component fails or if it loses the connection to the node for any other reason, the node can resort to a *default value*. In this event, the node sets its outputs to a pre-determined status for safety reasons.

The example below shows which logic conditions must be fulfilled to activate the right direction indicator. When ignition is on and the direction indicator switch is selected, the logic understands that a pulse signal is also required to generate pulsating output signals. When these three conditions have been fulfilled, the lamps will flash.

Voltage
&
Right direction indicator switch
+
Pulse
=
The front right and rear right direction indicators and the indicator lamp are activated

Parameter file

Each node is programmed with a parameter file. The parameters in this file determine which functions the BNS system in the particular vehicle should have. Therefore they indicate whether a certain function is available or not. However, they also contain various time constants or vehicle speed values. The parameter file is said to determine the vehicle's *configuration*, i.e. the physical design of the vehicle body electrical system.

The parameter file consists of a total of around 300 parameters. Many parameters are under certain circumstances interdependent, meaning that there are an almost infinite number of combinations.

It is important that all the nodes in the vehicle are programmed with the same parameter file. However, they may differ from vehicle to vehicle. As mentioned previously, programming takes place when the entire BNS system has been installed in the vehicle. The file is said to be end-of-line programmed.

Every time the BNS system is started, the BNS generation is identified. The parameter file indicates the correct generation.

ID codes

As mentioned earlier, all the nodes are programmed identically. Firstly with the logic conditions, followed by the parameter file. However, they still have different tasks in the system. What is it that determines the task of a specific node?

Each node has an ID code that indicates which location in the vehicle the particular node occupies. The code is physically present in the 37-pin connector in the vehicle cable harness. This is connected to the node and the ID code is stored in the memory of the node. The corresponding 37 pins on the connectors of the identical nodes are therefore used for various purposes depending on the ID code of the node.

The ID code tells the node its location in the vehicle and therefore also which parts of the application program it should use.

Node versions

One of the advantages of the BNS system is that all the nodes are identical from the spare parts point of view. They are differentiated by the parameter file and the ID code, which are not determined until the node is installed in the vehicle.

New, updated node versions are bound to emerge at regular intervals, but they are *backward-compatible* and so replace the previous versions.

However, there is one exception. The oldest BNS generations, BNS 1 and 2, differ in the following respect. They use nodes with 8-bit processors, whereas BNS 3.1 and later use 16-bit processors. A node with a 16-bit processor is *not* backward-compatible with BNS generations older than 3.1.

For this reason, the spare part range includes one node version with an 8-bit processor and one with a 16-bit processor.

Battery slave unit

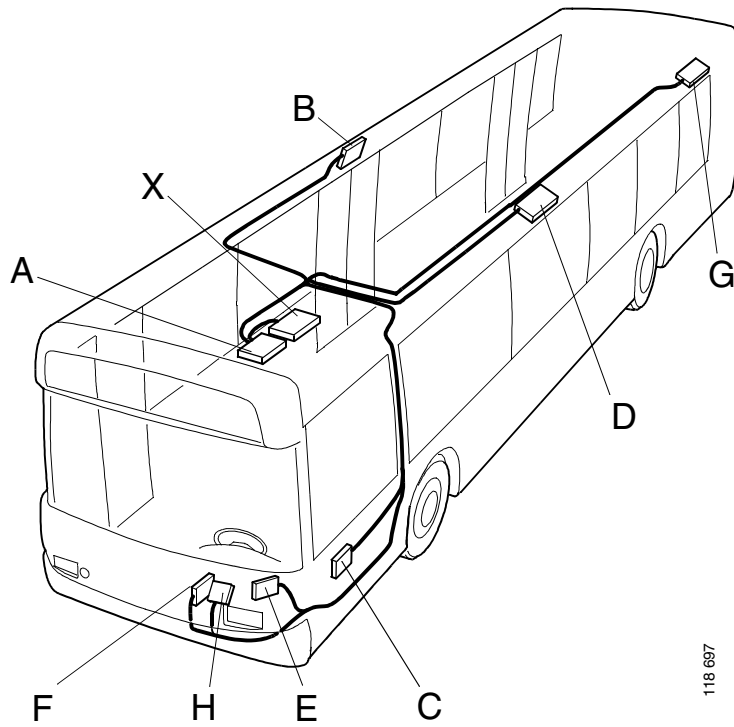
Earlier BNS generations contain a node known as the X node. This has also been updated and is in later designs known as the *battery slave unit*. It has the same exterior as an ordinary node, but the interior is different.

The battery slave unit is always supplied with voltage even when the battery master switch is off. Its task in the system is to control door opening from the outside, hazard warning lights and other functions that have to work when everything else is switched off.

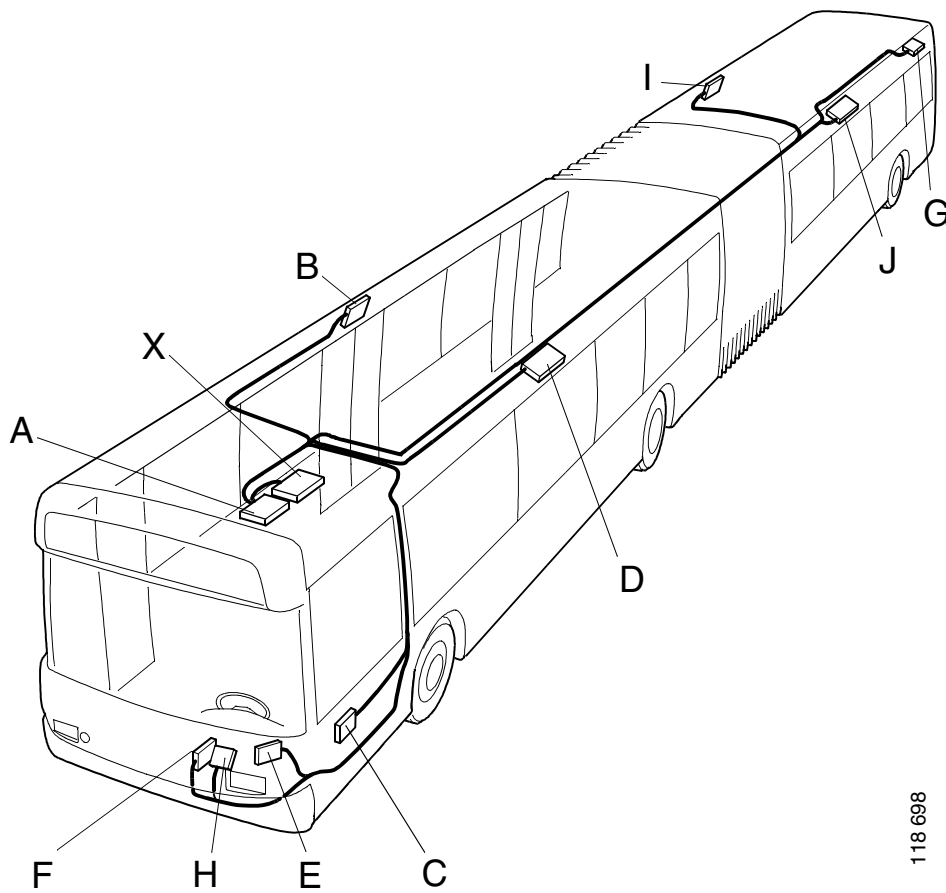
Node locations

The nodes are situated in the vehicle so that they are near the components they control and receive information from. However, the locations vary between different BNS generations.

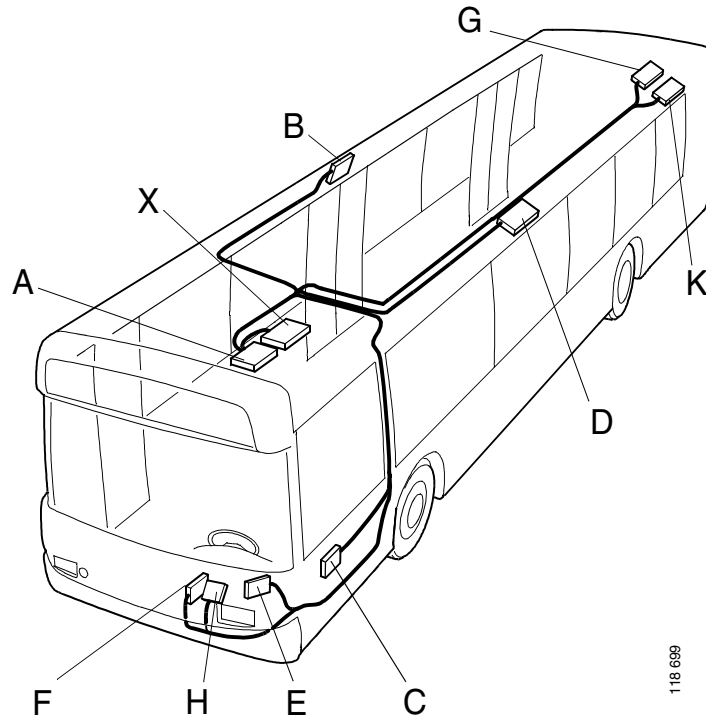
The following pages show some general illustrations of node locations in the BNS generations currently available. Note that due to the continuous development, the latest generations may not be represented. Note that the battery slave unit in the illustrations is marked "X", regardless of which BNS generation is shown.



Node location for BNS 1 and BNS 2.

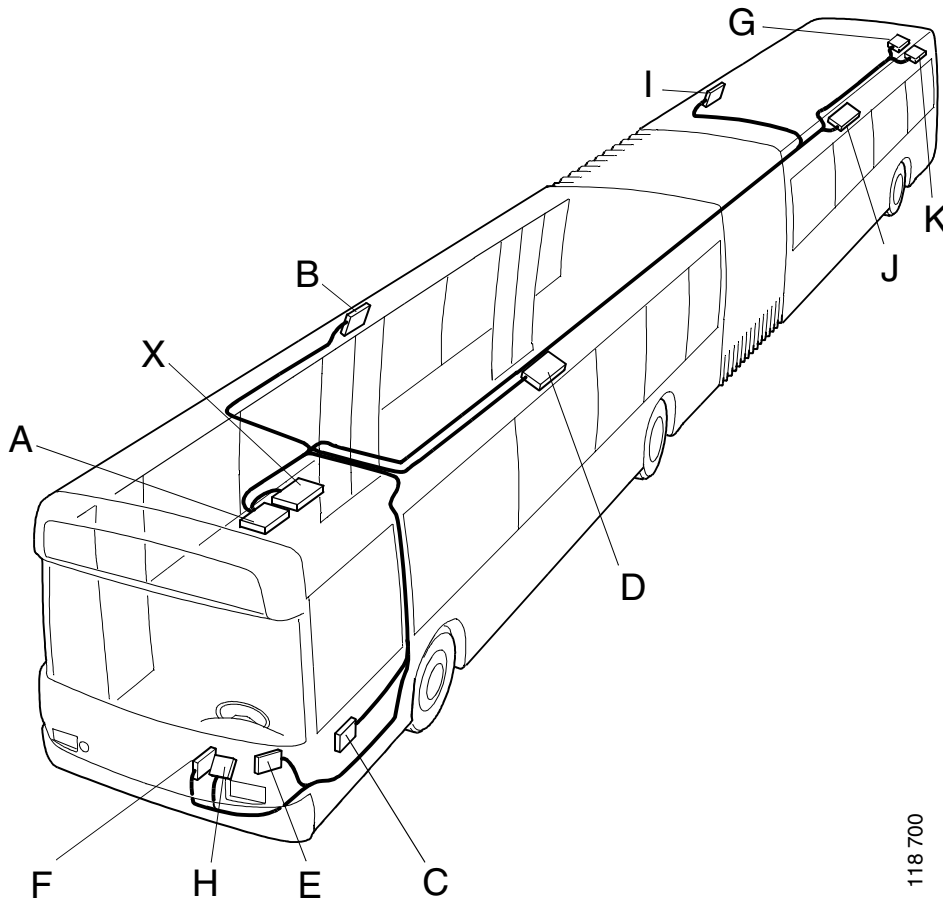


Node location for BNS 3.1.



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Node location for BNS 4.1, BNS 4.2 and BNS 6.



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Node location for BNS 5.1, BNS 5.2 and BNS 7.

Functions

The BNS functions do not differ in principle from those controlled by a conventional electrical system. This concerns lighting, heater control and other functions typical for any vehicle body electrical system. The difference lies in the fact that this system uses logical conditions in the nodes rather than relays along the circuit to determine how a function should appear.

This section briefly presents the main functions controlled by BNS. There are a great number of possible variations both in terms of which functions a vehicle should be equipped with and how each individual function should be programmed to operate. Therefore only a general overview is presented here of the most typical functions that apply to all BNS generations.

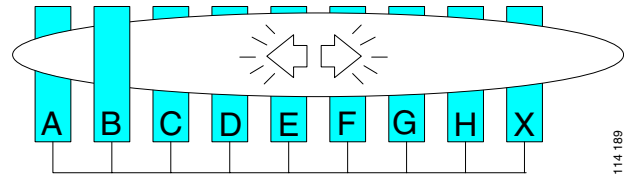
Outline description

As mentioned previously, most functions result from the interaction of several nodes.

A single node can control several functions independent of each other, and one function can be controlled by several nodes (see the example of the direction indicator circuit).

However, it is still said that each function is controlled by a certain node. The logic conditions that must be fulfilled to activate a particular function are located in a single node. The signals that control the function are gathered in the node in question, which then sends information to other nodes and components on how to act. For example, the direction indicator function in the example is located in node H.

Therefore, from a hardware point of view, a node cannot be said to have a particular function, as is the case with conventional control units. Instead, a form of virtual control unit can be imagined functioning across the entire node system.



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Example: The direction indicator circuit is affected by all nodes except node B. The remaining nodes each govern their own function in the circuit. (Note that the appearances vary between BNS generations. The illustration shows BNS 2.)

A) Voltage on

C) Hazard warning light switch

D) Left rear direction indicator

E) Left front direction indicator

F) Right front direction indicator

G) Right rear direction indicator

H) Switch, indicator lamp and acoustic signal for direction indicator

X) Only affected in case of hazard warning lights (must function even when the battery master switch is off)

Heating and ventilation

This includes:

- Heating control for driver area
- Heating control for passenger area
- Fan
- Defroster
- Parking heater
- Roof heating
- Heating during short breaks
- Air conditioning

Doors

Doors on a city bus involve much more than simple manual opening and closing. For safety and other reasons, a number of conditions must be fulfilled before the doors can be operated. These differ according to market and customer choice. The description below only contains what is generally applicable.

The doors are divided into entry doors (in front of the front axle) and exit doors (behind the front axle).

Entry doors

Opened manually from the driver area. The principle of operation can be selected to apply various conditions:

- If a bus stop brake is fitted, it can be programmed to be applied as long as the doors are open. This makes it impossible to drive away with open doors.
- If no bus stop brake is fitted, the vehicle may instead be equipped with a speed monitor. This ensures that the doors are closed when the vehicle speed exceeds, for example, 5 km/h.
- In order to operate the doors from the outside, the parking brake must be applied.

Exit doors

Just as with the entry doors, the exit doors can be manually controlled by the driver. However, they are normally set to automatic. Opening the doors automatically requires that:

- The entry doors are opened and...
- the bus is stationary or has a vehicle speed of less than 5 km/h (speed monitor always fitted), and...
- a passenger has activated a stop signal or an internal switch for opening the exit door.

A further condition is that any side hatches are closed.

The vehicle can be programmed with emergency door stop. If any passenger activates this, the doors stop immediately in their current position.

Emergency door opening may also be available. This always works in conjunction with the speed monitor, which prevents opening at vehicle speeds above 5 km/h.

If the vehicle is prepared for automatic doors, there are always photocells in the doorway area. If any passenger passes the cells and interrupts the beams, the BNS system receives signals to open the doors one more time. All this is providing that the previously mentioned conditions for door opening are fulfilled.

Sensing strips and electrically sensing edges

Both the entry and exit doors can be equipped with sensing strips or electrically sensing edges. Both fulfil the same function, but the electrically sensing edge is the more recent variant and is found in later BNS generations.

The sensing strip or the sensing edge is located at the front edge of the door leaf. It detects whether anything is in the way of the closing doors and if so ensures that the doors open again immediately. This means that the closing doors reverse and return to the open position, provided that the vehicle speed is low. After a few seconds, the doors will attempt to close again.

This function is active even if the battery master switch is turned off when the doors are open which makes the doors close.

Exterior lighting

BNS controls:

Driving lamps

The vehicle can be programmed for automatic dipped beams, automatic dipping of headlamps and/or auxiliary lamps.

Direction indicators

Position lamps and side marker lamps

Reversing light

Brake light

School signs

Pavement lighting

If this is fitted, it will light on an open outward-moving door, provided that the driving lamps are lit at the same time.

Fog light

The vehicle can be programmed for a front and/or rear fog light.

Interior lighting

In addition to the lighting of the passenger compartment itself, this includes:

Driver area and entry door lighting

Sign box lighting

Entry lighting

Coin table lighting

Other functions

BNS controls:

Bus stop brake

The function of this is to keep the vehicle stationary when the doors are open.

Differential lock

This is engaged and disengaged manually by the driver.

Driver gate alarm

This has the task of warning the driver if the driver gate is open in an instance when this is not permitted, e.g. if the parking brake is not applied.

Kneeling

The kneeling function itself is located outside the BNS system, in the so-called ELC control unit. However, BNS ensures that the correct conditions are fulfilled before permitting / preventing kneeling. Such a condition could be that the doors are open and that the bus stop brake is on.

Electrically heated rear view mirrors and entry floor

Horn

Passenger counter

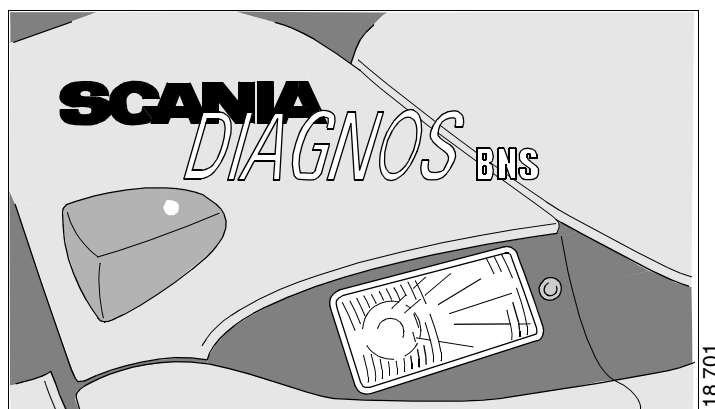
Certain vehicles may be equipped with a function to count the number of passengers exiting the vehicle by means of photocells at the exit doors.

Windscreen wipers and washers

Immobiliser

The immobiliser intervenes to prevent the engine from starting if, for example, any of the front hatches (or engine hatch) is open or if the gear selector is in drive position.

SDBNS



General

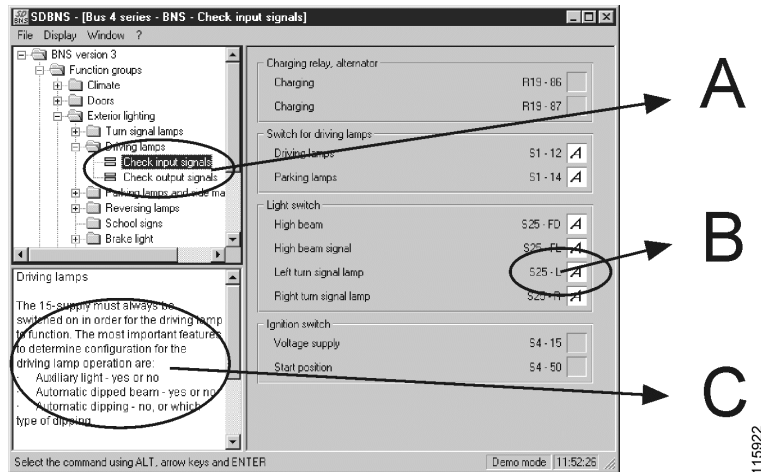
SDBNS is an acronym for Scania Diagnos Body Node System, which is a troubleshooting program for BNS.

The description that follows in this section gives the most essential information you need to know in order to use the program. The program contains a help file that can always be accessed for further information.

The nodes in BNS store no fault codes. Instead, troubleshooting is achieved by reading and activating input and output signals. In this way, you can check that the components of the node system for correct function and exclude causes of the fault.

For each function troubleshoot in SDBNS, there is a descriptive text summarising how the function should operate, and how the BNS is programmed for that particular vehicle.

Illustrations showing the locations of the nodes and the components in question can also be obtained. References to wiring diagrams are also available.



After the program has been started, the screen will be split into three fields.

A Navigator allowing you to choose the input and output signals to be read/activated.

B Signal status for selected components.

C Descriptive text for selected components.

Starting the program

On starting the program, a menu is displayed for selecting the system group. Select "vehicle body system", then "find in vehicle". Then the remainder of the start process continues automatically. The program reads the vehicle's BNS generation and attempts to contact the node system as follows:

- SDBNS attempts to establish contact with all the nodes.
- SDBNS checks the parameter files to ensure that all the nodes are of the correct version.
- SDBNS checks that all the nodes have the correct ID code, i.e. that they are correctly located.
- SDBNS checks that the parameter file is identical in all the nodes, i.e. that the files correspond to the vehicle configuration.
- If everything is OK, troubleshooting can begin by means of the SDBNS.

Troubleshooting

However, if the program does not give the all clear during start-up, but instead shows various dialogues containing fault messages, these must be processed first. If troubleshooting is continued without rectifying the fault, later troubleshooting tests will not be correct.

For example, the program may have found different parameter files in the nodes. This could happen, for example, if a node has been replaced with a new spare-part node. There will then be the opportunity to reprogram the node by copying the parameter file from another node.

If no further fault messages are shown, troubleshooting in the vehicle's BNS functions can begin. Continue in the normal Windows manner using the computer's pointing device (mouse) and proceed as follows:

Selecting the function to be troubleshot

The function is selected from the Navigator by scrolling down through the structure.

Checking the programming of the function

The text in the information window reports how the selected function is programmed to operate. If the function is not programmed in the vehicle, the folder will not open (there will be no plus sign in front of the folder).

Checking the programming can determine:

- if the vehicle is incorrectly programmed
- if the function the customer believes is on the vehicle is actually not present
- if there is a fault in any of the components

Checking the input and output signals

This is the main task. For every function, both the input and output signals can be checked. The components affected by the function in question are listed on the screen. Next to each component can be seen whether its inputs and outputs are active or not at a particular moment (if they are active, the symbol "A" appears).

For input signals, you can check that the correct input signal responds for example by changing the position of a switch; which it then does by showing the A symbol. The program's information window provides an indication of which input signal should be active at different moments.

The output signals are checked correspondingly. When everything reports that a function should be activated (switch in position, active input signal), the A symbol for the output signal should also be shown.

Certain functions allow the inputs and outputs to be forcibly controlled via the program. Then the button marked "Activate" will be displayed. This allows the signal in question to be activated directly from the screen.

If the function being troubleshoot is controlled via a potentiometer, rheostat or sensor (e.g. a temperature sensor), a scale is shown that displays the actual position of the potentiometer/sensor.

The input signals can also be checked per node or per pin. Further down in the navigator structure, each node can be selected individually and the active node pins viewed (the same A symbol is used here).

Obtaining information on the components

If a component is suspected to be faulty, further information can be found on it. This information is obtained by right-clicking on the component designation in the Navigator.

This provides information on the component's task in the system, its location and the relevant input and output signals.

Basic diagnostics program

Occasionally, support may not be available for certain BNS generations. In order to perform troubleshooting in any case, a simplified program known as the *basic diagnostics program* will open.

This does not show whether input and output signals are active, but only displays a separately calculated voltage level for each pin and each node. This value gives an indication on the status of the pin in question.

References to wiring diagrams

The table below shows the publication numbers of the relevant wiring diagrams for the respective nodes and BNS generations.

Certain functions have special diagrams (at the foot of the table). Note that the BNS system is updated at regular intervals, for which reason it cannot be guaranteed that the table is always up to date.

The differences between two BNS versions can sometimes be very minor. Therefore new diagrams are not always produced for each new version.

Diagram covers	BNS 1 and 2	BNS 3.1	BNS 4.1 and 4.2	BNS 5.1 and 5.2	BNS 6	BNS 7
Node A, X and battery slave unit	16:52-50	16:52-50	16:62-50	16:62-50	16:62-63	16:62-63
Node B	16:52-51	16:52-63	16:62-51	16:62-51	16:62-64	16:62-64
Node C	16:52-52	16:52-52	16:62-52	16:62-52	16:62-65	16:62-65
Node D	16:52-53	16:52-64	16:62-53	16:62-53	16:62-66	16:62-66
Node E	16:52-54	16:52-54	16:62-54	16:62-54	16:62-67	16:62-67
Node F	16:52-55	16:52-55	16:62-55	16:62-55	16:62-69	16:62-69
Node G	16:52-56	16:52-56	16:62-56	16:62-56	16:62-68	16:62-68
Node H	16:52-57	16:52-57	16:62-55	16:62-55	16:62-69	16:62-69
Node I		16:52-65		16:62-57		16:62-70
Node J		16:52-66		16:62-58		16:62-71
Node K			16:62-56	16:62-56	16:62-68	16:62-68
Supply and communication	16:52-60	16:52-60	16:62-60	16:62-60	16:62-60	16:62-60
Doors, operation	16:52-61	16:52-61	16:52-61	16:52-61	16:52-61	16:52-61
Doors, door shelves	16:52-62	16:52-62	16:62-62	16:62-62	16:62-62	16:62-62