

4th edition, May 2006

Translation

O R

Brakes - Electropneumatic brake (ep brake)

Electropneumatic emergency brake override (EBO)

Frein - Frein électropneumatique (frein EP)

Signal d'alarme à frein inhibable par voie électropneumatique (SAFI)

Bremse - Elektropneumatische Bremse (ep-Bremse)

Elektropneumatische Notbremsüberbrückung (NBÜ)



UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

Leaflet to be classified in Volumes :

IV - Operating

V - Transport stock

VI - Traction

Application :

With effect from 1 January 2006

All members of the International Union of Railways

Record of updates

2nd edition, January 1977	First issue titled: "Brakes - Electropneumatic brakes for passenger trains and freight trains"
3rd edition, January 1997	new title: "Brakes - Electropneumatic brakes (ep brake) - Electropneumatic emergency brake override (EBO)"
3rd edition, May 2003	Retyped in FrameMaker and incorporation of amendment of January 1998 in Appendix L
4th edition, May 2006	Diverse technical modifications, addition of points 5.7 and 11, modification of the diagram in Appendix B, publication of Appendices K and L on the UIC website

The person responsible for this leaflet is named in the UIC Code

Contents

Summary	1
1 - General.....	2
1.1 - Definitions	2
1.2 - Electropneumatic brake (ep brake).....	3
1.3 - Emergency brake override (EBO).....	4
1.4 - Train bus transmission.....	5
1.5 - Power transmission	5
2 - Specification for the compressed-air brake and ep brake	6
2.1 - Characteristics of the compressed-air brake	6
2.2 - Specification for the ep brake	6
3 - Specification for the emergency brake override (EBO).....	8
3.1 - General requirements	8
3.2 - Equipment on leading vehicle.....	8
3.3 - Equipment on passenger vehicles with and without driver's cables	9
3.4 - Testing of the EBO (Optional provision)	9
4 - Electrical circuitry of the ep brake and EBO - Principles.....	10
4.1 - General requirements	10
4.2 - Description of the electrical operation of the ep brake.....	11
4.3 - Description of the electrical operation of the EBO	16
5 - Definition of components.....	19
5.1 - General	19
5.2 - Components of the ep control cable	19
5.3 - Solenoid valves.....	23
5.4 - Essential components for monitoring the ep brake loop.....	23
5.5 - Essential components for monitoring the EBO loop	25
5.6 - Components required for testing	25
5.7 - Vehicles for push-pull operation	26

6 - Testing	27
6.1 - General	27
6.2 - Testing of the ep brake	27
6.3 - Testing of the EBO	27
6.4 - Testing of the ep brake equipment on the leading vehicle	28
6.5 - Testing of the EBO equipment on the leading vehicle	28
6.6 - Single-man brake test.....	28
7 - Marking of vehicles	29
7.1 - Marking of the ep brake and EBO	29
7.2 - Marking of the braked weight.....	29
8 - Approval.....	30
8.1 - Approval of the ep brake.....	30
8.2 - Use of the EBO	30
8.3 - Approval of the UIC standard coupler for the ep brake	31
9 - Functions associated with the public-address systems of passenger coaches	32
10 - Use of other possible means of transmission	33
10.1 -Train bus	33
10.2 -Power supply for freight rolling stock	33
11 - Fire protection	34
Appendix A - Electrical circuit diagram of a passenger coach	35
Appendix B - Electrical circuit diagram of a vehicle at the head of a train	36
Appendix C - Electrical circuit diagram of a vehicle at the head of a train	37
Appendix D - Electrical circuit diagram of a passenger coach - Simplified control system	38
Appendix E - Electrical circuit diagram of a vehicle at the head of a train - Simplified control system	39
Appendix F - Key to circuit symbols used in Appendices A - E	40
Appendix G - Attachment of cable and coupler elements for the ep brake	43

Appendix H - Coupler plug.....	45
Appendix I - Monitoring of the end-of-train contact - Principles	50
Appendix J - Characteristics of ep brake and EBO monitoring equipment	51
J.1 - Diagram of monitoring of ep brake loop.....	51
J.2 - Diagram of monitoring of EBO loop	52
Appendix K - Elements of electropneumatic brake (ep brake) approved for international traffic	53
Appendix L - Types of UIC standard coupler for the ep brake approved for international traffic	54
Bibliography	55

Summary

The electropneumatic brake and the electropneumatic emergency brake override are two systems with functions which overlap through their control and monitoring elements. These two systems make use in part of a common electrical cable laid through the train, which also undertakes other functions and is addressed in more detail in other leaflets (not yet complete). The equipment required for the electropneumatic brake and the emergency brake override is intended for passenger stock, while freight wagons have the electropneumatic brake equipment alone.

The operating conditions for sets of vehicles equipped wholly or partly with the electropneumatic brake are addressed elsewhere.

1 - General

1.1 - Definitions

For the purposes of the present leaflet, the following terminology is used:

Vehicles: All hauled passenger rolling stock with or without driving cab, freight wagons and tractive units.

Leading vehicle: Vehicle at the head of a train and with driving cab in operation.

Last vehicle: Vehicle at the end of the train and recognised as the last vehicle of this train.

Sharp braking: Safe braking in which the maximum power is created by the leading vehicle in the shortest possible time. It is initiated either through deliberate action by the driver or by a safety device (in the latter case also known as automatic application of the brakes).

Emergency braking: Braking actuated from a vehicle through operation of an emergency alarm. The characteristics of emergency braking may differ from those of sharp braking. Their object is to stop the train and to alert the driver.

Driver: Person entrusted with the driving of the train and located in the driving cab of the leading vehicle.

Driving cab: The driving cab concerned is always that which is in operation and from which the driver controls the train. Driving cabs not in use are not considered in the present leaflet.

End of train: Elements for identifying the last vehicle.

Conductor: Electrical cable through the train for the transmission of control and display data from the leading vehicle to the attached vehicles and vice-versa.

ep brake: Abbreviation for "electropneumatic brake".

MAP: Main air pipe (French: CG; German: HLL).

MARP: Main air reservoir pipe (French: CP; German: HBL).

EBO: Abbreviation for "emergency brake override" (the braking action triggered by the emergency alarm may be cancelled) (French: SAFI; German: NBÜ).

ep control cable: Name of the electrical cable running through the train and serving:

- the electropneumatic brake,
- the emergency brake override,
- other functions which may be transmitted but are not defined in this leaflet.

1.2 - Electropneumatic brake (ep brake)

1.2.1 - Purpose

A braking system with automatic brake conforming to *UIC Leaflet 540* (see Bibliography - page 55) has certain physical limits.

Braking is controlled by a reduction in pressure in the main air pipe (MAP) of the automatic brake. The rate of transmission of the pressure reduction wave through the train is limited. This phenomenon, which does not allow simultaneous application of the vehicle brakes, results in longitudinal reactions in long trains. It also leads to an extension of the braking distance of a train as compared with that of an individual vehicle.

The release is controlled by an increase in pressure in the MAP of the automatic brake. The compressed air must not only feed the MAP of the automatic brake, but also restore pressure to the auxiliary air reservoirs in every vehicle. The large quantity of air which the MAP has to convey leads to a release time for the last vehicle which is very disadvantageous for the release time of long trains. In both cases time is lost due to the volume of air which has to be supplied via the driver's brake valve. This results in a marked variation between changes in pressure in the MAP at the head of the train and on the last vehicle.

The purpose of the ep brake is to minimise response times during braking and release, and to make braking simultaneous along the whole length of the train. This is achieved by means of solenoid valves controlled by the driver's brake valve, which generate simultaneous venting or refilling of the MAP in every vehicle, in support of the pneumatic operation of the driver's brake valve.

The large volume of air required for release is supplied by an additional pipe, the main air reservoir pipe (MARP), which runs through the entire train and makes good the amount of compressed-air vented from the auxiliary air reservoir of each vehicle. The MARP is standard on vehicles used for international passenger services. During release, the air used by the ep brake for the local supply of the MAP is taken from the auxiliary air reservoir. The use of a MARP in conjunction with the ep brake therefore gives an improvement in the release time of the pneumatic brake.

The control and monitoring functions of the ep brake (see point 1.2.3 - page 4) are so designed that their effect in reducing braking distance in accordance with *UIC Leaflet 544-1* (see Bibliography - page 55) can be counted towards the braked weight.

1.2.2 - Principle

In the driving cab, the electrical braking and release impulses are generated by the driver's brake valve. The duration of the electrical impulse depends on the strength of the braking and release. These impulses are maintained so long as there is a difference between the pressure in the MAP achieved and that required.

The electrical impulses are transmitted through the train via conductors in the cable. Each vehicle is equipped with two solenoid valves, one for braking and the other for release. They are controlled by the electrical braking and release impulses transmitted by the respective conductors. The solenoid valves are so calibrated as to maintain a precisely-determined gradient $\Delta P/\Delta t$. During braking and release the pressure in the MAP of the train is almost immediately equal to the required value.

1.2.3 - Continuous monitoring

If allowance is made for the increase in the braked weight due to the ep brake, then the driver must be informed immediately, by an "ep fault" alarm, of any disruption to

- the ep brake command (no signal in the circuit or erroneous command to release the ep brake)
- the continuity of the lines used for ep braking

and a temporary or subsequent brake application must be supported by an automatic sharp brake application (rapid discharge of the MAP to ≤ 2 bar).

The principle of continuous monitoring of the circuits used for braking consists of checking systematically from the locomotive, apart from the braking and release process, on the continuity, separation or short-circuiting of conductors 2 and 4 through to the end of the train.

1.2.4 - Testing facility

Every time a train is formed or reformed, it is necessary to check that the monitoring circuit of the ep brake is in perfect order. Two types of test of the ep brake are therefore carried out in conjunction with testing of the pneumatic brake:

- Full brake test: an irregularity in the control circuits of the ep brake is simulated on the last vehicle using the P button, in order to verify the completeness of this circuit over the entire length of the train and to check the satisfactory operation of monitoring equipment on the leading vehicle.
- Simplified brake test: this test is used when two fault-free train sections are coupled together, to check that in recreating the continuity of the circuits from the head of the train to the end of the train, the two control circuits are correctly joined.

This test involves no activity at the end of the train.

1.3 - Emergency brake override (EBO)

1.3.1 - Purpose

In the event of an emergency, all passengers can operate the emergency alarm in order to bring the train to a stand. The operation of an alarm-signal case vents a control line which actuates the emergency brake valve described in *UIC Leaflet 541-1* (see Bibliography - page 55). The emergency brake valve bleeds the MAP of the automatic brake. The subsequent stopping of the train may take place at any point on the line. This can be a serious drawback on high-speed lines and on lines with many tunnels and bridges. In order to overcome this disadvantage, the emergency brake override may be used. This facility allows the driver to override the emergency brake and to select a sensible point at which to stop the train.

1.3.2 - Principle

In addition to the braking which is initiated through the working of the emergency brake valve when an emergency alarm is actuated, the driver receives information via a visual and audible warning device.

The driver may then override the emergency braking in the coach or coaches concerned.

This command is either combined with the release function of the driver's brake valve, or else sent via an independent control button. The driver is thus able to refill the MAP of the automatic brake, and release the brakes. This override system (EBO) can be used effectively only in conjunction with the ep brake.

When the driver activates the override, an impulse is sent down the line used for the message. The override is effected through the actuation of a solenoid valve in the coach in which the emergency alarm has been operated, which interrupts the venting of the MAP. This command remains effective at the location concerned until the alarm signal case has been returned to its normal position.

1.3.3 - Testing facility

The circuit as far as the end-of-train contact is tested in the full brake test (see point 1.2.4 - page 4) together with the operation of the corresponding warning devices. The override control is tested from the driving cab.

1.4 - Train bus transmission

Two screened twisted conductors in the cable and two contacts in the connector are reserved for transmission of data over a central data cable (train bus). The physical conditions for this cable are set out in point 5.2.4 - page 21. Train bus transmission may not lead to any interference with the operation of the ep brake.

1.5 - Power transmission

For the supply of power to electrical equipment in vehicles with no other adequate power supply, two conductors in the cable and two corresponding contacts in the connector are to be provided. This function shall not cause any interference with the operation of the ep brake.

2 - Specification for the compressed-air brake and ep brake

2.1 - Characteristics of the compressed-air brake

2.1.1 - The compressed-air brake and its components shall conform to the specifications of *UIC Leaflet 540* (see Bibliography - page 55).

The driver's brake valve shall comply with *UIC Leaflet 541-03* (see Bibliography - page 55).

2.1.2 - Vehicles constructed after the date of application of this leaflet shall have the facility for shutting-off the solenoid valves for braking and release, also for supplying the auxiliary air reservoir through the MARP by means of a single control element.

2.1.3 - During ep braking, the pressure in the MAP shall be reduced from 5 bar to 3,5 bar over a period of 3,5 to 5 s.

During ep brake release, the pressure in the MAP shall be increased from 3,5 bar to 4,9 bar over a period of 7 to 10 s, with an auxiliary air reservoir pressure of 5,3 to 5,5 bar.

The times shall be checked on an individual vehicle with the compressed-air brakes applied, with the MAP first being pressurised to 5 bar and then shut off. The times shall be calculated from the point when a constant signal is obtained for the braking or release solenoid valve.

2.2 - Specification for the ep brake

2.2.1 - With or without the ep brake in operation, the brake force level shall be the same for each brake step.

2.2.2 - The electrical control system shall be identical for all braking regimes (R, P or G). The electrical functions shall comply with point 4.1 - page 10.

2.2.3 - All new ep brakes shall be compatible with ep brakes approved for international services or in existence on the date of application of the present leaflet.

2.2.4 - With the electrical controls of the ep brake isolated, the normal functions of the compressed-air brake shall be available without the need for anything to be changed on the vehicle. It shall then satisfy the requirements of *UIC Leaflet 540*.

2.2.5 - The ep brake shall be so designed that vehicles may be marshalled in a train which is only partly equipped with the ep brake, but with at least the continuity of the MAP, MARP and the ep control cable (9 conductors) ensured. It shall be possible to marshall these vehicles at any point in the train. This may then be taken into account in calculating the braked weight of the train.

2.2.6 - With compressed-air and ep brake control, the brake shall be actuated simultaneously from the same driver's brake valve and in the same manner.

2.2.7 - The driver shall be informed immediately of faults (breaks or short-circuits) in the cables supplying the brake solenoid valves. When the train is running, a sharp braking shall be made:

- if the fault occurs in the course of braking, in order to ensure a safe stop,
- if the command to supply the ep control cable is not executed.

2.2.8 - Electrical control shall not have any adverse effects on the distributors of the compressed-air brake, even with long and heavy trains. Service braking, sharp braking, and brake application and release shall be possible in stages.

2.2.9 - Electrical equipment shall comply with the relevant provisions of regulations and standards relating to safety of personnel.

2.2.10 - Should a simultaneous activation of the solenoid valves for "ep braking" and "ep release" occur by chance, no rise in pressure in the MAP shall result. It is even recommended that this irregularity should lead to a drop in pressure in the MAP.

2.2.11 - Independently of the vehicle, the "ep braking" command shall have priority over the "ep release" command.

2.2.12 - In the event of a failure it shall be possible to isolate the ep brake controls in the leading vehicle using the U switch, in order to avoid any possible negative effect which might impair safety.

2.2.13 - If the compressed-air brake on any vehicle is isolated, then the ep brake on this vehicle shall also be made inoperative. On existing vehicles an additional isolating element for the ep brake, to shut off the connection between the MAP and the auxiliary air reservoirs, is permissible.

3 - Specification for the emergency brake override (EBO)¹

o 3.1 - General requirements

3.1.1 - Operation of the emergency alarm in a coach generates a drop in MAP pressure to a maximum value of 2,0 bar, in accordance with *UIC Leaflet 541-1* (see Bibliography - page 55).

3.1.2 - Through continuous monitoring, the leading vehicle is aware if an emergency alarm has been operated. Emergency alarm actuation triggers an optical and an audible signal in the driving cab. The optical signal remains on until all emergency alarm handles have been reset.

3.1.3 - The coach is equipped with "emergency alarm" indicator lamps.

- on the control panel (red light),
- optionally, on the outside of the coach on each solebar (purple light).

When the emergency alarm is operated, the indicator lamps on the coach start to flash. They go out when the emergency alarm is reset.

3.1.4 - The continuity of the electrical conductors within the train shall be monitored automatically from the leading vehicle. The driver shall be warned if one or more conductors are broken.

3.1.5 - In the event of a failure, it shall be possible to isolate the EBO in the leading vehicle. In this case, or in the event of a defective or failed emergency brake override, it is essential that the conventional emergency braking function as specified in *UIC Leaflet 541-1* (see Bibliography - page 55) is still available.

o 3.2 - Equipment on leading vehicle

3.2.1 - The emergency braking may be overridden by a control impulse transmitted from the leading vehicle, i.e. the air venting device of the emergency brake valve may be closed by remote control.

3.2.2 - The driver overrides the emergency braking by a deliberate action, involving the following alternatives:

- setting the driver's brake valve in the full-release position,
- pressing a special control key.

3.2.3 - The audible warning in the driving cab is switched off when the driver overrides the emergency braking or initiates sharp braking. The optical signal is not cancelled until the emergency alarm is reset.

3.2.4 - If an emergency alarm is operated following a previous override of an emergency braking, then the current status (flashing or steadily illuminated) of the optical signal does not change and the audible warning is not repeated. The driver's attention is drawn to the fresh emergency braking only by the braking action and the drop in pressure in the MAP. Override is possible by taking the same action as for the first emergency braking. The optical signal is only cancelled when all emergency alarms are reset and thus capable of further use.

1. "Safety" Committee to recommend specifications for testing and displays to Operating.

3.3 - Equipment on passenger vehicles with and without driver's cables

○ 3.3.1 - On the coach in which an emergency alarm has been operated, this action leads to:

- venting of the MAP, which can be interrupted on receipt of an override command,
- flashing of a red optical signal on the control panel of this coach.

Both functions are terminated by resetting of the emergency alarm.

○ 3.3.2 - An emergency brake in a coach which has previously been overridden shall automatically be restored to functional status as soon as the emergency alarm of this coach has been reset.

3.3.3 - (optional provision) The following may be provided on the coach control panel for manual testing of the emergency brake override:

- an "emergency brake test" button,
- a white "emergency alarm function" indicator lamp.

3.3.4 - Operation of an emergency alarm shall also lead to activation of the facility described in point 9 - page 32.

3.4 - Testing of the EBO (Optional provision)

(The feasibility of implementing the following provisions awaits confirmation from UIC WG 5).

3.4.1 - Actuation of the "emergency brake test" button on the vehicle causes simulation of an emergency braking. During the period of actuation:

- on the coach control panel the red indicator lamp "emergency alarm" shall flash and the white indicator lamp "emergency alarm function" shall be illuminated,
- in the driving cab, the audible warning sounds and the "emergency alarm" indicator lamp flashes; when the driver overrides the simulated emergency braking, the "emergency alarm function" indicator lamp in the coach should start to flash, to confirm that the electrical wiring to the leading vehicle is continuously connected,
- the indication of the direction of the coach in the train is activated.

3.4.2 - For testing of the EBO during the brake test, see point 6.5 - page 28.

4 - Electrical circuitry of the ep brake and EBO - Principles

o 4.1 - General requirements

The electrical control system shall be so designed that it is free from interference from other circuits on the vehicle or the track, and does not itself interfere with such circuits. Because of the important tasks of the ep brake and the EBO, their equipment must function perfectly and reliably. This requires that the basic principles of the design of the circuits are respected. With the ep brake and/or EBO activated, the following should be ensured:

- monitoring that the train is complete:

It is essential that:

- the vehicle at the end of the train can be distinguished from the other vehicles in the train by electrical means,
- before departure of the train, a suitable test is carried out to ensure that the special vehicle is unique and is located at the end of the train,
- there is continuous monitoring to ensure that this situation does not change;

- reliable operation:

It is essential that:

- there is monitoring of the continuity to the end of the train of the conductors used for electrical control of the brake - (conductors 4 and 2) and of those used for the emergency alarm and the overriding of emergency braking - (conductors D and 4);
- monitoring is ensured by a permanent constant current, so that any break or short circuit in the monitored wiring can be detected,
- there is a check on whether the braking and override commands are actually being transmitted to the monitored wires,
- component failures and malfunctions are indicated by a visual signal or else drawn to the driver's attention by the abnormal behaviour of the systems,
- the testing of all components is possible;

- safety:

It is essential to ensure that the most probable types of fault of any component (breakage of conductors, power failure, damage to contacts):

- are indicated to the driver,
- during braking, lead to a sharp braking if the failure might impair braking performance, in particular in the event of:
 - a failure in continuity of the conductor concerned with the brake circuit,
 - a failure in supply to the braking conductor,
 - an accidental supply to the release conductor;
- do not impair the working of the compressed-air brake,
- do not lead to an unintended release of the brakes,

- do not lead to an automatic override when an emergency alarm is operated,
- do not lead to an automatic override after the operation of an emergency alarm, but to the blocking of any ep release command.

Parallel circuits on the brake solenoid valves shall be prohibited apart from circuits which are functionally necessary.

- availability:

It is essential that:

- the ep brake and EBO circuits can be switched on independently of one another,
- the control and monitoring functions of the ep brake and EBO can be switched out independently of one another from the driving cab in use, taking into account the intended use of the train and the indicated faults,
- the conductors in the trailing vehicle or passenger coach contain no control elements fitted in series (relays, push-button contacts, etc.) interrupting the conductors.

4.2 - Description of the electrical operation of the ep brake

Appendices [A - page 35](#), [B - page 36](#) and [C - page 37](#) show schematic circuit diagrams which satisfy the requirements of point [4.1 - page 10](#). Their symbolic presentation makes clear the functional conditions and they provide an indispensable aid to explaining the functions described in the text.

Alternative circuits may be accepted on condition that it can be demonstrated that they provide equivalent functions and security of operation.

o 4.2.1 - On vehicles

See Appendix [A - page 35](#).

The components for the pneumatic control of braking and release are solenoid valves, the characteristics of which are set out under point [5.3 - page 23](#).

The braking solenoid valve is fed via a diode from conductor 4 (positive polarity) and conductor 2 (negative polarity).

The release solenoid valve is fed via a diode from conductor 3 (positive polarity) and conductor 2 (negative polarity).

The vehicles also have a:

- push-button P,
- display S

which are provided for the brake test.

Minimum requirements with regard to the working of the components of the circuits for the ep brake are set out in point [5 - page 19](#).

o 4.2.2 - On the leading vehicle

See Appendix B - page 36.

The driving cab shall have:

- a switch U for bringing the ep brake into service,
- a button AR for switching-on and reactivating the ep brake,
- a lamp "ep" for fault indication,
- a switch IEP with 3 positions normal, test, simplified ep brake control (see point 4.2.3.5 - page 14).

The electrical controls of the ep brake on the master controller of the driver's console comprise two relays:

- the relay DES, which is in the rest position when there is no release command. It is energised by a release command given by the brake control.

On a release command, contact "des 1" feeds conductor 3, on condition that there is no brake command (contact "ser 1" closed);

- the relay SER, which is in operating state (idle-current principle) when there is no braking command, is energised by the brake control.

When the supply is interrupted by a brake command, its contact "ser 3" feeds conductor 4.

The return of the commands via conductor 2 passes through no other switching contact apart from that required for the de-energising itself.

The control voltage is supplied from the leading vehicle.

o 4.2.3 - Monitoring and testing

4.2.3.1 - Monitoring of the ep brake loop on the leading vehicle

See Appendix C - page 37.

At end-of-train, contact Q_1 on the last vehicle (see point 5.4.1 - page 24) closes conductors 4 and 2 via a resistor R1 and a diode. The loop thus formed through the train and which is known as the "ep brake monitoring loop" is energised from the leading vehicle through a unit which measures the resistance on conductors 4 and 2.

This unit is an SEP generator, the characteristics of which are described under point 5.4.3 - page 24. During running it indicates to the driver by an optical signal "ep", if the measured resistance varies excessively from the normal value of the resistor R1. This ensures that any interruption or short-circuit in the "ep brake monitoring loop" is detected. This function is tested during the brake test (see points 6.3 - page 27 and 6.4 - page 28).

During the braking and release process the monitoring unit is connected to a resistor 1k equivalent to R1, assuming that the resistance measured shortly before has been judged correct (contact "sep 1").

For proper working of this monitoring unit, it is necessary to connect diodes in series to the brake solenoid valves in the coach and to relay RT in the leading vehicle.

4.2.3.2 - Monitoring the working of the ep braking and ep release commands

See Appendix B - page 36.

The command functions on the ep brake operate according to the closed circuit current principle, to ensure safety. This principle is used to monitor the correct implementation of ep brake commands while they are being issued.

The self-holding principle requires an acknowledgement procedure when the ep brake is switched on, to activate the holding function and at the same time check on the automatic triggering of a sharp brake application by the monitoring unit. In the explanations that follow, and in the circuit diagram in Appendix B, the acknowledgement is given using button AR. Other forms of acknowledgement are however acceptable as a means of activating the holding and monitoring functions. If the system that initiates the sharp brake application (venting of the MAP) is not checked by the monitoring unit, this check must be possible by some other means.

The ep brake and relay SOS are switched on by actuating push-button AR. The self-holding function on relay SOS is established through contacts "ser 2" and "sos 1". Between starting up and switching-on of the ep brake, the monitoring chain is checked by means of relay SOS (see point 4.2.3.5 - page 14).

In the event of a malfunction, the monitoring unit activates relay SOS, which orders sharp braking through its contact "sos 2", while contact "sos 3" gives the driver a warning through the illumination of optical signal "ep".

During braking commands, self-holding on relay SOS is no longer performed by the braking relay (contact "ser 2"), but instead by the closed contacts rt1, def1 and sep3 on relays RT, DEF and SEP:

- Relay RT monitors whether the command voltage is actually applied to conductors 2 and 4.

This requires the following:

- physical connection 4/1 must lie between connection 4/2 of the monitoring of the ep brake loop and conductor 4, so that the relay is connected to the part of the circuit through which the monitoring current flows;
- relay RT must switch to the open position at a voltage amounting to ~ 10% of the rated voltage of the control circuit.
- Relay DEF monitors that there is no accidental feed to the release conductor 3, irrespective of the priority of the braking command over the release command (contact "ser 1"). The electrical connection (point 3/1) of relay DEF must lie between contact "ser 1" and the wire of conductor 3;
- Relay SEP checks before the brake command that the correct resistance value of R1 has been maintained in the control circuit through to the train end.

A braking command therefore results in sharp braking if one of the following factors coincides with a brake command:

- no control voltage for the solenoid valves,
- a release command voltage,
- a fault in the control circuit of the brake solenoid valves detected and indicated before the brake command.

The monitoring chain is tested by relay SOS immediately after the "normal" position has been selected on switch IEP and until push-button AR is activated. Until acknowledgement is given using the push button, a sharp brake application takes place. Once the push button has been activated, the sharp brake application is cancelled, providing all conditions are met.

When the leading vehicle is shut down, the ep brake circuit and all self-holding activity is switched off.

4.2.3.3 - Full brake test

See Appendix [A - page 35](#).

Each side of the vehicles is provided with a push-button P by which resistor R3 can be substituted for resistor R1.

Actuation of the push-button on the last vehicle simulates for the monitoring unit, interruption of the ep brake loop and activates lamp "ep" in the driving cab.

This test is carried out to confirm that the end-of-train contact, which ensures closing of the ep brake and EBO loop, is in fact on this vehicle. It permits the testing of all monitoring units and displays.

During actuation of push-button P, a braking command from the leading vehicle activates display S in the vicinity of the push-button.

It becomes inactive after the push-button is released.

The contacts of push-button P required to perform these functions must be mechanically connected, i.e. it must not be possible for one to be actuated without the other also being actuated.

4.2.3.4 - Simplified brake test

See Appendix [A](#).

Actuation of push-button P on any vehicle other than the last vehicle results in the parallel connection of resistor R1 of the last vehicle to resistor R3 of the other vehicle. This action causes the loop monitoring unit to respond and activates lamp **ep** in the driving cab.

This test, which is performed on the vehicle situated directly in the rear of the point where two train sections - regarded as in good order - are combined, allows confirmation that there is only one end resistor R1 on the other vehicles, and that switching of contacts Q has taken place correctly.

During actuation of push-button P, a brake control voltage activates display S on the coach.

It becomes inactive after the push-button is released.

4.2.3.5 - Isolation of ep brake monitoring

The IEP switch in Appendices [B - page 36](#) and [C - page 37](#) with its 3 contact levels IEP 1, IEP 2 and IEP 3 has three positions:

- normal,
- test,
- simplified ep brake control.