UIC CODE 541-5

OR

4th edition, May 2006

Translation

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

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

O **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.

O **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.

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.

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.

The "normal" position is the operating position of the ep brake and meets all the requirements set out in point 4.1 - page 10.

The "test" position has recommendatory status. In this position, relay RT is de-energised and at the same time disconnected from conductors 1 and 4. It serves to check, during a braking command, that relay SOS has switched on the monitoring unit, by simulating an interruption of one of the two conductors.

The "simplified ep brake control" position is an optional requirement on leading vehicles that are also designed to control passenger vehicles with simplified ep brake control as described in point 4.2.4 and Appendix D - page 38. In this position, the wiring is as shown in Appendix E - page 39.

This position cuts out:

- the monitoring of resistance of the ep brake loop (contact "IEP 1") and its actions (contacts "IEP 2" and "IEP 3"),

- the supply to relay RT through conductor 4 (contact "IEP 3"),

The creation of a connection to conductor 1 via a diode maintains the supply to relay RT. This only guarantees the energising of conductor 4 for the ep brake via the end-of-train contact and conductor 1. For this reason, once monitoring of the ep brake loop has been isolated it is no longer permissible for the ep brake to be counted towards the braked weight.

R

4.2.4 - Simplified ep brake control system

See Appendices D - page 38 and E - page 39.

It is recommended that vehicles not intended for use in international traffic be equipped with a minimum of components, in order to ensure the working of ep brake control without monitoring of the loop as shown in the circuit diagrams in Appendices D and E and a control circuit with 4 conductors. See also point 4.2.3.5 - page 14 for explanations on the "simplified brake control" position of the IEP switch.

In international traffic it is permissible, by agreement between the railways concerned, for vehicles with simplified ep brake control systems to be used temporarily. Such vehicles shall at least conform to the functional conditions shown in the circuit diagram of Appendix D.

4.3 - Description of the electrical operation of the EBO

The minimum requirements for the working of components of the electrical circuits of the EBO are set out under point 5 - page 19.

4.3.1 - On vehicles

See Appendix A - page 35.

On the last vehicle of the train a resistor R2 is connected in series to a diode between conductors D and 4 by the end-of-train contact Q, which is described in point 5.4.1 - page 24. This contact is common to both the ep brake and EBO loops, which are thus formed from the leading vehicle via conductors D and 4 and resistor R2.

The pulling of any emergency alarm handle on a coach closes a circuit, in addition to the pneumatic effect of the emergency braking. This circuit is comprised of relay A, a diode connected in series and located between conductors D and 4, and also an independent circuit fed from the coach battery. The resistance of the EBO loop is varied by the placing of relay A.

Relay A is used for the impulse control of emergency brake override. The closing of its contact a1 energises the override device B of the vehicle which becomes self-holding (contact "b 1") until the emergency alarm is reset.

The contacts of the emergency alarm handle 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.

4.3.2 - On the leading vehicle

See Appendix C - page 37.

A monitoring unit – SSA – for the resistance of the EBO loop detects the change in resistance generated by the parallel connection of relay A in the passenger vehicle when the first emergency alarm is operated.

Detection switches the contacts of the SSA to the open position and:

- prohibits the release command (contact "ssa 1"),
- indicates by the flashing of the EBO lamp and the transmission of an audible signal, that an emergency alarm has been operated (contact "ssa 2"),
- authorises the command to override the emergency braking (contact "ssa 2").

Activation of the IFA device to override emergency braking brings a d.c. voltage of 48V ± 5% to conductors D (positive polarity) and 4 (negative polarity), and energises a relay C which has the same characteristics as the override relay A in the coach.

The override command energises relay C and triggers its self-holding function (contact "c4") and the constant illumination of the EBO lamp (contact "c3"), and cuts off the audible signal. At the same time, a brake release command is again permitted via the closed contact "c1". On resetting of the last emergency alarm operated, the device monitoring EBO loop resistance once more permits (or, following override, continues to permit) a release command and cuts off the supply to relay C and the indicator lamp. The EBO lamp goes out, irrespective of whether or not an override command has been given beforehand.

Contacts "ifa 1" and "ifa 2" must be mechanically connected to one another, so as to indicate any melting of contacts before an unintentional override is made during an emergency braking.

4.3.3 - Monitoring and testing

4.3.3.1 - Monitoring of the EBO loop

The device measuring the resistance on the EBO loop covers not only an operated emergency alarm but also any short-circuit in or interruption of the EBO loop, indicating the latter as an operated emergency alarm. The driver distinguishes the latter occurrences from an operated emergency alarm by the fact that the MAP is not vented.

4.3.3.2 - Monitoring of the command to override emergency braking

The connection of relay C on the leading vehicle to the monitored section of the EBO loop confirms by its activity the effective energisation of the loop during an override.

Relay C shall be connected to a point D/1 which lies electrically between point D/2 and the wire of conductor D.

4.3.3.3 - Full brake test

The full brake test, which is made by actuation of a push-button P on the coach at the train end, tests the ep brake and EBO loops simultaneously. Actuation of push-button P permits checking of the monitoring units and displays through illumination of the ep lamp and EBO lamp in the driving cab. Release of the push-button extinguishes the lamps.

4.3.3.4 - Simplified brake test

The actuation of a push-button P on a vehicle which is not the last vehicle, has no effect on the monitoring unit of the EBO loop.

4.3.3.5 - Testing of the command to override emergency braking

This test is possible if passenger vehicles are coupled together and the EBO loop registers an end-of-train (no emergency alarms triggered).

Override command IFA inserts relay C in the EBO loop (contact "ifa1"), similar to the case of an operated emergency alarm, and generates recognition by the monitoring unit. The mode of operation and the display are identical to those for an emergency alarm, and an override command continues so long as this command is maintained.

Cancellation of the override command has the same effect as the resetting of the emergency alarm.

4.3.3.6 - Isolation of EBO monitoring

It shall be possible to isolate the monitoring unit of the EBO loop by means of the ISA switch, for operation with freight wagons in particular.

This isolation switches off the resistance measurement, the emergency braking indication and the override option, and removes the block on release commands.

5 - Definition of components

5.1 - General

The rated control voltage supplied from the leading vehicle shall be either 72 V or 110 V d.c. It can be taken from either a battery or a transformer.

Irrespective of its battery voltage, the leading vehicle shall have at its disposal a control voltage of 48 V ± 5%/1,0 A.

All diodes shall have the following characteristics:

- minimum rated current: I_N = 1 A,
- maximum usable portion: I_N = 0,5,
- minimum reverse voltage: 1 200 V.

5.2 - Components of the ep control cable

These components comprise the cables and electrical connections of the vehicles to one another, together with their attachment to the headstocks.

5.2.1 - Attachment of the connection cable and coupling elements

The attachment points for the connection cables, coupler sockets and dummy sockets to the vehicle headstocks are shown in Appendix G - page 43. It is permissible for the connection cable on locomotive headstocks to be replaced by a second coupler socket.

5.2.2 - UIC standard connector for the ep brake

5.2.2.1 - Coupler plug and coupler socket

The coupler plug fitted at the end of the connection cable between vehicles is shown in Appendix H, Fig. 1 - page 45.

Taking into account the necessary insertion forces, the coupler plug has two side attachments with rollers to assist insertion.

The coupler socket shown in Appendix H, Fig. 2 - page 46 is provided with a handle which connects two side levers. Due to the profile of the guide slots with which these levers are equipped, the cover of the coupler socket and the coupler plug can be actuated and locked. The pins and sockets with which the coupler socket and coupler plug respectively are equipped for electrical connection are as follows:

- 4 contacts of 7 mm diameter for conductors of 10 mm^2, with a maximum permissible insulating sheath diameter of 7,5 mm;
- 2 contacts of 4 mm diameter for conductors of 6 mm^2, with a maximum permissible insulating sheath diameter of 5,5 mm;

- 3 contacts of 3 mm diameter for conductors of 2,5 mm^2, with a maximum permissible insulating sheath diameter of 3,5 mm.

The coupler plug shall be provided with a pull relief and sealing conforming to protective system IP 66 as specified in *EN 60529* (see Bibliography - page 55).

5.2.2.2 - Working of the plug connection

5.2.2.2.1 - Opening of the coupler socket

The cover is released by actuating the handle, and the coupler socket is opened. At the lifting end, the handle holds the cover in an almost horizontal position, thereby facilitating insertion of the coupler plug. The cover and handle must drop down as soon as the handle is released. It is then permissible for locking not to be effected.

5.2.2.2.2 - Insertion of the coupler plug

Once the coupler socket is open, the coupler plug can be inserted in a position defined by elevation and groove. The coupler plug can be inserted without a great deal of force, until the contact pins and sockets of the electrical connections touch one another. In this approach position (Appendix H, Fig. 3 - page 47, drawing A), the coupler plug is gradually pushed into the coupler socket by the pressing down of the handle. This insertion is effected by the guide slots in the two movable levers and the movement of the guide pins mounted on the side of the coupler plug. During this operation, the position of the cover is not forcibly changed by the operation of the handle.

5.2.2.2.3 - Locking of the coupler plug

At the lifting end, the seal is compressed by the suitable profile of the guide slots (Appendix H, Fig. 3, drawing B), and the handle and plug are firmly locked (Appendix H, Fig. 3, drawing C). The plug connection shall then conform to protective system IP 66 as specified in *EN 60529*.

5.2.2.2.4 - Release and withdrawal of the coupler plug

By pulling the handle upwards, the coupler plug is released and pulled out of the coupler socket, until the pins and sockets of the electrical connections are separated. This pulling-out is achieved through the action of the guide slots of the movable handle on the guide pins fitted to the coupler plug. The coupler plug is now no longer moved along by the handle, but only the cover is raised, so that the coupler plug may be pulled out easily by hand.

5.2.2.2.5 - Closing of the coupler socket

The cover is moved by pressing down the handle. At the lifting end, the guide slots of the lever ensure that the cover lies in the closed position and compress the seal, so that cover and handle are interlocked in a stable position. The cover of the coupler socket shall conform to protective system IP 66 as specified in *EN 60529*.

5.2.2.2.6 - End-of-train pilot contact

Depending on the type of end-of-train monitoring used (see point 5.4.1 - page 24), the coupler socket either has or does not have an additional single-pin pilot contact. In the absence of a coupler plug, the pilot contact remains closed. It is opened by insertion of the coupler plug into the coupler socket. The working of the pilot contact between the approach and pre-locking position (see Appendix H, Fig. 3 - page 47) makes it possible to detect that a coupling has remained in the approach position.

In order to ensure reliable operation of the contact, it is automatically actuated directly by the coupler plug, at least during the insertion process. In the closed position the contact shall be vibration-resistant.

The contact and its operating elements are located in a sealed casing on the coupler socket in the space provided for this purpose (for example see Appendix H, Fig. 5 - page 49).

The contact shall be connected via a two-core cable passing through the mounting plane of the coupler socket via a suitable sealing system.

If contact is not required, there shall be no visible opening in the body of the coupler socket at this point.

o 5.2.3 - Dummy socket

5.2.3.1 - For the working of the ep brake and EBO, it is sufficient to couple a single cable between the vehicles. The coupler plug not used for any connection between the vehicles shall be inserted in a dummy socket and locked in place. The physical design of the dummy socket shall be identical to that of the coupler socket and shall also conform to protective system IP 66 as specified in *EN 60529* (see Bibliography - page 55).

5.2.3.2 - Depending on the type of end-of-train monitoring used (see point 5.4.1 - page 24), the dummy socket either has or does not have an electrical contact for conductor 4. The contact is required to indicate as necessary that the coupler plug is missing or has been incorrectly inserted.

5.2.4 - Cables

o 5.2.4.1 - General characteristics

The insulation between conductors shall withstand a dielectric test of 1 500 V - 50 Hz over one minute.

The quality of the insulating materials and casings shall be selected for good performance at low temperatures down to -25°C and exceptionally -40°C, also for good weather-resistance. The temperature classification of insulating materials shall be at least 90°C.

These materials shall also be flame-resistant, with only low levels of toxic or halogen smoke and gas emission in the event of fire.

The cable insulating materials shall be resistant to ozone and hydrocarbons. The outer sheath shall also be resistant to acid (standard solution of hydrochloric acid) and basic (standard caustic soda solution) cleaning agents.

The various conductors and any gap fillers (inserts) shall not adhere to one another, in order to ensure good performance under mechanical loadings.

The conductors shall be identified by suitable markings.

O **5.2.4.2 - Connection cable between vehicles**

The connection cable between vehicles shall meet the criteria set out below. This cable is not intended for installation inside vehicles.

O **5.2.4.3 - Description**

The connection cable between vehicles is a slightly flexible cylindrical cable with a maximum diameter of 33,5 mm. It comprises, within its common casing, the following elements:

- 4 conductors of 10 mm^2 cross-section, designated 1 to 4,
- 2 conductors of 6 mm^2 cross-section, designated A and B,
- 1 conductor of 2,5 mm^2 designated D,
- 1 screened and sheathed pair of two twisted conductors with a minimum cross-section of 0,75 mm^2, designated X and Y for a data bus conforming to the provisions of *UIC Leaflet 556* (see Bibliography - page 55).

Each of the conductors shall, as specified above, be marked 1 to 4 and A, B and D. The conductors for the data bus are X = white and Y = black.

O **5.2.4.4 - Technical data**

Conductors 1 to 4, A, B and D are designed for an operating voltage of 250 V, and their cores belong to class 6 as defined in *Norm IEC 228* (see Bibliography - page 55).

The composition, characteristics and test conditions for the two-core screened cable are specified in *UIC Leaflet 558, points 2.3 and 2.5* (see Bibliography - page 55).

R **5.2.4.5 - Precautions against pulling-out of the connection cable**

Since connectors and sockets are not designed for automatic uncoupling, individual or combined connection of conductors is recommended, so that only a minimum of damage will result from any accidental separation.

O **5.2.4.6 - Wiring in the vehicle**

The following copper conductors shall be laid in the vehicle:

- 4 conductors of 10 mm^2 cross-section (1-4),
- 2 conductors of 6 mm^2 cross-section (A and B),
- 1 conductor of 2,5 mm^2 (D),
- a separate screened and sheathed pair of two twisted conductors (X and Y) conforming to the provisions of point 5.2.4.4.

Inside the vehicle the control cables shall have a minimum cross-section of 1,5 mm^2 copper.

5.2.5 - Contact assignment

The following table shows the assignment of the nine contacts.

Conductor No.	Contact No.	Assignment
1	1	ep brake return conductor, simplified control system (see point 4.2.4 - page 15)
2	2	(negative) ep brake and EBO
3	3	Release ep brake
4	4	Apply ep brake
A	A	Power supply (see point 10.2 - page 33)
B	B	Power supply (see point 10.2)
X	C	Train bus (white)
D	D	EBO functions (positive)
Y	E	Train bus (black)

5.2.6 - Equipment of vehicles

Vehicles shall without exception be provided with all the conductors specified under points 5.2.4 - page 21 and 5.2.5. This equipment shall also be obligatory for vehicles which do not have all the functions permitted by the ep control cable.

5.3 - Solenoid valves

5.3.1 - Each vehicle is equipped with a separate solenoid valve for application and release of the ep brake. The solenoid valves may either be connected to the distributors of the compressed-air brake or else installed separately.

5.3.2 - The braking and release elements - or the components which perform the same function - are activated directly by the voltage supplied from the leading vehicle. The permissible nominal control voltages are 72 V and 110 V. Consequently the solenoid valves should operate at any voltage from 50 V to 137 V and at temperatures between -25°C and 40°C. The excitation voltage of the solenoid valve fed at 5 bar shall not fall below 30 V, and the minimum resistance shall be 1 200 Ω.

If protective devices are required at the terminals of the brake solenoid valve, their failure shall in no case allow the parallel connection of a resistance of less than 100 Ω on their coils.

5.4 - Essential components for monitoring the ep brake loop

The components required for monitoring of the ep brake loop are:

- the end-of-train contact,
- resistor R1 with diode connected in series,
- the monitoring unit of the resistor between conductors 2 and 4.

5.4.1 - End-of-train contact

The end of the train is identified by the closing of contact Q. Contact is produced by means of one of two variants, which operate on the basis of pressure regulators or a pilot contact. Both variants are shown in schematic form in Appendix I - page 50. Any new variant shall require the approval of UIC Sub-Commission 04 for Braking.

5.4.1.1 - Pressure regulator variant

The principle of the pressure regulator variant (Appendix I, first Fig.) is based on the fact that the two brake couplings of the divided MARP are unpressurised only when no pneumatic coupling has been made. The two pressure regulators at each vehicle end are each connected to a brake coupling of the MARP. They close their contact when the brake coupling has a pressure of less than 3 bar. At each vehicle end the contacts of the two pressure regulators are connected in series. Contact Q is formed through the connection in series of the two contacts of the pressure regulators at the same vehicle end. Each vehicle end which may be marshalled at the end of a train is equipped with two pressure regulators.

5.4.1.2 - Pilot contact variant

The principle of the pilot contact variant (Appendix I, 2nd Fig.) is based on the fact that, at the rear end of the last vehicle, there is no electrical connection to a following vehicle. In other words, the coupler plug belonging to the vehicle is inserted in the dummy socket, and there is no coupler plug inserted in the coupler socket. The dummy socket is equipped with an insulating body which contains the contact pin for conductor 4. The coupler socket is provided with a pilot contact which is electrically closed when no coupler plug is inserted. Contact Q is formed by this pilot contact connected in series with conductor 4 via the contact pin in the dummy socket. Each vehicle end which may be marshalled at the end of a train is equipped with a pilot contact and the contact pin in the dummy socket.

5.4.2 - Resistor R1

Resistor R1 has a resistance of 1 000 Ω ± 1%, 5 W.

5.4.3 - SEP monitoring unit of the resistance between conductors 2 and 4

The SEP monitoring unit in the ep brake loop in the leading vehicle generates a constant current I in the range 20 to 28 mA for a voltage U of 2 V < U < 48 V.

If the ratio between the generator voltage and the current supplied corresponds to a resistance of 800 to 1 250 Ω, then the information output of the monitoring unit shall be active (normal operating situation).

If this resistance is greater than 1 350 Ω or less than 700 Ω, then the output information of the monitoring unit shall be inactive. Appendix J.1 - page 51 shows the current-voltage characteristic of the monitoring unit in the leading vehicle together with its range of effectiveness.

The SEP monitoring unit operates contacts sep1, sep2 and sep3 like a relay. The contacts are shown in Appendices B - page 36 and C - page 37 with the monitoring unit in non-active position

NB : Optionally, the SEP monitoring unit may also indicate in which of the 3 defined ranges the measured resistance occurs.

5.5 - Essential components for monitoring the EBO loop

The components required for monitoring of the EBO loop are:

- resistor R2 with diode connected in series,
- the SSA unit monitoring the resistance between conductors D and 4,
- relay A.

5.5.1 - Resistor R2

Resistor R2 has a resistance of 1 300 Ω ± 1%, 5 W.

5.5.2 - SSA monitoring unit of the resistance between conductors D and 4

The SSA monitoring unit in the EBO loop in the leading vehicle generates a constant current I in the range 20 to 28 mA for a voltage U of 2 V < U < 48 V.

If the ratio between the generator voltage and the current supplied corresponds to a resistance of 450 to 1 500 Ω, then the information output of the monitoring unit shall be active (normal operating situation). If this resistance is greater than 1 600 Ω or less than 350 Ω, then the output information of the monitoring unit shall be inactive. Appendix J.2 - page 52 shows the current-voltage characteristic of the monitoring unit in the leading vehicle together with its range of effectiveness.

The SSA monitoring unit operates contacts ssa1, ssa2 and ssa3 like a relay. The contacts are shown in Appendix C - page 37 with the monitoring unit in non-active position

5.5.3 - Relay A

Relay A is a relay with a coil (nominal voltage 48 V) and any connected resistors having an equivalent resistance of 240 Ω. Its threshold voltage lies between 20 V and 30 V.

When activated, the relay switches the equivalent resistance from 240 Ω to 1 200 Ω, in order to save the power supply for the emergency brake override system if several emergency alarms are actuated at the same time. It is recommended that a resistance of 1 200 Ω be selected for the relay and, in parallel, a value of 310 Ω for the resistance taken up by the relay through break contact.

5.6 - Components required for testing

The components for testing comprise:

- a resistor R3,
- a push-button P,
- a component S for the display,
- relay C.

Push-button P and display S are mounted on each side of the vehicle and marked as belonging to the ep brake.

5.6.1 - Push-button P

The contacts of the push-button are mechanically connected and are actuated directly by the button without an intermediate spring. The contact for closing and the contact for opening may not be closed simultaneously, not even in the event of failure of a component of the push-button. The push-button shall conform to protective system IP 66 as specified in *EN 60529* (see Bibliography - page 55).

5.6.2 - Resistor R3

Resistor R3 has the values 1 600 Ω ± 1%, 5W.

5.6.3 - Display element S

Display element S may be a lamp or some kind of electromechanical device. It responds due to the voltage used to control the solenoid valves and changes from a dark to a bright colour.

5.6.4 - Relay C

Relay C in the leading vehicle is used to check the override command IFA in accordance with points 4.3.3.2 and 4.3.3.5 - page 17 and controls the optical indication of an overridden emergency brake application. Relay C is a relay with a coil (nominal voltage 48 V) and any connected parallel resistors having an equivalent resistance of 240 Ω. Its threshold voltage lies between 20 V and 30 V.

5.7 - Vehicles for push-pull operation

Vehicles that can be used at both the front and the rear of the train must have the same equipment for monitoring the ep brake loop, monitoring the EBO loop and carrying out the checks listed in points 5.4 - page 23, 5.5 and 5.6 - page 25.

6 - Testing

6.1 - General

For the characteristics of the ep brake to be counted towards the braked weight it is necessary not only to verify the correct working of the compressed-air brake but also to test the monitoring loop and monitoring unit. The brake test assumes that the driving cab is equipped with the test facilities described under point 4.2.3 - page 12.

The various types of brake tests and their execution are regulated by *UIC Leaflet 453* (see Bibliography - page 55). Here, only the special technical details related to the ep brake and the EBO will be considered.

The brake test can be performed only when:

- the pneumatic continuity of the MAP and the MARP have been verified with the ep brake isolated,
- no irregularities are detected by the monitoring loop of the ep brake.

6.2 - Testing of the ep brake

6.2.1 - Full brake test

A full brake test shall include testing of the ep brake. For details see point 4.2.3.3 - page 14.

6.2.2 - Simplified brake test

For details see point 4.2.3.4 - page 14.

6.3 - Testing of the EBO

The test can be performed only when testing of the monitoring loop reveals that no emergency alarm has been operated. It takes place at the same time as the testing of the ep brake.

6.3.1 - Full brake test - EBO test

In addition to the ep brake loop, the completeness of the EBO loop is checked during the full brake test.

Actuation of one of the P push-buttons also interrupts the EBO loop. The monitoring unit of this loop must then activate the relevant display in the driving cab. It becomes inactive when the push-button is released.

6.3.2 - Simplified brake test - EBO test

The EBO test is not necessary for the simplified brake test.

6.4 - Testing of the ep brake equipment on the leading vehicle

The test may be performed on the leading vehicle already coupled to the train or standing alone. See also point 4.2.3.5 - page 14.

In this test the IEP switch is set to "Test". A brake command leads to venting of the MAP.

6.5 - Testing of the EBO equipment on the leading vehicle

On railways which consider it necessary, the test is conducted on the leading vehicle coupled to the train, after execution of the full brake test.

Testing of the monitoring unit of the EBO loop, together with the override control and display elements, is effected by means of an override command. The lamp is illuminated, the audible warning for the operated emergency alarm sounds, and the lamp confirming the override command is also illuminated.

6.6 - Single-man brake test

Railways wishing to permit conduct of the brake test by the driver alone using the ep brake shall in no way allow any deterioration in the safety and operation of the ep brake.

7 - Marking of vehicles

7.1 - Marking of the ep brake and EBO

UIC Leaflet 545 (see Bibliography - page 55) governs the marking of vehicles equipped with the ep brake or with the ep control cable and EBO alone.

A leading vehicle may only be marked with the symbol for the ep brake (ep control cable with 9 conductors) in IVORY / YELLOW if it is possible to take account of the increase in braked weight resulting from the ep brake in service. This condition is met by ensuring compliance with the monitoring unit requirements in point 1.2.3 - page 4.

7.2 - Marking of the braked weight

There are no particular markings for the braked weight when the ep brake is operational.

8 - Approval

8.1 - Approval of the ep brake

8.1.1 - Compressed-air brakes for freight and passenger trains, approved for use in international traffic under the conditions specified in *UIC Leaflet 540* (see Bibliography - page 55), shall be used for the ep brake.

8.1.2 - Any railway wishing to use vehicles with an electropneumatic brake in international traffic shall submit to the UIC Braking Sub-Committee an explanation of the electrical circuitry accompanied by a circuit diagram, together with a functional description of the brake [1] and a test report[1] of tests on the specific vehicle. In order to permit evaluation of the working, compatibility and reliability of the circuitry, the report shall include specific details of the:

- solenoid valves (including pressure gradients),
- end-of-train elements,
- relays and test components used and tested.

8.1.3 - The UIC Braking Sub-Commission shall first check, with the aid of the submitted circuit diagram and test results, whether or not the conditions of this leaflet have been satisfied.

It shall give approval for use of the solenoid valves, the end-of-train elements and their interconnection (in accordance with the circuit diagram).

8.1.4 - Recently-approved elements of the ep brake are described in Appendix K - page 53.

8.2 - Use of the EBO

8.2.1 - The EBO is not subject to approval. It shall be used only on vehicles which are fully equipped with the ep brake.

8.2.2 - Any railway wishing to use an electropneumatic EBO in international traffic shall equip the vehicles concerned with the necessary components on its own responsibility. It shall test the electrical circuitry together with the working of the EBO on the vehicle on its own or when marshalled in a train. A functional description with an electrical circuit diagram shall be supplied to other railways involved in use of the equipment.

1. 25 copies in German, 25 copies in French and 10 copies in English.

8.3 - Approval of the UIC standard coupler for the ep brake

8.3.1 - UIC standard couplers for the ep brake shall conform to the provisions and dimensions of Appendix H - page 45. Irrespective of the type of contacts, the contact resistance in the electrical coupler shall be less than 1 milli-Ohm. The female contacts of the coupler socket shall provide perfect contact with the contact pins after 10 000 instances of coupling and uncoupling with the same coupler plug. The contact resistance may reach 2,5 times the values originally measured.

8.3.2 - The 9-contact connector of CARRIER KHEOPS BAC, Groupe Compagnie Deutsch, F 72024 LE MANS CEDEX shall be regarded as the basic version of the UIC standard coupler for the ep brake.

8.3.3 - Connectors manufactured by other companies in accordance with Appendix H shall be compatible with the basic version as specified in point 8.3.2, also with one another including all attachments, and shall work correctly in all respects under these conditions.

8.3.4 - Any railway wishing to use a coupler for the ep brake from a manufacturer other than that specified under point 8.3.2, shall verify the compatibility of the coupler with the basic version and with other couplers already approved for use in international traffic. Observance of the conditions specified under point 5.2.2 - page 19 and the dimensions specified in Appendix H shall be verified. The contact resistance levels are to be determined. If there is a pilot contact, this shall be checked for its functional capability and robustness. The design shall be described in the report. The contact shall be vibration-resistant in the closed position. If results are positive, the railway shall submit a test report and drawings of the new coupler to the UIC Braking Sub-Committee, requesting its inclusion in Appendix L - page 54.

8.3.5 - UIC standard couplers for the ep brake, approved for use in international traffic, are listed in Appendix L.

9 - Functions associated with the public-address systems of passenger coaches

Still under consideration.

10 - Use of other possible means of transmission

10.1 - Train bus

Reserved.

o 10.2 - Power supply for freight rolling stock

When conductors A and B are used for power supply from the leading vehicle or in the case of a stabled train from a shore-based installation, 230 V - 50 Hz shall be used. In either case conductor B shall be connected to earth directly or via the power source.

The conditions of use for conductors A and B will be specified in due course by the relevant UIC bodies.

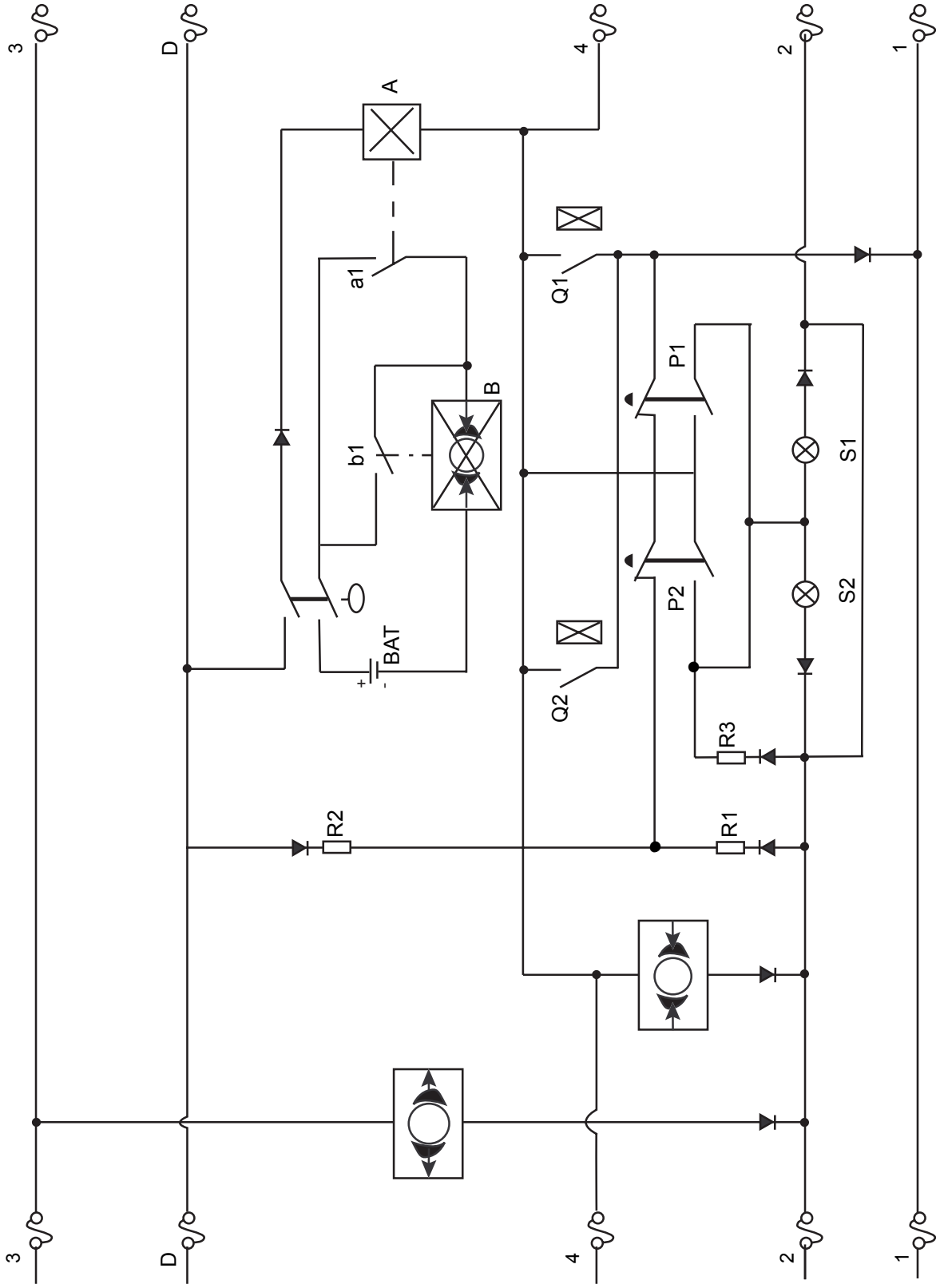
11 - Fire protection

If a fire breaks out on board the vehicle, the emergency brake and emergency brake override functions must remain operational for as long as possible.

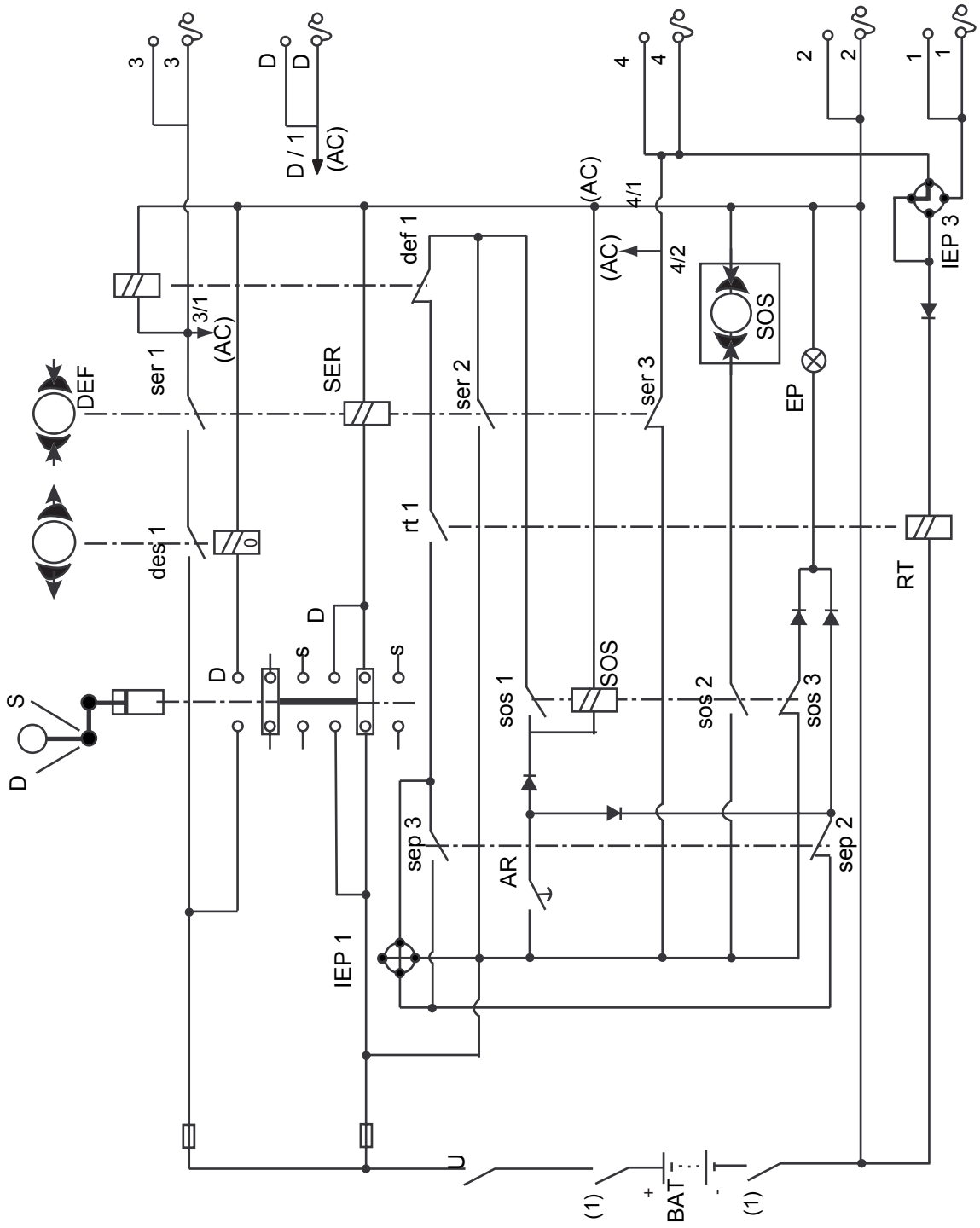
For this reason:

- the materials selected for the components and wiring of the emergency brake and the emergency brake override systems must conform to the provisions of EN standards currently in force;
- air pipes and their connections should in principle be made from metal;
- electrical wiring should be protected from direct exposure to flames.

Appendix A - Electrical circuit diagram of a passenger coach

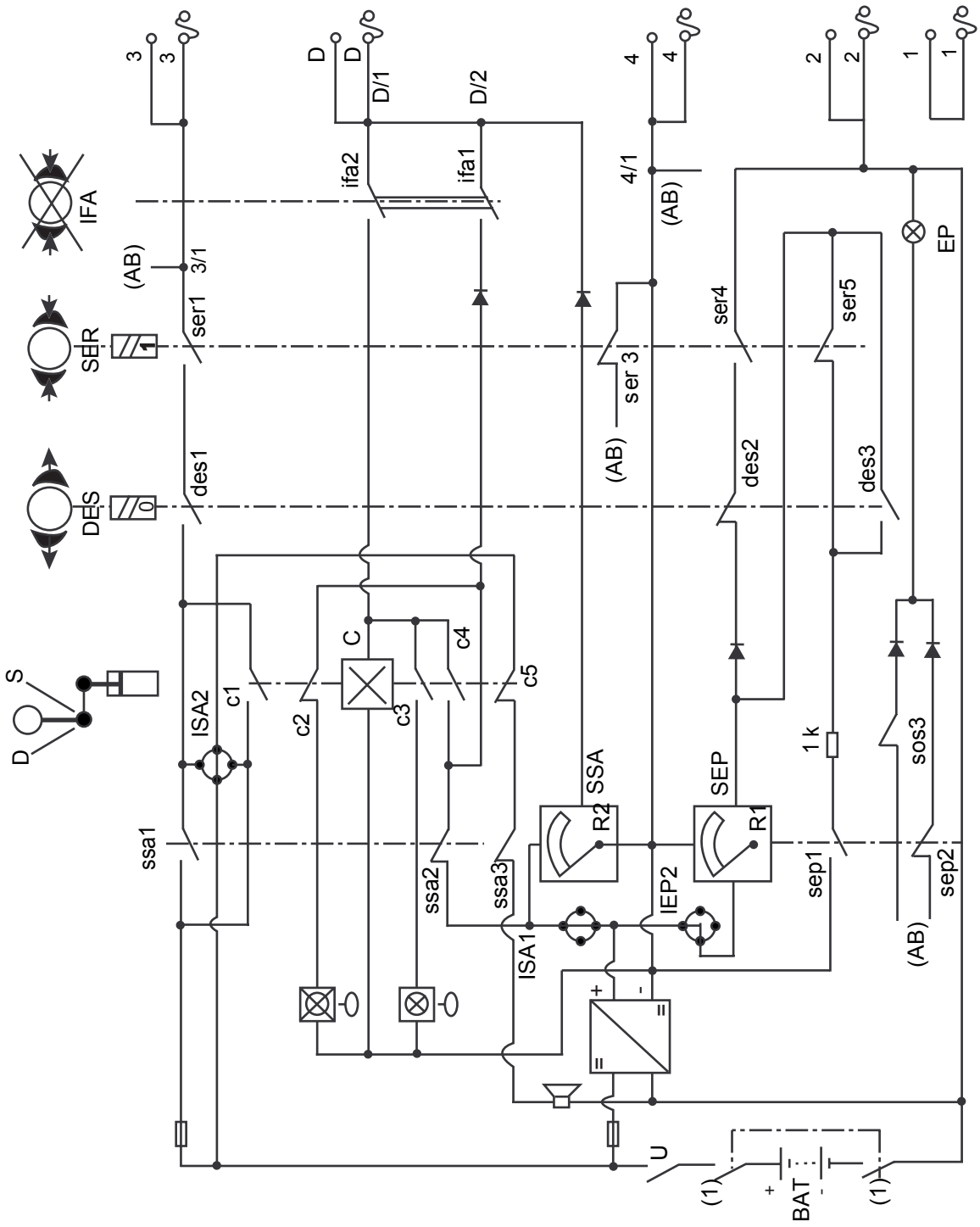


Appendix B - Electrical circuit diagram of a vehicle at the head of a train



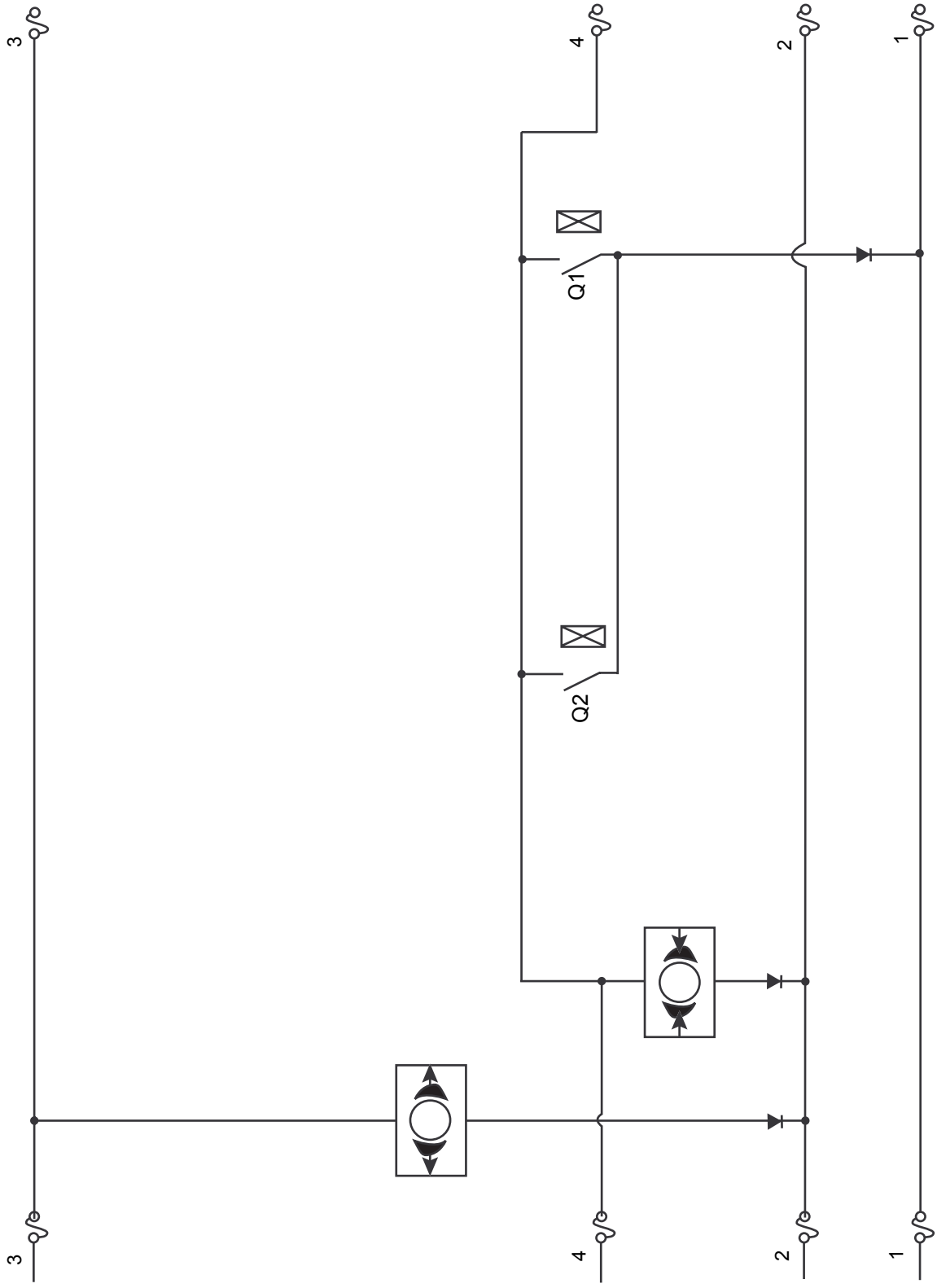
(1) The circuit is shown in quiescent state, with battery contact opened.

Appendix C - Electrical circuit diagram of a vehicle at the head of a train

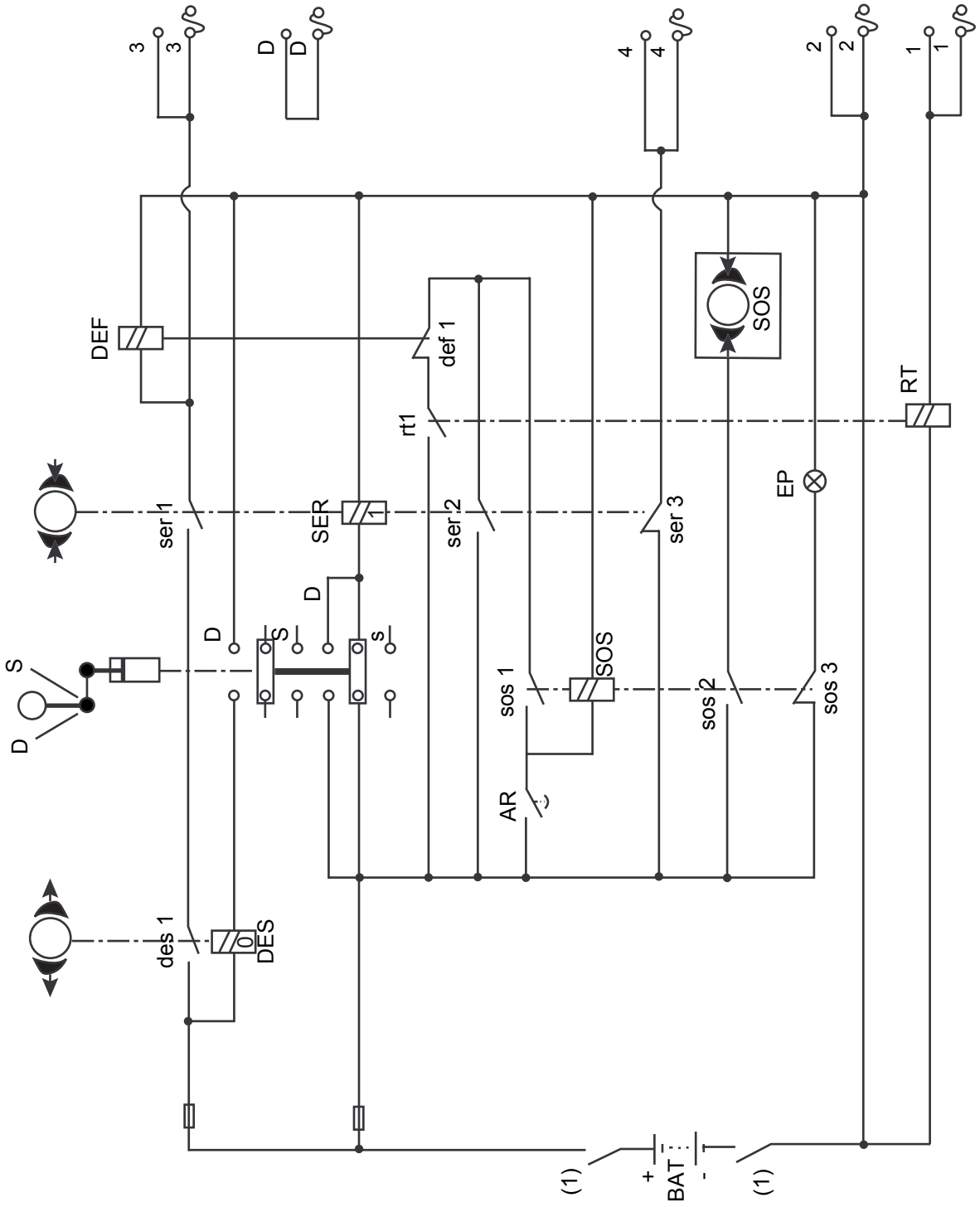


(1) The circuit is shown in quiescent state, with battery contact opened.

Appendix D - Electrical circuit diagram of a passenger coach - Simplified control system

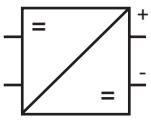
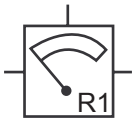
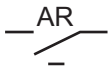


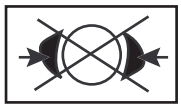
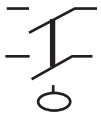
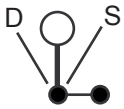
Appendix E - Electrical circuit diagram of a vehicle at the head of a train - Simplified control system



(1) The circuit is shown in quiescent state, with battery contact opened.

Appendix F - Key to circuit symbols used in Appendices A - E

B A T	Battery of leading vehicle	
	Switch	
	Electrical braking command	SER
	Electrical release command	DES
	Electrical command for emergency brake override	IFA
	DC voltage converter with electrically-isolated output	
	Device for ep brake monitoring - SEP	
	Device for EBO monitoring - SSA	
 	EBO indicator: ● Flashing light indicates an emergency alarm has been activated ● Steady light displayed after an override command	
	Indicates a fault in the continuity of the braking function of the ep brake	
	Audible signal in the driving cab	
	Push button	
	Solenoid valve: ep braking	

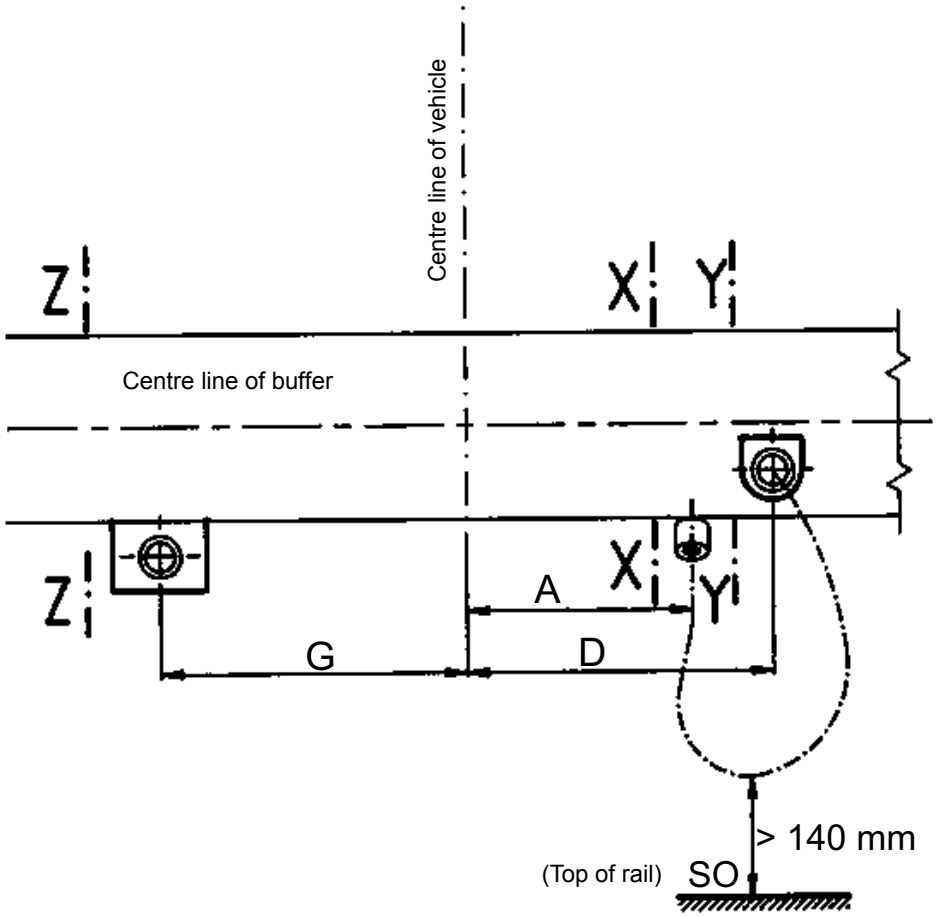
B A T	Battery of leading vehicle
	Solenoid valve: ep release
	Device for overriding emergency braking on the vehicle
	End contact closed
	End contact open
R1, R2, R3	Resistors
	Receiver unit for the emergency brake override command Relay A, Relay C
	Test key
	Device with contacts which close as soon as an emergency alarm is activated
	Diode with specified characteristics
	Release relay
	Braking relay
	Driver's brake valve
	Pressure regulator for comparing the control pressure with the MAP pressure
	Relay for control of the emergency brake
	Emergency braking command

B A T	Battery of leading vehicle
 RT	Relay for detecting a braking command
 DEF	Relay for detecting a release command
 S	Display for full brake test

ep brake switch	Normal	Testing	simplified ep brake control
IEP 1			
IEP 2			
IEP 3			

EBO switch	Normal	Isolated
ISA1		
ISA2		

Appendix G - Attachment of cable and coupler elements for the ep brake

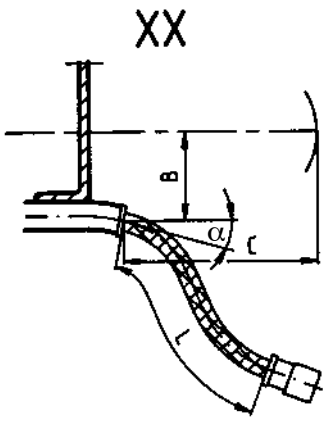


C, F and I relate to a position in which the buffers are not compressed.

L is the length of the cable measured between the point where it emerges from the pipe socket and the point where it enters the metal guide of the connector.

SO = top of the rail.

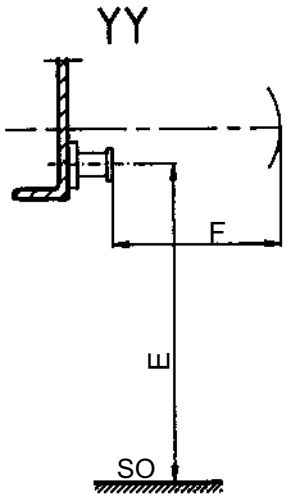
Coupler cable



Coupler cable	
A	475 ÷ 660
B	125 ÷ 375
C	530 ÷ 600/650(1)
L	1440 ÷ 1450
α	25 - 35°

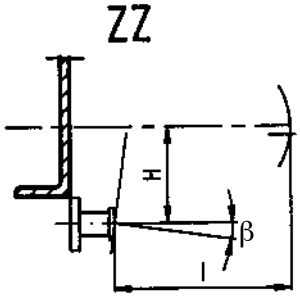
(1) 650 mm is acceptable for passenger stock

Dummy socket



Dummy socket	
D	May be chosen freely in accordance with point ...
E	
F	

Coupler socket



Coupler socket	
G	475 ÷ 660 (2)
H	125 ÷ 275
I	535 ÷ 605
β	0 - 15°

(2) Dimension G_{max} = 660 mm may be increased by ΔG if, at the same time dimension I_{max} = 605 mm is reduced by ΔI ($\Delta I = 0{,}75\ \Delta G$).
ΔG_{max} 80 mm

Appendix H - Coupler plug

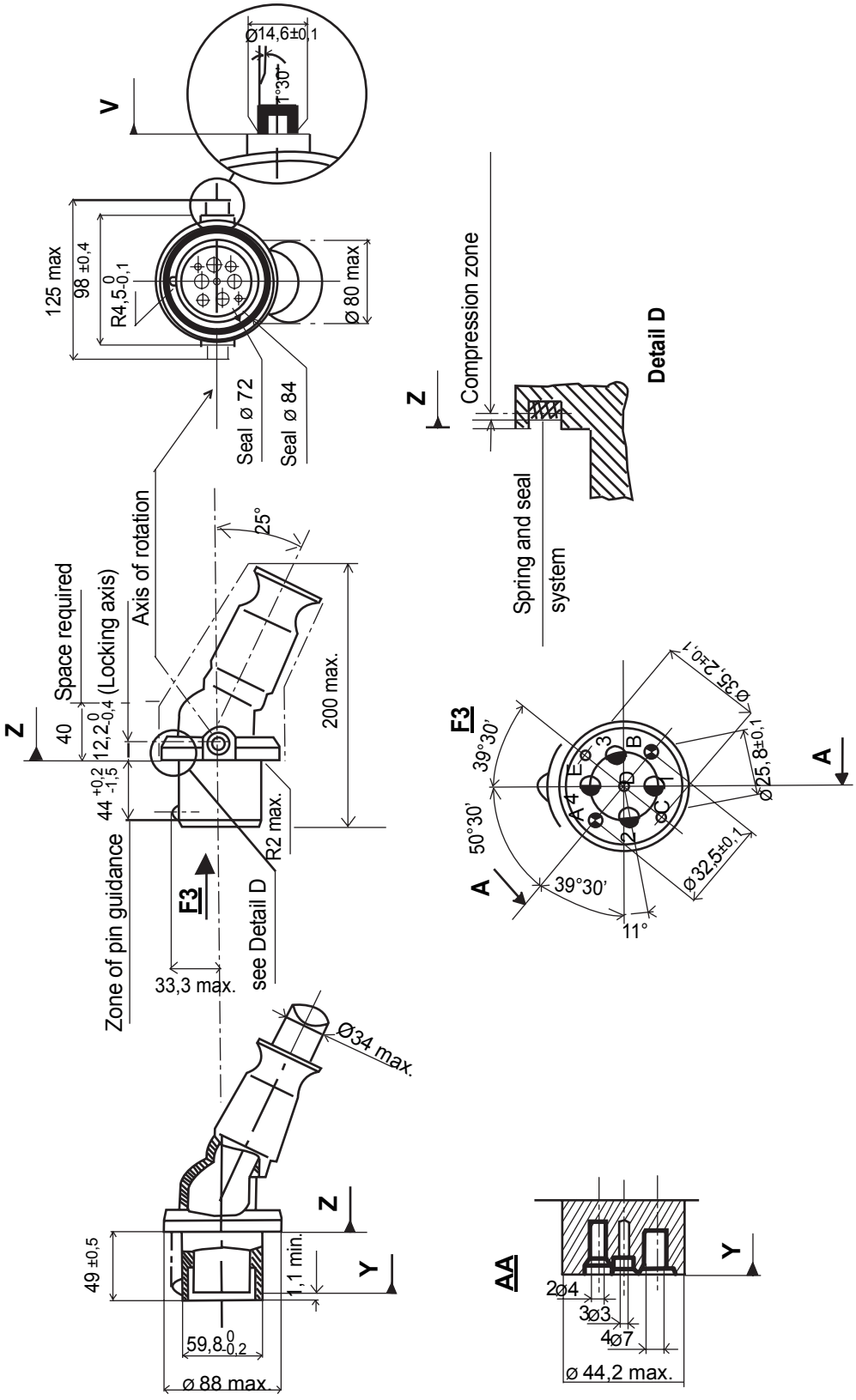


Fig. 1 - Connector

Contact designations are: embossed on the front with reference Y, colour print on the side facing the wiring.

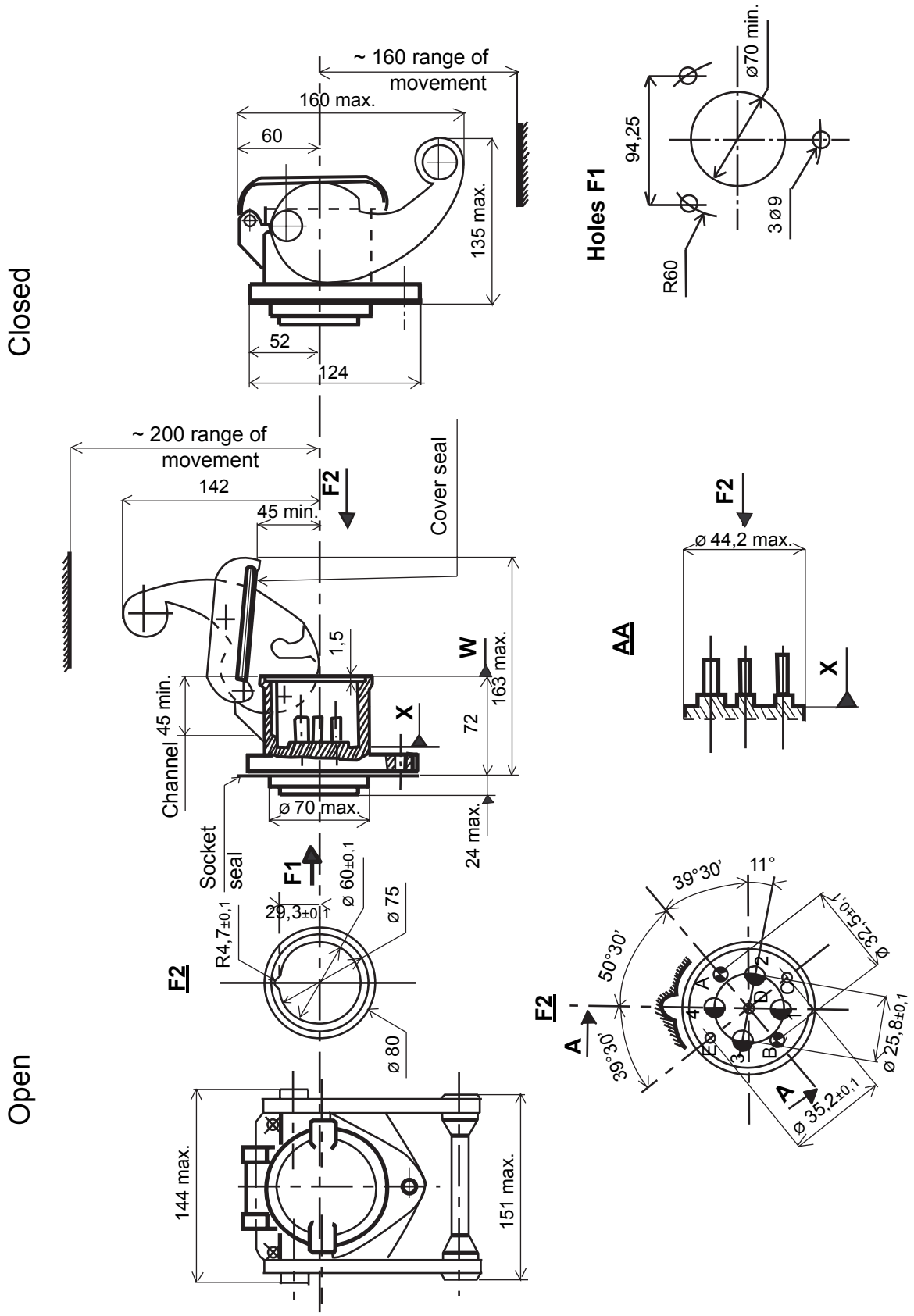
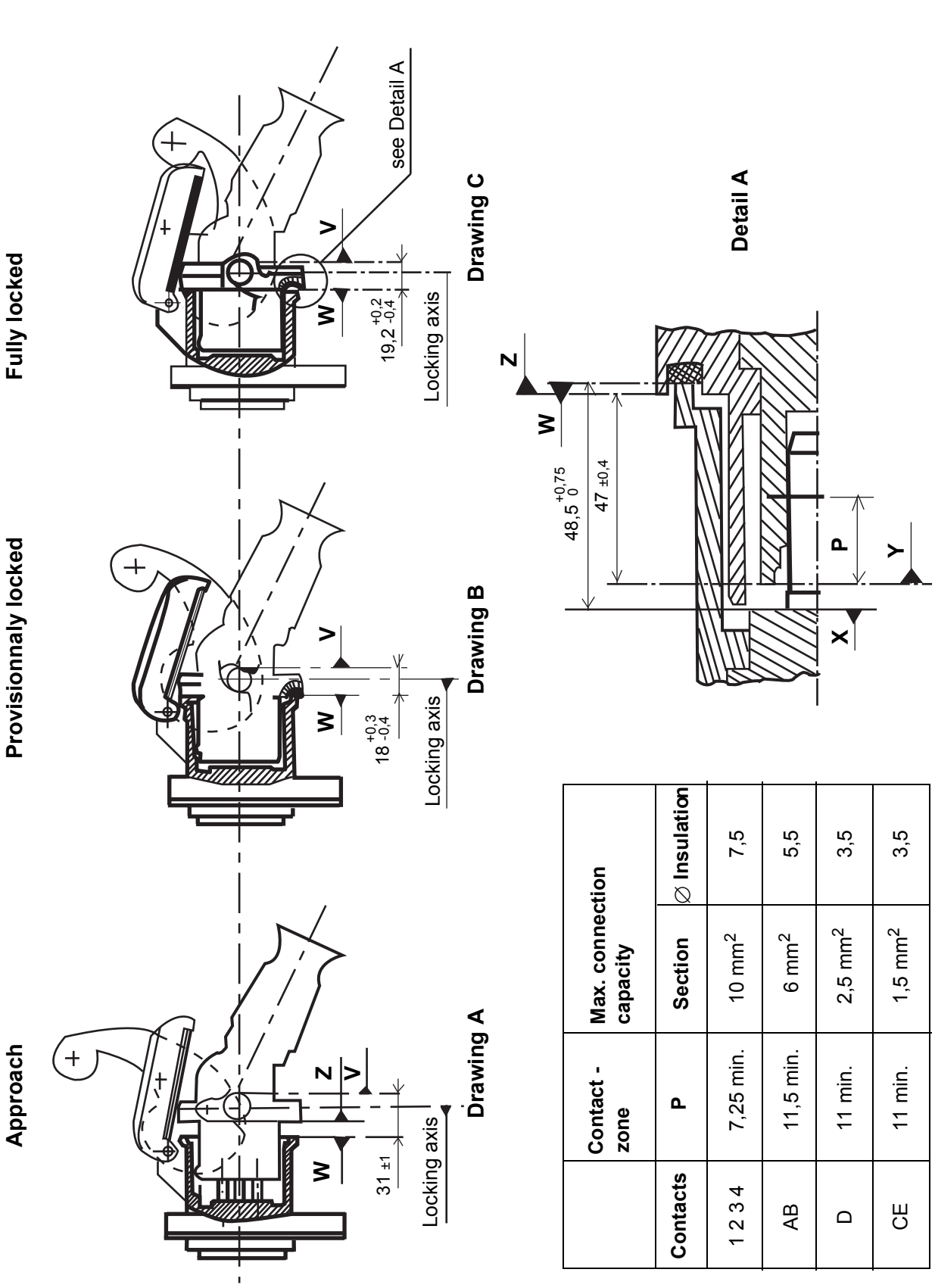


Fig. 2 - Coupler socket

Contact designations are: embossed on the front with reference X, colour print on the side facing the wiring.



	Contact - zone	Max. connection capacity	
Contacts	P	Section	∅ Insulation
1 2 3 4	7,25 min.	10 mm²	7,5
AB	11,5 min.	6 mm²	5,5
D	11 min.	2,5 mm²	3,5
CE	11 min.	1,5 mm²	3,5

Fig. 3 - Coupling

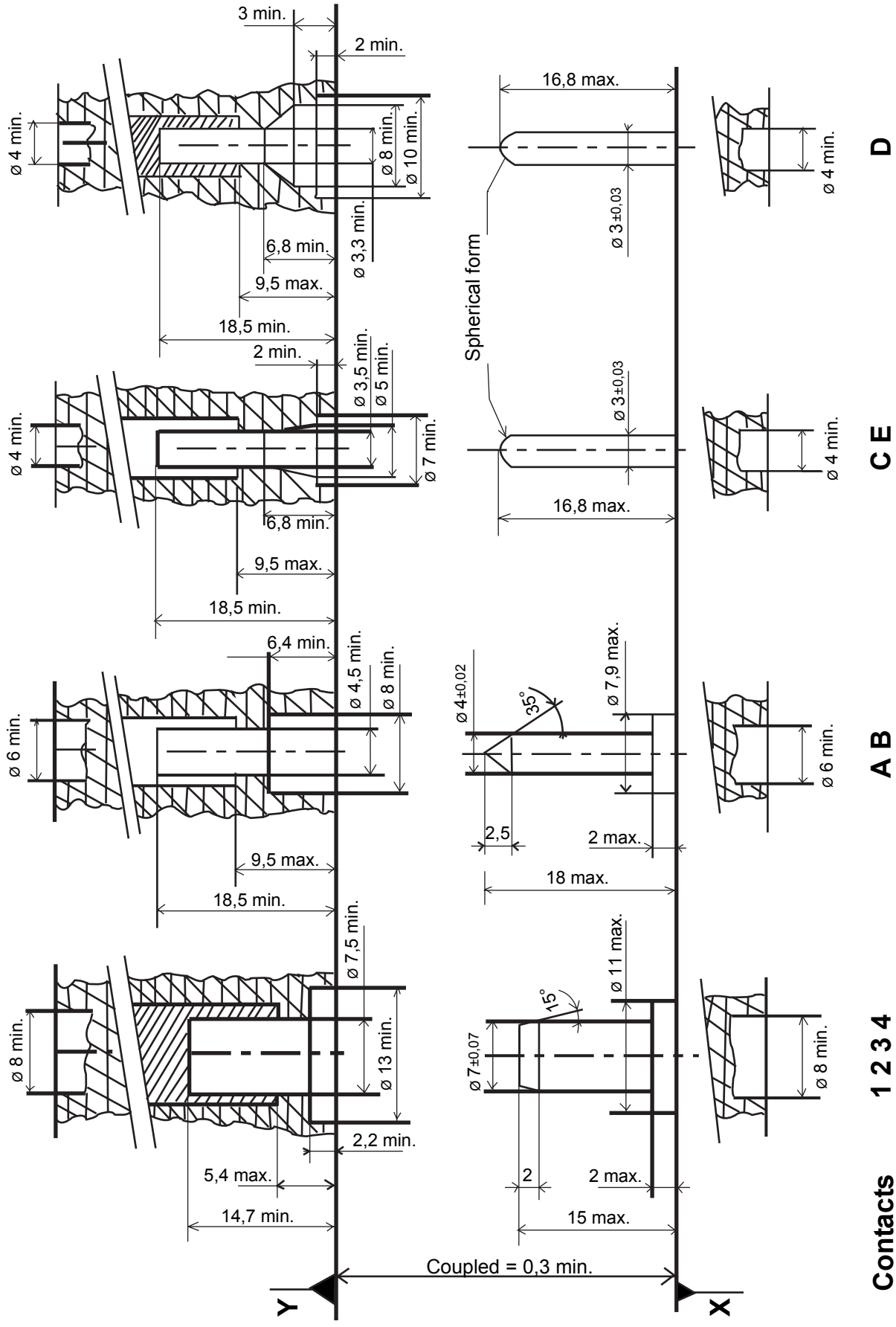
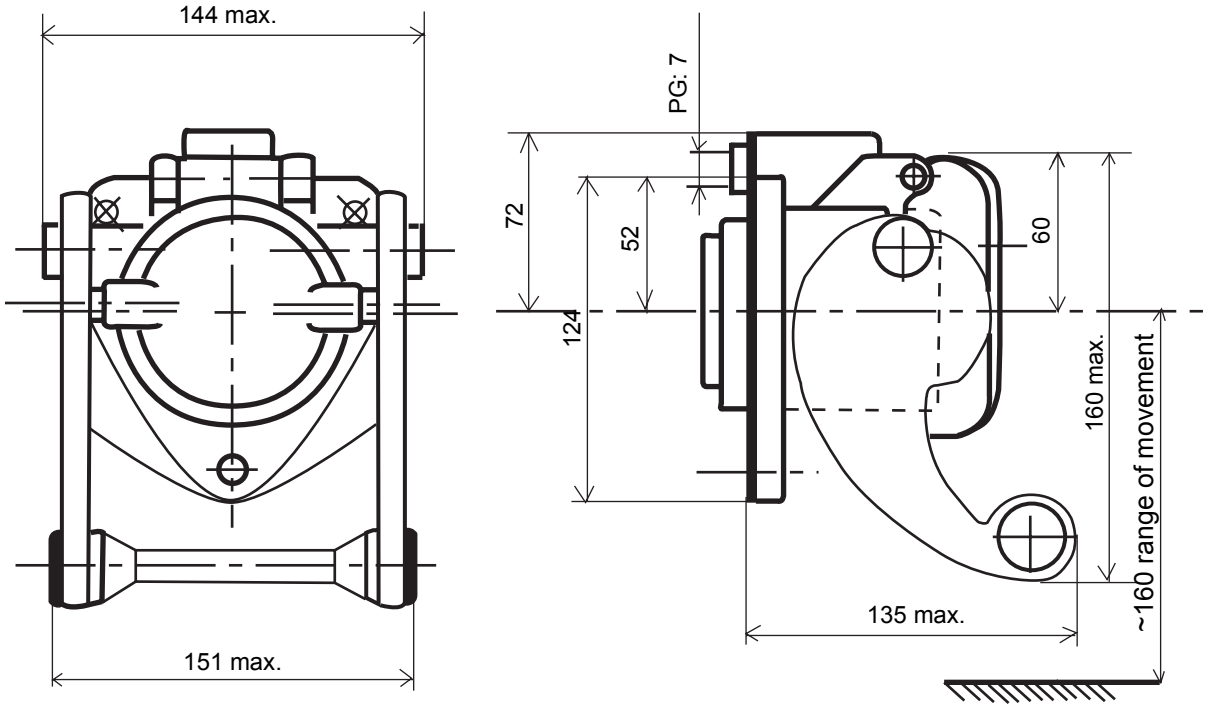


Fig. 4 - Contacts


144 max.
151 max.
PG: 7
72
52
124
60
160 max.
~160 range of movement
135 max.

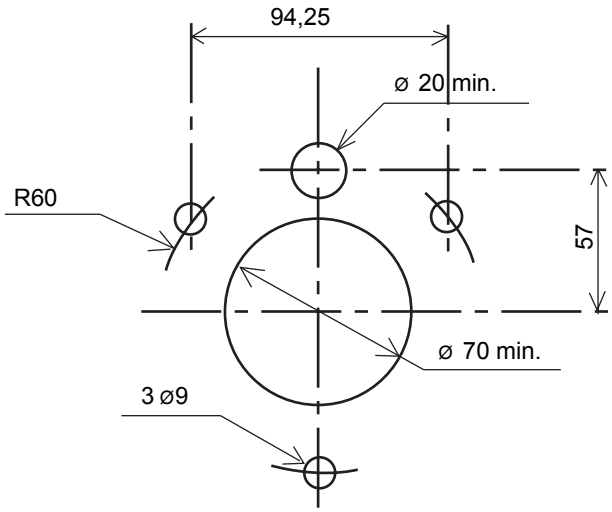
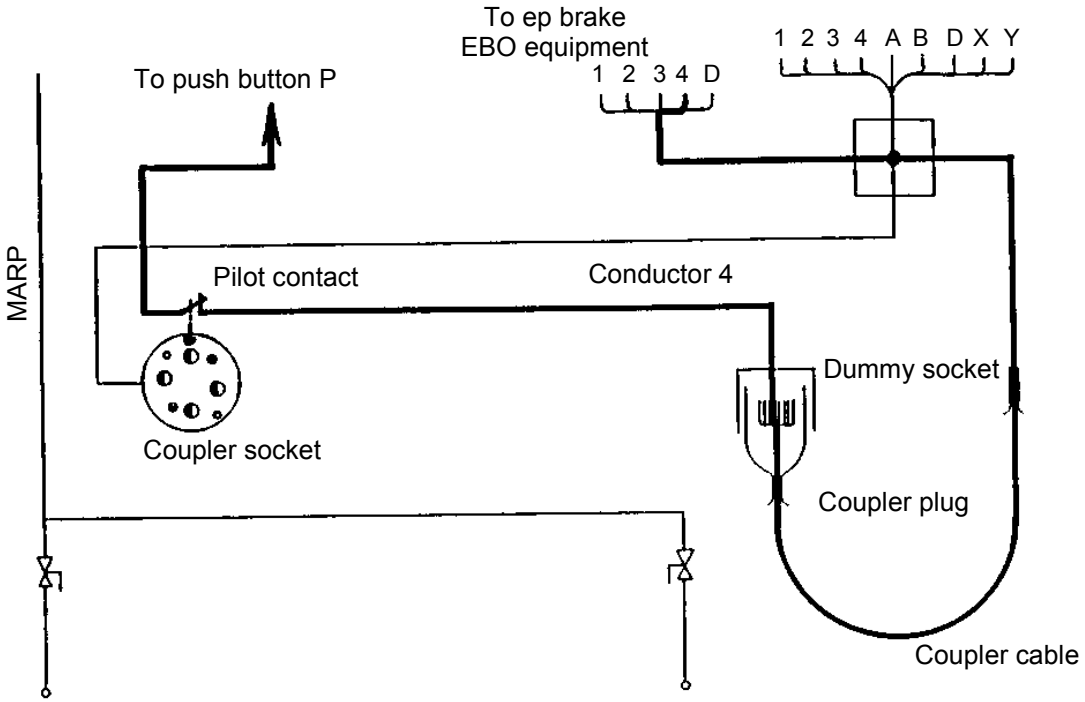

94,25
ø 20 min.
R60
57
ø 70 min.
3 ø9

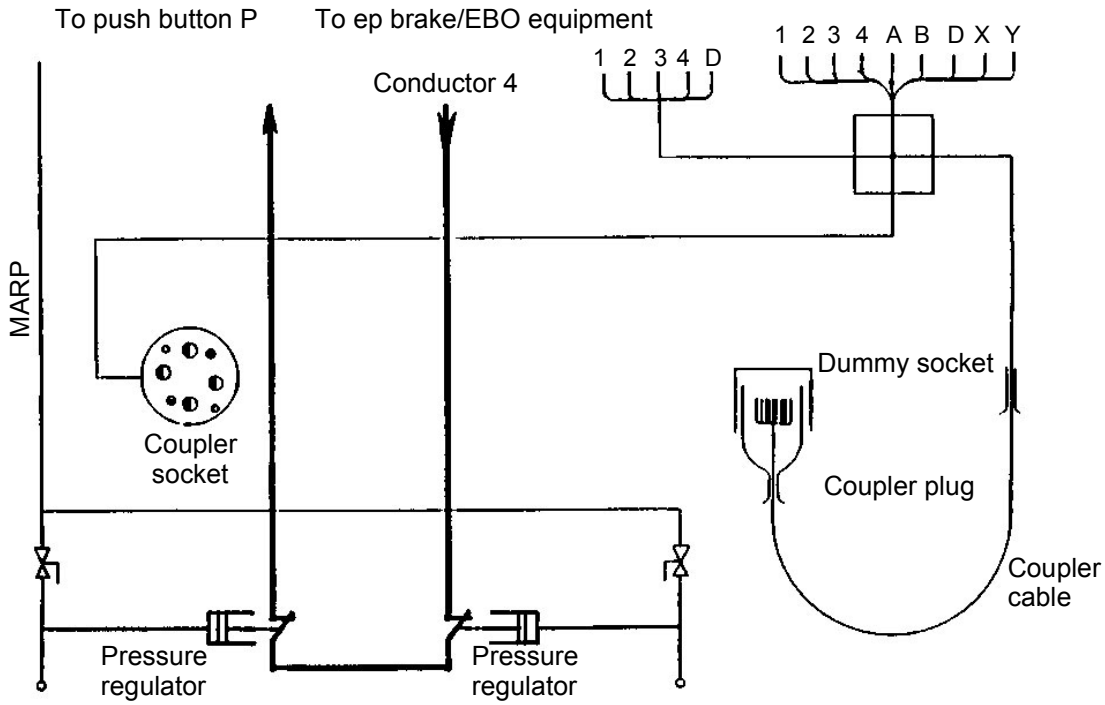
Fig. 5 - Holes

Appendix I - Monitoring of the end-of-train contact - Principles

End-of-train contact realised through pilot contact

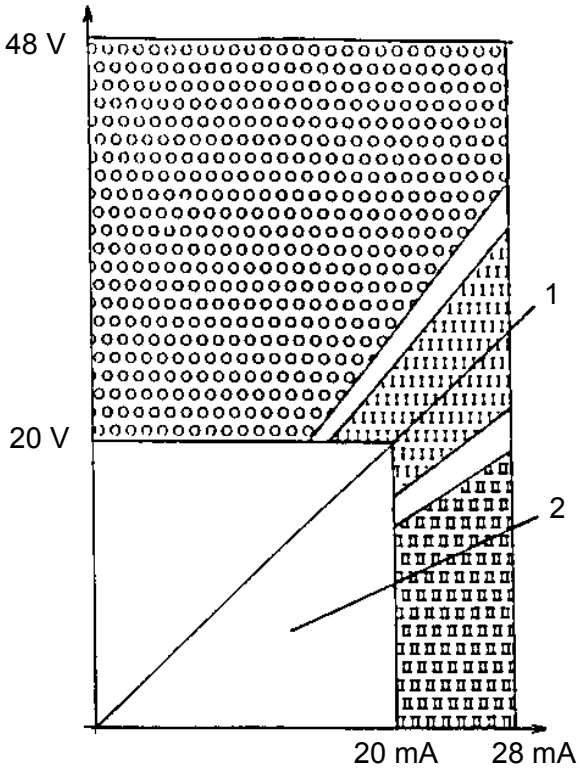


End-of-train contact realised through manostats



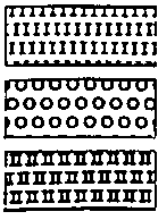
Appendix J - Characteristics of ep brake and EBO monitoring equipment

J.1 - Diagram of monitoring of ep brake loop



Situation 1:
1 000 Ω resistance for one end-of-train contact. Normal situation

Situation 2:
500 Ω resistance for two end-of-train contacts

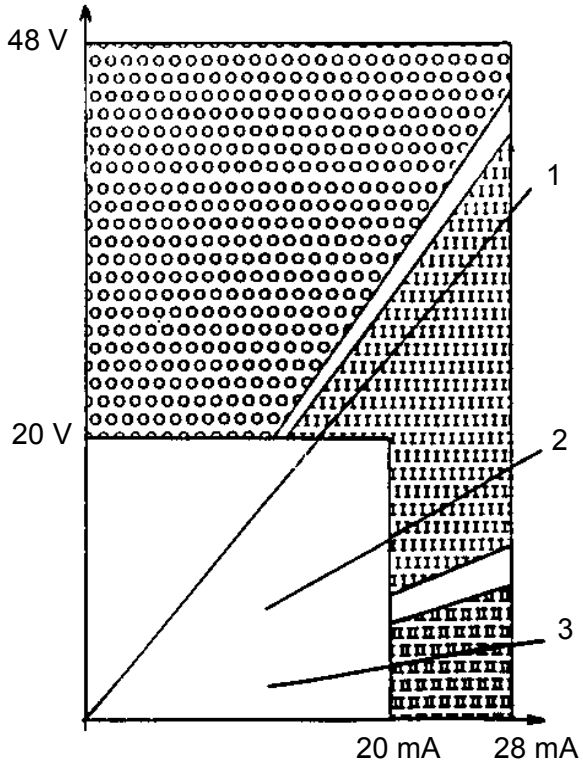


Normal

Fault, interruption

Fault, two end-of-train contacts or short circuit

J.2 - Diagram of monitoring of EBO loop



Situation 1:
1 300 Ω resistance for one end-of-train contact.
Normal situation

Situation 2:
650 Ω resistance for two end-of-train contacts

Situation 3:
Resistance with one end-of-train contact and an activated eme-gency alarm

Normal

Fault, interruption

Emergency alarm or short circuit

Appendix K - Elements of electropneumatic brake (ep brake) approved for international traffic

The list of the ep brake elements approved for international traffic can be found on the UIC website at http://www.uic.asso.fr.

Appendix L - Types of UIC standard coupler for the ep brake approved for international traffic

The list of UIC Standard ep brake coupler designs approved for international traffic can be found on the UIC website at http://www.uic.asso.fr.

Bibliography

1. UIC leaflets

International Union of Railways (UIC)
UIC Leaflet 453: Procedures for air brake tests effected with a powered unit - Provisions concerning international trains, 2nd edition, Juli 2001 (reissue)

UIC Leaflet 540: Brakes - Air Brakes for freight trains and passenger trains, 4th edition, June 2002

UIC Leaflet 541-03: Brakes - Regulations concerning manufacture of the different brake parts - Driver's brake valve, 1st edition of 1.1.84

UIC Leaflet 541-1: Brakes - Regulations concerning the design of brake components, 6th edition, November 2003

UIC Leaflet 541-2: Dimensions of hose connections (brake hoses) and electric cables; types of pneumatic and electric connections and their positioning on wagons and coaches equipped with automatic couplers of the UIC and OSJD Member Railways, 1st edition of 1.7.81 with 2 Amendments

UIC Leaflet 543: Brakes - Regulations governing the equipment of trailing stock, 12th edition, June 2003

UIC Leaflet 544-1: Brakes - Braking power, 4th edition, October 2004

UIC Leaflet 545: Brakes - Inscriptions, marks and signs, 7th edition, April 2002

UIC Leaflet 546: Brakes - High-power brakes for passenger trains, 5th edition of 1.1.67 - Reprint dated 01.01.80 with 5 Amendments

UIC Leaflet 547: Brakes - Air brake - Standard programme of tests, 4th edition of 1.7.89

UIC Leaflet 550: Power supply installations for passenger stock, 11th edition, April 2005

UIC Leaflet 550-1: Electrical switch cabinets on passenger stock, 1st edition of 1.1.90

UIC Leaflet 556: Information transmission in the train (train-bus), 4th edition, August 2005

UIC Leaflet 558: Remote control and data cable - Standard technical features for the equipping of RIC coaches, 1st edition of 1.1.96

UIC Leaflet 568: Loudspeaker and telephone systems in RIC coaches - Standard technical characteristics, 3rd edition of 1.1.96

UIC Leaflet 616: Rules for electric traction equipment, Withdrawn on 1.2.02

UIC Leaflet 648: Connections for electric cables and air pipes on headstocks of locomotives and driving trailers, 4th edition, September 2001 (reissue)

UIC Leaflet 651: Layout of driver's cabs in locomotives, railcars, multiple-unit trains and driving trailers, 4th edition, July 2002

UIC Leaflet 895: Technical specification for the supply of insulated electric cables for railway vehicles, 3rd edition of 1.7.76

2. Minutes of meetings

International Union of Railways (UIC)
Question 5TFIC - Revision of UIC leaflets. Revision of UIC Leaflet 541-5: Brakes - Electropneumatic brake for freight and passenger trains,

Question 5T45 - Modification and improvement of the alarm system in cases of emergency on international passenger trains,

Committee C5 Rolling Stock - Question 5TFIC - Approval of the 2nd edition of 1.1.1997, March 1996

Sub-Committee for Braking - Question 5/T/36 - Conditions for brake-gear approval. i) DB request for approval of UIC standard couplers in accordance with UIC Leaflet 541-5, for the EP brake - (without pilot contact) - manufactured by Litton Veam and Schaltbau, January 1997

3. ERRI reports

International Union of Railways (UIC)
ERRI B 180 / RP2: System for overriding the emergency brake - Emergency brake override systems (EBO) - Appendix 1: Requirements of the emergency brake override (electropneumatic system), February 1992

4. European standards

European Committee for Standardization (CEN)
EN 60529:1989 : Enclosure protection systems (IP Code) (IEC 529), 1989 (current version: 02/2001)

5. International standards

International Electrotechnical Commission (IEC)
IEC 228: Wiring of insulated cables and conduits, (current version IEC 60228:2004)

Warning

Printed by the International Union of Railways (UIC)
16, rue Jean Rey 75015 Paris - France, May 2006
Dépôt Légal May 2006

ISBN 2-7461-1025-3 (French version)
ISBN 2-7461-1026-1 (German version)
ISBN 2-7461-1027-X (English version)