Norske tog

APPENDIX A2-3

Description of Traction and Brakes Control Devices and Functionality of Driving Modes

29.06.2021

INDEX

Rev.04 2019-02-13 As used on Class 77

1. About this document

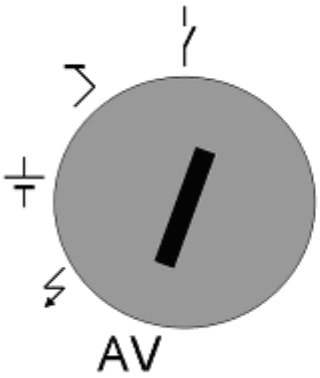
This document describes the main driver functionalities for moving, driving and braking of the latest Norwegian passenger trains. It also describes the main design and layout of the Type 74/75 driver's desk. Both the functions and layout are results of a continuous evolution based on experiences with numerous projects concerning the design of the man-machine interfaces on Norwegian trains.

It is a goal for Norske tog to standardize the train operation as much as possible both for safety reasons and for the ease and cost of educating onboard personnel. The description in this document is therefore to be understood as a specifying and leading guideline for the designing of new trains in addition to necessary Man-Machine-Interface analysis that has to be made for each new project.

2. Traction & Brakes – Main Control Devices for train movement

2.1. Key Switch (example type 74/75)

The types 74/75 have a separate key switch for activating and closing down the train. The key can only be physically removed when the selector is in position ‘AV’.



AV	Off
	Train radio on
	Control electronic on
	Pantograph up
	Close VCB’s

The key switch is mechanically interlocked with the master controller and the driving mode switch, so that the key switch can only be brought into the ‘AV’ position when the master controller is in position ‘VH’ and the driving mode switch is in position ‘PE’, ‘0’ or ‘M’. In ‘M’ the train will shut down the train control system and open the battery circuit. In ‘PE’ and ‘0’ the train enters a parking mode.

The key switch can be combined with the Driving Mode Selector Switch like on the EMUs type 70, 71, 72, 73 and 93. Also with a combined switch the key can only be physically removed when the selector is in position ‘0’.

2.2. Driving mode selector switch

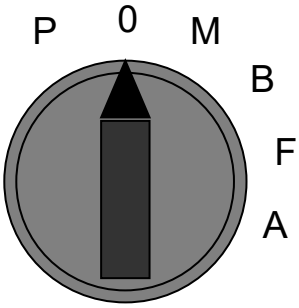
The driving mode is selected with a turning switch that also activates or deactivates the occupied drivers cab.

There is one parking mode ’P or PE’ and four different driving modes available ’M’, ’B’, ’F’ and ’A’. Together with the ’0’ position of the switch, this adds up to 6 possible switch positions. On the switch the modes are arranged in the following sequential order: P-0-M-B-F-A.

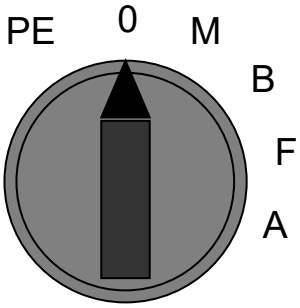
On the EMU types 70, 71, 72, 73 and 93, this switch is also the key switch. On these trains the key can only be physically removed when the selector is in position ‘0’. The types 74/75 have an additional key-switch (see previous chapter).

On Type 73 the parking mode is called 'P', on the 74/75 it is called 'PE' (E for economic).

Type 73



Type 74/75



P/PE Parking mode (driver’s desk deactivated and several systems closed down to save electrical power)

0 Driver’s desk deactivated and P-brake applied (also used while changing direction).

M Train activated and configurated.

B Manual reverse mode (traction controller gives 0-100% traction and 0-100% braking force).

F Manual forward mode (traction controller gives 0-100% traction and 0-100% braking force).

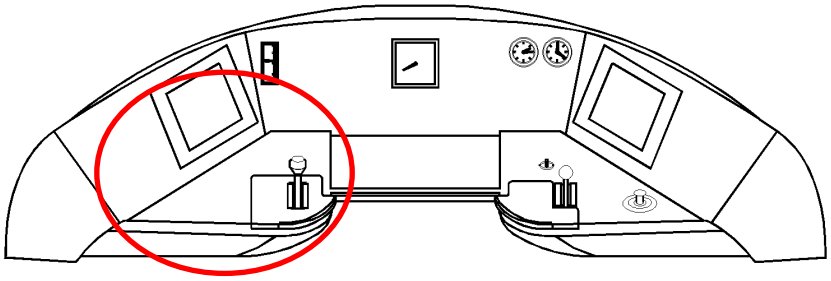
A Automatic (forward) mode (traction controller gives speed reference 0 to max speed).

The driver can switch from ‘A’ to ’F’ during driving. The master controller must then be passed through ‘FL’ /’0’ for a reset to regain traction power.

Shifting from ‘F’ to ‘A’ and between ‘B’ and ‘F’ can only be done at standstill.

A switch operation that is not accepted by the system will not lead to a changed control status, but will trigger a warning on the IDU about the illegal change that has been attempted. On 74/75 a traction interlock is activated in addition to the warning on the IDU.

The driving mode selector switch shall be placed on the left side of the driver in the area near the main controller (traction controller).



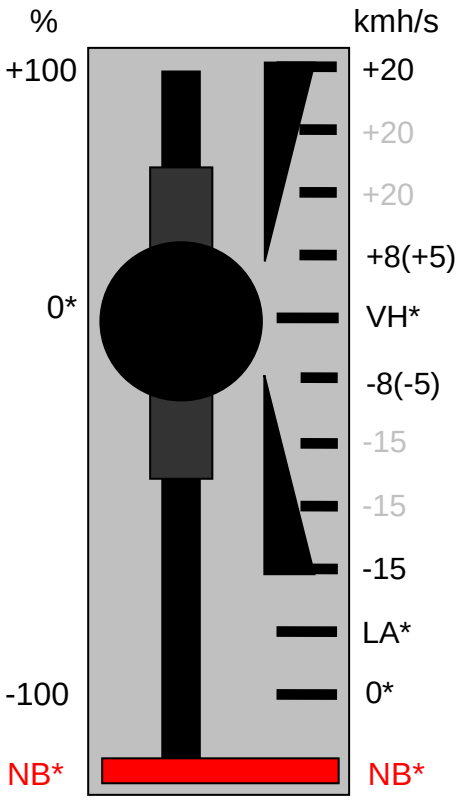
2.3. *Master controller (traction and speed controller)*

The master controller is the main controlling handle for moving the train and doing speed regulation. The current driving mode (selected with the driving mode selector above) decides its current functionality. It sets either the reference for the traction force from 0-100% and the dynamic brake force -100%-0, or it sets the target speed reference for automatic speed regulation.

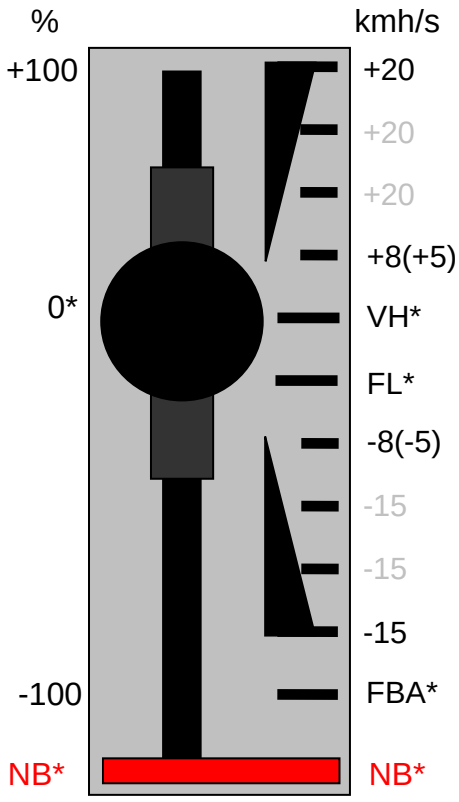
VH = Keep speed.
FL = Coast & deactivate/reactivate traction (only 74/75).
FBA = Full Brake Automatic (only 74/75).
LA = Release Automatic (only 73) includes functions in FBA (74/75).
0 = Deactivate/reactivate traction (only 73).
NB = Emergency brake

Positions with star (*) are notched positions.

Type 73



Types 74/75



Manual modes (B & F)
(left side picture text)
Traction force is increased by pushing the handle forwards from 'VH' position. Pulling the handle backwards from 'FL'(Types 74/75)/'VH'(Type 73) position increases the dynamic brake force (left side text). The analogue position of the handle directly resembles % utilization of the traction (or brake) force curve. The indicator on the traction force gauge follows the position.

Automatic mode (A)
(right side picture text)
Pushing the handle forwards increases the reference speed. Pulling the handle backwards reduces the reference speed. The position of the handle determines how quick the reference speed is changed per second. Near 'VH/FL' the reference speed changes slowly, and at end positions it is changed at a higher rate each second the handle is held in the position. Values in parenthesis are for train speeds lower than 20 km/h.

In position 'FL' (types 74/75) the train is coasting without traction and brake power, and the train speed is allowed to be controlled by the vertical curvature and train resistance. When going from 'FL' and to 'VH', the train will reactivate and maintain the old reference speed saved prior to entering the 'FL' position. Exception is when 'FL' is used for a needed reset of traction effort. In this case the current speed is the new reference speed.

In position 'FBA' ('LA' and '0' on 73) the Vref is set to 0 km/h, and the speed control applies full preset deceleration. If the lever is brought back into 'VH' before the train stops, the current speed is kept as speed reference.

On 73 the 'LA' position also is used for releasing the holding brakes if the train is at standstill. On 74/75 a separate button must be used for releasing the holding brake during brake test.

Holding brakes are applied when the train comes to a halt in automatic mode. The holding brakes are released when the achieved traction force has reached a certain level (12 kN on 73).

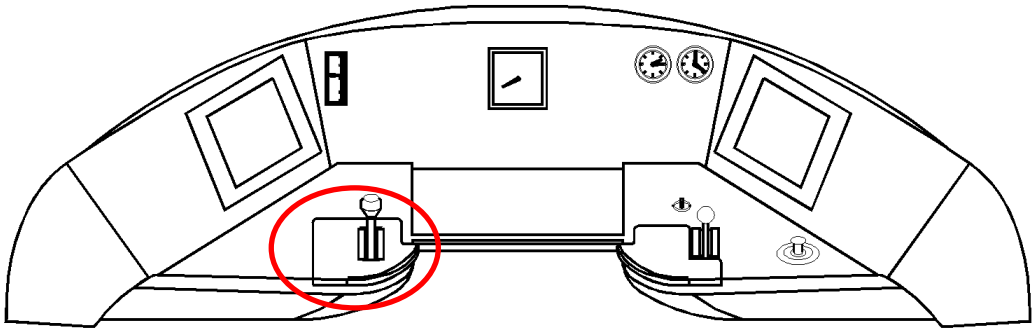
Automatic & Manual modes (B, F & A)
Position '0' on 73 and position 'FL' on 74/75 is the position for deactivating and resetting the traction power after an error and after Sifa or ATC/ETCS emergency braking. Also, when the driver's brake valve is released after a braking, the master controller must be put through the '0'/'FL' position to regain traction.

In position 'FL' the train is coasting in both automatic mode and manual mode.

In the backmost position ‘NB’ the master controller will in all modes activate the emergency brake loop. This will evacuate the main brake pipe (HL) via an electrically operated emergency brake valve.

If the driver’s brake valve requires a higher brake force than the master controller or the speed regulating system, the driver’s brake valve will be given precedence.

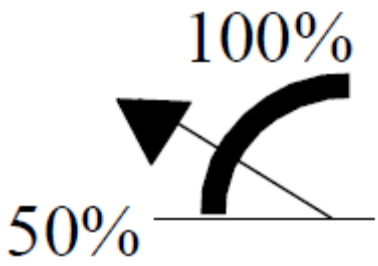
The master controller is placed on the left horizontal plane of the driver’s desk.



Coasting Function Solutions
The coasting on type 73 is activated by a push button near the master controller. On type 74/75 the coasting function is integrated in the master controller.

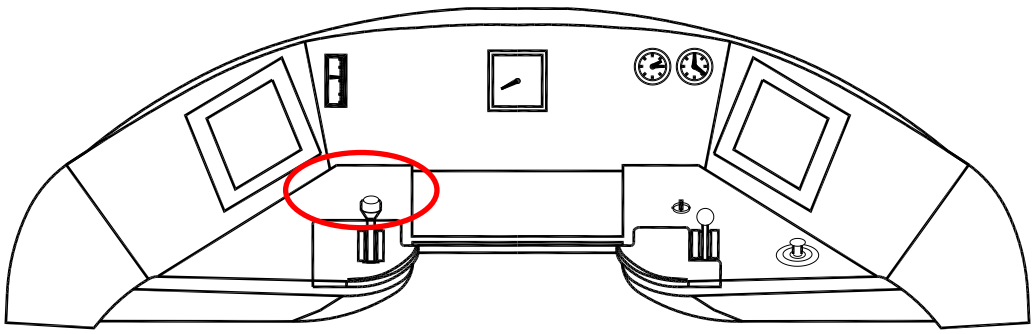
2.4. Maximum power limiting selector

The maximum power limiting selector is used when driving on locations where the catenary power net is weak, and the catenary voltage gets too low when maximal effect is drawn by the train. It has no effect on the utilization of the dynamic brake.



The selector is an analogue turning switch. The driver can select between 50% and 100%. The 100% level follows the speed-dependant traction curve at nominal catenary voltage, and the selection sets the percentage utilisation of the nominal curve.

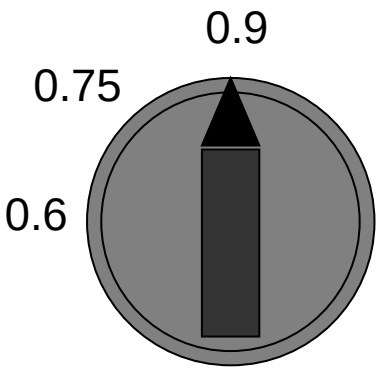
The maximum effect limiting selector is placed behind the main controller (seen from driver's seat).



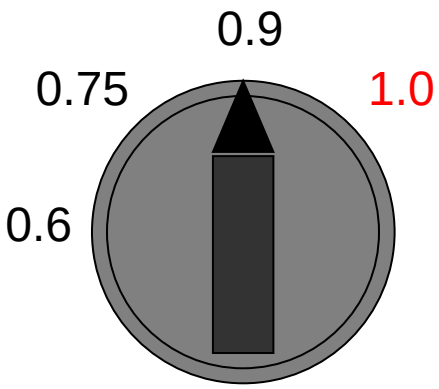
2.5. Maximum retardation limiting selector

The maximum retardation limiting selector sets the maximum retardation to be utilized by the brake blending system of the master controller (ED+EP) when the train is regulating the speed downwards in automatic speed mode. It has no effect on the blending system controlled by the brake handle (ED+HL) or when driving in manual mode.

Type 73



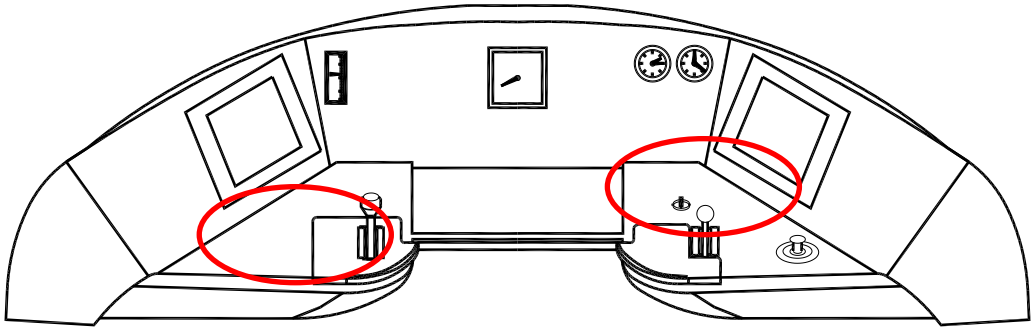
Types 74/75



Normally the switch is set to 0.9 m/s^2, but the system will only use this value when the speed reference is 0 km/h. As long as the target speed reference > 0km/h, the value 0.75 m/s^2 will be used in order to reduce the usage of mechanical brakes when braking from higher to medium speeds. When driving on slippery track where too much braking power could make the system overreact in automatic mode, the driver can select 0.75 m/s^2 or 0.6 m/s^2. In these cases the preselected value will be used both for target speed = 0 and for target speeds > 0. The selector works in steps and is not analogue. Types 74/75 have an additional position with 1.0 m/s^2, which applies the same rules for the 1.0 position as for the 0.9 position.

On types 74/75 the location of this switch is near the master controller on the left horizontal plane of the driver's desk. On 71, 72, 73, and 93 the switch is on the right horizontal plane.

NB! For future trains the 74/75 style and placement are preferred.



2.6. *Driver's brake handle*

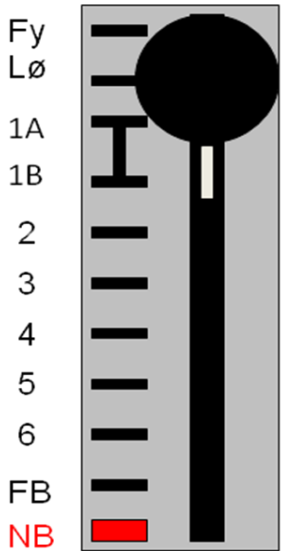
The driver's brake handle operates the automatic indirect train brakes by sending control signals to the drivers brake valve system that regulates the pressure in the main brake control pipe (HL) according to the functionality defined in UIC541-03.

On types 70 and 73 the handle is an electronic element that gives electrical signals to a Knorr HSM electronic driver's brake valve system with an analogue valve creating a pilot pressure for the RH3 relay valve that in turn lets the pressure in and out of the main brake pipe. The emergency position cuts the electrical emergency brake circuit and activates an electrical emergency brake valve.

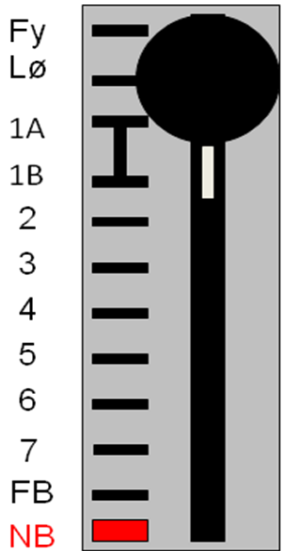
On 72, 92, 93, 74/75 the handle is pneumatic and produces the pilot pressure for the RH3 relay valve directly. The emergency position evacuates the main brake pipe directly.

The functionality of the drivers brake handle is independent of the master control mode. The blending functionality of the dynamic brake and the automatic train brake (ED+HL) is described in chapter: "Modes M, F, B and A – Drivers brake system" below. This blending function is not to be confused with the ED+EP blending that the master controller uses in automatic mode.

Types 72/73/93



Types 74/75

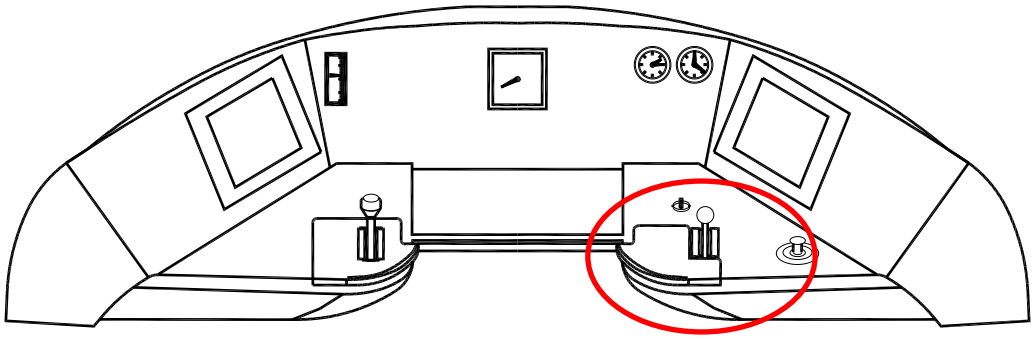


Fy	Filling position (if implemented)
Lø	Release position (driving position)
1A	First brake step (analogue step)
1B	End of analogue step
2-6(7)	Brakes steps 2 to 6(7)

FB	Full service brake	**NB**	Emergency brake position

On 74/75 all assimilation is controlled by a separate push button. On the other types there will be automatic assimilation when going from position 1A to FY.

On 74/75 after an emergency brake the brake pipe will not be filled again until the brake handle is shortly put through the Fy position. Alternatively, the push button for the assimilation can reactivate the filling for the brake pipe. The driver's brake handle is located on the right horizontal plane of the driver's desk.



3 Traction & Brakes - Driving Modes & Functionality

3.1 Mode P – Parking mode

Parking modes shall be designed for lowest possible energy consumption and lowest possible wear while keeping needed train functions active and protecting the train systems against frost.

Details and final functionality shall be defined in collaboration with NT during the design phase.

3.2 Mode 0 – Deactivated driver's desk mode

Parking brakes are automatically applied when entering this mode.

Details and final functionality shall be defined in collaboration with NT during the design phase.

3.3 Mode M – Activated & configurated mode

In mode M the driver´s desk is activated and vehicle composition is configured, but the traction is inhibited.

Details and final functionality shall be defined in collaboration with NT during the design phase.

3.4 Modes F and B - Manual mode forwards & backwards

In modes F and B, the acceleration and deceleration is controlled by setting the traction force and pure dynamic brake power by the main (traction) controller. The handle is moved forwards for 0 to 100% traction power and backwards for 0-100% dynamic brake power. This sets the percentage utilization of the momentary maximum traction or brake force available. At emergency shut off, emergency braking or traction cut off any positive traction force will be set to 0.

Mode 'B' is like mode 'F' but direction reference on the traction controller is inverted.

In modes 'F' and 'B' the limiting selectors for retardation has no function.

It is not allowed to switch between 'F' and 'B' during operation. The train must be at standstill.

3.5 Mode A - Automatic speed mode (ED+EP blending)

In this mode the target speed is selected by moving the main controller (traction handle) forwards for increasing the target speed and backwards for lowering the target speed.
The train system then automatically regulates to obtain and keep the set target speed by using traction and blending-brake.

Master controller in position 'VH':
Train automatically keeps the preset speed as long as no other action (like applying automatic brakes) overrides the speed regulation.

Master controller in position 'FL' (FriLøp = coasting):
Speed control is deactivated but selected speed reference is kept. When position 'FL' is left, the speed control is reactivated with the already set speed reference.

Master controller in position 'LA'(73)/'FBA(FLIRT)'
At standstill the holding brake is released in this position (only 73).
If the train is running, the speed reference is set to 0 km/h, and the train starts braking with the rules of the preset retardation.

For acceleration the trains use the traction system. The maximum traction force that the train uses for speed regulation is limited by the traction power limiting switch that regulates the maximum force between 50% and 100% of the speed dependant traction curve.

For deceleration the train uses the (ED+EP) brake blending system. The dynamic brakes are utilized to a maximum before EP brakes are added. On 73 the EP brakes are first added on the trailer bogies and finally on the motor bogies. On FLIRT the EP brakes are added uniformly on all bogies. The rate of deceleration is limited with the maximum retardation limiting switch.

When the difference between actual and wanted speed is less than 20 km/h only the dynamic brakes are applied.

If the driver's brake handle is set to a brake demand of step 2 or higher the automatic speed regulation is stopped and the train coasts until automatic brakes are released and speed regulation and traction power is reset.

Shortly before the train comes to a halt, a holding brake is automatically applied.

The driver is not allowed to switch from 'F' to 'A' during operation, but he can switch from 'A' to 'F'.

For full functionality of drivers brake system see chapter below.

3.6 Modes M, F, B and A – Driver's brake system (ED+HL blending)

The driver's brake handle together with the drivers brake system has the same functionality in all these modes. Hence the behaviour of the safety brake system does not change with changing driving modes.

In manual mode the driver's brake system is the only brake system in use.

In automatic mode the drivers brake system is used as an addon in those cases where driver needs to support and "beef up" the relatively low retardation rate of the ED+EP blending.

In position 'Lö' all brakes are released, and the train can use traction (or coast if no traction is set).

Service brake

Moving the brake lever into the service brake area (step 1 to 7) reduces the pressure in the brake pipe from 5.0 bar to 3.5 bar. Brakes are then applied equally on all bogies, but ED brakes are given priority on the motor bogies (not to be confused with ED+EP blending in automatic mode, where no mechanical brakes are applied before the dynamic brakes are fully utilized).

Service brake – Trailer bogies
On all trailer bogies the pressure from the distributor valve and relay valves is lead directly to the brake cylinders for brake activation.

Service brake – Motor bogies
On the motor bogies the dynamic brake (if available) is given priority (ED+HL blending). The reference for the wanted brake effort comes from a pressure sensor on the main brake pipe. A magnetic Cv-blocking valve with holding current closes the Cv pressure from the distributor valve so the bogie can be braked solely with dynamic brake. If the dynamic brake fails, or if the brake demand referenced by the pressure in the main brake pipe is higher than the brake force provided by the dynamic brakes, the holding current to the Cv-blocking valve is broken, and the already present Cv pressure from the distributor valve is lead to the cylinders via the relay valves. The maximum dynamic brake effort corresponds to the maximum brake effort that can be achieved by the pneumatic brakes.

The EP brakes shall not be activated through the driver's brake handle. The driver's brake handle shall only operate the indirect brakes together with the above described supervised use of dynamic brakes.

Emergency brake

Moving the brake lever in back position activates the emergency brake loop, and the control pressure of the main brake pipe (HL) is evacuated to a pressure below 2.5 bar.

The emergency loop cuts the current to the Cv-blocking valves so pneumatic brake is applied to all bogies.

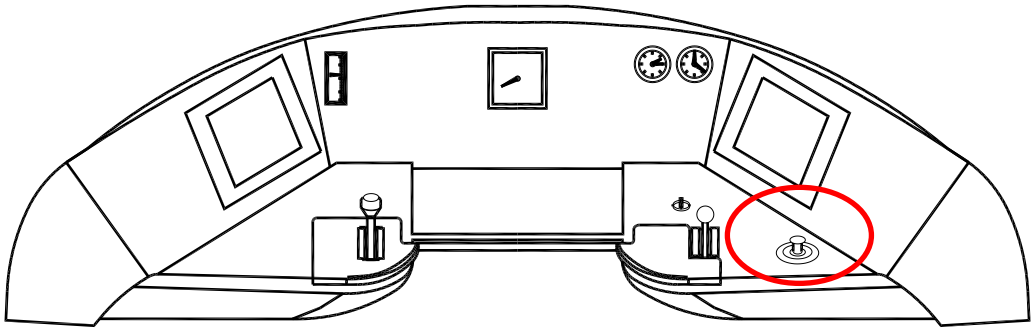
On the bogies with dynamic brakes the dynamic brake effort is limited to a smaller percentage of the momentaneous braking force applied by the pneumatic brake. On 73 this percentage is 25%, on the FLIRT it is 50%.

4 Traction & Brakes – Additional Control Devices

4.1 Driver's emergency brake mushroom button with electrical shut-off function

The mechanical part of this valve empties the automatic brake pipe (HL) and cuts the emergency brake loop. In addition, an electrical contact on the valve initiates the same functions as the electrical emergency stop mushroom button (main circuit breaker is opened, and the pantograph is rapidly dropped).

The emergency brake mushroom is placed on the right horizontal plane of the driver's desk at the right side of the main brake controller.

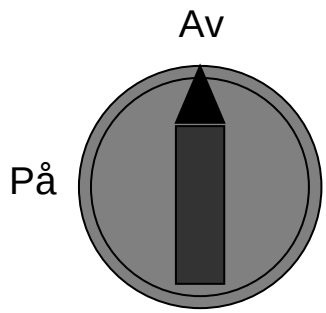


4.2 Magnetic track brake switch

In position ‘Av’ (normal position) the magnetic track brake is deactivated when the speed gets less than 10 km/h (UIC=20km/h), and it is not activated until speed is above 30 km/h (UIC=50km/h), and only when the emergency brake loop is active. When setting the turning switch in position ‘På’, the track brake is immediately activated regardless of emergency brake activation.

73: No speed limitations
When train is standing still the switch must be put into position ‘Av’ again to obtain traction force.

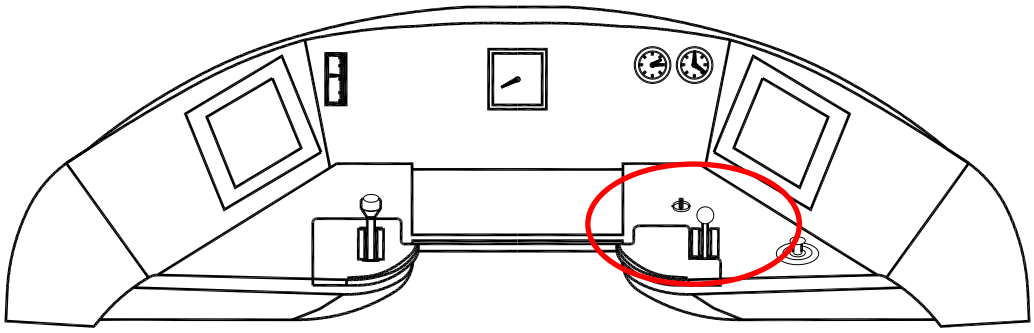
FLIRT: Speed must be > 5km/h
In standstill the track brake can only be lowered with separate button during brake test.



Av = Off

På = Activated

The switch for activation of the magnetic track brake is placed on the right horizontal plane of the driver’s desk near the brake controller.



4.3 Brake Assimilation Button

When hauling rolling stock with UIC brakes, this button is used to assimilate all distributor valves to the main pipe pressure of the leading trainset. Pressing the button makes the main pipe pressure rise above the 5.0 bar nominal pressure and slowly decrease to the normal pressure for the driver's brake system again.

4.4 Pressure Tightness Test Button

When doing a pressure tightness test this button stops the filling of the (HL) pipe so leakages can be measured over 5 min.

Main brake pipe (HL) tightness test can be done by the driver from any activated cab by a pressure button with two positions. The refilling of the main brake pipe pressure is blocked via a magnetic valve in the driver's brake valve system. It remains blocked until the button is returned by the driver, or until traction or brake demand is ordered. While blocked the driver can monitor the HL gauge for checking of any leakage on the main brake pipe. The activation and deactivation of the blocking is supervised by the master VCU, and if there is any discrepancy between wanted activation by the driver and real activation of the magnetic valve, a message is sent to the driver via the train diagnosis system.

4.5 Parking Brake Activation and Deactivation Buttons

APPLICATION
To apply the parking brake the activation button is pushed. On 73 the button flashes with the red colour during the activation procedure. When application time is out the light in the button remains lit.

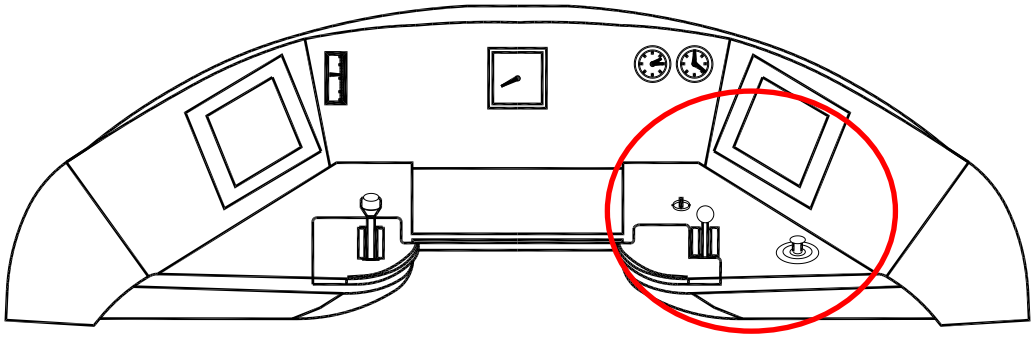
DEACTIVATION
To deactivate the parking brake the deactivation button is pushed. On 73 the button flashes with a different colour during the deactivation procedure. When deactivation time is out, the light in the button is unlit on 73 and remains lit on FLIRT.

If coupled trains have indifferent states of parking brakes the lamps should show this to the driver via a flash function.

4.6 ED-brake Deactivation Button

When the button is pressed the dynamic brake is deactivated. When pressed again the dynamic brake is activated again. As long as the dynamic brake remains deactivated, the lamp in the button is lit.

This button should be placed in the brake group near the brake controller near the right horizontal plane of the driver's desk.



4.7 Passenger Emergency Brake Override Button

When a passenger has pulled an emergency handle a red pushbutton is lit on the driver's desk. The driver must decide whether to intervene the process by pushing the button or not.

Type 73
The system is an emergency override system (NBÜ) where an emergency brake will always be initiated (by venting the HL pipe) when a passenger pulls a handle. The driver must in all cases decide whether to override the emergency brake or not.
The button is placed on the right side of the central vertical panel of the driver's desk.

Types 74/75
The system is an emergency brake request system (NBA) where the driver cannot override when the train is within a certain distance from standstill.
Button is placed in the middle of the central vertical panel of the driver's desk below the tachometer.

Future trains shall have the NBA system as on the types 74/75.

4.8 Pantograph Up and Down devices

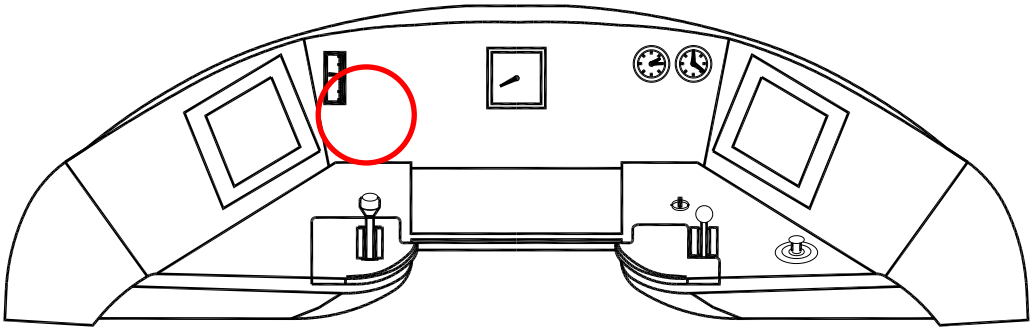
Type 73
Up and down movement of the pantograph is controlled with push buttons.

Types 74/75
Pantograph is controlled by the key switch.

4.9 Electrical emergency mushroom button with rapid pantograph drop function

When the electrical emergency stop mushroom is hit, traction converters are deactivated, the main circuit breaker is opened, and the pantograph is rapidly dropped. For this function there is an extra magnetic valve that vents the pneumatic circuit to the pantograph cylinders. The circuit then exhausts via a larger nozzle than the nozzle in the system for normal raising and lowering of the pantograph.

The locations of this button should be placed on the vertical front plane near the voltmeter for the catenary power.



4.10 Door operation buttons

The door operation buttons are placed on the right horizontal plane of the driver's desk at the right side of the main brake controller.

4.11 Departure indicator

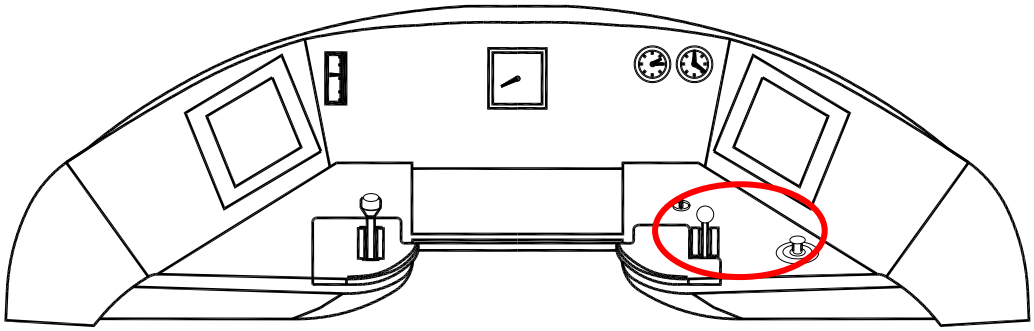
The indicator of the departure is located on the right horizontal plane of the driver's desk at the right side of the main brake controller.

4.12 Wiper washer switch

The switch to activate the wiper washer is located in the front right side of the main brake controller.

4.13 Switches and pushbuttons to control front and rear lights

The switches and pushbuttons to control front lights and rear lights are located on the right horizontal plane of the driver's desk at the right side of the main brake controller.



5 Traction & Brakes – Instruments and Gauges

5.1 Catenary Voltage Gauge

Type 73
A circular analogue meter in the middle of the central vertical panel shows the catenary voltage in kV.

Types 74/75
A vertical linear meter on the left side of the central vertical panel shows the catenary voltage in kV.

Other types of gauges or displays also may be considered.

5.2 Tractive Effort Gauge

Type 73
A circular analogue meter in the middle of the central vertical panel shows the traction force of the occupied train in kN.

Types 74/75
A vertical linear meter on the left side of the central vertical panel shows the traction force of the occupied train in kN.

Other types of gauges or displays may also be considered.

5.3 Tachometer

Tachometer is centrally placed on the driver's desk and shows the current train reference speed with a light arrow on black background. In addition, the reference speed for the automatic speed regulation is showed with an arrow on the outer edge of the instrument.

The tachometer functions will in the future be an integrated part of the ETCS DMI.

5.4 Pneumatic Gauges

There are two combined pneumatic gauges on the driver's desk.

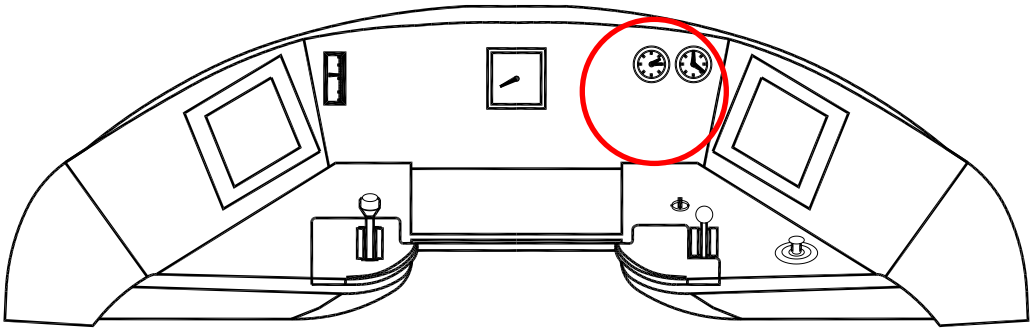
1 Combined analogue gauge for main brake pipe (HL) and main pressure pipe (HBL) with white indicator for HL and red indicator for HBL.

1 analogue gauge for cylinder pressure(s)
73: Combined gauge for C1 and C2 of the bogies of the leading car.
FLIRT: Simple gauge for C1 on end bogie of leading car.

Both gauges have black background with white text and night illumination. The HL/HBL gauge must have a design distinct from the C1/C2 gauge so it will be the first of the two instruments to catch the focus of the driver. On

some rolling stock this gauge is larger than the C1/C2 gauge to accommodate this.

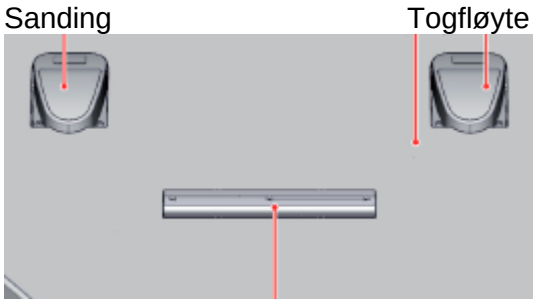
The gauges should be placed together near the right corner on the vertical front plane. If placed above each other, the HL/HBL is the topmost gauge. If placed side by side the HL/HBL is to be placed against the dashboard centre.



6 Foot Pedals

The driver shall have the possibility to operate the following functions with their feet:

- Drivers vigilance (SIFA) in the center and to be operated with both feet
- Sanding (Sanding) on the left side
- Horn (Togfløyte) on the right side



The foot pedals must be placed on a foot board with height adjustment for optimum ergonomics for drivers regardless of size.
There must be suitable provisions to warrant that gravel and other items can't be trapped and block the operations of the foot pedals.
It is emphasized that the SIFA foot pedal is used continuously and must be very robust.

7 Automatic Train Operation (ATO)

7.1 ATO

New train projects shall in its design foresee a possible future introduction of driverless trains.

The train control system and its interfaces shall make it possible to integrate ATO features on a later stage without changing hardware in the core control system of the train.

Tender documentation shall explain how the train builder will make preparations and design the train for future Automatic Train Operation.

7.2 Automated Supervised Driving

As an option Norske tog AS wants an offer on a driver assistant system that makes it possible to run the train from one station to another automated in supervised mode. The goal is to make it possible to optimize the train operation to save energy consumption and wear.

The tender should contain an overall description of how the train builder would realize such a system.