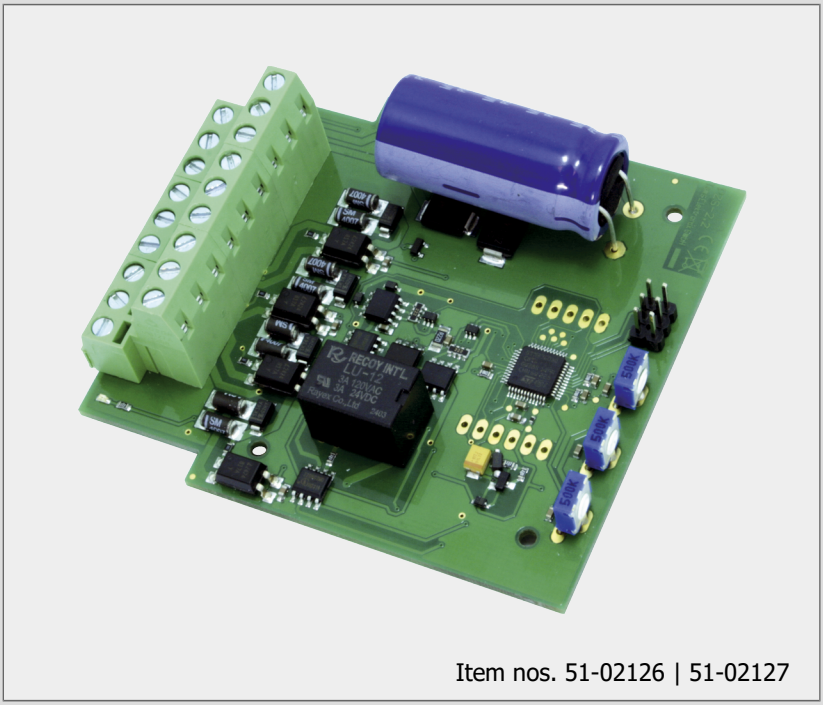
PZS-2.2

Shuttle-train control for analogue d.c. model railway layouts

Manual



Item nos. 51-02126 | 51-02127

tams elektronik

Contents

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Printing the manual

The formatting is optimised for double-sided printing. The standard page size is DIN A5. If you prefer a larger display, printing on DIN A4 is recommended.

1. Getting started

The instructions will help you step by step with the safe and proper installation and use of your shuttle-train control. Before you put the shuttle-train control into operation, read this manual completely, especially the safety instructions and the section on possible errors and their elimination. You will then know what you have to pay attention to and thus avoid errors that sometimes can only be rectified with a lot of effort.

Keep the instructions in a safe place so that you can restore functionality later in the event of any malfunctions. If you pass the shuttle-train control on to another person, also give the instructions with it.

1.1. Contents of the package

- 1 ready-built and tested circuit board PZS-2.2 (item no. 51-02126-01) or
  1 shuttle-train control PZS-2.2 in housing (item no. 51-02127-01)
- 3 jumpers

1.2. Accessories

Power supply

To supply the PZS-2.2 shuttle-train control system, the tracks of the shuttle section, the turnout and the connected signals, you need a model railway transformer or a power supply unit with a **fixed** output voltage. The output voltage must be sufficient to switch the turnout. Recommended output voltage:

Nominal size	Z	N/TT	H0	0, 1, 2
DC voltage	12 V	14–16 V	18–20 V	20–22 V
AC voltage	10 V	12 V	16 V	18 V

Connection cables

The use of stranded wire is recommended for making the connections. Stranded wires consist of several thin individual wires and are therefore more flexible than rigid wires with the same copper cross-section. Recommended cross-section: $\geq$ 0.25 mm² for all connections.

Stop diodes

To prevent the trains from driving beyond the end of the tracks in terminal stations, you can install stop diodes in the tracks. You can use Si all-purpose diodes 1N400x (x=2..7) for this (e.g. article no. 83-11200-10).

Push buttons

The circuit board has three switching inputs (stop, start, emergency stop) to which you can connect push buttons. Use push buttons with 1x normally open contact (e.g. item no. 84-5211x-10 or 84-5212x-05).

Turnout

For alternating operation with two trains, you must connect a turnout to terminal station A. You can directly connect a turnout with a double-coil drive or a motor-driven turnout. It is not possible to use a turnout with a servo drive.

1.3. Intended use

The shuttle-train control is intended for use in model railway layouts as specified in the instructions. Any other use is not in accordance with the intended use and will result in the loss of the warranty claim. Intended use also includes reading, understanding and following all parts of the instructions. The shuttle-train control is not intended to be connected or operated by children under the age of 14.

1.4. Safety instructions

Note:
The shuttle-train control contains integrated circuits (ICs). These are sensitive to electrostatic charging. Therefore, do not touch these components until you have "discharged" yourself. For this purpose, e.g. a grip on a radiator is sufficient.

Improper use and non-observance of the instructions can lead to incalculable hazards. Prevent these dangers by carrying out the following measures:

- Only use the shuttle-train control in closed, clean and dry rooms. Avoid moisture and splash water in the environment. After condensation has formed, wait two hours for acclimatisation before use.
- Disconnect the shuttle-train control from the power supply before carrying out wiring work.
- Supply the shuttle-train control only with extra-low voltage as specified in the technical data. Use only tested and approved transformers / power supply units.
- Only plug the mains plugs of transformers / power supply units into properly installed and fused earthed sockets.
- When making electrical connections, ensure that the cable cross-section is sufficient.
- Heating of the shuttle-train control during operation is normal and harmless.
- Do not expose the shuttle-train control to high ambient temperatures or direct sunlight. Observe the information on the maximum operating temperature in the technical data.
- Regularly check the operational safety of the shuttle-train control, e.g. for damage to the connection cables.
- If you notice damage or if malfunctions occur, disconnect the connection to the power supply immediately. Send the shuttle-train control in for inspection.

2. Function

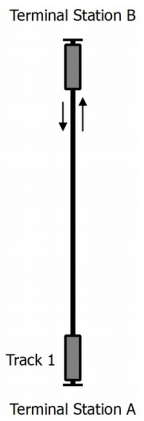
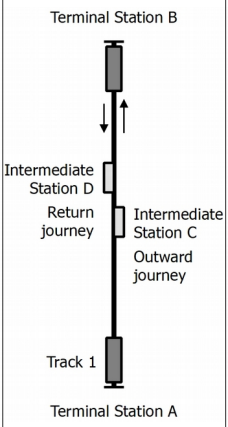
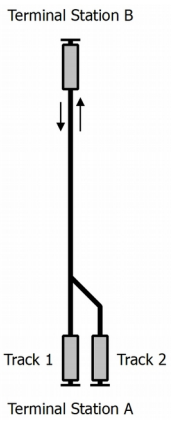
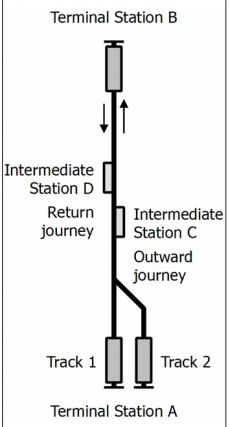
2.1. Versions of the shuttle-train line

The circuit controls the shuttle-train operation between two terminal stations of an analogue DC model railway layout. In the simplest version, the shuttle operation between the two terminal stations is carried out with one train.

Optional extensions

The shuttle-train line controlled by the PZS-2.2 can be extended by:

- Connecting a turnout and a second track at terminal station A. This makes it possible for two trains to operate in alternating shuttle service.
- Setting up an intermediate station for the journey from terminal station A to terminal station B ('outward journey').
- Setting up an intermediate station for the journey from terminal station B to terminal station A ('return journey').

Single-track terminal station A Operation with one train		**Double-track terminal station A** Alternating operation with two trains	
			
without intermediate stations	with intermediate station	without intermediate station	with intermediate stations

Individual additional stops

The shuttle-train control has two switch inputs ('Stop' and 'Start'). If they are briefly connected to ground, additional stops are triggered or terminated. These additional stops are independent of the automatic shuttle-train operation and can be triggered at any point on the shuttle-train line.

Buttons or external circuits that switch to ground can be connected to the inputs. Combinations with reed contacts, light barriers or complex controls are conceivable. This means that signal stops or additional stops can be controlled along the shuttle-train line.

2.2. Operation on the shuttle-train line

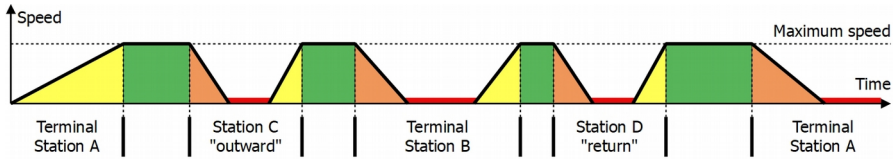
The shuttle-train operation between the terminal stations or the terminal stations and the intermediate stations is automatic. The braking of the locomotives in front of the terminal stations and the two intermediate stations is initiated as soon as a track occupancy detector, which is integrated in the module, reports the entry of a locomotive or another power consumer (e.g. an illuminated control car) into the relevant section of the line. The further process (braking, stopping and starting) is time-controlled. Between the phases of starting and braking, the locomotive travels at its set maximum speed.

The settings are made on trim potentiometers on the circuit board and are stored in an IC.

Settings for automatic control

The journey between the terminal stations or between the terminal stations and the intermediate stations each runs in four phases:

- **starting up** within the acceleration time set for the section and the locomotive
- **clear track** at the maximum speed set for the locomotive
- **braking** within the braking time set for the section and the locomotive
- **stopping** for the holding time set for the section and the locomotive



The lengths of the braking, stopping and starting phases are set:

- individually for terminal station A
- individually for terminal station B
- jointly for the two intermediate stations. The settings for the 'braking' and 'starting' phases at the two intermediate stations are adopted for the individual additional stops controlled by the switching inputs.

Shuttle operation with two trains

The PZS-2.2 automatically switches the turnout at terminal station A and the two trains run alternately on the shuttle section.

For operation with two locomotives, the maximum speed for 'clear track' and the length of the acceleration, braking and stopping phases are set separately for the terminal stations and intermediate stations for each of the two locomotives.

The settings are assigned to the two tracks at terminal station A when they are saved. The locomotives should therefore always start from the same track so that they run on the route with the settings stored for them.

2.3. Additional connection options

Emergency stop

With a short ground pulse (e.g. with a pushbutton) at the 'Emergency Stop' input of the PZS-2.2, operation on the shuttle-train line is stopped immediately without brake delay. The emergency stop is terminated as soon as the 'Start' input is briefly connected to ground.

Control of signals

The PZS-2.2 has connections for a two-aspect light signal. The display automatically changes between 'Proceed' and 'Stop' when a train enters one of the two terminal stations. With the appropriate assignment of connections, you can control light signals for both directions of travel.

When operating with two trains, wing signals with double-coil drives for the two tracks at terminal station A can be connected in parallel to the turnout at terminal station A.

2.4. Overcurrent protection

In the event of an overload or short circuit on the track, the PZS-2.2 automatically switches off to protect the circuit, tracks and vehicles from damage. Before shuttle operation can be resumed, the PZS-2.2 must be switched off and then back on again.

3. Connecting the shuttle-train control

Electrically isolate the shuttle-train line from the layout!

The shuttle-train line must be completely electrically isolated from the rest of the layout. If there is an electrical connection to parts of the rest of the layout, the PZS-2.2 can be irreparably damaged by equalising currents.

Remove the interference suppression capacitors!

Remove any interference suppression capacitors that may be present on the tracks of the shuttle-train line. These can cause massive disruptions to operations.

3.1. Dividing the shuttle-train line into sections

The stops at the terminal stations and the two intermediate stations are triggered after a train has entered the associated route section **and the** track occupancy detector integrated in the PZS-2.2 has detected the entry of the locomotive or another power consumer (e.g. an illuminated control car). To define a new section, you have to cut a rail where the braking phase is to begin.

You must divide the shuttle-train line into sections as follows:

- at least: terminal station A and terminal station B
- optional: additional (second) track at terminal station A
- optional: intermediate station C and/or intermediate station D

Divide the route sections in such a way that the complete trains come to a stop within the sections. Between the terminal stations and the intermediate stations there is a section of 'clear track' in which the locomotive runs at the set maximum speed.

Execution of the separation points

Always execute the separation points very carefully. It is recommended to check the separation points with a multimeter before commissioning.

Do not bridge the separation points!

If an separation point is bridged (e.g. by displacing the tracks or with metal shavings), the PZS-2.2 will not detect the entry of a train into a section and cannot control the shuttle-train operation as intended. If the entry into a terminal station is not detected, the train will not be braked. **Risk of damage to vehicles!**

The following generally applies when executing the separation points:

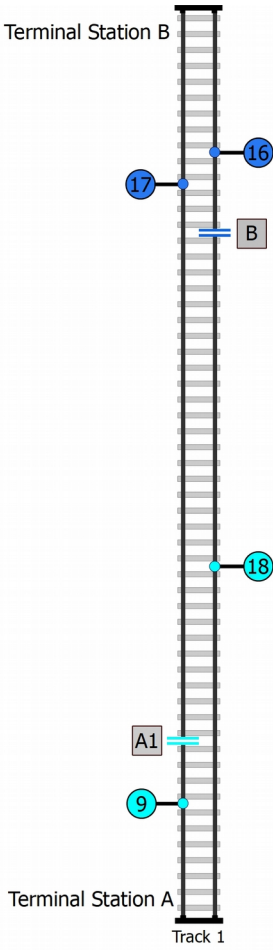
- 2-rail layouts according to NEM 631 (= standard), where the right rail in the direction of traffic is positive: In these layouts, the right rail in the direction of traffic must be isolated to define a new section (→ Section 3.2).
- 2-rail layouts that deviate from NEM 631 (= special case, e.g. LGB), where the left rail in the direction of traffic is positive. For these layouts, the left rail in the direction of traffic must be isolated to define a new section (→ section 3.3).

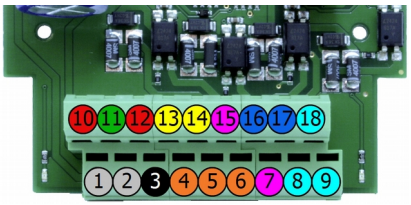
Please note that different wiring diagrams are provided in the instructions for the two variants (according to NEM 631 and deviating from NEM 631).

3.2. Layouts according to NEM 631

3.2.1. Single-track terminal station A | without intermediate stations

according to NEM 631



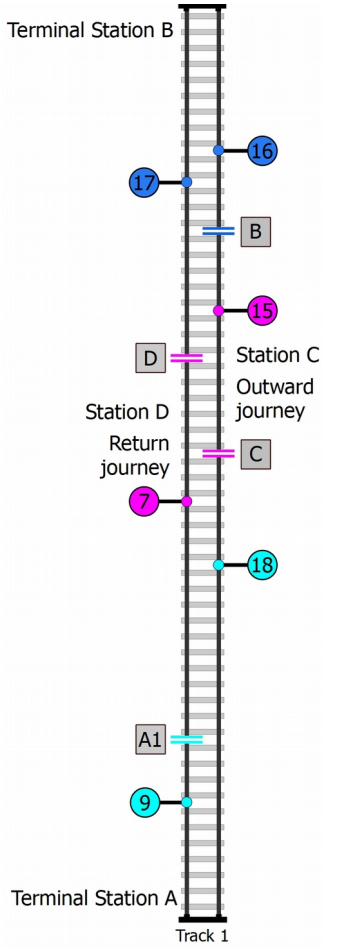


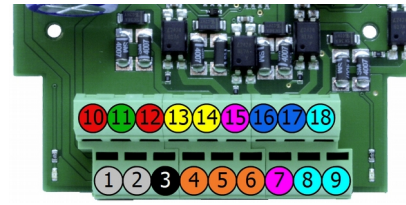
			Seperation point
1	Supply voltage	X	
2	Supply voltage	X	
3	GND / Return conductor for button	O	
4	Turnout	---	
5	Turnout with double coil drive (+) / Return conductor for light signals	---	
6	Turnout	---	
7	Intermediate station D for return journey	---	
8	Terminal station A, track 2	---	
9	Terminal station A, track 1	X	A1
10	Stop	O	
11	Start	O	
12	Emergency stop	O	
13	Light signal position 1	O	
14	Light signal position 2	O	
15	Intermediate station C for outward journey	---	
16	Terminal station B	X	B
17	Terminal station B	X	B
18	Terminal station A	X	A1

X = required | O = optional | --- not applicable to this connection variant

3.2.2. Single-track terminal station A | with intermediate stations

according to NEM 631



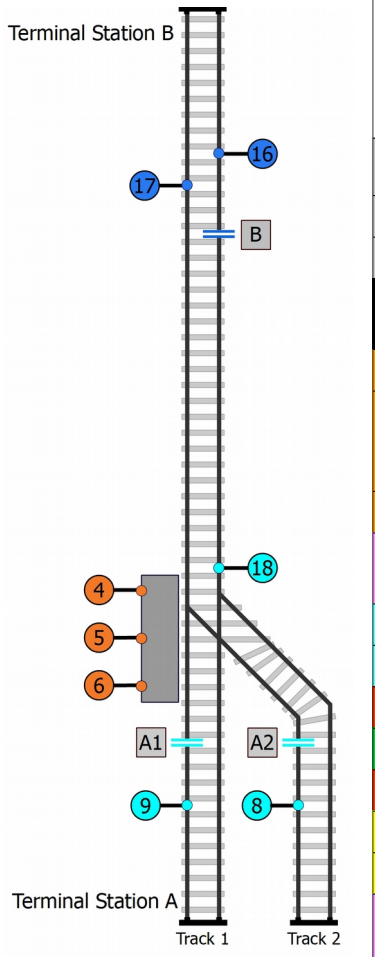


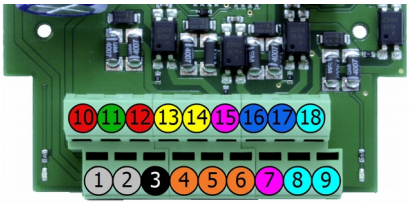
			Seperation point
1	Supply voltage	X	
2	Supply voltage	X	
3	GND / Return conductor for button	O	
4	Turnout	---	
5	Turnout with double coil drive (+) / Return conductor for light signals	---	
6	Turnout	---	
7	Intermediate station D for return journey	X	D
8	Terminal station A, track 2	---	
9	Terminal station A, track 1	X	A1
10	Stop	O	
11	Start	O	
12	Emergency stop	O	
13	Light signal position 1	O	
14	Light signal position 2	O	
15	Intermediate station C for outward journey	X	C
16	Terminal station B	X	B
17	Terminal station B	X	B
18	Terminal station A	X	A1

X = required | O = optional | --- not applicable to this connection variant

3.2.3. Double-track terminal station A | without intermediate stations

according to NEM 631



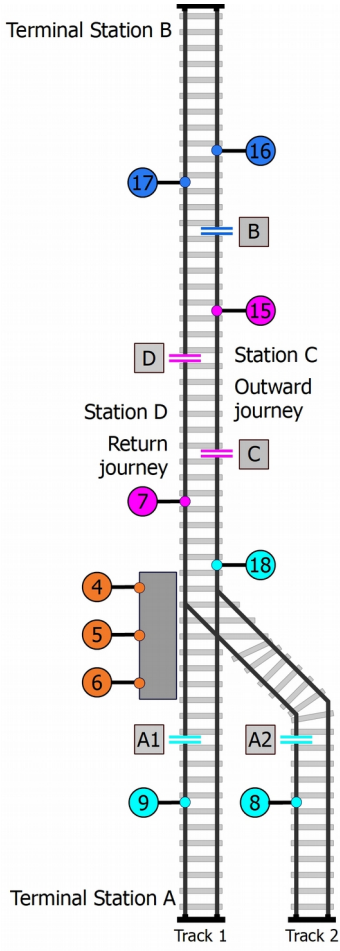


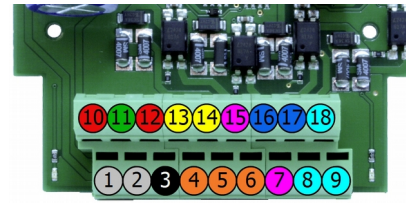
			Seperation point
1	Supply voltage	X	
2	Supply voltage	X	
3	GND / Return conductor for button	O	
4	Turnout	X	
5	Turnout with double coil drive (+) / Return conductor for light signals	X*	
6	Turnout	X	
7	Intermediate station D for return journey	---	
8	Terminal station A, track 2	X	A2
9	Terminal station A, track 1	X	A1
10	Stop	O	
11	Start	O	
12	Emergency stop	O	
13	Light signal position 1	O	
14	Light signal position 2	O	
15	Intermediate station C for outward journey	---	
16	Terminal station B	X	B
17	Terminal station B	X	B
18	Terminal station A	X	A1/A2

X = required | O = optional | --- not applicable to this connection variant
X* is not applicable to a motor-driven turnout (→ section 3.5)

3.2.4. Double-track terminal station A | with intermediate stations

according to NEM 631





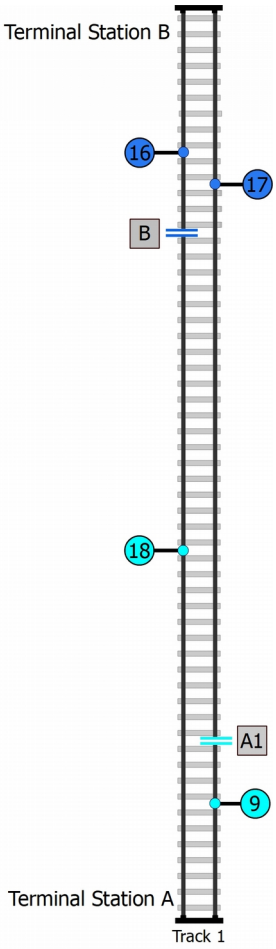
			Seperation point
1	Supply voltage	X	
2	Supply voltage	X	
3	GND / Return conductor for button	O	
4	Turnout	X	
5	Turnout with double coil drive (+) / Return conductor for light signals	X*	
6	Turnout	X	
7	Intermediate station D for return journey	X	D
8	Terminal station A, track 2	X	A2
9	Terminal station A, track 1	X	A1
10	Stop	O	
11	Start	O	
12	Emergency stop	O	
13	Light signal position 1	O	
14	Light signal position 2	O	
15	Intermediate station C for outward journey	X	C
16	Terminal station B	X	B
17	Terminal station B	X	B
18	Terminal station A	X	A1/A2

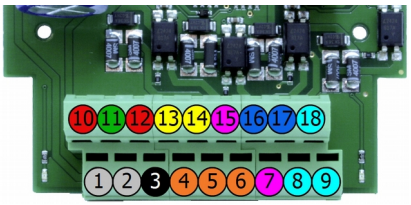
X = required | O = optional | --- not applicable to this connection variant
X* is not applicable to a motor-driven turnout (→ section 3.5)

3.3. Layouts not conforming to NEM 631

3.3.1. Single-track terminal station A | without intermediate stations

not conforming to NEM 631



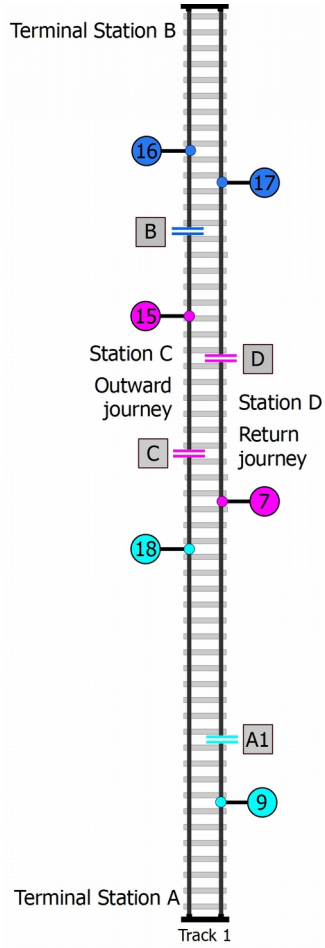


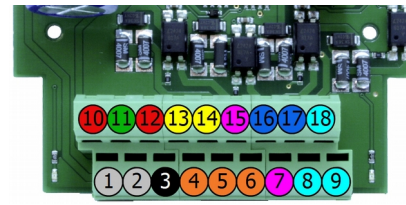
			Seperation point
1	Supply voltage	X	
2	Supply voltage	X	
3	GND / Return conductor for button	O	
4	Turnout	---	
5	Turnout with double coil drive (+) / Return conductor for light signals	---	
6	Turnout	---	
7	Intermediate station D for return journey	---	
8	Terminal station A, track 2	---	
9	Terminal station A, track 1	X	A1
10	Stop	O	
11	Start	O	
12	Emergency stop	O	
13	Light signal position 1	O	
14	Light signal position 2	O	
15	Intermediate station C for outward journey	---	
16	Terminal station B	X	B
17	Terminal station B	X	B
18	Terminal station A	X	A1

X = required | O = optional | --- not applicable to this connection variant

3.3.2. Single-track terminal station A | with intermediate stations

not conforming to NEM 631



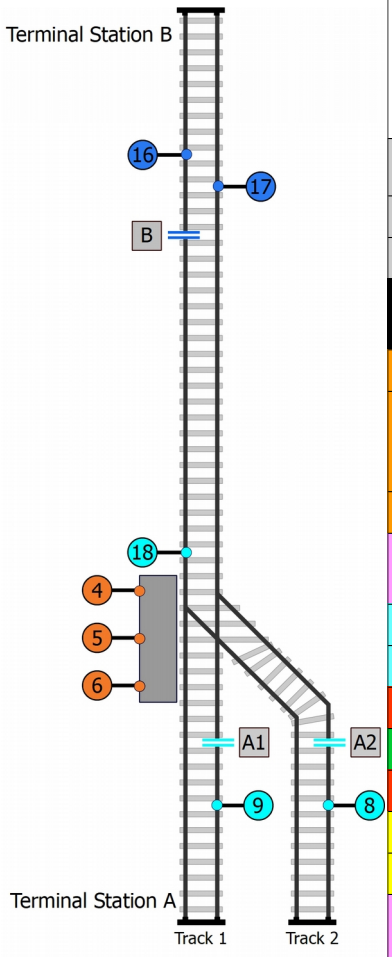


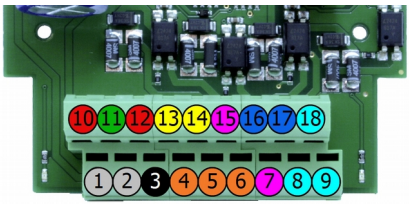
			Seperation point
1	Supply voltage	X	
2	Supply voltage	X	
3	GND / Return conductor for button	O	
4	Turnout	---	
5	Turnout with double coil drive (+) / Return conductor for light signals	---	
6	Turnout	---	
7	Intermediate station D for return journey	X	D
8	Terminal station A, track 2	---	
9	Terminal station A, track 1	X	A1
10	Stop	O	
11	Start	O	
12	Emergency stop	O	
13	Light signal position 1	O	
14	Light signal position 2	O	
15	Intermediate station C for outward journey	X	C
16	Terminal station B	X	B
17	Terminal station B	X	B
18	Terminal station A	X	A1

X = required | O = optional | --- not applicable to this connection variant

3.3.3. Double-track terminal station A | without intermediate stations

not conforming to NEM 631



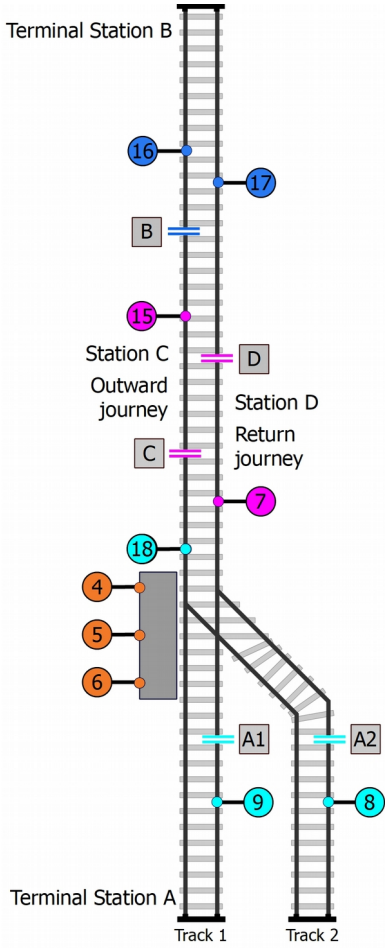


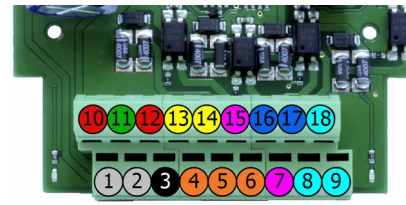
			Seperation point
1	Supply voltage	X	
2	Supply voltage	X	
3	GND / Return conductor for button	O	
4	Turnout	X	
5	Turnout with double coil drive (+) / Return conductor for light signals	X*	
6	Turnout	X	
7	Intermediate station D for return journey	---	
8	Terminal station A, track 2	X	A2
9	Terminal station A, track 1	X	A1
10	Stop	O	
11	Start	O	
12	Emergency stop	O	
13	Light signal position 1	O	
14	Light signal position 2	O	
15	Intermediate station C for outward journey	---	
16	Terminal station B	X	B
17	Terminal station B	X	B
18	Terminal station A	X	A1/A2

X = required | O = optional | --- not applicable to this connection variant
X* is not applicable to a motor-driven turnout (→ section 3.5)

3.3.4. Double-track terminal station A | with intermediate stations

not conforming to NEM 631





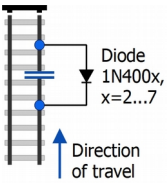
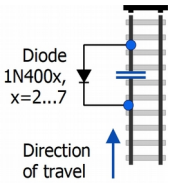
			Seperation point
1	Supply voltage	X	
2	Supply voltage	X	
3	GND / Return conductor for button	O	
4	Turnout	X	
5	Turnout with double coil drive (+) / Return conductor for light signals	X*	
6	Turnout	X	
7	Intermediate station D for return journey	X	D
8	Terminal station A, track 2	X	A2
9	Terminal station A, track 1	X	A1
10	Stop	O	
11	Start	O	
12	Emergency stop	O	
13	Light signal position 1	O	
14	Light signal position 2	O	
15	Intermediate station C for outward journey	X	C
16	Terminal station B	X	B
17	Terminal station B	X	B
18	Terminal station A	X	A1/A2

X = required | O = optional | --- not applicable to this connection variant
X* is not applicable to a motor-driven turnout (→ section 3.5)

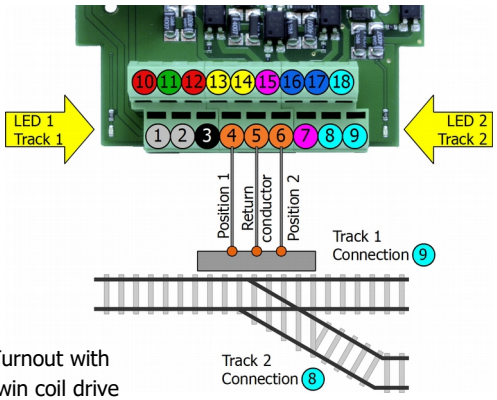
3.4. Connecting stop diodes

To prevent the trains from travelling beyond the end of the tracks in the terminal stations, it is advisable to install additional stop diodes in the tracks.

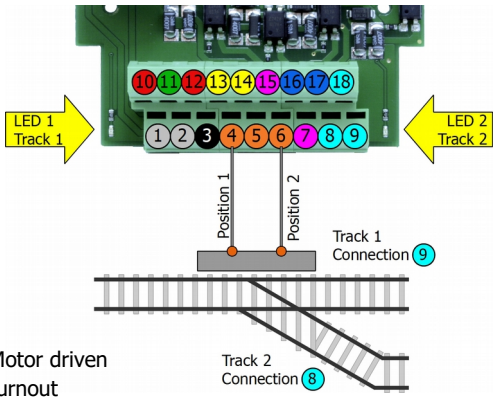
Connect the diodes (e.g. Si all-purpose diodes 1N400x, x=2...7) according to the drawings. Design the separation point so that all current collectors driving the motor have crossed the separation point before the train reaches the end of the track.

Layout according to NEM 631	
Layout not conforming to NEM 631	

3.5. Connecting a turnout



Turnout with twin coil drive



Motor driven turnout

If you are running terminal station A on two tracks, connect

- a turnout with twin coil drive to connections 4, 5 and 6 or
- a motor driven turnout to connections 4 and 6.

A turnout with servo drive is not suitable.

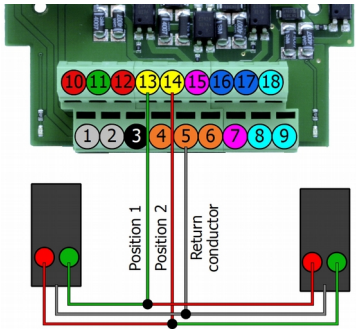
Check the turnout position!

When you first start up, check that the turnout is set correctly. An LED on the circuit board indicates which of the two tracks is switched on for a locomotive to exit. If necessary, you have to swap the turnout connections 4 and 6.

You can connect wing signals with a double-coil drive for the two tracks in parallel with the turnout.

The turnout (and the wing signal) are supplied with power by the PZS-2.2.

3.6. Connecting light signals

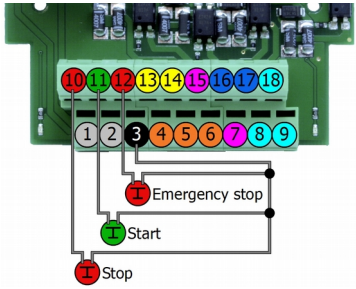


You can connect two-aspect light signals to connections 13 and 14. Connect the return conductor to connection 5 of the PZS-2.2.

The display will automatically switch between 'Proceed' and 'Stop' when a train enters one of the two terminal stations. With appropriate assignment of the connections, you can control light signals for both directions of travel.

The light signal is supplied with power by the PZS-2.2.

3.7. Connecting push-buttons

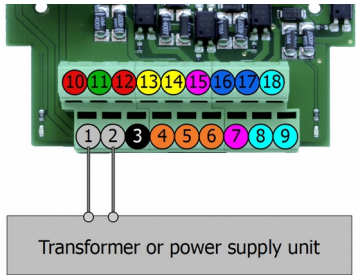


Use buttons or circuits whose outputs switch to ground if you want to interrupt shuttle operation at other (any) points along the route for additional stops.

The connection of an emergency stop button is recommended to stop operation immediately without a braking phase in an emergency.

The buttons are supplied with power by the PZS-2.2.

3.8. Connecting the power supply



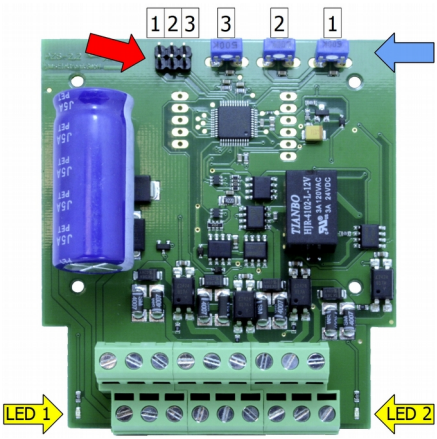
Use a model railway transformer or a power supply unit with a **fixed** output voltage for the power supply of the circuit and the shuttle section. The required output voltage depends on the nominal size and the demand of the connected turnouts.
(→ Table "Recommended output voltage" in section 1.2).

⚠ **Do not** use the transformer to supply power to other circuits that are connected to the rails in any way. Otherwise, equalising currents can cause irreparable damage to the module.

4. Settings and operation

There are pin headers on the circuit board to which jumpers (shorting plugs) are plugged to select the operating mode and the programming steps. To adapt the control to your individual requirements, the settings of the trim pots must be changed using a small screwdriver. The settings are stored in an IC after the 'Stop' input has been connected to ground.

If your PZS-2.2 is installed in a housing, you have to remove the housing cover to access the pin headers and the trim potentiometers.



Pin headers (red arrow):
- Setting the operating mode
- Selection of the programming step

Trim pots (blue arrow):
Setting of
- maximum speed
- acceleration time
- braking time
- holding time

LEDs:
- Display of faults
- Display of the active locomotive
- Display of progress when saving

4.1. Commissioning

Secure the ends of the tracks!

If the shuttle-train line ends in a dead end track, you must secure the ends of the tracks before commissioning and programming so that vehicles cannot cross the end of the track, even at high speeds. **Risk of damage to vehicles!**

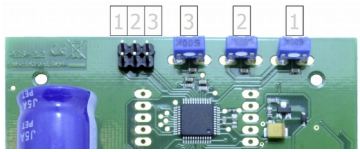
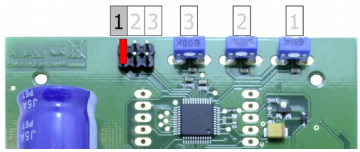
It is recommended to install stop diodes at the ends of the tracks (→ Section 3.4).

After setting up the route sections and connecting them to the PZS-2.2, carry out a test run. This is to check whether all connections have been made correctly and whether the automatic shuttle-train operation is running as intended. With the factory settings, the maximum driving voltage on the open track is about 50% of the output voltage of the transformer / power supply.

It is recommended that individual additional stops, which are controlled via the switching inputs of the PZS-2.2, only be set up when the automatic shuttle operation is running smoothly.

Setting the operating mode

Before you switch on the PZS-2.2, you must set whether the shuttle-train operation will be carried out with one train or alternately with two trains.

 no jumper	**Operation with two trains** The trains start alternately from track 1 and track 2 at terminal station A. The turnout at terminal station A is switched accordingly.
 jumper on pin header 1	**Operation with one train** A second track at terminal station A and the turnout at terminal station A are not controlled.

Putting the locomotive(s) on the track

If both terminal stations on your shuttle-train line are single-track, you can locate the locomotive anywhere on the layout. The PZS-2.2 recognises which area of the line the locomotive is in and controls the shuttle operation accordingly.

If you have connected two tracks to terminal station A, a locomotive must be placed on one of these two tracks when the PZS-2.2 is switched on. The other locomotive can be put on the track at any other point on the layout.

Please note:

The maximum current of the train on the shuttle-train line (including all consumers such as carriage lighting) may not exceed 2,000 mA. If the maximum current is exceeded, the integrated fuse will switch the circuit off. In the worst case, components on the circuit may also be damaged.

Checking the turnout position

After switching on the PZS-2.2, shuttle operation starts immediately. One of the two LEDs on the circuit board lights up as long as the associated locomotive is on the shuttle-train line (LED 1 for locomotive from track 1, LED 2 for locomotive from track 2).

Please note:

When you first start up, observe whether the PZS-2.2 sets the turnout correctly as soon as a locomotive starts from a track in terminal station A. An LED on the circuit board indicates which of the two tracks for a locomotive's exit is switched on.

If necessary, you have to swap the turnout connections 4 and 6.

4.2. Programming mode

The settings are made individually for each locomotive in four programming steps:

- Maximum speed
- Acceleration time
- Holding time
- Braking time

The length of the acceleration, deceleration and braking phases is set separately for each of the two terminal stations and jointly for the two intermediate stations using trim pots. The settings are stored in an IC. After saving, the position of the potentiometers has no effect.

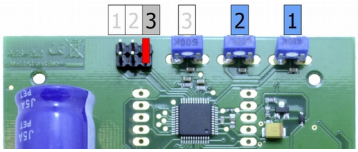
4.2.1. Preparations

Remove the housing cover	If your PZS-2.2 is installed in a housing, you must remove the housing cover, because you have to change the trimmer potentiometer settings and move the jumpers during programming.
⚠ Trim pots to the left stop	Before programming the PZS-2.2 for the first time and after a reset, set all potentiometers to the left stop. This will set the lowest possible maximum speed and the shortest possible phase lengths for starting, stopping and braking. Otherwise, it may happen that the locomotive(s) starts/start racing at high speed when the PZS-2.2 is switched on.
Secure the tracks at the terminal stations	Check that the tracks at the terminal stations are sufficiently secured (e.g. by stop diodes → Section 3.4).
For operation with two trains: Determine the starting tracks	The maximum speed and the phase lengths for accelerating, stopping and braking a locomotive are stored for a specific starting track. Therefore, before you set the driving characteristics of the locomotive, determine from which track the locomotive should start when shuttle operation begins. If you start a locomotive from a different track than the one you selected when setting the driving characteristics, the locomotive will not run with 'its' characteristics, but with those of a different locomotive.
Rerail the locomotive(s) and let them warm up	At terminal station A, place the locomotive on the track or, for a shuttle section with two tracks, place both locomotives on the tracks at terminal station A. Run a test operation with the factory settings. Only make the settings after the locomotive has made a few laps (and the motor is warm).
Switching **off** the PZS-2.2	Before you insert a jumper to select a programming step, disconnect the PZS-2.2 from the power supply.

4.2.2. Programming: basic procedure

Insert jumper(s)	→ Selecting the programming step
Switch **on** the PZS-2.2 ⚠ Ensure the correct turnout setting!	Shuttle operation starts immediately after the power supply for the PZS-2.2 has been switched on. Shuttle section with **one single** track at terminal station A: The locomotive travels back and forth on the shuttle section, LED 1 is lit. Shuttle section with **two tracks** at terminal station A: LED 1 and LED 2 light up as long as the associated locomotive is on the route (LED1 for locomotive from track 1, LED 2 for locomotive from track 2). Programming step 1: The two locomotives travel back and forth on the shuttle section in turn. Programming steps 2 to 4: One of the two locomotives travels back and forth until the settings for this locomotive have been saved. Then the second locomotive starts the shuttle run. You can select the locomotive you want to start the shuttle service with in programming steps 2 to 4 (→ section 4.2.4).
Set the potentiometers	→ Setting the maximum speed and the phase lengths for acceleration, braking and stopping The settings on the trim potentiometers are adopted immediately. In shuttle-train operation with two trains, the settings only apply to the train that is currently on the track.
Connect the "Stop" input to ground until the LEDs flash alternately	→ Saving the settings Operation on the shuttle section will be stopped as soon as the “Stop” input is connected to ground. After saving the settings, the locomotive will continue its shuttle run to the terminal station A. When operating a shuttle-train with two trains, only the settings for the train currently on the line are adopted.
Switch **off** the PZS-2.2	→ Exiting the programming step As soon as the LEDs stop flashing alternately, the settings are saved. Disconnect the PZS-2.2 from the power supply before reconnecting the jumpers for selecting a different programming step or normal operation.

4.2.3. Programming step 1: Setting the maximum speed



Jumper on pin header 3

Shuttle operation with two locomotives: After switching on the PZS-2.2, the two locomotives run alternately.

Setting the maximum speed:

- locomotive 1 (starting from track 1): trim pot 1
- locomotive 2 (starting from track 2): trim pot 2

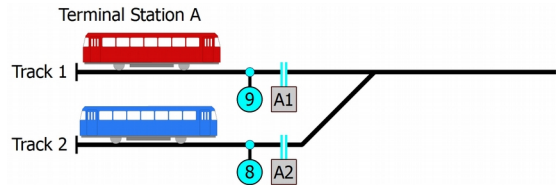
To store, connect the "Stop" input to ground until the LEDs flash alternately!

Saving during operation with two locomotives:
To save the settings for a locomotive, the 'Stop' input must be connected to ground while the locomotive is on the shuttle section!

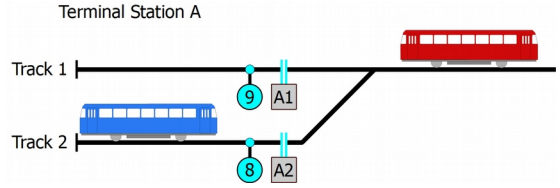
4.2.4. Selecting a locomotive for programming steps 2 to 4

If both locomotives are in the terminal station A when the shuttle-train control is switched on, the (blue) locomotive from track 2 (connection 8 of the PZS-2.2) always starts the shuttle run. After saving the settings for the blue locomotive, the shuttle operation with the red locomotive starts automatically, so that the settings for this locomotive can then be changed and saved.

If you only want to execute programming steps 2, 3 or 4 for the (red) locomotive from track 1 (connection 9 of PZS-2.2), you must place the (red) locomotive on the track outside terminal station A before switching on the shuttle-train control. After switching on the PZS-2.2, the (red) locomotive will start the shuttle service. After saving the settings for the red locomotive, the shuttle service with the blue locomotive will start automatically. If you do not want to change the settings for the blue locomotive, switch off the PZS-2.2 without saving.

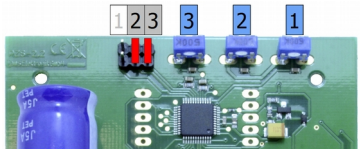


Starting the shuttle service with the (blue) locomotive from track 2 for programming steps 2 to 4



Starting the shuttle service with the (red) locomotive from track 1 for programming steps 2 to 4

4.2.5. Programming step 2: Setting the acceleration time



Jumpers on pin headers [2] and [3]

Shuttle operation with two locomotives:
After switching on the PZS-2.2, only one locomotive moves back and forth at first. The second one only starts after the settings for the first one have been saved.

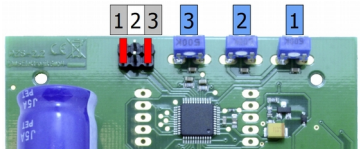
Setting the acceleration time:

- Terminal station A: trim pot 1
- both intermediate stations and manual additional stops: trim pot 2
- Terminal station B: trim pot 3

To save, connect 'Stop' to ground until the LEDs flash alternately!

Saving when operating with two locomotives:
The settings are saved for the locomotive that is currently driving back and forth. After saving the settings, shuttle operation with the other locomotive starts as soon as the first locomotive has returned to terminal station A.

4.2.6. Programming step 3: Setting the braking time



Jumpers on pin headers [1] and [3]

Shuttle operation with two locomotives:
After switching on the PZS-2.2, only one locomotive moves back and forth at first. The second one only starts after the settings for the first one have been saved.

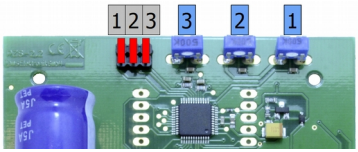
Setting the braking time:

- Terminal station A: trim pot 1
- both intermediate stations and additional manual stop: trim pot 2
- Terminal station B: trim pot 3

To save, connect 'Stop' to ground until the LEDs flash alternately!

Saving when operating with two locomotives:
The settings are saved for the locomotive that is currently driving back and forth. After saving the settings, shuttle operation with the other locomotive starts as soon as the first locomotive has returned to terminal station A.

4.2.7. Programming step 4: Setting the holding time



Jumpers on pin headers 1 2 and 3

Shuttle operation with two locomotives:
After switching on the PZS-2.2, only one locomotive moves back and forth at first. The second one only starts after the settings for the first one have been saved.

Setting the holding time:

- Terminal station A: trim pot 1
- both intermediate stations: trim pot 2
- terminal station B: trim pot 3

Please note: In order to reduce the time required for setting the holding time, the holding time in programming mode is shortened by a factor of 10. During operation, the holding time is therefore 10 times longer than during programming.

The holding time for all stations and intermediate stations can also be extended by a factor of 10. → Section 4.3

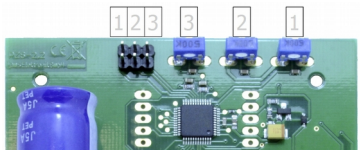
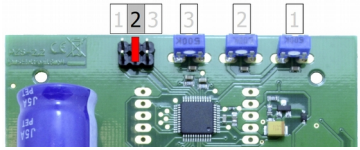
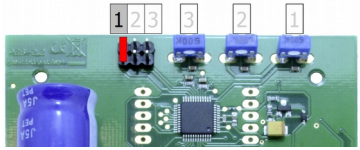
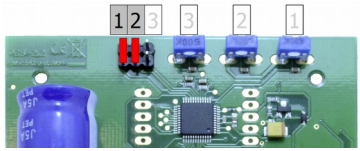
To save, connect 'Stop' to ground until the LEDs flash alternately!

Saving when operating with two locomotives: The settings are saved for the locomotive that is currently driving back and forth. After saving the settings, shuttle operation with the other locomotive starts as soon as the first locomotive has returned to terminal station A.

4.3. Normal operation

Setting the operating mode

After you have made all the necessary settings, you must set the desired operating mode for normal operation. You can extend the holding times at the terminal stations and intermediate stations by a factor of 10 by placing a jumper on pin header 2. Note that the holding times during operation are already 10 times longer than the holding times during programming in programming step 4.

 no jumper	**Operation with two trains** The trains start alternately from track 1 and track 2 at terminal station A. The turnout at terminal station A is switched accordingly.
 Jumper on pin header 2	**Operation with two trains** **+** Extension of the holding time at all stations and intermediate stations by a factor of 10 Maximum holding time: 410 seconds (= 6.8 minutes)
 Jumper on pin header 1	**Operation with one train** A possibly existing second track at terminal station A and the turnout at terminal station A are not controlled.
 Jumpers on pin headers 1 and 2	**Operation with one train** **+** Holding time at all stations and intermediate stations increased by a factor of 10 Maximum holding time: 410 seconds (= 6.8 minutes)

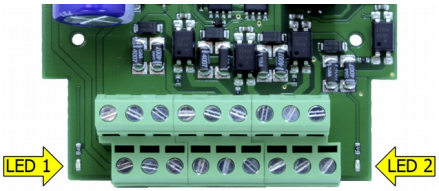
Overload protection

> **Please note:**
> The maximum current of the train on the shuttle-train line (including all consumers such as carriage lightings) must not exceed 2,000 mA. If the maximum current is exceeded (overload, short circuit), the control system switches off the power for the shuttle section and the two LEDs flash quickly.

Before you can restart shuttle operation after eliminating the short circuit or reducing the power consumption, you must switch the PZS-2.2 off and then on again.

LED displays

The two LEDs on the circuit board indicate operating states and faults.



LED 1 or LED 2 is lit	→ LED 1: train from track 1 (connection 9) active → LED 2: train from track 2 (connection 8) active
alternating flashing of the two LEDs	→ Settings from programming steps 1 to 4 are saved (after there was a ground connection to the 'Stop' button during a programming step).
Fast flashing of the LEDss	→ Overload / short circuit on the tracks Before you can restart shuttle operation after the short circuit has been eliminated or the power consumption has been reduced, you must switch the PZS-2.2 off and then on again.

4.4. Performing a reset

To reset the PZS-2.2 to the factory settings, you have to connect the 'Stop' input to ground when switching on the shuttle-train control (e.g. by pressing and holding a connected button). As soon as the two LEDs flash, you can release the ground connection. The reset is complete after the LEDs have flashed alternately 10 times.

5. Checklist for troubleshooting and error correction

Warning: If you notice a strong heat development, immediately disconnect the connection to the supply voltage. **Fire hazard!**

Possible causes:

- One or more connections are faulty. → Check the connections.
- The module is defective. → Send the shuttle-train control in for inspection.

Commuter service does not start

The shuttle service does not start even though the shuttle-train control is correctly connected and switched on.

Possible causes:

- The locomotive or one of the two locomotives does not have sufficient contact. → Check that the locomotive(s) is/are properly on the rails and that the wheels have sufficient contact.
- When operating with two locomotives, neither of the two locomotives is on one of the two tracks at terminal station A. → Place at least one locomotive on one of the two tracks in terminal station A.
- The PZS-2.2 has switched off the power for the shuttle section due to an overload or short circuit. The LEDs on the circuit board flash quickly. → Check whether there is a short circuit on the tracks or whether the power consumption of the locomotives and cars is more than 2,000 mA. Switch off the power supply. Remove the short circuit and/or the overload and switch the power supply back on.

No braking when entering a route section

When the train reaches the 'terminal station' or 'intermediate station' section of track, it does not brake but continues at top speed.

Possible causes:

- One or more separation points are incorrectly arranged or (accidentally) bridged. → Check the arrangement of the separation points. Note the different wiring diagrams for layouts according to NEM 631 and deviating from NEM 631.
- One or more connections to the rails are not correctly executed or incorrectly arranged. → Check the rail connections. Note the different wiring diagrams for layouts according to NEM 631 and deviating from NEM 631.

No timely stop at the terminal station

The train runs into the buffer stop at the terminal station, even though a stop diode is installed.

Possible causes:

- The stop diode is installed with the wrong polarity. → Check the stop diode and change the installation direction if necessary.
- The stop diode is connected to the wrong rail. → Check the arrangement of the stop diode and the separation point. Note the different wiring diagrams for layouts according to NEM 631 and deviating from NEM 631.

Undesired driving behaviour

The locomotive(s) do not drive with the set driving characteristics.

Possible causes:

- When programming, the settings were not saved correctly. → Repeat the programming step(s) for the locomotive and make sure that the locomotive is in shuttle operation when saving.
- When you started shuttle service with two locomotives, the locomotives did not start from their assigned starting track in terminal station A. They are therefore running with the settings for a different locomotive. → Switch off the power supply. Put all locomotives on their assigned starting tracks and start again.

The locomotive does not reach the set maximum speed.

Possible cause:

- The acceleration time is set so long that it has not yet ended before the next section of track is reached (and the next braking phase begins). → Repeat programming step 3 for the locomotive and shorten the acceleration phase.

5.1. Technical Hotline

If you have any questions about the use of your shuttle-train control, our technical hotline will help you (telephone number and e-mail address on the last page).

5.2. Repairs

You can send us a defective shuttle-train control for inspection / repair (address on the last page). Please do not send us your return freight collect. In the event of a warranty or guarantee claim, we will reimburse you for the regular shipping costs.

Please enclose the following with your shipment

- proof of purchase as evidence of any warranty or guarantee claim
- a brief description of the defect
- the address to which we should return the product(s)
- your email address and/or a telephone number where we can reach you in case of queries

Costs

The inspection of returned products is free of charge for you. In the event of a warranty or guarantee claim, the repair and return are also free of charge for you.

If there is no warranty or guarantee case, we will charge you the costs of the repair and the costs of the return. We charge a maximum of 50% of the new price for the repair according to our valid price list.

Carrying out the repair(s)

By sending in the product(s), you give us the order to inspect and repair it. We reserve the right to refuse the repair if it is technically impossible or uneconomical. In the event of a warranty or guarantee claim, you will then receive a replacement free of charge.

Cost estimates

Repairs for which we charge less than € 25.00 per item plus shipping costs will be carried out without further consultation with you. If the repair costs are higher, we will contact you and carry out the repair only after you have confirmed the repair order.

6. Technical data

Outputs and inputs

Outputs (mandatory use)	2 outputs for connecting the route sections Terminal station A track 1 Terminal station B
Outputs (optional use)	3 outputs for connecting the route sections Terminal station A track 2 Intermediate station C Intermediate station D 1 connection for a turnout with a double-coil drive or a motor-driven turnout 1 connection for a two-aspect light signal
Inputs (optional use)	2 inputs for connecting external buttons (Stop and Start) or external circuits for triggering and ending individual additional stops 1 input for connecting an emergency stop button

Electrical characteristics

Power supply for the PZS-2.2 and the shuttle-train line	Model railway transformer or power supply unit with **fixed** output voltage. The output voltage must be at least sufficient to switch the turnout. Recommended output voltage:

Nominal size	Z	N/TT	H0	0, 1, 2
DC voltage	12 V	14–16 V	18–20 V	20–22 V
AC voltage	10 V	12 V	16 V	18 V

Current consumption of the circuit	approx. 50 mA (without external consumers)
Maximum output current for the tracks of the shuttle-train line	2,000 mA
Maximum output current for the turnout	1,500 mA
Maximum output current for the light signal	1,000 mA

Protection

Protection class	Ready-made module (without housing): IP 00 Meaning: No protection against foreign bodies, contact and water. Ready device (in housing): IP 20 Meaning: Protected against solid foreign bodies with diameter ≥ 12.5 mm and access with a finger. No protection against water.

Environment

	For use in closed rooms
Ambient temperature during operation	0 ~ + 30 °C
Permissible relative humidity during operation	10 ~ 85% (non-condensing)
Ambient temperature during storage	- 10 ~ + 40 °C
Permissible relative humidity during storage	10 ~ 85% (non-condensing)

Other features

Dimensions (approx.)	Circuit board: 72 x 82 mm Ready device including housing: 100 x 90 x 35 mm
Weight (approx.)	Assembled board (ready-made module): 59 g Ready device including housing: 104 g

7. Warranty, EU conformity & WEEE

7.1. Guarantee bond

For this product we issue voluntarily a guarantee of 2 years from the date of purchase by the first customer, but in maximum 3 years after the end of series production. The first customer is the consumer first purchasing the product from us, a dealer or another natural or juristic person reselling or mounting the product on the basis of self-employment. The guarantee exists supplementary to the legal warranty of merchantability due to the consumer by the seller.

The warranty includes the free correction of faults which can be proved to be due to material failure or factory flaw. With kits we guarantee the completeness and quality of the components as well as the function of the parts according to the parameters in not mounted state. We guarantee the adherence to the technical specifications when the kit has been assembled and the ready-built circuit connected according to the manual and when start and mode of operation follow the instructions.

We retain the right to repair, make improvements, to deliver spares or to return the purchase price. Other claims are excluded. Claims for secondary damages or product liability consist only according to legal requirements.

Condition for this guarantee to be valid, is the adherence to the manual. In addition, the guarantee claim is excluded in the following cases:

- if arbitrary changes in the circuit are made,
- if repair attempts have failed with a ready-made module or device,
- if damaged by other persons,
- if damaged by faulty operation or by careless use or abuse.

7.2. EU Declaration of Conformity

CE This product fulfils the requirements of the following EU directives and therefore bears the CE marking.

2001/95/EU Product Safety Directive

2015/863/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)

2014/30/EU on electromagnetic compatibility (EMC Directive). Underlying standards:

DIN-EN 55014-1 and 55014-2: Electromagnetic compatibility - Requirements for household appliances, electric tools and similar electrical appliances. Part 1: Emitted interference, Part 2: Immunity to interference

To maintain electromagnetic compatibility during operation, observe the following measures:

Only connect the supply transformer to a professionally installed and fused earthed socket.

Do not make any changes to the original components and follow the instructions, connection and assembly diagrams in this manual exactly.

Only use original spare parts for repair work.

7.3. Declarations on the WEEE Directive

This product is subject to the requirements of the EU Directive 2012/19/EC on Waste Electrical and Electronic Equipment (WEEE), i.e. the manufacturer, distributor or seller of the product must contribute to the proper disposal and treatment of waste equipment in accordance with EU and national law. This obligation includes

- registration with the registering authorities ("registers") in the country where WEEE is distributed or sold
- the regular reporting of the amount of EEE sold
- the organisation or financing of collection, treatment, recycling and recovery of the products
- for distributors, the establishment of a take-back service where customers can return WEEE free of charge
- for producers, compliance with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive.

The "crossed-out wheeled bin" symbol means that you are legally obliged to recycle the marked equipment at the end of its life. The appliances must not be disposed of with (unsorted) household waste or packaging waste. Dispose of the appliances at special collection and return points, e.g. at recycling centres or at dealers who offer a corresponding take-back service.

Further Information and Tips:

http://www.tams-online.de

Warranty and Service:

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