DRAFT

Handbook for Fremo N

Fremo *fi*Ne-scale

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What is FREMOdul?

FREMOdul can be many things, namely...

- A piece of model railway/diorama with all design possibilities, which fits together with other FREMO modules thanks to standardised ends
- A transportable section of the layout that can be taken to meetings and conferences
- The answer to the complaint: "No room for a layout".

This is typical for FREMOdul:

- free geometry, except for the standardised transitions (interfaces)
- distinction between stations and open track
- correct height for stationary operation
- timetable operation with walk-around control
- no circular routes

Fremo-N objective

This manual presents and specifies the module standards introduced in FREMO for N fiNescale. The first FREMO N-scale module standard originated in 1989 among the Braunschweig N-scale model railroaders and was subsequently introduced to FREMO, where it has since achieved supra-regional and international distribution. Since several years of experience with these N-scale modules have accumulated since the last edition of the handbook, a new edition of the module standard seems justified. In addition to this experience, several changes have also been incorporated. These include, for example, the couplings, the electrical components, the integration of the Nm standard, and the extension to the fiNe scale standards (fs160).

The handbook is intended to enable all interested model railroaders to create interchangeable modules in N scale across regions, in order to participate in module meetings such as those of FREMO.

When this manual refers to "FREMO," it does not necessarily mean the association as a whole. Specific information can be obtained from individual

FREMO members. More detailed information is available from the N-scale model railroaders within FREMO. There exist several groups within FREMO-N which have there own standards all at a scale 1:160:

- FREMO-N (Standard gauge 1435 mm (9 mm), Code 40, turned wheel flanges)
- FREMO-N fiNe-scale (Standard gauge 1435 mm (9 mm) with finer wheel-rail dimensions)
- FREMO-NRE (Standard gauge 1435 mm (9 mm) with coarse scale NEM wheels and Code 55)
- FREMO-Nm (Narrow gauge 1000 mm (6.5 mm), according to NEM)
- FREMO-Nm fiNe-scale (Narrow gauge 1000 mm(6.25 mm) with finer wheel-rail dimensions)
- FREMO-N-USA (Standard gauge 1435 mm (9 mm), Code 55, to NMRA)

We and our individual subgroups can be found online at:

https://www.fremo-net.eu/modulsysteme (FREMO as a whole, with all scales);

http://www.n-bahn-bs.de/nstamm.htm (information about FREMO-N);

https://www.n-bahn.net/ (information about FREMO-N-RE);

https://www.fs160.eu (information about FREMO-N-fiNe-scale).

https://www.fremo-net.eu/american (information about Fremo-N-USA)

The modules built according to this standard are intended to illustrate the possibilities and advantages of N gauge. It allows for a largely scale-accurate model railway in a relatively small space, while still ensuring reliable operation.

The N-scale model railroaders in FREMO share the common goal of operating prototypical layouts on well-designed modules with smoothly running vehicles. This requires a considerable amount of scratch-building. While this certainly can not be achieved immediately, it should always remain the aspiration. With the help of other FREMO N-scale model railroaders, however, it is not so difficult to reach. FREMO N-scale model railroaders want to enjoy model railroading. For us, this includes a high standard of design and running qualities.

The relatively small space requirement of N scale is consistently used for a spacious, prototypical design. The curve radii largely correspond to the prototype.

However, scale accuracy applies not only on a large scale, but also on a small scale: preferably track material with Code 40 rails is used. Emphasis is placed on well-running vehicles. Many locomotives are improved by a different motor (coreless motor) with a flywheel and/or by gearbox modifications, so that they run better than original. The vehicles are selected to match the theme and era. Where possible, they receive an individual running number and are weathered/ distressed realistically.

The operation is essentially the same as the prototype. Timetables are available. Freight cars have waybills indicating the cargo and destination. Locomotives have a driver, and stations are staffed by at least one train dispatcher (or train control is used). Train reports are made in accordance with the prototype. Speeds are based on the prototype.

This list could go on indefinitely, bringing us ever closer to the ultimate goal, the vision of the "perfect" model railway, without ever quite reaching it...

FREMO-N origins

As early as 1989, this group began building and operating N-scale modules according to a newly created module standard. FREMO-N is largely based on the European Model Railroading Standards (NEM).However, changes have been made, particularly to the rail and wheel flange height (Code 40 and wheel flanges turned down to 0.5 mm), for both technical and aesthetic reasons. The fundamental principle of FREMO-N is a convincing, detailed landscape design with reliable, prototypical railway operation, where technical operational reliability takes precedence over visual refinement. The operation usually takes place in era 3, sometimes also 4. Further information about FREMO-N can be found at http://www.n-bahn-bs.de/nstamm.htm

FREMO-N-fiNe-scale

For some FREMO members, it was not enough to refine the wheels only in terms of flange height. FREMO-N- fiNe-scale consistently applies the concept of fine design to the vehicles. The width of the wheels and wheel grooves, as specified by NEM standards, also needed improvement. This led to the formation of the fiNe-scale group in 1992. The dimensions of the wheel set and track essentially correspond to the British Two Millimetre Scale Association, but naturally with a track gauge of 9 mm. Additionally, the bulky

standard coupling is replaced by a replica of the original coupling. This creates a new, finer wheel-rail system which, in conjunction with the scale track geometry, eliminates many compromises (often referred to as "model railway-related"). Frames, cylinder blocks, and bogie side frames can (but don't have to) be mounted closer to the wheels, resulting in a more prototypical overall impression. This makes it possible to have both: vehicle views as seen in larger scales and the good scenery effect that N scale offers. This creates a relatively large viewing area. The operation usually takes place in era 3, sometimes also 4.

Further information on FREMO-N- finescale can be found at

https://www.fs160.eu/fiNeweb/standards/HANDB.php

http://www.raw-nette.de/

FREMO-N-RE

The N-RE model railroaders have made greater compatibility with NEM their mission. This makes it easier to get started. The operation usually takes place in epoch 3, but there are also working groups that specialise in epochs 1 and 5.

Further information about FREMO-N-RE can be found at

https://www.fremo-net.eu/modulsysteme/baugroesse-n/n-re

https://www.n-bahn.net

FREMO-Nm

This is the narrow-gauge version of the FREMO N standard. So far, it has not gained significant popularity. However, it is included in this handbook to provide a framework for interested parties.

FREMO-Nm-fiNe-scale

There is also interest in narrow-gauge railways within the fiNe-scale category, which are then consistently built to the scaled-up gauge of 6.25 mm. This group is also not yet very widespread.

Compatibility

Although the standards differ, modules and vehicles can be exchanged between the groups to a certain extent. It is technically feasible to built track with plain turnouts that can be accommodated to run NEM and fiNescale, but not at the same time. As general rule:

• Vehicles with NEM wheel flanges only run on FREMO-N-RE

• Vehicles with turned wheel flanges run on FREMO-N and FREMO-N-RE

• Vehicles with narrower wheels only run on FREMO-N-Finescale

• Track modules with Code 40 flex track are suitable for FREMO-N and FREMO-N-Finescale

• Track modules with soldered plain Code 40 track are suitable for all vehicles.

• Modules with turnouts with NEM groove width and soldered Code 40 track are suitable for FREMO-N and FREMO-N-RE.

• Modules with turnouts with NEM groove width and Code 40 flex track are only for suitable for FREMO N.

• Modules with turnouts with movable frog and soldered Code 40 track

are suitable for all vehicles, provided the wing rails are designed accordingly.

• Turnouts with wide NEM grooves can also be used for FREMO-N-Finescale with inserted pieces to be made functionally fit for purpose

• Modules with turnouts with narrow grooves are only for FREMO-N-Finescale suitable.

With Nm, the track gauge differs between the classic standards and FS, therefore the modules are not freely interchangeable, however, FREMO-Nm-fiNe-scale vehicles can also run on FREMO-Nm modules.

Content and scope of the manual

This manual consists of several parts. First, the objectives are presented, outlining what we actually want to achieve and specifying the corresponding characteristics of the prototype. This concerns railway construction (substructure, superstructure, equipment), the vehicles, and operation. This is followed by the model-specific implementation with module box, electrical system, etc. The manual is structured as follows:

1 General

2 Objectives

3 railway facilities

4 wheel/rail standard

5 Operation

6 module boxes (model-specific)

7 Electrical system (model-specific)

8 Design and scenery

Part 2 describes the goals we are pursuing and the conclusions that follow from them. It also provides guidance for deciding whether to build a particular module. Part 3 deals with all the boundary conditions of the railway facilities: substructure, superstructure, track alignment, station design, clearance gauge, and signaling equipment. Operational aspects must also be included. Part 4 contains all the information relevant to the vehicles to be selected, e.g. wheelsets and coupling. Part 5 deals with how the vehicles can be moved on the tracks in a sensible and fun way, and the necessary prerequisites and documents. Now we get down to the specifics of module construction: Part 6 will cover the module box with everything that goes with it, and Part 7 will cover the electrical components. Part 8, which deals with general design issues that go beyond pure railway construction, it is not so relevant for operations, but is important for a uniform and exemplary appearance.

Nomenclature, Notes on Use

The use of certain terms is based on DIN 820 Part 23. This is for the purpose of understanding the standard. This is important because there are points of varying importance.

must: obligate, requirement

It must be, e.g., technical compatibility, especially Key points are underlined.

"Should": Rule, principle is strongly recommended, e.g. for trouble-free operation

should: Recommendation predominantly for a uniform design

can, may: Non-binding alternative solutions are also permissible.

Organisational matters

At the latest when the module is completed and is to participate in FREMO module meetings, the module must be registered with FREMO. A CAD drawing at a scale of 1:1 (possibly 1:10) is required for this preferably digital in DXF and DWG format is required

At least for station modules, the following should also be considered: Module registration forms must be completed. The owner will then receive a unique identification from FREMO. Identifying a module helps to uniquely identify the modules and reduces the sending around module sketches for meeting planning. Modules, especially operational units, should also be given a name, which the owner assigns. The new module must be functionally tested before the first use. The system will then be tested at a meeting. On its first participation in a FREMO meeting it will be integrated into the module arrangement at the edge, or in a less crucial position.

The meeting organizer is responsible for coordinating the meeting.

Communication among members takes place not only through direct exchanges at module meetings but also via the FREMO Forum and email lists, some of which are only accessible to FREMO members.

Objectives

First, let's talk about what we actually want. What do we expect from a prototypical model railway? What do we want to achieve, what do we want to show, how do we want to use the modules?

The manual first considers the large-scale railway system, and only then does it address the model-specific implementation in the other parts.

We aim to combine safe, interesting, and varied operation with a good, prototypical appearance for the modules and vehicles. Prototypical means that everything should be built to scale as far as possible, from the track height to the length of the entire station. An attractive design of the railway facilities and the landscape is also part of this. Operation should also be based on the prototype, and the vehicles should have an appearance that corresponds to real-world operation.

Module Topic

The design and theme of the modules are, in principle, entirely up to each builder. However, the topic of railways is far too extensive for everything to be harmoniously integrated on a single modular layout. Excessive thematic tension would make the modular layout feel fragmented and ruin the cohesive landscape impression. Therefore, the current members have agreed on the following theme for modular arrangements, which may include a:

- standard-gauge, single-track, non-electrified main or branch line or
- standard-gauge, double-track, non-electrified main line or
- meter-gauge narrow-gauge railway
- in Central Europe
- in the low mountain ranges or in the lowlands
- in a rural or small-town environment
- during the summer

No major contradictions should occur when the topic fits to era 3b (approx. 1958-1970). However, other topics and eras are permissible and do exist.

When choosing a station, it is possible to replicate a specific prototype or to create your own design. Particular attention should be paid to the following:

- at least 2 main tracks (preferably also 2 platform tracks) to allow train crossings
- sufficient loading facilities (goods shed, ramp, loading road, sidings)
- shunting operations with minimal disruption to train traffic on the main tracks (not so easy to implement anymore).

Short prototype railway stations (low mountain ranges) must be taken into account in the operations during model implementation. These should not be compressed. An exact scale replica is always optimal. When deciding whether to build a single- or double-track line, and whether it will be a main or branch line, the corresponding length of main line stations should be taken into account. As a rule, such a station is approximately 1.6 km (10 m) long from entry signal to entry signal!

Branch lines allow for considerably more (shunting) operations relative to their space requirements but because of failing junctions may not always be included in the arrangement.

Beginners should start by building a track module or a junction. This allows them to learn (almost) all the construction principles without too much dependence on it. Furthermore, numerous track modules are always needed and particularly short straight ones or those with large curves (>4m) can serve well. Afterward, a station can be built. In conjunction with a hidden staging yard, operations can then be carried out.

A certain reduction in track length compared to the prototype is inevitable with modular layouts (limited participants, limited transport capacity and a lack of track modules). The "life" of the layout (in the form of numerous shunting operations) takes place in the industry connections and stations. However, we don't want to forgo train journeys over beautiful, long stretches of track. In order to achieve reasonable track lengths, the track length brought to module meetings should therefore be at least equal to the station length brought along.

Simple stopping points (without points) further reduce the distance between passenger train stops. Even on larger modular layouts, the station spacing is still small compared to the prototype. Stopping points offer no advantage for freight traffic. Therefore, their construction is not recommended. Block posts are less useful on the comparatively short track lengths compared to the prototype. The requirement to run interesting and varied operations on small branch lines with complete infrastructure using steam and diesel traction leads to different possible time periods for different railway administrations. For the DB (German Federal Railway) prototype, this results in Era IIIb. Therefore, Era IIIb (approx. 1956-1970) is generally used at FREMO meetings. If a different era is to be represented at a meeting, this will be mentioned in the invitation so that participants can prepare accordingly (e.g., regarding rolling stock). The meeting organizer makes the final decision, taking into account the available rolling stock and the wishes of the participants.

Unlike the vehicles, the design of the modules is not so much era-specific. Therefore, modules can be used across different eras, as long as the design is not extremely different (e.g., modern elevated platforms).

Vehicle Selection/Deployment

For scheduled operation, the vehicles should correspond to prototypes that do justice to the character of the modules and whose use was possible or is possible on the actual or imagined prototypes of the modules. This also includes period-appropriate paintwork and, where possible, lettering. Models that deviate significantly from the theme or period chosen for a meeting may be excluded from scheduled operation.

The vehicles and train sets should be appropriate to the character of the modules (e.g., branch line, considering gradients, limitations on train length due to platforms and passing loops, geographical focus).

Freight traffic should be based on the goods predominantly loaded at the operating points and the corresponding wagon types required; an overview should be available at the station and industry modules.

Vehicles must be marked by their owners so that they can be identified and returned to their rightful owners at meetings. A two-color marking is suitable for this purpose; it should be affixed to the underside of each vehicle (and any accessories) to identify the owner. A list of already assigned colors is available from FREMO. Before marking, please check with the administrator of this list to see which color combinations are still available.

A wagon card must be prepared for each freight car. See Part 5 for details.

Vehicles brought to meetings should be in perfect visual condition. This does not preclude the occasional use of, for example, unfinished conversions.

Vehicle Technology

All vehicles must be in perfect working order. This applies in particular to:

- Wheel set dimensions, especially the back-to-back gauge
- Current collection: in addition to generally good current collection, locomotives must be clean when participating in a module meeting
- Running characteristics of locomotives: low shunting speed possible, quiet, smooth running, etc.

- Running characteristics of wagons: good rolling characteristics, wheels cleaned before the meeting.

- Coupling dimensions, especially the height adjustment and, with MFK (MagnetFeld Kupplung), the smoothness of operation, must be checked from time to time.

Vehicles that do not meet these conditions may be excluded from operation. Here, a damage report is created for the vehicle, stating the defects noted, and given to the owner. The owner then rectifies these defects on the vehicle before using it again at a meeting.

Loading vehicles should exhibit prototypical, smooth running characteristics. For this, a conversion with a coreless motor, flywheel, and matched gearbox is often recommended. The maximum speed at nominal voltage (12 V for N gauge, 8 V for Nm gauge according to NEM standards) should not significantly exceed the prototype's maximum speed. This allows for slow shunting manoeuvres, especially when used with DCC. A locomotive must have flawless running characteristics before being digitised. A load-controlled decoder with precisely set parameters is also required to enable both slow-speed operation and a prototypical top speed.

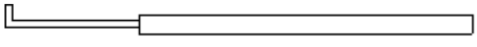
The weight of the cars should not deviate too much from the average. For N gauge, we recommend approximately 15 g for two-axle cars and approximately 30 g for four-axle cars to ensure consistent running characteristics within the train. Narrow gauge cars should weigh approximately 10 g, and four-axle cars up to 20 g.

Couplings

Various couplings are used, which are described in the following sections. Vehicles that are not separated during operation (multiple units, freight trains, fixed passenger car units) can also be connected with a different coupling (e.g., close coupling head or rigid coupling or magnetic)

FREMO-N and FREMO-N-RE Coupling

FREMO-N and N-RE currently still use the N standard coupling according to NEM 356. Particular attention must be paid to the correct height (coupling center 4.5 mm ± 0.5 mm above the top of the rail). Since no automatic uncouplers are used, it is recommended to shorten the uncoupling pin so that it does not catch on protruding parts in the track. The vehicles can be separated manually using the following uncoupling tool:



FREMO-N-Finescale Coupling

In FREMO-N-Finescale, the magnetic field coupling (MFK) is used as a standard coupling, which closely resembles the original screw coupling. The installation of brake, heating, and control line simulations is possible without interfering with the coupling's function. The compressive forces are absorbed by the buffers, therefore certain restrictions apply:

- Buffer length with base plate: 3.9 – 4.1 mm
- Buffer height above rail: 6.5 mm +/- 0.3 mm

The coupling hook corresponds quite closely to the prototype. On locomotives with closed fronts where the coupling loop can not be underslung only hooks are mounted. The loop of the wagon is used to couple in these cases.

The prefabricated (etched) steel coupling hook of the magnetic field coupling allows operation with a strong magnet without touching the vehicles. For this, the iron weight in the vehicles must be removed and replaced with another metal (lead, brass).

Alternatively, it is also possible to build your own couplings using fine chain The coupling hook should be designed to be compatible with the MFK.

The coupling is mounted centrally between the buffers. The height of the coupling corresponds to the height of the buffers. According to EBO 940, these may be between 940 - 1065 mm above the top of the rail (SO), which corresponds to 5.9–6.7 mm.

The distance from the leading edge of the hook to the buffer level is 1.8 mm.

Figure of an open wagon modified for fiNescale compared to original.

Coupling for Nm

The coupling resembles a tramway coupling with an extra loop that is hooked over the coupling of the next vehicle.

Wheel sets

Due to the Code 40 flexible track used on some modules, the wheel flanges of the vehicles brought to module meetings (this doesn't have to be the entire collection) must be turned down to a maximum height of 0.6 mm, otherwise the vehicles cannot be used without restrictions. The NEM 310 standard must be observed in the transverse dimensions. This applies in particular to the wheel set gauge, which must be at least 7.4 mm.

Turning down can also be done on a small mini drill stand using a file. The flange of one wheel of the clamped wheel set is first reduced in height to 0.6 to 0.55 mm. Then, to ensure smooth running over switch points and module transitions, the inside of the flange is chamfered towards the running surface. Finally, everything is rounded off with a fine file.

Wheel sets for FREMO-N

Tracks conforming to the fiNe-scale standard allow for an even more prototypical appearance of the layout. In addition to the reduced flange height of the N standard, the track widths are also reduced compared to NEM and brought closer to the prototype. This standard is based on the standards of the British 2mm Association, adapted to "continental" dimensions, i.e., the 1:160 scale with a 9mm gauge. Tracks and rolling stock conforming to N and fiNe-scale standards are not fully compatible. Interchangeability is still possible with track modules; however, this is no longer possible once turnouts are present. Rolling stock for operation on fiNe-scale modules must have appropriately modified wheel sets. The use of wheel sets from the Two-Millimetre-Scale Association is possible. The enclosed figure gives the cross section of a fiNe scale wheel, industrial production of a series is in research.

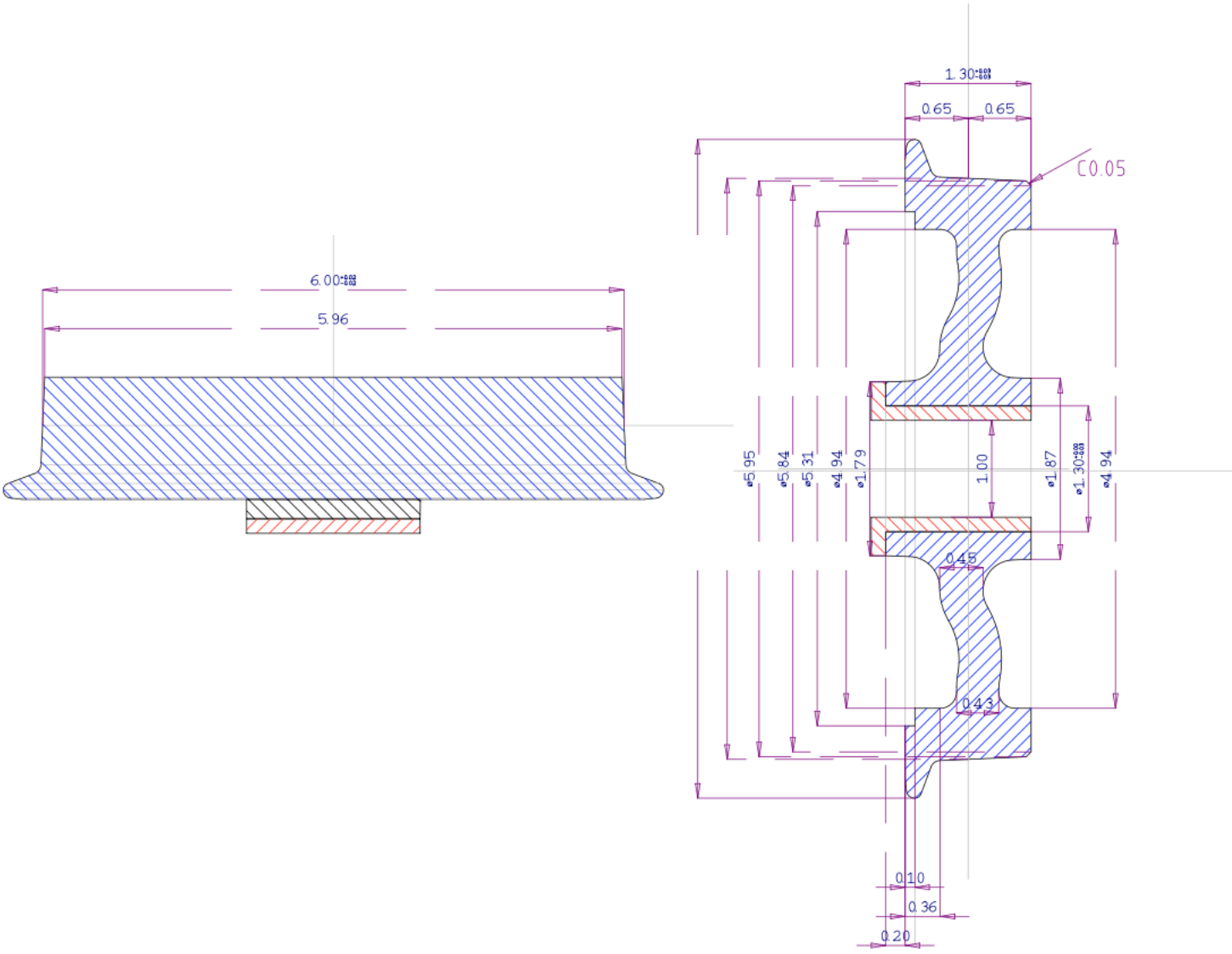


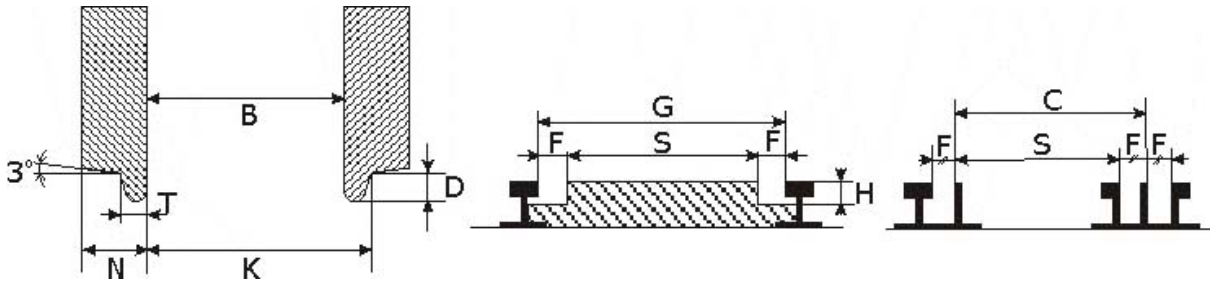
figure: Proposed wheel dimensions for fiNescale.

Wheel sets for FREMO-Nm

The wheel sets conform to NEM 310 for 6.5 mm gauge.

Wheel sets for Nm-Finescale

Nm-Finescale combines a precisely scaled track gauge (6.25 mm) with the finer wheel dimensions of N-FiNescale. This allows for finer turnouts and narrower chassis. Wheel sets for FREMO-Nm-Finescale are also compatible with FREMO-Nm track.



Wheelset dimensions

description	dimension	NEM	Fremo-N	Fremo-Nm	FS160-1435	FS160-1000	FS160-1067
nominal gauge width	G min	9.0	9.0	6.5	9.0	6.25	6.65
max. gauge width	G max	9.3	9.3		9.2		
check gauge	C min	8.1	8.1	5.9	8.5	5.75	6.15
between checks	S max	7.3	7.3	5.2	8.0	5.25	5.65
flangeway width	F max	1.0	0.8	0.75	0.5	0.5	0.5
flangeway depth	H min	0.9	0.6	0.6	0.5	0.5	0.5
check gauge	K max	8.1	8.1	5.9	8.5	5.75	6.15
back to back	B min	7.4	7.4	5.25	8.1	5.35	5.75
tread width	N min	2.2	2.2	1.55	1.3	1.3	1.3
flange width	T min	0.5	0.5	0.5	0.25	0.25	0.25
flange width	T max	0.6	0.6	0.5	0.3	0.3	0.3
flange height	D max	0.9	0.6		0.5	0.5	0.5
flange height	D min				0.25	0.25	0.25
railheight	R		code 40	code 40-code 32	code 40-code 32	code 32	code 32

Table: Dimensions of NEM, Fremo-N and FS160 standards

All dimensions in this table are in millimeters rounded to closest value of 0.05 mm. The dimensions in this table Nc (Cape track 1067 mm) is a proposal. For dual gauge track the rail height to apply will be defined by the main track rail height.

Notes:

The minimum gauge (9 mm) - 2x the flange width (2 x 0.3) mm - the back to back (8.2 mm) = track tolerance (0.2 mm = 2 x 0.1 mm). This dimension is also the maximum acceptable tolerance from ideal dimensions due to manufacturing and mounting practicalities. The wheel set should be running free in all positions (wheel wobble + dimensional errors around circumference). Test criterium is the clear running through dimensional correct and error free point work. To define all dimensions and clearances with exact tolerances will

lead to dimensions that can not be manufactured and measured with the normal hobby equipment of the average modeller. This extreme accuracy is not necessary as the above maximum tolerance of 0.2 mm is kept. The above dimensions have been eased to make modelling more practical and are based on the 50 years engineering practice of the 2 mm Scale Association.

A dimensional drawing for the wheel standard can be found in earlier chapter on wheels. For practical reasons the wheel standard was chosen to be compatible with 2 mm Scale Association. However if you choose to produce your own wheels take notice that the recommended wheel profile according to the Fremo Handbook has a flange height of 0.4 mm, which leads to less acute angles of the flange, more close to the prototype, see drawing. This results in an easier way-finding in critical areas such as found at the tip area of point tongues. This type of flange has preference when NEM wheels are reduced in width by means of a lathe to the nominal flange width of 0.3 mm. About 0.2 mm is used in the tapered section to the tread. This is also the range necessary for tolerances in track lining out (transverse offset) between modules and in the range of tongues in point work. Smaller flanges are possible (min. about .2 mm), but the track keeping properties due to dimensional track failures will be low. The wheel set will show a strong tendency to climb over obstacles when the track is not constructed without dimensional errors. The actual flange tyre radius and conus are not very critical to collected experience. Particularly the surface flatness of the tapered section of the flange is important and the width of the tapered section should preferably have a ratio of about 2/3 to the total flange width. The flange-tyre radius should not be too large. The ideal track play is circa 0.1 mm. With a flange-tyre radius larger than 0.15 mm the wheel set will be running on the radius section and this will lead to a continuous rocking of the chassis along its main axis. Particularly "Fleischmann" wheels have a very large radius between flange and thread. When you use these as semi-manufactured product than this radius should be machined. When the transition looks as an obtuse angle it is about right.

The working range of the flange height lies between 0.25 and 0.5 mm. The flange height bears a relation to wheelbase and frame construction. Frames with fixed axles and long wheelbases profit from the maximum flange depth in order to compensate for track failures such as uneven track. Short wheelbase frames and equalised or compensated axle techniques that guarantee track-wheel contact under all track circumstances may use wheel sets that are close to prototypical dimensions. Different flange depths may come to use within a

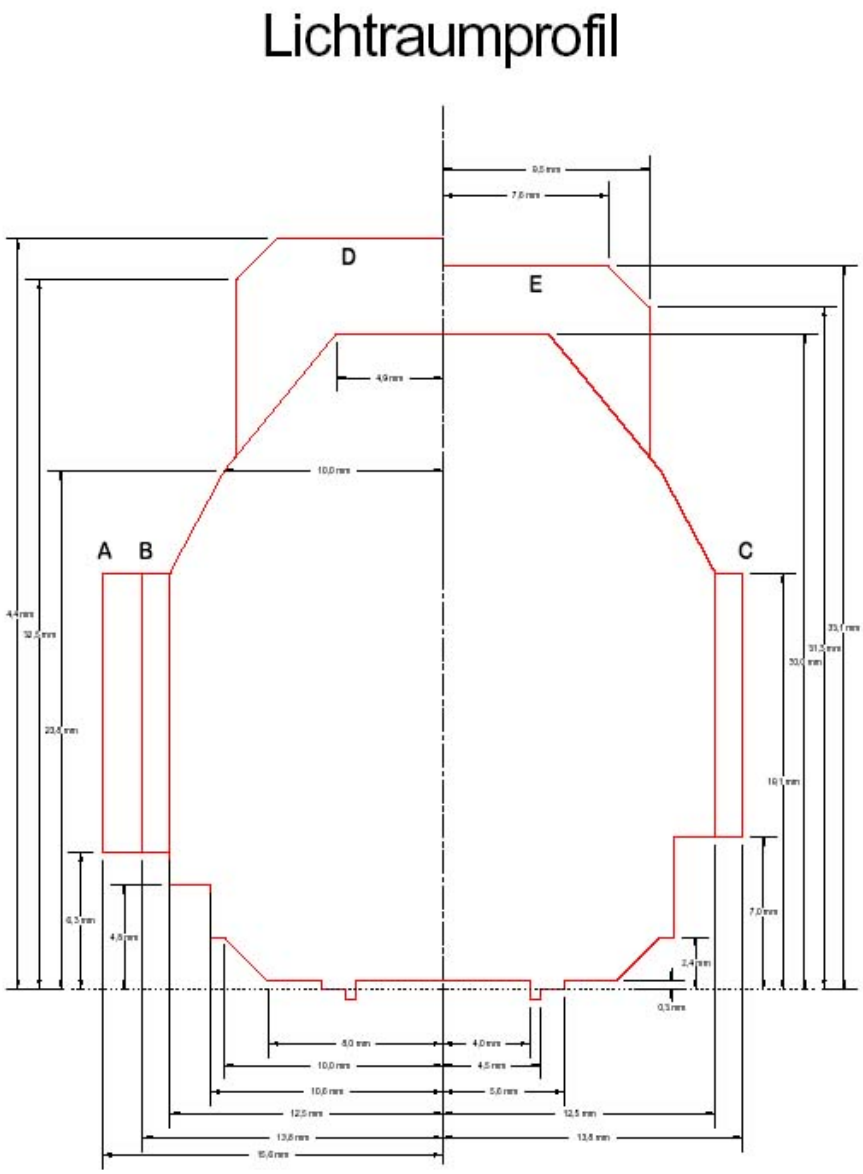
single chassis depending on the application. Particularly the highly visible pony and bogie wheel sets can often profit from finer flanges due their independent suspension from the main chassis. A wheel with a prototype tyre with a width of .9 mm will not run faultless over turnouts and crossings.

description	standard gauge	narrow gauge
length	2600/16.25	1800/11.3
width	260/1.6	260/1.6
distance between sleepers main	600-650/3.8-4.1	650/4.1
distance between sleepers sub	650-750/4.1-4.7	
min. distance between tracks	3500/22	
reccom. distance between tracks	4000/25	
reccom. distance for 'rollwagen' operation	4500/28	

Table: track and sleeper dimensions for continental UIC railways

This table shows the recommended sleeper dimensions for UIC track for standard gauge as well as for narrow gauge of 1 m. The first number is the original dimension and behind the slash the scale length.For modelling the thickness of sleepers is not important and thus not quoted here. For point work the length of the sleepers is different, but contrary to UK practice the cross dimension is equal to normal track sleepers. The distance between sleepers as well as between tracks differs for main railways and secondary railways. The largest sleeper distances are found on secondary tracks on stations and light yards. Also the type of traffic can influence the distance between tracks. 'Rollwagen' traffic concerns the transport of standard gauge wagons on narrow gauge lorries, a common form of transport for rural areas in the first half of last century on the continent.

Loading gauge



The above sketch is based on the UIC dimensions. This profile is divided into 2 halves each with its own interpretation. The left half is for lines with passenger traffic, the right half for all other tracks. The shown extensions B and C for tracks in stations which may have various obstacles on station platforms, and signals between tracks, tunnel entrances, bridges and viaducts in the open which cannot be easily dismantled. For all other obstacles like signal and lighting masts extension A is valid. This profile is used for over-wide transports. The extensions D and E are for tracks with catenary support structures. There also exists UIC gauge dimensions for wagons and motive power, which fit this loading gauge.

Operation

The modules can, in principle, be operated in any way:

- at home alone (even in a small apartment) with, for example, just a small (terminal) station and a hidden yard,

- with a few other operators, for example, in an attic or in a clubhouse or similar premises,

- at public model railway exhibitions as demonstration layouts with dense train traffic,

- at module meetings with timetable operation, train reporting procedures, freight car circulation, and prototypical shunting operations.

The last point is certainly the most interesting and demanding, although the boundaries are, of course, fluid. By "operation," we mean the simulation of operations on a given network as close to the prototype as possible. This includes information about the economic structure of the chosen (or imagined) prototype, use of the prototype's operational regulations (where applicable), operation according to a timetable, application of a common (model) time, control of freight flows using suitable instruments, and several other points. The last point is certainly the most interesting and demanding, although the boundaries are, of course, fluid. Even at FREMO meetings, there are periods of "free running," meaning running without a timetable.

The operating procedures described here correspond to those used by the DB (German Federal Railway) in Era III. Other, prototypical operating procedures are also possible.

Setting up the Layout

Based on the registered modules (module number), the submitted drawings (1:10 scale paper or DXF with 1:1 scale), and other information (module registration form), the meeting coordinator compiles the layout and displays a sketch in the room. Arriving participants receive instructions and set up their own modules, roughly adjusting the height. At this stage, the various modules should not yet be connected to form larger units. The coordinator will designate a starting point for the setup, usually a staging yard or a larger station, that is difficult to move. Now the individual modules and module groups are assembled according to the plan. In the event of unforeseen, site-specific arrangement changes, smaller track modules, especially curves, may

sometimes not be installed initially, but kept as a reserve to compensate for errors in the drawings.

Once the critical points (pillars, doors, and windows) have been addressed, there is usually a free track section where these modules can then be installed. It has been shown that modules with small curves (5° - 15°) and large radii can prove particularly valuable to the coordinator, as they allow for easy adjustments to the available space. To minimise deviations, especially when planning large gatherings, precise measurements of the module dimensions are essential. The recorded data is entered into a module database.

When modules from different prototype railways are integrated into a modular layout, it is important to ensure, where possible, that orderly transfer traffic is possible. With private railways, the transfer often takes place at a shared station with the state railway. Through (passenger) trains are also possible. Freight trains should have change of loco at this station. If different state railways meet, a border station must be designated where (at least as a rule) the locomotive change takes place.

Train Reporting Procedure (Zugmeldebetrieb)

All operating positions must be staffed, if necessary with a train dispatcher as well as a locomotive driver and/or shunter.

Train operations are carried out using a simplified train reporting procedure so that no one is surprised by a train suddenly waiting in front of the entry signal. A train is offered with:

> Here station xx, Will train 1234 be accepted?

Acceptance is done with

> Train 1234 yes

otherwise

> no, wait

All further procedures, such as feedback, etc., are not required here. We want to have fun and not get bogged down in regulations. Using a telephone system for this purpose is best. An alternative to telephone is the RGZM system using a Wlan network and computer to report trains between stations.

Train Control (Zugleitbetrieb)

With low traffic and small operating locations, it is advisable not to staff every station with a local train dispatcher. A train dispatcher regulates traffic on the

controlled line. Only he can grant trains permission to proceed, as they have access to the relevant timetable documents and an overview of the operational situation.

Trains are accompanied by train crews (engine drivers, and possibly train conductors).

The train conductor submits a request for a move to the train dispatcher:

> Is train 1234 allowed to proceed to xx?

The train dispatcher grants the train driver permission to proceed:

> Train 1234 may proceed to xx
>
> (and stops at the trapezoidal marker)
>
> (and crosses paths with train 4321)

Crew-Caller

In normal operations, the tasks (train dispatcher, train driver, train controller) are assigned for a full timetable day. Division into multiple "shifts" is also possible, allowing each individual player to take on several roles during a timetable and thus experience varied operations. With the crew caller system, there is a timetable for each train. These timetables are issued to the players by the crew caller and returned after the task is completed. This achieves a high degree of flexibility. Individual participants can manage their time more freely, yet reliable operations are still possible. In exceptional cases, train services may be canceled if there is too few personnel available.

Execution at Meetings/Operations

To ensure the smooth execution of the operating procedures described above, in addition to some concentration and enjoyment, fully functional modules and vehicles are essential.

Non-functional vehicles will be returned to the owner with a damaged vehicle card (see Part 4 "Vehicles").

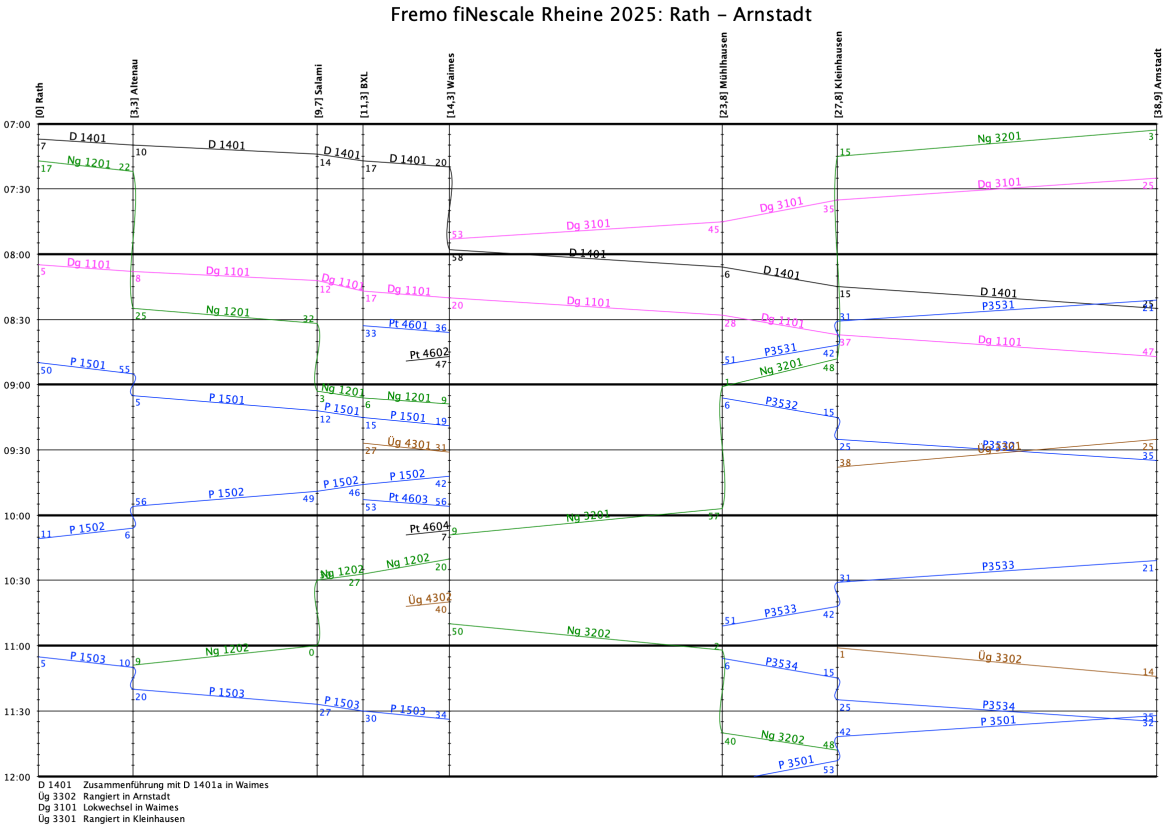
The owner of a non-functional module will also be notified of the malfunction and asked to rectify it. If the defects have not been repaired by the next meeting, the module should not be registered, or its inclusion in the schedule should be suspended until it is repaired.

Nothing should be placed on top of the modules with scenery. Appropriate storage options for hand controllers, vehicle cards, timetables, etc., should be

provided on or under the module. Besides protecting against wear and tear/ damage, this also ensures that the modules do not detract from their visual appeal.

Shunting operations will also be carried out in the staging yard using a shunting locomotive. Fingers should be avoided whenever possible, among other things, to prevent fouling the paintwork of the valuable vehicles – besides it's simply more fun to do "proper" shunting in the staging yard!

Timetable



Fremo fiNescale Rheine 2025 - Zugplan Waimes

		Waimes								
Zug	Von	AN	Rang.	AB	Nach		spur	an/IN	fertig	an/IN	fertig
D 1401a	Montzen	07:15	Ja				11→3				
D 1401	Rath	07:20		07:58	Arnstadt	D1401a aufnehmen	2→3→2				
Pt 2601	Montzen	07:34					11→3→12				
Dg 3101	Arnstadt	07:53		08:23	Montzen	Lokwechsel	3				
Pt 2602				08:00	Montzen		12→3→11				
Dg 1101	Rath	-		8:27	Arnstadt	fahrt durch	1,2				
Pt 4601	Wasserburg	08:36					1				
Pt 4602				08:47	Wasserburg						
Dg 5101				09:00	Montzen		3				
Ng 1201	Rath	09:09	Ja			Lok 1202	3				
P 1501	Rath	09:19				Lok umlaufen	1				
Üg 4301	Wasserburg	09:31	Ja			Lok 4302	3				
Pt 2603	Montzen	09:34					11				
P 1502		09:42			Rath		1				

The timetable should be based on the prototype conditions of the modules used. It has proven useful to create at least a graphical timetable and station operating instructions for the timetable. The graphical timetable, as the basis for all operational planning, is the quickest to create and provides an overview of the entire operational process. The station timetable specifies the exact arrival and departure times, the tracks to be used, and any other relevant notes. Shown are examples of time table and station timetable and manual timetable.

D 1403

Strecke

Fremo fiNescale Rheine 2025: Rath - Arnstadt

gültig vom 16.10.2025 bis 19.10.2025

Zusammenführung mit D 1403a in Waimes

Lage	Betriebsstelle	Ankunft	Abfahrt
0.0	Rath		15:07
3.3	Altenau		15:10
9.7	Salami		15:14
11.3	BXL		15:17
14.3	Waimes	15:20	15:58
23.8	Mühlhausen		16:06
27.8	Kleinhausen		16:15
38.9	Arnstadt	16:25	

Manual timetables are required when train crews are employed in addition to train dispatchers. With the crew caller system, a manual timetable consists of only one sheet for the respective train. If train crews are scheduled for a longer period (a full timetable day), this becomes a booklet with information on several trains, containing the complete schedule. Additional timetable

documents can include rolling stock schedules for locomotives and, if applicable, passenger cars, as well as freight train formation plans.

Freight traffic should be oriented according to the goods predominantly loaded at the operating locations and the wagon types required for this purpose; an overview of this should be available at the operating location modules and provided to the respective planner as basic material before the meeting planning.

Model Time

The time according to which our timetable operations are carried out is not standard time. This has several reasons. Firstly, it is pointless to recreate a specific time on the modules at a specific time. Secondly, a complete timetable session (= 1 "model day") should not last too long so that the whole thing remains enjoyable. A duration of 2 to 3 hours is still possible without a noticeable decrease in concentration. To ensure that no random section of a timetable is run during this time, this period is referred to as 1 "model day". If the timetable then runs from approximately 6 a.m. to midnight, this results in a time reduction of approximately 1:6. A less stressful option for the players is the crew caller principle, where each participant can decide whether they want to take on another task immediately or take a break. This makes a total timetable of up to 3 hours easier for the players to manage.

This time reduction is set using fast clocks, which have either a fixed time reduction setting or a free scalable adjustment.

When creating a timetable, the time reduction must be taken into account, as well as the actual travel times of the trains at the assumed speeds. Shunting times should not be too short. 10-15 real-time minutes are just enough to drop off or pick up a few cars from a well-formed train in a small station. In stations built without length reduction, a shunting operation takes almost as long as in real time.

Wagon cards and Waybills

The wagon card in the center showing its waybill pocket with inserted waybill and 2 other wagon cards. The card on the left is an original printed card in Edmondson format ratio of 46 x 70 mm from the early nineties, hand drawn in black ink with a Rotring pen using a template, over 30 years old thus it can be considered antique by now. The cards are now printed at home on the desktop printer, complete with photo for easier identifying the particular wagon.

Waybills

In transport each wagon needs a cargo and a waybill which states the destination, receiver, sender, contents and weight and pointers to suitable wagon category. Of course the cargo can be nill if it concerns a request for an empty wagon to be loaded at a specific railway yard. All wagons need a wagon card which holds important details about the wagon such as its number and this card is also equipped with a pocket for holding the waybill. In real life every wagon has on each side a waybill cage, each one holds a copy of this freight paperwork during transport. Useful dimension of the waybill are 66 x 42 mm and should fit in the pocket of wagon card. When a train arrives in a station than all wagons are checked on destination if particular wagons should be shunted out of the train or should carry on in the same train. Sometimes errors occur but the waybill stays with the wagon and a falsely shunted wagon is shunted into the next train towards its destination.

With this system, the traffic with freight wagons gets sense. The cars would otherwise only be pointless run back and forth. In addition, this ensures that

the necessary and meaningful for a station wagons and cargo actually appear there, in a number that – depending on the freight orders placed – lead neither to boredom nor to severe stress and crowded tracks.

An example of a waybill for fixed traffic of coal between Splitveld Fabriek and staging yard black.

Zielbhf.		Zielbhf. Splitveld Fabriek	
Empfänger N.V. Zwartgoed		Empfänger BELFER S.A.	
Wagen-gattung O	UIC Typ E	Wagen-gattung O	UIC Typ E
Ladung Leeg terug naar Waterschei		Ladung kolen	
Versandbhf. Splitveld Fabriek		Versandbhf.	
Versender BELFER S.A.		Versender N.V. Zwartgoed	
Ladehinweise 4 wagens		Ladehinweise 80 ton = 4 wagens	

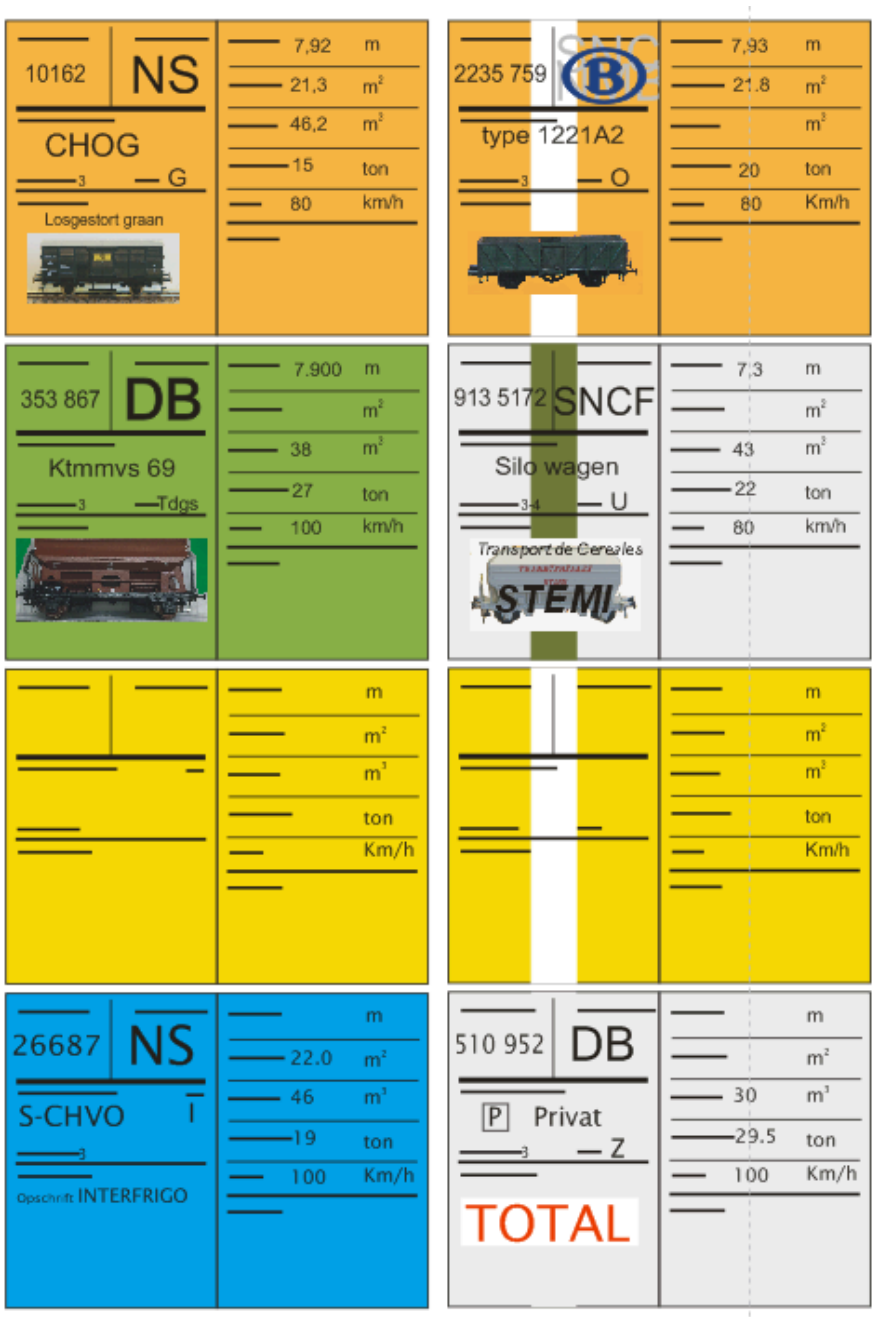
Fixed traffic waybill

Waybills can be used single for one way trips, that can be either half of the above form. However wagons may also be used for round trips in fixed traffic between a location and staging yard. Such waybills generally have two sides, one for the shipment of the load, (the front), right half in above picture, and one for the wagon return trip to the staging yard, (the back), left half in the above picture.

In this example, the destination Splitveld Fabriek requires a fresh load of coal and ordered 80 ton coal. Therefore they supply the fiddle yard with a set of waybills for the required load, in this case for 4 wagons, also because it concerns open wagons with a visible cargo, they have to supply the 4 loads of coal to transport. In the staging yard a set of suitable wagons is then selected and loaded with the cargo and added to a freight train that will serve Splitveld Fabriek at some time in future. The waybill contains some specific boxes to fill in, such as which wagon category is required, here "O" or UIC "E" and it states

the receiver such that the train crew will know where to deliver the wagon in the yard, in this case the connection of Belfer S.A., it further states to be loaded with coal, although that will be clearly visible of course in an open wagon, and its origin such that Splitveld Fabriek can trace where this particular cargo came from. It also has an area for notes at the bottom. This one tells that it is part of a 80 ton shipment existing of 4 wagons.

After unloading, the waybill is rotated and put back in the wagon card. Now it shows a black box as the destination station at the top and the load



description says it are empties. This means that the freight wagon must be

transported to the black staging yard in order to reach its fictional destination. If this box is uncoloured (white) it can be returned to any staging yard for general use, normally this is the closest staging yard, but this may depend on specific requirements on traffic imposed by the timetable and traffic routes set-up for the layout arrangement.

Depending on the size of the layout and the position of the staging yards it may concern long trips taking several runs of the timetable with the wagons travelling in different types of trains over the layout before they finally reach destination. For instance border crossing traffic may require first a local goods from origin, then an international freight train passing the border, followed by another local goods to destination. This process generally means that if you want to simulate a steady traffic flow of x wagons per day/timetable you may need several (sets of) wagons, 1 in the fiddle yard being loaded for delivery the next day, 1 arrival being unloaded and 1 full or empty somewhere in transport.

Staging yards

In real life cargo's are usually transported over long distances. However fiNescale arrangements have only a limited route length, thus we represent the rest of the world with staging yards. Generally there are 2 to 4 staging yards on the layout arrangement. In order to distinguish between different staging yards and make the traffic more interesting each staging yard is appointed a colour and this colour indicates the sort of traffic. These staging yard colours are reflected in the waybill in the colour of the destination box. There are 6 colours for the fiddle yards. For example, green is the color for agricultural products, brown for industrial areas, red for chemicals, black for mining products, blue for an overseas import or export and yellow for Mediterranean import and export products. Thus you can easily define freights that go "over the border", which may restrict your choice of wagon!

For waybills there exists an extra colour "white" which is specifically for local traffic between stations on the layout or return for general use to the nearest staging yard.

Staging yard colours

Colour	type of traffic	Sending	Receiving
black	Mining industy	coal, cokes, iron ore, pig iron, steelproducts, tubes	mining logs, chalk and lime
green	Agricultural goods	cereals, wood, animals, milk, flowers, vegetables, sand	tractors, combines, fertiliser, seeds
yellow	European Im/Export products	wine, citrusfruit, marmer, furniture, cognac , wood, ore	harvesters, coal, fertiliser
blue	Oversea Im/Export products	oil, tropical wood, bananas, ore, fish, chemicals	machines, fertiliser, canned products, petrol, cars, chemicals
red	Chemical products	fertiliser, plastics, medicines, petrol	chemicals, oil, coal, liquid gas
brown	Industrial products	cars, freezers, washing machines, paper, tubing, cables	steel profiles, coal, chemicals, semi-finished products
white	Local goods or return for general use	all local goods	all local goods

Various waybill colours are used to send wagons back to their respective staging yards otherwise staging yards may get filled-up with wagons for which there is little use in that particular staging yard.

Wagon cards

The cards have a format of 46 mm width by 70 mm height and were originally printed on ~0.8 mm thick card. This can be represented by sticking the prints on thick drawing paper cut to the right dimension. Each wagon card has a front and back side. In use you will need the front of the card to identify the wagon. Here you enter the wagon number, owner company, wagon category and preferably a photo of the wagon. On the back you not only find various fields for the technical data of the prototype, but also a field for you as model owner with contact details and specifics such as markings on the wagon

bottom to help to identify ownership of the wagon. This side holds the waybill pocket, when in use the technical data is thus covered by the waybill.

Wagon cards are continuously handled during transport thus to give them a longer standing time laminating them in plastic helps. On the back of the card you need to attach a transparent pocket that can hold the waybill such as shown by the green wagon card in the photo on top. This lamination, including its pocket, can be easily made with self-adhesive transparent foil such as used for book covers.

Colours of wagon cards

To help identifying wagons, the wagon cards also have colours with or without coloured bands. There are 8 different categories, the most common category concerns covered vans in light (yellowish) brown, the open coal wagon has the same yellowish brown colour but carries a white band from top to bottom. Examples of wagon cards for various different wagons, made anonymous, thus add your own ownership details. These examples

Colour	Category	UIC Type	examples
brown	Covered van in standard form and specialties	G, H	goods van, wagons with sliding walls
brown **-white**	Open top in standard form and specialties	E, F	Open mineral wagons, open hoppers
green	Closed wagons loaded from above	T	wagons with sliding roofs, closed hoppers loaded via roof hatches
yellow	Flat wagons	K, R, O	Wagons with rungs, wagons with low side boards
gelb**-weiß**	Wagons for special loads	L, S	Wagons for heavy loads, coil wagons
blue	Refrigerated and isolated vans	I	Refrigerated wagons for fish, banana transport
light grey	wagons for liquid cargo	Z	tank cars, liquid gas and other chemicals

Colour	Category	UIC Type	examples
light grey-**green**	Other wagons	U, P	Silo wagons, wagons with compressed air connection, private owner wagons

were made with Corel Draw. Similar files can be made in Inkscape, an open source programme that can be downloaded from internet, Inkscape can import .cdr files such files can be saved as .svg.

With this part of the standard, we finally get to how-to. The requirements from the preceding parts are implemented and installed in a modular box. The modules are designed to be so robust that they will still function even after frequent assembly and disassembly. They also should look good. Nevertheless, a refined design is possible and desirable. This includes the construction of the module box from high-quality plywood (waterresistant birch multiplex) using glue and dowels, with reinforcing brackets or strips in the corners. The rails should be attached to the module ends. The sleepers and/or screws must be soldered. Trees and buildings should be firmly anchored. Very large buildings may be removable and transported in dedicated boxes. The modules should be built in such a way that they can be laid on its side, without any damage, as this can make setup easier. The modules must be secured for transport. There are various options for this:

- complete transport cases offer ideal protection (also against dust, etc.), but are complex to build and require a relatively large amount of space (e.g., during a module meeting) if they are not used as module legs.

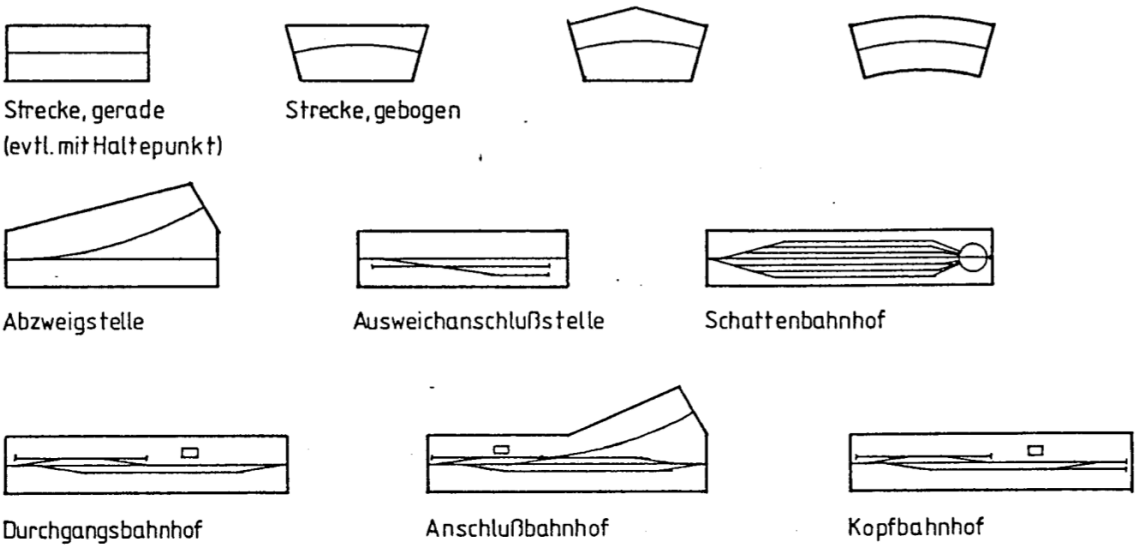
- Transport boards allow two (or even three) modules of identical dimensions to be stacked on top of each other. The modules are attached to the transport boards using standard screws.

Each module should have assembly and operating instructions so that even "strangers" can assemble and, above all, operate the module.

Modular types and forms

We distinguish between track modules and operating module modules. Operating module modules are stations (Bf; this also includes staging yards), stops (Hst), junctions (Abzw) and passing loops (Awanst). The modules can be of any length. They can be straight or curved.

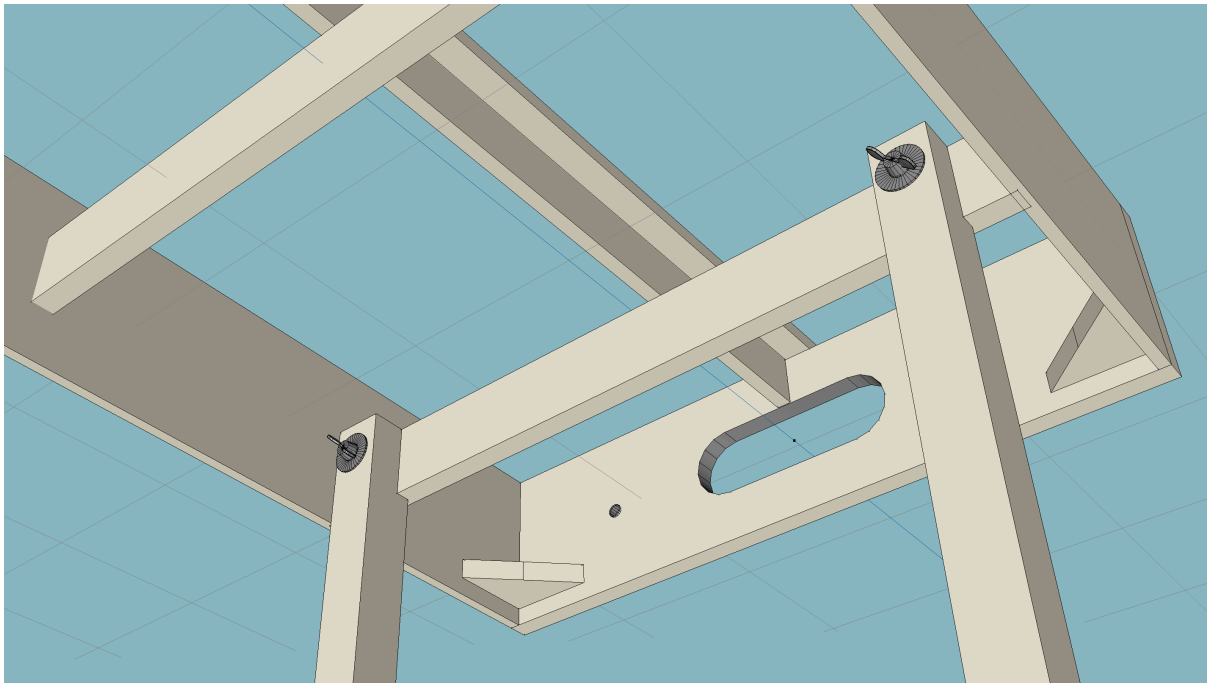
The length is primarily determined by ease of handling. For transport in a car (estate) and carrying by one (or possibly two) people, a length of approximately 1 meter (max. 1.20 meters) has proven practical. The modules should not be shorter than approximately 80 cm, as they may not be stable



when very short. Each module should be able to stand securely on its own legs to ensure a smooth setup of the arrangement.

Module boxes

The module box consists of standardised end profiles, longitudinal profiles, the trackbed, and cross members. Lightweight, warp-resistant materials should be used. Multiplex wood is recommended, with a minimum thickness of 12 mm for the end profiles and 6 or 8 mm for the side panels. Waterresistant birch plywood is a favoured working material.



The trackbed should also be made of at least 8 mm thick plywood in T-bone construction to prevent the track board from warping. For weight reasons, the rest of the landscape substructure should consist of rigid foam. (e.g., Styrodur, this is also a good material for undulating your landscape). The side panels and the track bed should be connected by cross braces at least every 40 cm.

The frame must be manufactured without distortion, i.e., it must lie flat on a level table. The end profiles must be flat and perfectly vertical. The track must meet the end profile at a precise right angle, both horizontally and vertically.

This can be checked with a small mirror. The trackbed with ballast shoulder of wood is fitted between the end profiles so that the top of the rail is exactly 58 mm above the screw holes. It is recommended to drill the screw holes only after the track has been laid to ensure precise dimensions. Cork should not be used in the construction of the trackbed as it too soft and deforms.

The modules are connected using 2 M6x40 wing screws with large washers and wing nuts. Wing bolts and wing nuts should preferably be of the flat German DIN type and not the American type with sharp edges. Please do not use hex, machine, or other screws. Anyone without tools should be able to tighten the screws by hand. Each module owner must provide at least one connection kit.

All exterior surfaces should be painted brown (RAL 8011 nut brown, matte or satin).

If no use is made of waterresistant plywood then the inside of the module box should also be painted to prevent warping due to moisture absorption. The uppermost part of the end profile should be painted in a green tone similar to the surrounding landscape color to avoid visual inconsistencies in the transitions.

Each module should be labelled with the module name, module number, and the name of the creator. The owner's name must be marked. If the marking is applied external sides, it should only be placed at the bottom edge of the module box to avoid disrupting the uniform appearance.

End profiles

The modules must be fitted with standardised end profiles. The dimensions that must be precisely adhered to for proper functionality are underlined in the drawings. All other dimensions serve for visual compatibility and may therefore be modified in exceptional cases. The end profiles are symmetrical so that the modules can be rotated 180° if necessary. This solution is more advantageous than an asymmetrical profile shape, which imposes greater restrictions when

setting up a modular arrangement. Therefore, unlike other module standards, there is no designated north and south side. If a north or south

side is occasionally mentioned (e.g., in the electrical section), the south side refers to the side that emerges as the "front." The flat shape of the end profiles allows for considerable freedom in terrain design. Whether a cutting, plain, or embankment is entirely up to the builder. This particularly simplifies the accurate reproduction of prototype situations. It is therefore not a purely "flat terrain module"; some variation in the terrain is highly encouraged! If other end profiles are used, a complete module group with the standard flat end profile should always be brought to the meeting.

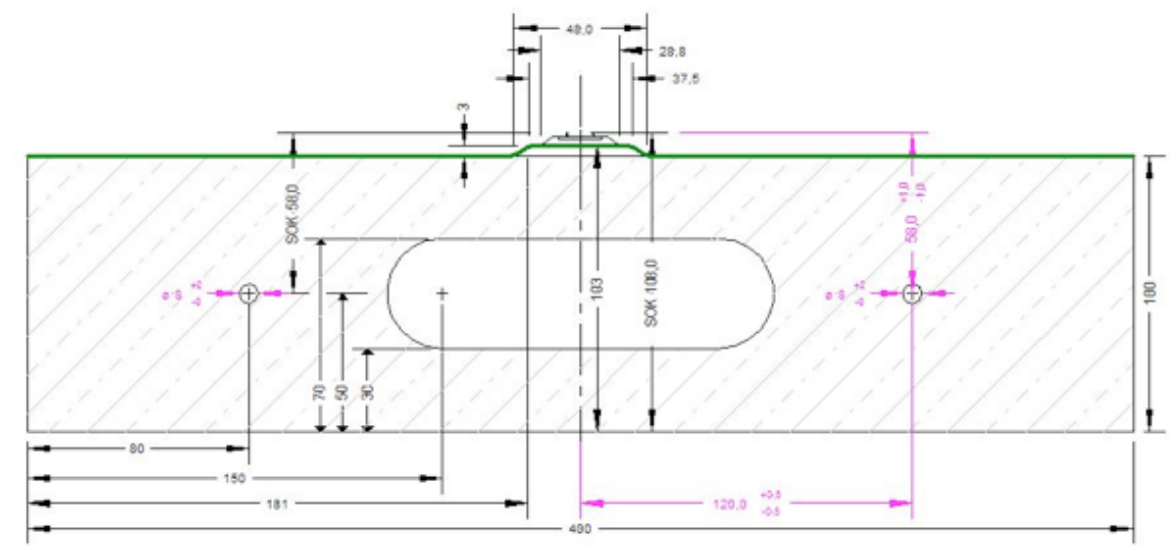
A different module width (larger or smaller than 400 mm) is only recommended inside stations/module groups.

The profiles must be cut from at least 12 mm thick plywood according to the templates. You can, for example, have rectangular sheets cut to size at a hardware store or carpentry shop and then finish them accordingly, or you can purchase ready-made profiles. A guide for drilling the holes after track construction is available from a FREMO member. Where a connection between single- and double-track lines cannot be made in a suitable station or

junction, the end pieces can, if necessary, be joined offset by 12.5 mm using screw clamps.

End Profile N 90

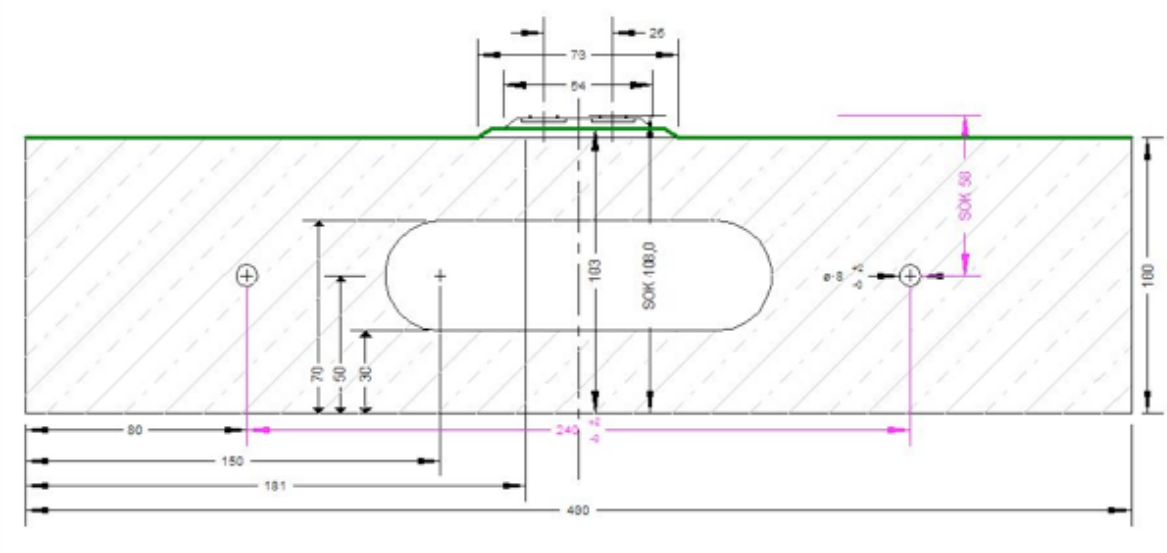
This end profile is the “classic” form of the FREMO N end profile. The vast majority of modules are equipped with this end profile. It is characterised by simple and clear dimensions and a low track embankment.



End Profile N 90-2

The double-track version of the N-90 end profile has also been used successfully for many years. Particular attention must be paid to maintaining a precise track spacing of 25 mm. For beginners, we recommend not starting with double-track modules right away, but first gaining practical experience building single-track modules.

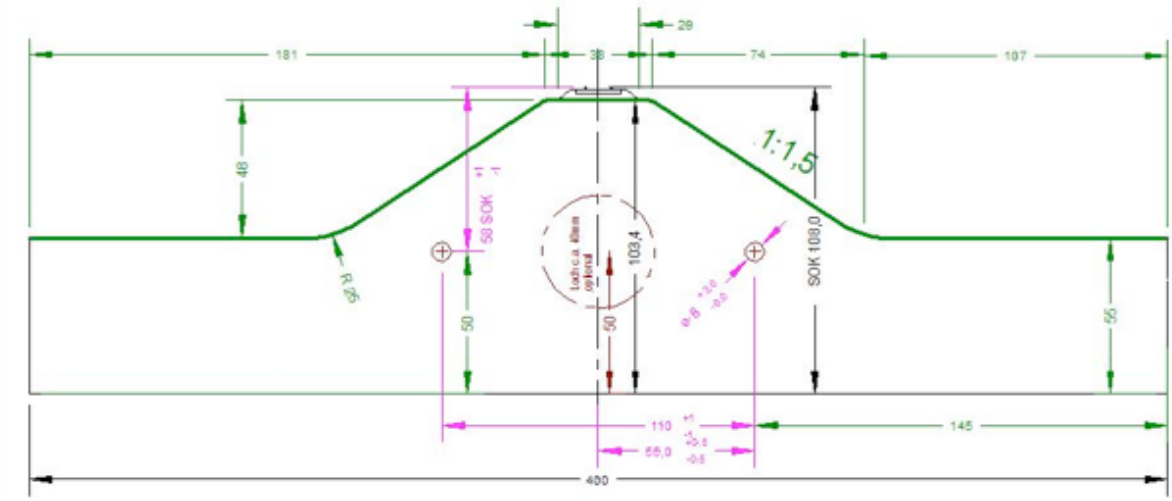
It may be advisable to add two more holes, offset by 12.5 mm each, in addition to the two regular holes for the connecting screws (120 mm from the center of the track). This would allow for a connection to single track modules if

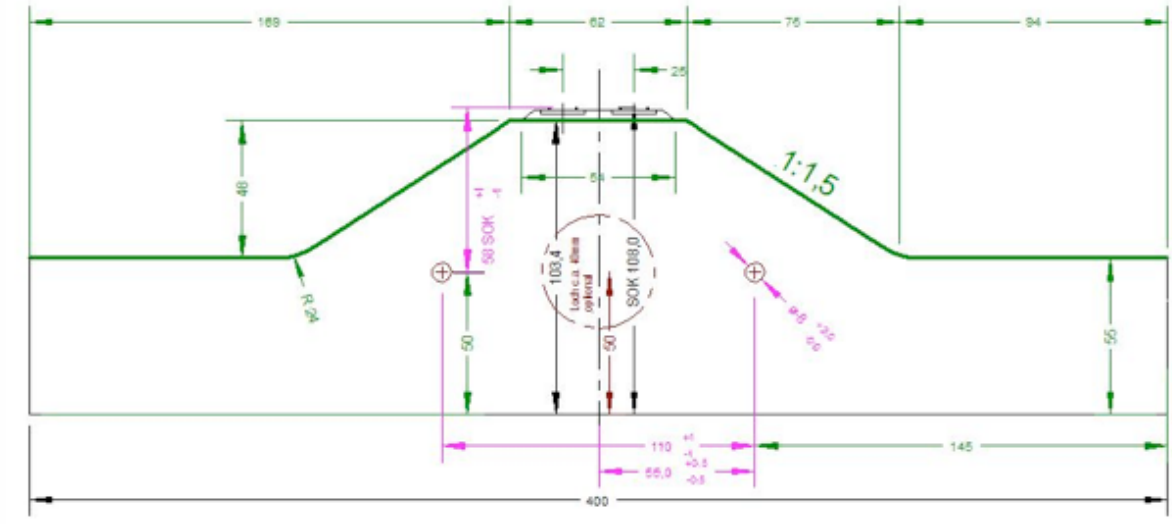


necessary, which would otherwise require clamps.

Dam profile

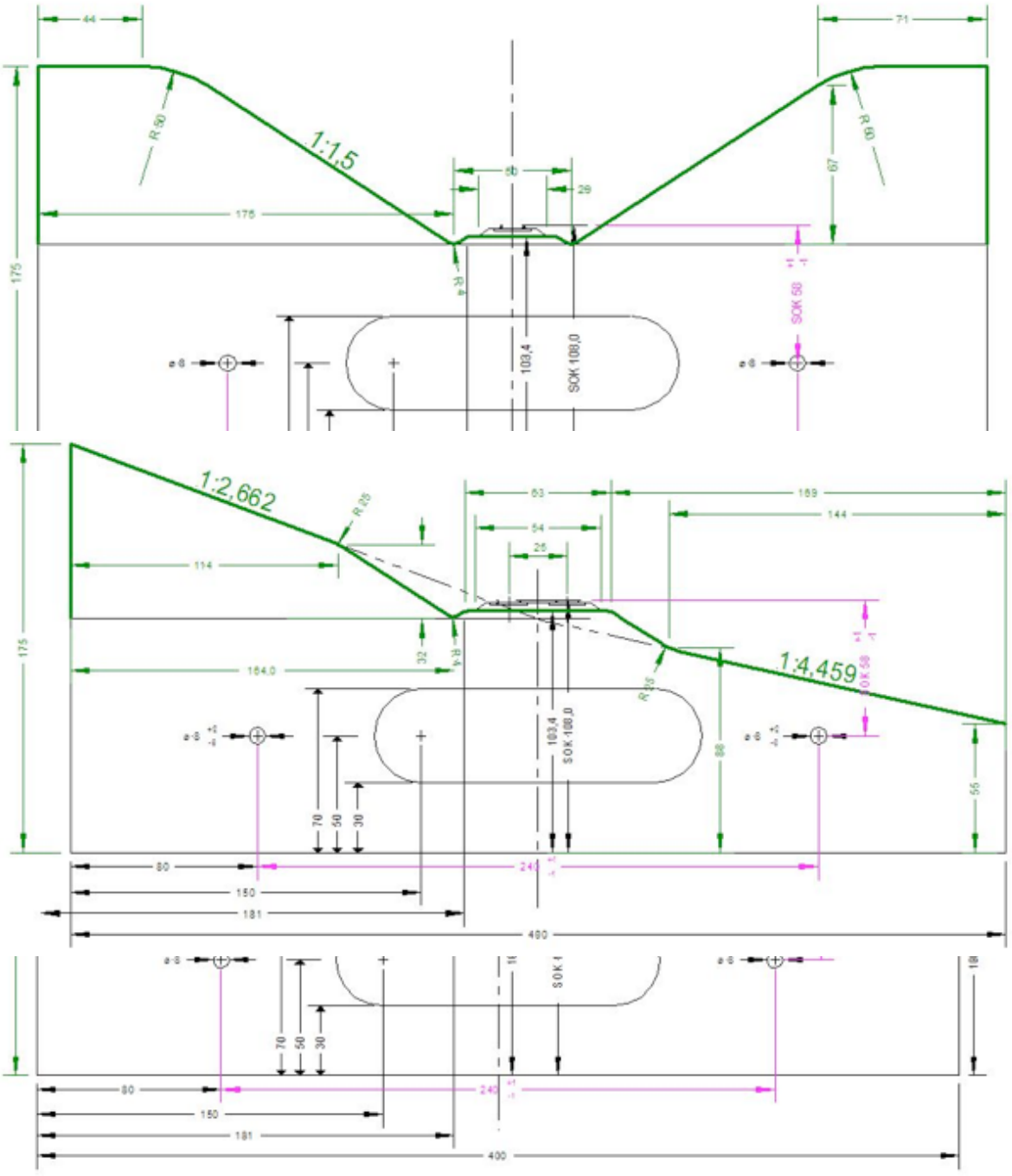
This profile represents a railway embankment. This profile should only be used within closed module groups because technical compatibility with the standard profile is not guaranteed, so connections can only made by using clamps when necessary.





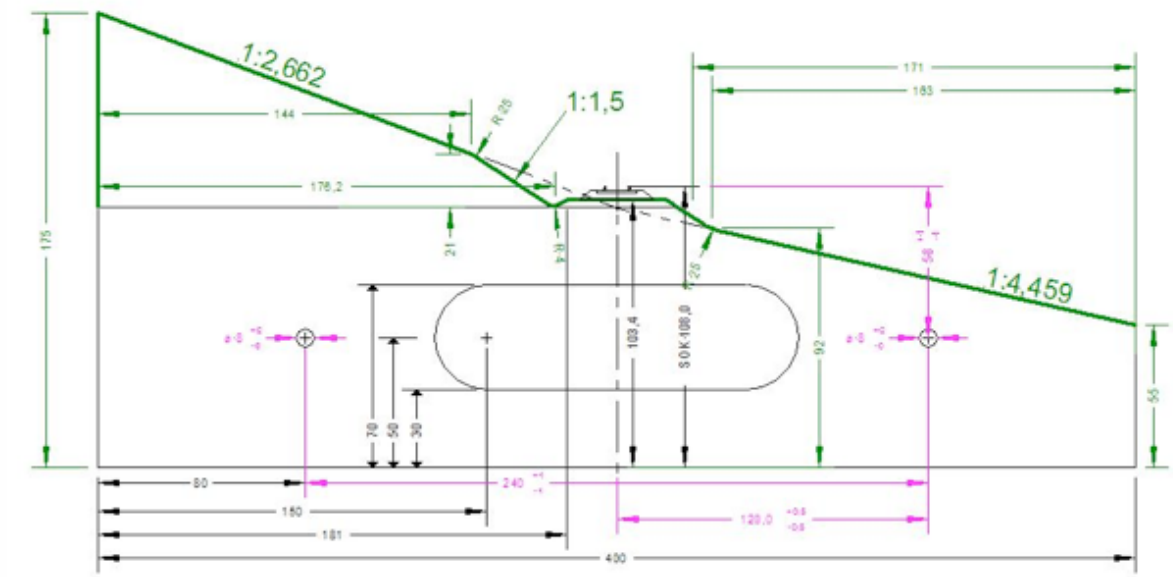
Cutting profile

This profile represents an entrenchment. This profile should only be used within closed module groups. Technical compatibility with the standard profile is ensured.



Slope profile

This profile represents a slope. This profile should only be used within closed module groups. Technical compatibility with the standard profile is ensured.



End profile Nm-90

The Nm-90 profile represents the narrow-gauge version of the N-90 profile. Apart from the track gauge and the width of the track bed, there are no changes.

Module height

The nominal height of the modules is 1300 mm between the top of the rail and the floor.

Experience shows that the chosen height is ideal for operating the model railway with a handheld controller while standing (and walking!), allowing for eye-level observation of the trains. Especially in larger and more complex layouts, it also simplifies or even makes possible the ability to "dive under" the modules. If the train dispatcher wishes to sit occasionally, a (foldable for transport) bar stool can be used.

Module legs

Each module must be able to stand freely on its own height-adjustable legs. Therefore, two pairs of legs are needed for each module. Anything else, such as only one pair of legs at one end or even in the middle, has proven impractical and hinders assembly. For this reason, the module length should not be too short (at least approximately 80 cm). An exception to this is complete modular station layouts consisting of several parts. Here, a different leg arrangement can be chosen depending on requirements, but it must always guarantee stability.

The feet must be designed so that the required module height of 1300 mm can be adjusted to compensate for uneven floors. For this purpose, the leveling screw (e.g., a base adjustment screw from a furniture fittings supplier) must allow for an adjustment of at least ±10 mm. If a slope is planned within a module, the corresponding section must also be built and brought to the meetings to avoid problems with the module height of subsequent modules.

The base should be braced with diagonals or similar to ensure that the module stands without wobbling. The module feet can be assembled and connected to the module according to the following construction, for example:

Approximately 15 cm from the end of the module, crossbeams are installed in the module housing to stabilise the module and support the legs. Holes with a diameter of 7.5 mm are drilled into these crossbeams 20 mm above the bottom edge of the module (for standard height) at intervals of 320 mm (for standard module width), and M6 threaded inserts are inserted into these holes.

The module legs consist of wooden slats (approx. 30 x 30 mm) with height-adjustable feet (adjustable by screws) and a standard length of 1232 mm (1300 mm SO height - 108 mm module box height + 40 mm for mounting within the module). The feet must be a maximum of 360 mm wide at the top to ensure they fit easily within the modules. 6 mm holes (larger if the spacing is not exact) are drilled 20 mm below the top edge and at 320 mm intervals. The feet are attached to the module box through these holes using wing bolts. See also the figure of a standard module in the appendix at the end.

If the module widths differ, the feet can also have a corresponding width. Other designs for the module legs are of course permitted. They should be as stable as possible and must not pose a tripping hazard (e.g., protruding feet on the sides).

Equipment

Each module includes the necessary connecting screws and corresponding cables, which should be securely attached to the module as described in Part 7. It is recommended that these parts, like the vehicles, be color-coded. Each operating location must bring the following electrical equipment:

- Magnet for coupling uncoupling
- Power supply or Transformer (VDE compliant)
- Power cord, extension cord, multiple sockets (VDE compliant)
- Booster for digital operation
- Connection cables
- Loconet boxes with loconet cables

It is recommended to bring the following additional materials:

- Track cleaner
- Clamp spotlights for additional lighting
- Clock
- Clock timer

At least each operating module must have storage facilities.

These are:

- for hand controllers on the module box or leg, a wooden box with the following internal dimensions W45xT30xH45 mm

• At least one strip to hold wagon cards on the module box. It is better to have a separate storage area for each track, ideally holding as many cards as fit on track.

• A suitable, easily accessible surface for a telephone, possibly with a separate stand for a improved stability.

• For timetables, several storage options are recommended, preferably clips for DIN A4 height paper (but can also be attached to the outer edge of the module with adhesive tape if necessary)

• For unneeded or defective vehicles, tools, (vehicle) packaging, cargo, etc. adequately sized storage areas

Electrical side of modules, general

The electrical systems of the modules have evolved over time. Digital operation by DCC for completely unrestricted driving across the entire layout is the only remaining option. For this use is made of Loconet boxes with handheld controllers. The LocoNet specification and assembly instructions for the LocoNet boxes are available from FREMO. The LocoNet cable also carries the power supply for the handheld controllers – and a RailSync signal for the boosters.

Handheld controllers are used to control the locomotives. Almost exclusively, the FRED/FREDi's (FREMO's simple rotary controller) are used. Alternative are the newer wiFreds that operate over WLAN. All these are relative inexpensive to purchase, making it possible to have each locomotive used at a meeting a permanently assigned to a FRED. FREMO members can obtain instructions for building their own from kits via collective orders; otherwise, a version is generally also available ready-made unit.

Boosters/Digital station

Boosters must be adapted to the Fremo standards supplying 14V and maximum 2 A. The old Fremo design Spax booster is still in use, but has shown some restart problems after shorts when numerous soundloco’s are within its reach. These are originating in the Pic microcontroller particular the 12C508 is sensitive to this feature. These designs are not recommended for new layouts. For suitable commercial boosters there are instructions on how to set-up these for Fremo use. These can be found on the Fremo website and forum.

Various members bring digital stations to meetings but for home use members may have need for a small digital station. For this is the Fremo developed miniBOX is advised, further information on how to obtain these can be found on Fremo website and via Fremo forum.

Traction material

Digital operation by DCC for completely unrestricted driving across the entire layout is required. For this all traction material needs to be equipped with a DCC-enabled decoder and its own handheld controller (Fred,Fredi or wiFred). The handheld controller should be clearly marked to which traction material it belongs.

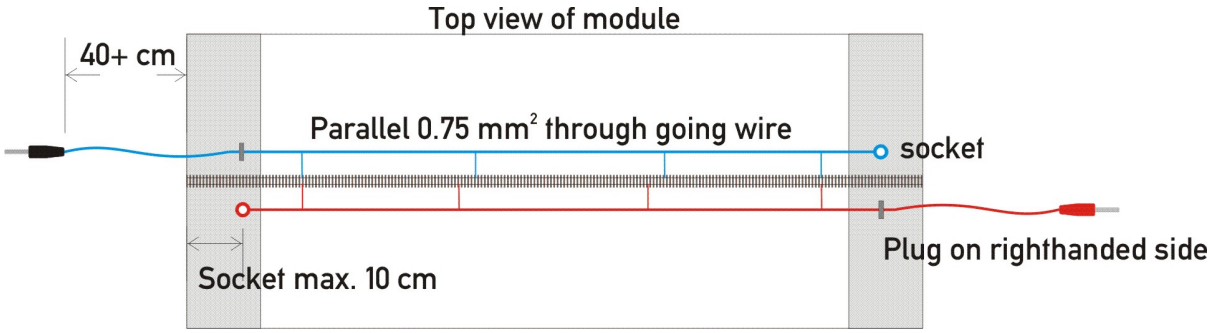
Sufficiently small decoders are available on the market today and new material is often already available as ready-to-run DCC versions. The decoder must be able to process "long addresses" (until 9999). The allocation of addresses is regulated by a central database. Handheld controllers for traction material with sound functions should carry a slip-in card on the back of the controller that describes the particular functions.

Cables, plugs and sockets for traction power supply

Each track module receives two continuous wires for powering the tracks. The wire cross-section must be at least 0.75 mm^2, preferably 1.5 mm^2, especially for digital operation. These wires are connected to the rails, with each individual section of rail having its own cable connection, as soldered rail connections are proven to be not durable.

The old analogue system used a north and south side of a module, unfortunately on most rural track modules this cannot be defined. The electrical connection between the modules is made using cables with 4 mm banana plugs (use high-quality banana plugs) and corresponding sockets.

When using modules rotated by 180°, this may involve to connect a red module socket with a black socket. Therefore the sockets must be clearly marked with their assignment to the corresponding rail. The geometric assignment of the cable or the socket for the rail is crucial, not the color!



To eliminate this confusion between the connections, the current standard is to permanently attach a cable with 4mm banana plug to the right hand rail on the right side and vice versa on the opposite side of the module. This system needs fewer loose cables as they are now permanently attached to the module. For double track modules each track should have its own set of connections i.e. 2 plugs and 2 sockets, there is no electrical connection between tracks in order to enable (future) detection for line block signalling between stations.

Sockets should be installed no more than 10 cm from the end of the module. A cable with connector must extend at least 40 cm beyond the module end. Loose cables must be at least 50 cm long. If cables are permanently attached to the module, they must be secured for transport, e.g. attached to the module with clothespins.

The electrical separation between two modules is achieved in the simplest way by a small distance. The rails must be slightly (~0.15 mm) spaced apart for this. For additional cables that are loosely routed through the modules during assembly (Loconet, telephone, Lan etc.), fixings (screw hooks, Velcro straps, etc.) should be attached to the inside of the long sides to prevent the cables from sagging excessively.

Signal shafts

In order to position block and entry signals for stations at appropriate distance modules can be equipped with signal shaft allowing removable signals. These shafts should be closed with a lid with appropriate scenic finish when not in use. These shafts have a dimension of 20 x 20 mm and can be 3D printed. These exist of permanently fixed shaft and an insert on which the signal is mounted. This allows to adapt the signals to specific railway company or to switch between arm signals and light signals for adapting to different eras. The currently suggested standard connection is by 8 pin RJ45 LAN socket that can be glued in the shaft. (standard connection proposal follows in the appendix).

However battery operation with control over Wifi via MQTT protocol are a more modern development avoiding pulling cables on meetings.

Dedicated signal modules disturb the continuous flow of the scenic landscape therefore these should be either as short as possible (~65mm) or better, implemented as standard module of about 60-80 cm with shafts and have its own set of legs.

Turnouts

The turnouts must have switchable frog polarity. The frog and subsequent track sections of turnouts are not powered via the switch blades, as experience has shown this to be unreliable. Additional switches or turnout motor drives (e.g. MTB or Tortoise) are to be used. Also turnouts should be compatible for digital operation thus the switch blade has the same potential as the corresponding stock rail to prevent short circuits caused by the wheel when the blade and stock rail are in contact simultaneously.

Train stations

The station modules must be equipped with a separate power supply, DCC booster and loconet sockets for FREMO handheld controllers these can be either the clamp-on boxes or inbuilt versions.

Signal boxes modelled on prototypes are preferred. Where possible, operating the stations should be possible from both sides. For this purpose, for example, a separate control panel can be built such that it can be mounted on either side. Alternatives is handheld operation over push/pull rods mounted on the long sides. These should however not stick out as they will be damaged during transport or catch items when personal is moving close along the modules by narrow paths.

Control panels and switches for turnouts should be clearly laid out and labeled in a way that is easy to understand (ideally self-explanatory) so that even those unfamiliar with the system can use them without difficulty. This includes clear labeling of tracks and points, unambiguous assignment of switches. Normally, all tracks are live; if tracks are de-energized by switches, this should be clearly indicated.

Point motors, signals, etc., are not controlled via the DCC track voltage.

LOCONET, including the DCC signal, is solely for train operation! (Interference sources must be kept away from it.) Anyone wishing to control points or

signals digitally must set up a separate system for this purpose. Therefor a separate power supply must be provided for each operating location. This must comply with the relevant regulations (DIN, VDE, GS, etc.) and must not be permanently connected to the module. This power supply can also be used to supply electrically operated points, signals and lighting at the operating site.

When using multiple (model railway) transformers, care must be taken to ensure that their secondary AC outputs are not connected to each other. Such a connection is life-threatening.

Other operating modules

Industry connections and passing loops (Awanst) are used like a track module in normal operation. However, if shunting operations are to be carried out within the connection, a separate power supply, DCC booster and a loconet handheld controller sockets are advised. These latter can also be permanently installed in the module, even in very small operating locations.

Electrical Safety

Each module owner is responsible for the electrical safety of their modules.

The relevant VDE regulations must be observed. This applies in particular to the use of approved materials that carry mains voltage (cables, transformers).

If the modules are used in public exhibitions, further regulations according to NEM 609 must be observed.

We exclude all liability for damages or hazards resulting from faulty execution of electrical circuits, incorrect application, or from potentially incorrect representations of circuits contained in this standard.

Landscape and scenery

The design of the basic railway facilities is described in chapter 3, Railway Construction. This section contains recommendations for the scenery. These serve to create a unified image despite different builders and themes. The information is limited to the essential points for the overall picture. Further details can be taken from specialist literature or developed independently. Everyone can and should take the detailed design as far as they want. The topic of the modules is described in chapter 2. Integration into a suitable modular arrangement should be convincing and contribute to the overall impression.

The design of the modules and the required minimum radii allow for a generous design. This opportunity should be used to achieve a realistic impression of a railway in a landscape.

The flat end profile allows for a wide range of landscape design: possibilities extend from flatlands to cuttings (possibly with a road bridge) and railway embankments (possibly with a bridge over a stream, river, or road), all the way to (rarely) tunnels. The flat profile must be maintained only at the module's end. In some cases, it may be advantageous to build a longer group of modules (subdivided for transport) to accommodate the desired landscape with a more expansive design.

The landscape substructure should be as thin and level as possible in the area of the end profiles to maintain the profile shape. The finished surface should be grass green at the module end (a shade as similar as possible to Woodland T 49). Other landscape features which can transition abruptly into grassland are also conceivable at the end profile, e.g. field or forest. Roads and watercourses should not be parallel or extend in the direction of the track to the end profiles, as the lack of continuation on the adjacent module is disruptive.

Telegraph poles (without wires) are to be erected but can be planted in sockets such that operation to modern era allows to remove them.

Groups of modules consisting of several individual parts (segments) can also be manufactured in such a way that the individual parts can be used in a different configuration or in a different frame. In this case, for example, roads may be routed across the final profile. Such groups of modules must always be inserted into an arrangement as a whole. A background backdrop is not used.

When tracks are laid on embankments or in cuttings, the slopes should have a gradient of 1:1.5.

Staging yards are generally not fully detailed, as they lie outside the main depicted landscape. However, some (limited) detailing is possible to create a more unified appearance.

Materials and colours

Since the modules are primarily used, viewed, and photographed under artificial light, the design should be optimised accordingly. Some elements look better in daylight, but too colourless when actually used in a modular arrangement. However, daylight can clearly reveal many a blunder built in the basement. Here, we should take advantage of our modular construction and view the modules in daylight as well.

The material to be used for the design is not prescribed in order to avoid unnecessary restrictions. However, recommendations are given here to ensure that the modules have a uniform appearance.

Ballast: On standard-gauge railways, medium-grey, slightly aged stone ballast; on narrow-gauge railways, sand bedding, represented by medium-grey, slightly yellowish, scatter material in a very fine grain.

Sleepers: Material depends on track construction type, color dark grey-brown

Small iron parts: Brake dust paint

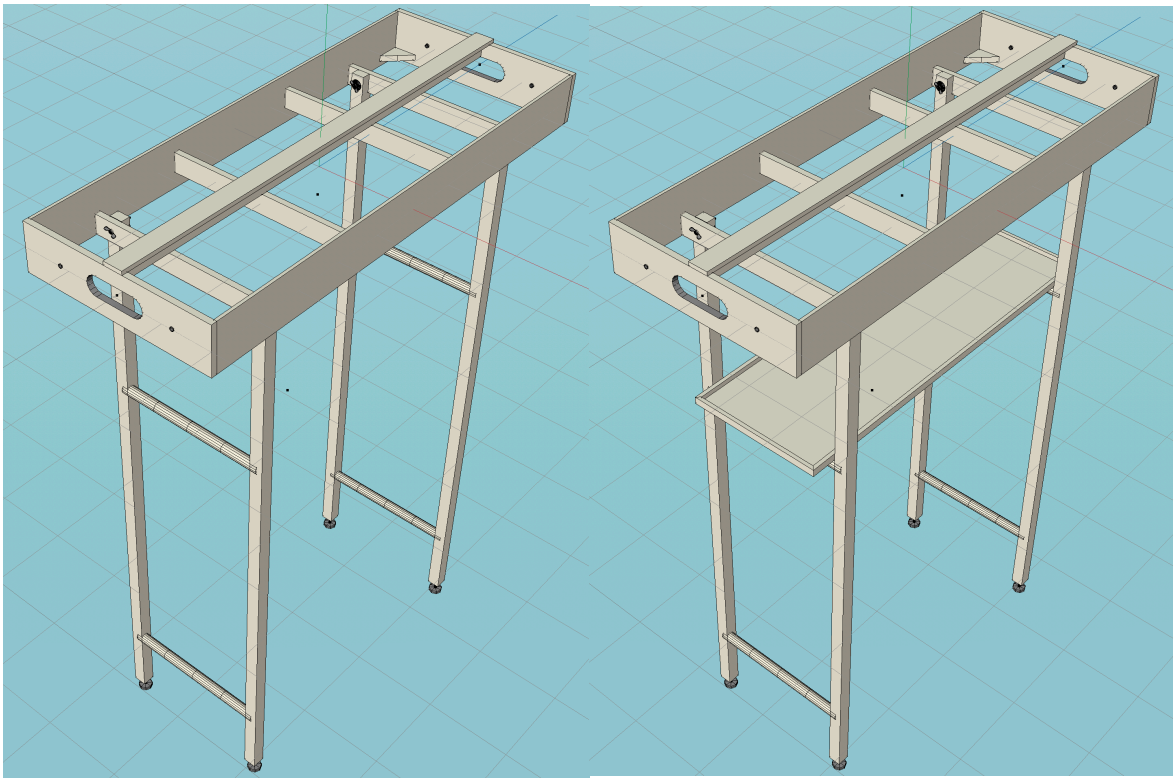
Rails: dark rust tone

bridges and buildings: Generosity also includes the economical use of all types of buildings. Tunnels, bridges, but also simple houses should be used sparingly. The buildings should be appropriate to the landscape appearance of the module, or better yet, be built according to specific models.

Module and landscape maintenance

Time leaves its mark on model modules. Therefore, care should be taken to refresh dusty trees or faded meadows, and to reattach broken parts of houses, etc. The goal for every module builder should be to present a presentable and exemplary module.

Appendix



A figure of standard rectangular module with 2 sets of standard module legs with adjustable feet and crossmember for a board to put items on.

Signal shaft, to avoid short these can be best made from insulated material, This item is excellently suited for 3D printing. A design can be found on Thingiverse but this needs adaption to Fremo N trackbed, newer design will follow.

Sources for materials

code 40 rail (available via Fremo meetings/Fremo post)

http://www.rst-modellbau.de/rstshop/index.php/gleisbau/code-40-schienenprofil-blank.html

0.8 and 1mm copperclad board for production of sleepers and turnouts: Ebay/ Ali