FREMO H0 – Modular Standard
Standard Gauge 1435 mm
in 1:87

MMIX

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1 Introduction

In more than 30 years of FREMO, there has not been a comprehensive document defining the standards for constructing and operating modular layouts according to FREMO practices. New members in particular found it difficult to get acquainted with the standards, which previously were only published in a series of articles and individual publications.

This document is intended to help existing and new FREMO members, as well as other enthusiasts, who want to build modules in their clubs or at home according to the proven and wide-spread FREMO method. The standards defined herein are binding for anyone wanting to build modules in H0 scale 1:87 based on standard gauge 1.435 mm. They include definitions for modular systems ranging from NEM to Proto:87.

The standard is broken down into three categories:

- Minimum requirements – basic requirement that must be met to enable members to connect their modules
- Standard practices – standards for building and operating modules that have proven successful over the years; all members wanting to participate in a meeting with their own modules are requested to honour these
- Recommended practices – practices and solutions that have proven useful but where other approaches and solutions leading to similar results may be possible; these recommendation were not added to the standards body because they are a not pre-requisites for successful operation of modules

Further, the standards aim is to ensure that modules and rolling stock of a particular modular system interoperate on a mechanical and electrical level. A combination of different modular systems is possible in principle, because the module height and electrical system defined in the minimum requirements apply to all standard gauge 1:87 modules.

Due to wheel standards with differing distances between the inside faces of flanges (back to back) and different flange depths and the resulting differences in turnouts, not all systems listed below are compatible. FREMO:87 modules, for instance, track work modelled to scale clearances, which means that only rolling stock with Proto:87 and NMRA RP25/88 (H0fine) wheels can be run on them.

This document defines the following FREMO modular systems and their respective track and wheel standards:

1.	H0-Europa	NEM (+RP25/110)*
2.	H0-Hauptbahn (mainline) – double-track modules	NEM (+RP25/110)*
3.	H0-RE-QS (H0 standard gauge quality standard)	NMRA RP25/110
4.	FREMO-E – operation with live catenary	NMRA RP25/110
5.	H0-P – private railways	NMRA RP25/110
6.	H0-Hafen – harbour railways	NMRA RP25/110
7.	H0fine	NMRA RP25/88
8.	H0fine – Kleinbahn (small railways)	NMRA RP25/88
9.	FREMO:87	NMRA Proto:87

Most FREMO modules are set in the still popular German era III with its wide variety of rolling stock and track that were later scrapped and removed. Besides era III, there are ranges of modules focusing on other periods as defined in NEM 806 D. These include

- H0 era II – German prototype between 1920 and 1932
- H0 era IV – German prototype between 1965 und 1990

- H0 era V – German prototype between 1990 und today

as well as European prototypes including

- A, CZ, GDR, DK, FIN, I, N, NL, PL, S, SLO, and others

This country-specific focus can of course be combined with various time periods. The standards attempt to take into consideration all known variations.

One of the main reasons for becoming a member of FREMO is of course prototypical operation and working with like-minded enthusiasts. Members are therefore encouraged to consider existing modular systems before trying to launch their own. If a member is determined to create a new system or interest group and recruit fellow members, they are asked to inform the Board so that changes to systems or new developments may be added to the standards making them available to the entire membership.

The phrase “standards are what’s being built” is one of the mantras of FREMO. This collection of standards is therefore not set in stone but rather a living document derived from the active work and experience of the members and merely serves as a guideline.

Separate standards for H0 1:87, define modular systems for European narrow gauges, including the gauges 1,000 mm, 750 mm and 600 mm in NEM, NMRA RP25/110 and Proto:87, as well as modules and operations for US prototypes. Other scales such as 0, 0m, 0e, TT and N are also represented in FREMO. These standards can be found on the FREMO website at www.fremo-net.eu.

At first glance, the standards may seem restrictive, seemingly leaving little room for individualism. As you read on, you will discover that most practices are common sense and create an environment for problem-free and relaxed operation. Module builders enjoy enough freedom to turn their ideas into reality. As indicated before, this standard is not a be all and end all. It will always be possible to introduce improvements and additions, if it is in the interest of the membership at large.

The overarching goal of anyone involved in the construction and operation of model railways in FREMO shall be to work according to the highest technical standards. In the context of FREMO this means a continuing trend away from the NEM wheel standard, towards NMRA RP25/110, RP25/88 as well as Proto:87. In addition to that, it has become apparent that operational realism and enjoyment are vastly improved by using scale radii and turnouts instead of tight curves and short turnouts. Many members already support these developments.

In the early days of FREMO, the idea of building short modules that can be integrated into a home layout and transported in a car was dominant. In recent years, however, the idea of merely setting up modules for testing at home and operation at FREMO meetings in gymnasiums or exhibition halls has become prevalent. There is enough room at our events to build stations for a branch line or secondary railway that are easily 12 metres in length.

Modules and in particular stations are long-term investments in which their builders put significant financial resources and time. Careful planning, study and well thought out construction, exact workmanship and liberal track lengths have demonstrated to be more future-proof than quickly assembled modular stations with 15-degree turnouts.

For information on module construction, FREMO meetings, operation or DCC see our club magazine Hp1 and the FREMO website at www.fremo-net.eu. A bibliography is included in this document.

FREMO is considering publishing a separate module handbook, which aims to inform about the current recommendations on module construction techniques. To achieve a coherent appearance of the layout, the recommendations and proposals of individual sub-groups and countries should be taken into consideration. Depending on the prototype, variations in ballast, local architecture and vegetation are possible.

2 FREMO H0 Modular Systems – Overview

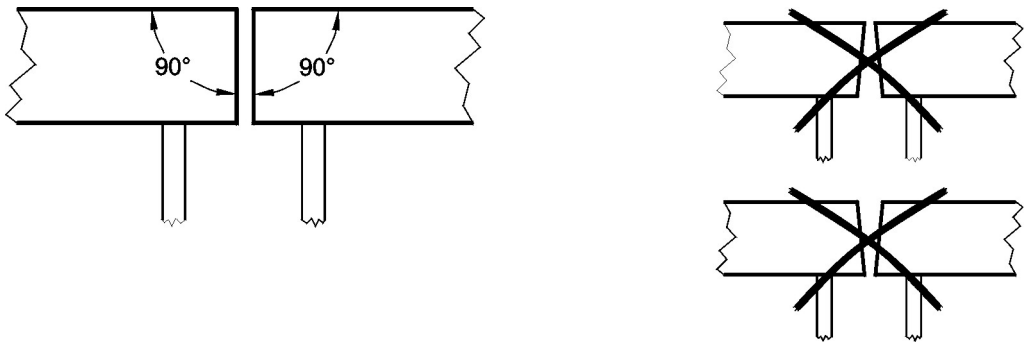
	Standard:	Description:
2.1	H0-Europa	*Still the most widespread modular group in FREMO, H0-Europa started as a quiet branch line operation that has developed into a de-facto single track mainline. Traditional NEM wheels are giving way to NMRA RP25/110.* *Many technical developments originated in this group including the introduction of DCC, the RUT clock and phone system, as well as prototypical safety technology such as interlocked block signalling*
2.2	H0-Hauptbahn (mainline) – double-track modules	*This interest group operates long trains on double-track mainline with straight modules running the length of gymnasiums featuring big radii as well as block sections*
2.3	H0-RE-QS (H0 standard gauge quality standard)	*This group is for everyone who is not satisfied with operating rolling stock equipped with NEM wheels and wants to create a more sophisticated module standard with NMRA RP25/110. Due to the overall improvement in module standards and a higher number of meetings requiring RP25/110 wheels, this groups has lost importance as a separate group*
2.4	FREMO-E – operation with live catenary	*If you don't have enough challenges yet, you can install live catenary over your modules. This group is still in its infancy.*
2.5	H0-P – private railways	*Private railways with small stations and calm operation using a central dispatcher*
2.6	H0-Hafen – harbour modules	*Fans of switching and transfers are starting to build entire port facilities with connected rail yards that can serve as feeders for the main layout.*
2.7	H0fine	*The achievements H0-RE-QS did not go far enough for some members who are striving for fine scale modelling but still want to maintain a level of backwards compatibility. Operation of both RP25/110 and H0fine with RP25/88 is possible.* *Due to the low flange height of H0 fine wheels, they can be used on FREMO:87 modules that do not have turnouts.*

	Standard:	Description:
2.8	H0fine – Kleinbahn (small railway)	*While H0fine is primarily modelling state railway operations, H0fine – Kleinbahn is portraying small or private railways, including small state-owned railways of the DR, with little stations and small module end plates.* *Only vehicles with less than 15t axle load are permitted.*
2.9	FREMO:87	*This group is pushing the envelope on what is physically possible, It uses heavily customized and scratch-build models, prototype couplers, and prototypical track and wheels. Detailing and landscaping are representative of this group's high standards.* *FREMO:87 operation requires good eyes and a steady hand to couple and uncouple rolling stock.*

3 Modules

3.1 Module – Minimum Requirements

	Standard	Description
3.1.1	Module height 1,300 mm above the floor	Following extensive tests, the module height of 1,300 mm was determined, which represents a compromise between looks (one is not only looking at rooftops but can look at models from the side) and operability (switching). Further, all other FREMO modular groups use this height, which for instance makes interchange between standard gauge and narrow gauge possible. Note that the module height is measured from the top of the rails and not from the top of the module baseboard.
3.1.2	The module height needs to be adjustable vertically by 15 mm	Adjustable module height by ±15 mm is required to balance out uneven floors.
3.1.3	Module end plates must be vertically aligned	If disregarded, a warp-free setup with clean track connections may not be possible and may result in damage to modules.



3.1.3 Perpendicular module end plates

3.1.4	Modules are to be built sturdily and may not be warped	*Please see related articles in FREMO HP1 issue 1/2004 and 1/2008.*

3.2 Module – Standard Practices

	Standard	Description
3.2.1	Track modules with appropriate end plates	*Track modules can be equipped with matching or different end plates e.g. as transition modules from a sloped profile to a dam profile.* *Using end plates conforming to the standard makes layout planning easier and helps avoid breaks in scenery.* *Custom end plates may be used within fixed module groups or station modules, provided these use standard end plates at the outer ends.*
3.2.2	12 mm drill holes for connecting bolts as indicated in the drawings	*The alignment of a drill hole located at the track centre serves as a reference for other drill holes and provides freedom in track placement on the module.* *Note that the two additional holes need to be easily accessible to tighten the bolts and should therefore not be obstructed e.g. by internal bracing*
3.2.3	Module connection with three M8 bolts using wing nuts and large flat washers	*Using bolts that are threaded to the head with large undersize (2 mm), small construction inaccuracies may be compensated for.* *Large flat washers prevent damage to the end plates.*
3.2.4	500 mm minimum width for track and station modules	*Mostly for visual reasons; thinner modules put rolling stock at risk of falling onto the floor following a derailment.*
3.2.5	Station modules may differ from track modules in width and height but need standard end plates on the outer joints	*Large station modules can be set up as surface structures that have a lower profile than track modules.*
3.2.6	Stations modules need to be optimized in width and accessibility as to not interfere with shunting operation	A maximum width of 1.4 m should not be exceeded; due to the use of prototype couplers, FREMO:87 stations should not be wider than 1 m.

	Standard	Description
3.2.7	Track should not be laid closer than 100 mm to the module side; otherwise security measures such as acrylic safety glass need to be installed	*This minimum distance between track and module side, as well as appropriate safety measure in stations where smaller distances between the outer track and the module side may be necessary, help prevent rolling stock from falling from a height of 1.3 m.*
3.2.8	Use static grass applicators	*Ensures harmonious transition between modules. Using appropriate grass fibre will help hide possible gaps between modules.* *Coloured saw dust is no longer state-of-the-art.*
3.2.9	Modules shall be painted using colours defined in the standards of the their respective modular system	*Despite efforts to use more eco friendly materials,* ***do not*** *use water-based paint. Experience has shown that paints that do not completely harden tend to create sticky surfaces causing difficulties during the separation of modules that may result in damage to module surface.* *Further, it has proven useful to paint the underside of modules white to provide better contrast when working underneath the layout.* *In principal, it is possible to use other colours than the ones indicated below. This, however, works against the efforts to create a homogenous appearance.*

1	H0-Europa	RAL 7001 / RAL 8011 silver grey / nut brown
2	H0-Hauptbahn (mainline) – double-track modules	RAL 7001 / RAL 8011 silver grey / nut brown
3	H0-RE-QS (H0 standard gauge quality standard)	RAL 6025 fern green
4	FREMO-E – operation with live catenary	RAL 7001 silver grey
5	H0-P – private railways	RAL 6005 moss green
6	H0-Hafen – harbour modules	RAL 7001 silver grey
7	H0fine	RAL 7035 / RAL 8011 light grey / nut brown
8	H0fine – Kleinbahn (small railway)	RAL 6025 fern green
9	FREMO:87	RAL 7003 / RAL 8017 moss grey / chocolate brown

3.2.9 module colours (semi gloss)

	Standard	Description
3.2.10	Modules measuring more than 500 mm in length must able to stand on their own Shorter modules may use only one pair of legs or can be inserted into the layout with no legs at all	*Each module needs to be able to stand on its own legs to ensure that it can be freely moved when a layout is assembled. This is especially important for track modules.* *Modules that need to be held by a person before they can be bolted onto another module prevent smooth layout setup and optimal space use.* *Installing pockets for legs under the module has proven useful; adjustable legs compensate the difference in height between adjacent modules.*
3.2.11	Each module must be labelled with the owner's name and module number on the underside. Additional information regarding operation and special handling instructions may be useful	*Proper labelling prevents mix-ups and possible loss, especially when the owner is not present at the meeting.* *Naming track modules, in addition to stations, makes layout planning and setup easier. If modules have special functions, such as safety technology, transport wagon interchange, loading mechanisms, etc., it is helpful to provide instructions to members unfamiliar with the module.*

3.3 Module End Plates – Standard Practices

In this standard, long standing members will note that a number of module end plates that have been developed over the years are not included. Modules with end plates not listed herein can of course continued to be used. New modules, however, should preferably be outfitted with the end plates listed below.

We have purposely limited the number of end plates to those most widely used in FREMO. End plates developed for specific modular systems may be included in the standard practices when they have been built and successfully deployed in significant numbers.

For reasons of backwards compatibility, end plates have been adapted to the prototypical 1:1.5 incline of embankment. This ensures that:

- There is continuity between modular systems ranging from NEM to FREMO:87
- Layout planning is made as easy as possible
- The creation of custom end plates is kept to a minimum

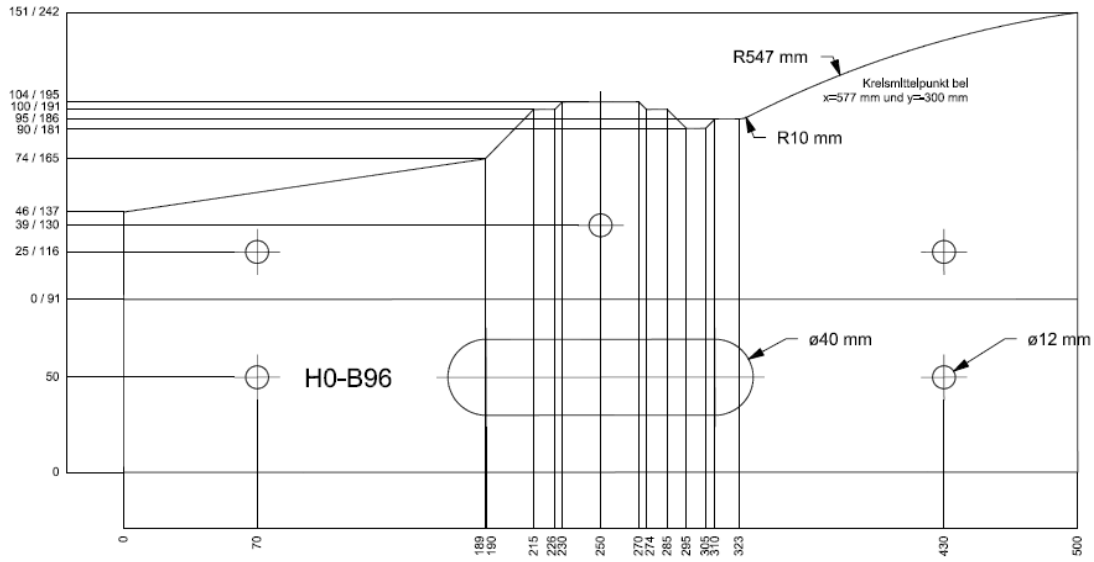
End plates that have been developed in the past but were only used in small numbers are not included in this standard. The FREMO:87 end plate H0-F02, for instance, is only 5 mm lower than H0-E96. It's at the discretion of each modular system to promote any special end plates. See also www.fremo-net.eu.

Note that end plates need not be built in the tall version. They can be lower by a measure of 91 mm or less to save on volume and weight. Flat modules also have the advantage of making it much easier to duck under the layout during operation. Module height, therefore, needs to be indicated when registering modules for a meeting (see 8.1.1), so that the layout designers can place the modules in the setup at the best place.

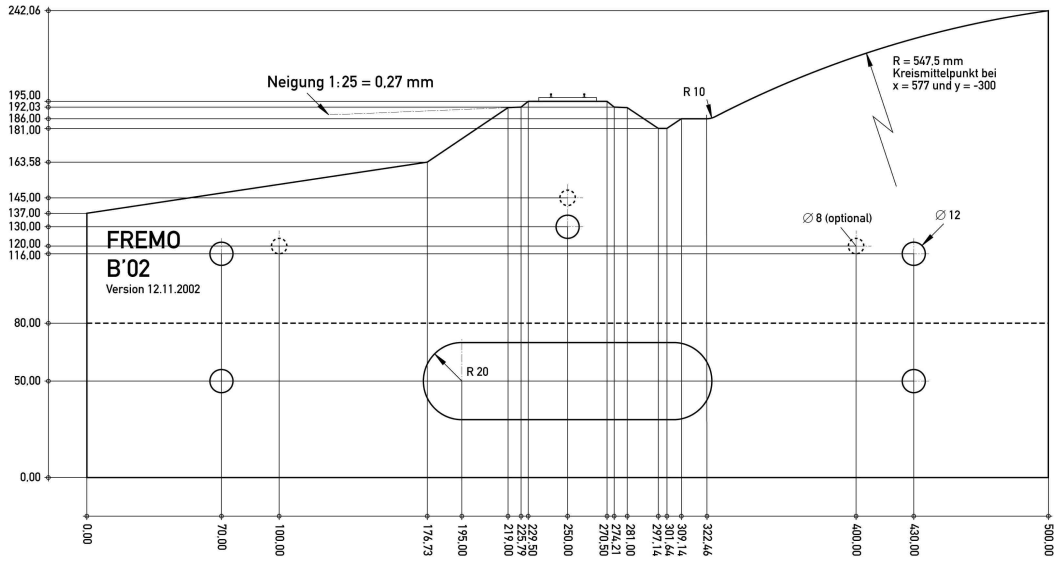
Track modules can be built wider than indicated in the standard, though the change in width should occur beyond the end plate.

Attachment 2 lists all end plates scaled to page size.

	Standard	**Description**
3.3.1	Preferred module end plates: • H0-B96 • H0-B09 • H0-E96 • H0-F96	*Ensures that modules built according to the H0 standard can be combined into a layout.* *The widely used end plate H0-B96 has an embankment with a 45-degree slope. It is used when the subgrade itself is made from crushed stone. The wider 1:1.5 grade, as seen in the new H0-B09 end plate draft, is more prevalent in the prototype.*



3.3.1a End plate H0-B96

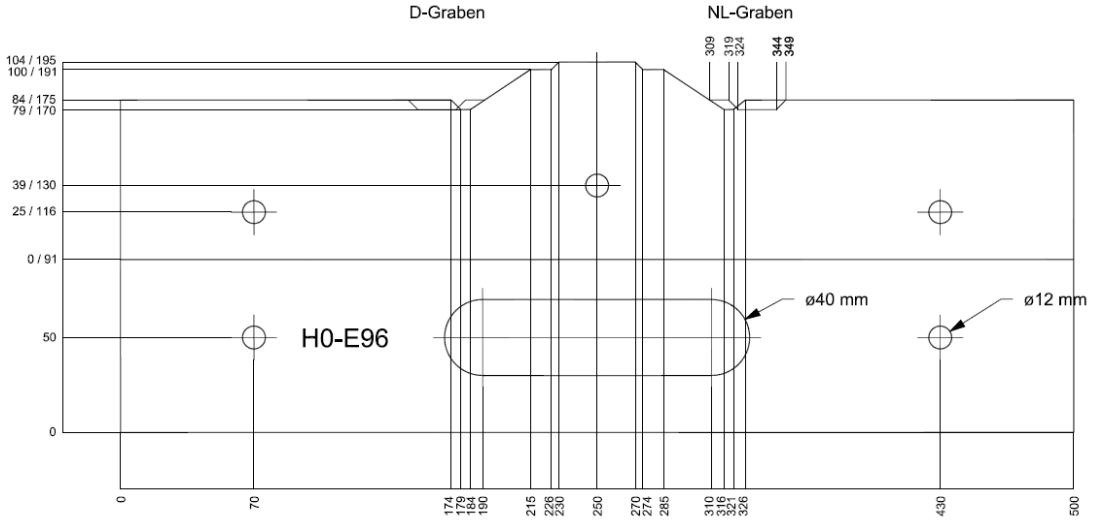


3.3.1b End plate H0-B02

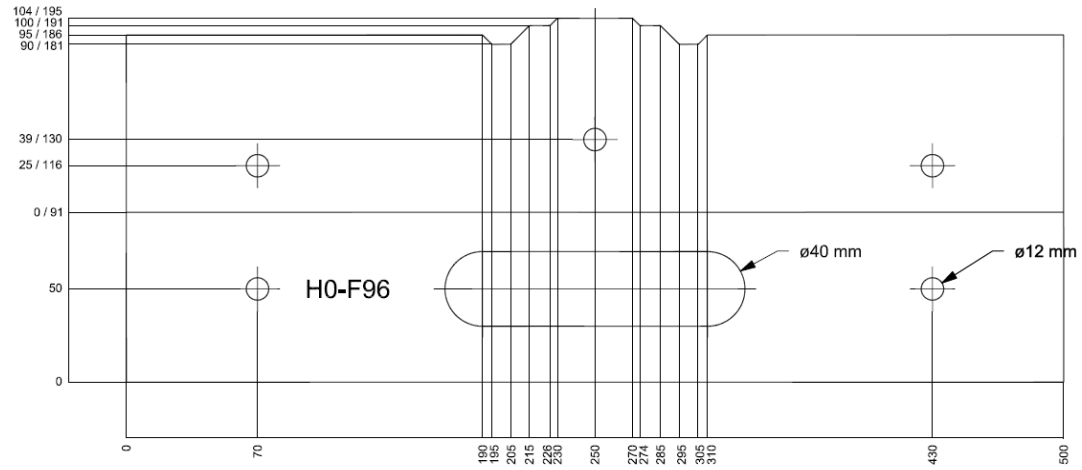
Standard **Description**

H0-E96 and H0-F96 are symmetrical. They simplify layout planning and should therefore be used in preference

The Dutch version of H0-E96 has a wider trench.

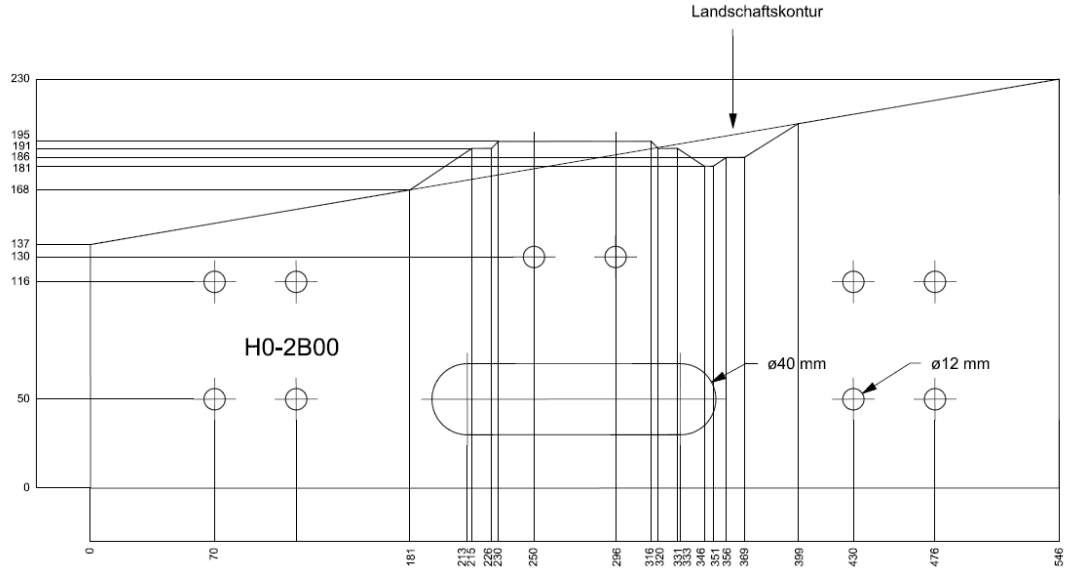


3.3.1c End plate H0-E96

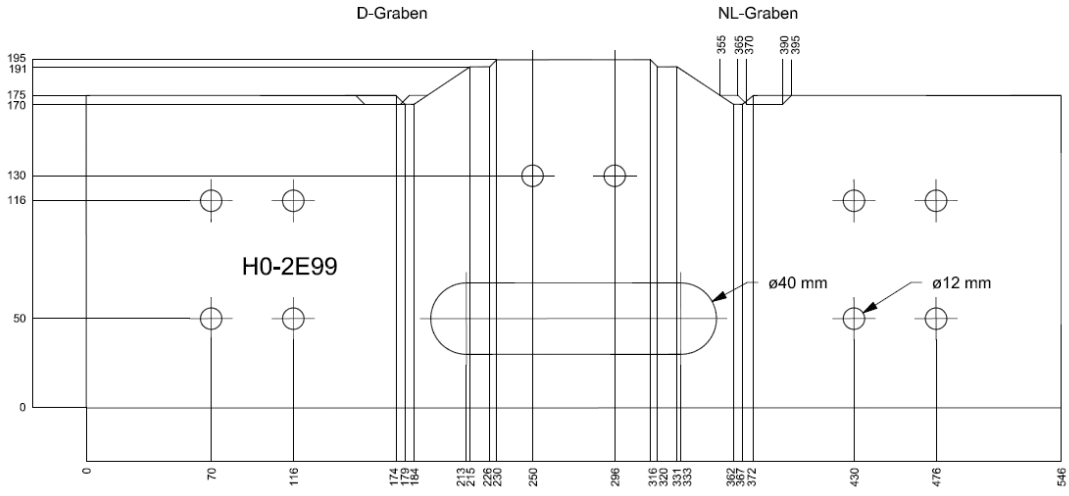


3.3.1d End plate H0-F96

	Standard	Description
3.3.2	• H0-2B00 • H0-2E99	*Double-track FREMO modules are built using end plates that are 46 mm wider than their single-track counterparts.* *Additional bolt holes ensure compatibility with single-track end plates without using a conversion module.* *The Dutch version of H0-2E99 has a wider trench.*



3.3.2a End plate H0-2B00

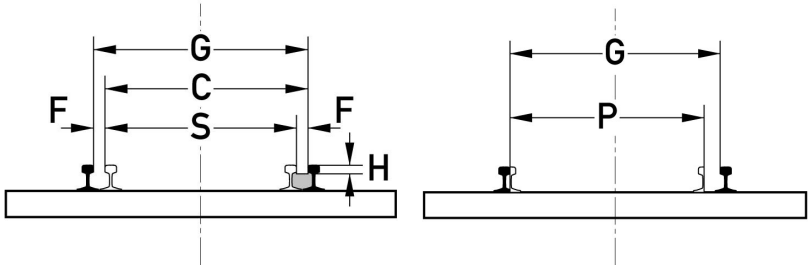


3.3.2b End plate H0-2E99

4 Rail and Track

4.1 Rail and Track – Minimum Requirements

	Standard	Description
4.1.1	Track and module end plate are perpendicular	*When disregarded, kinks in track joints will compromise safe operations and may cause derailments.* *A mirror can help to check right angles at the end plate and detect kinks.*
4.1.2	Track dimensions	Please adhere to measurements as indicated.



	Prototype EBO* [mm]	1:87 [mm]	NEM [mm]	RP25/110 [mm]	H0-fine [mm]	FREMO:87 [mm]	
Turnout dimensions							
G	1430 - 1470	16,44 - 16,90	16,50 – 17,00	16,50 – 17,10	16,50 – 16,90	16,50 - 16,60	Gauge at frog (min.)
C	1394	16,00	15,30	15,40	15,60	15,90 – 16,10	Check gauge (min.)
S			14,10	14,30	14,80	15,30 – 15,60	Span (max.)
F1	41	0,47	1,30	1,30	0,90 – 1,00	0,50 - 0,55	Flangeway at guard
F2	47 - 70	0,54 – 0,80	1,30	1,30	1,00	0,50 - 0,60	Flangeway
H	38	0,44	1,30	0,70	0,70	0,45	Flange depth (min.)
P	1290	14,83	k. A.	15,00 – 15,10	15,24	14,80	Point spread (max.)

4.1.2 Track dimensions

4.1.3	Rail height	*Maximum rail height is 2.10 mm (Code 83)* *Note: It is recommended to use rail in the shape of S49, which resembles Code 70.* *Other rail sizes and corresponding flange heights are possible if the modelled prototype calls for it.*

*Eisenbahn-Bau- und Betriebsordnung – German Ordinance on the Construction and Operation of Railways

	Standard	Description
4.1.4	Turnouts with frogs that touch wheel flanges are not permissible	*Due to the combined operation of rolling stock with NEM and RP25/110 wheels, as well as RP25/110 and H0-fine wheels, turnouts with frogs that touch wheel flanges may cause derailments.* *H0fine and FREMO:87 use turnouts modelled exactly to scale. FREMO:87 turnouts also feature prototypical chairs.* *Note that turnouts with prototypical angles are usually safer in operation than short "toy" turnouts. In industrial sidings, shorter turnouts can be used. These include Tillig Pilz Elite code 83 turnouts, Peco code 75 turnouts, and long Roco-Line turnouts with modified frogs. Short turnouts may not be used for H0-fine and FREMO:87.* *Scratch-built turnouts and turnouts made from kits are preferred. These may include turnouts made from soldered rail on copper clad board or the new Tillig Pilz Elite turnouts W5 and W6.*
4.1.5	Turnout angle not greater than 12 degrees	*Turnout angles greater than 12 degrees (Peco) are not permissible.*

4.2 Rail and Track – Standard Practices

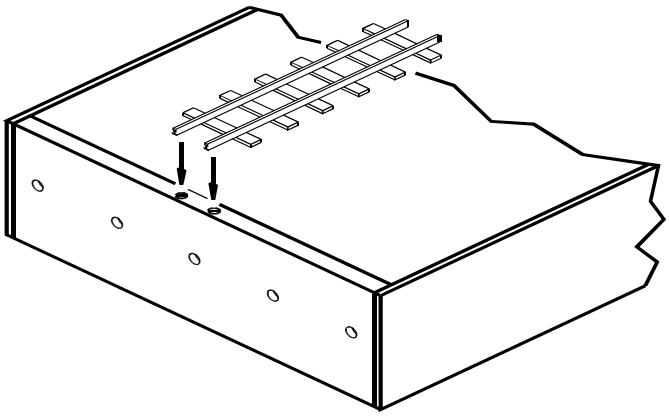
	Standard	Description
4.2.1	Prototypical dimensions of stations	*It has been demonstrated that station modules with prototypical dimensions make prototypical operation possible.*
4.2.2	Minimum length of passing sidings	*If a station is not built according to a prototypical track plan, passing sidings need to be able to hold trains with at least 32 axles.*
4.2.3	Minimum radii	*The through line and turnouts along the way should have a minimum radius of 2,000 mm. Smaller radii are possible for instance in the case of Länderbahn turnouts.*

1	H0-Europa	2,000 mm
2	H0-Hauptbahn (mainline) – double-track modules	2,000 mm in turnouts, 3,000 mm on track modules
3	H0-RE-QS (H0 standard gauge quality standard)	2,000 mm
4	FREMO-E – operation with live catenary	see H0-Europa
5	H0-P – private railways	see H0-Europa
6	H0-Hafen – harbour railways	see H0-Europa
7	H0fine	prototypical radii
8	H0fine – Kleinbahn (small railways)	prototypical radii
9	FREMO:87	prototypical radii

4.2.3 Minimum radii

	Standard	Description
4.2.4	The H0-fine and FREMO:87 modular systems only allow prototypical radii	*The modification of rolling stock into prototypical models makes scale radii necessary. Smaller radii are only possible in the case of Länderbahn turnouts.*
	175 m = 2,010 mm (1:87)	*Minimum radius for H0-fine track modules.*
	190 m = 2,184 mm (1:87)	*Minimum radius for turnouts and curves in the through line, which can only be smaller when a prototype calls for an exception. Note that this is the smallest permissible radius for a German Class 01 steam engine.*
	300 m = 3,448 mm (1:87)	*For curve modules without super elevation V_{max} = 50 km/h; with super elevation V_{max} = 80 km/h. The latter is the general speed limit on branch lines. This is also needs to be considered when developing timetables.* *Minimum radius on double-track mainline.*
	180 m = 2,069 mm (1:87)	*Minimum radius for through line on single-track lines. Many steam engines outfitted with widened frames and inset cylinders cannot be operated on smaller radii.*
	80 m = 919 mm (1:87)	*Smallest radius that can be used in sidings and should technically be negotiable by all rolling stock operated on the layout. Still used by the prototype in sidings for freight traffic.*
	35 m = 402 mm (1:87)	*Used in sidings with very limited space. This radius cannot be negotiated by vehicles with a wheelbase larger than 4.5 m and vehicles with bogies. The Machinenfabrik Deutschland developed a special type of rail in the 1930s that minimized wear in such curves. Flanges ride on top of the outer rail and the inner rail is a girder rail. Since the diameter of the outer wheel is increased, wear on track and wheels is minimized.* *Large modern freight cars cannot negotiate this curve.*

	Standard	Description
4.2.5	Reverse curves	*Avoid buffer locking by inserting at least 100 mm of straight track in-between two reverse curves as well as diverting track after turnouts. Two modules with opposing curves should always be linked using a straight module.* *This applies to all track including industrial sidings.*
4.2.6	Avoid track super elevation	*Super elevation is only permissible in module sections of more than 3m in length. Note that super elevation can impede connectivity and integration in a layout.*
4.2.7	Rails need to be secured at module ends	*Insert brass screws into the top of the end plate, remove screw head, and solder rail to the top of the screw. Pieces of sleepers may be used to hide the soldering points.* *To ensure safe connections between modules, it is important that rails are flush with the end plate and that they meet the module ends at a right angle.* *Small inaccuracies in track and drill holes can be compensated for with M8 bolts. The Track should be ballasted all the way to the module ends.*
4.2.8	FREMO:87 modules use half a twin sleeper at module ends	*Applies to models of Reichsbahn Oberbau (track construction) K. Other prototype track systems may be modelled without twin sleepers.*



4.2.7 Fasten rails at module ends

5 Electrical

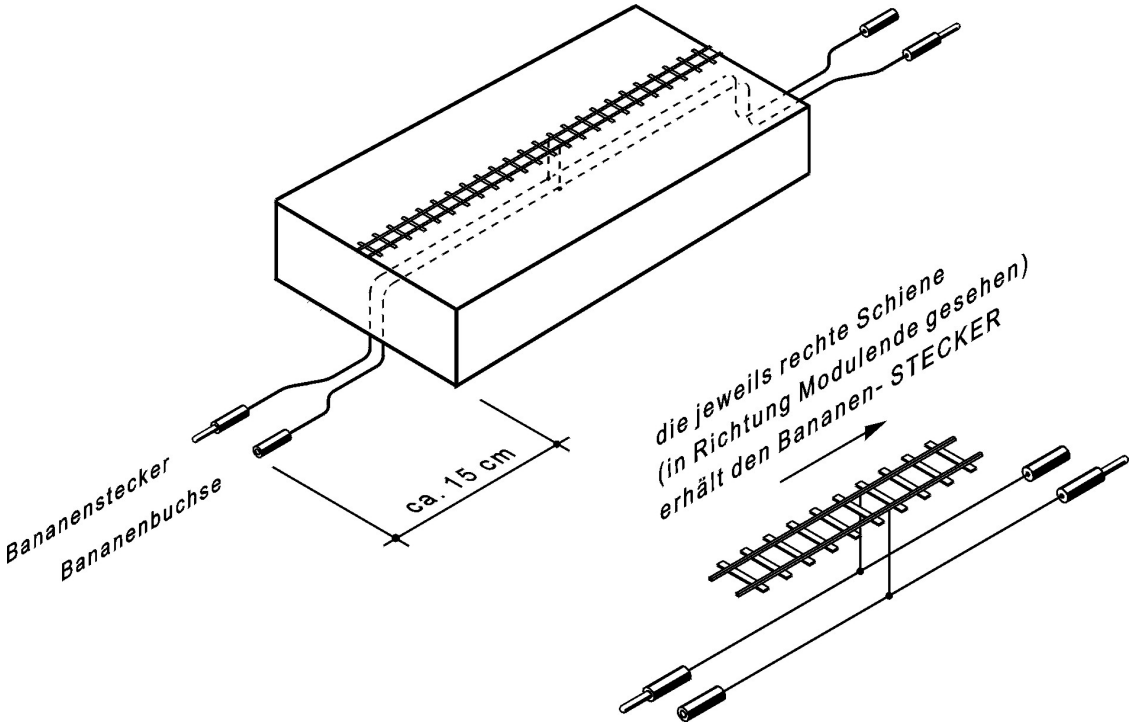
5.1 Electrical (230 V) – Minimum Requirements

	Standard	Description
5.1.1	Power cords carrying mains voltage (230/240V) are not permissible in modules	*Modules carrying mains power are not allowed to participate in FREMO meetings.*
5.1.2	Use model train power supplies and transformers exclusively	*3 amp power supplies are strong enough for modern rolling stock with small power consumption. Stronger currents may damage power pick-up contacts as well as turnouts.* *Power supplies and transformers may not be mounted in modules.*
5.1.3	Homemade 230/240V transformers are not permissible	*Use only commercially available transformers.*
5.1.4	Custom-built electrical devices with 230/240V input need to meet VDE* standards	*Electrical devices can be built by members with the necessary experience. If in doubt, consult FREMO colleagues with expertise in electrical engineering.*
5.1.5	Each station should be equipped with safety RCD adaptors	*Residual currents can be detected and the risk of electrocution be minimized.*
5.1.6	For more information consult the July 2006 version of the requirement specifications for meeting attendees. (See attachment 1.)	*National laws in EU member states may differ from German requirements; meeting hosts should inform attendees about of any relevant differences.*

VDE = Association for Electrical, Electronic and Information Technologies e.V.

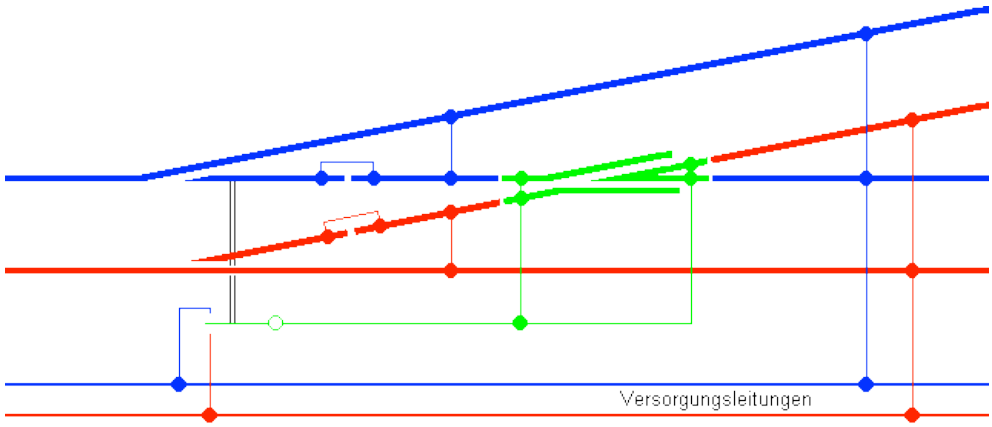
5.2 Module Electrical – Minimum Requirements

	Standard	Description
5.2.1	Two continuous bus wires supply track with power through feeder wires on the module	*Bus wires ensure steady power to supply to the track. Rail joiners should not be used for visual reasons. Each section of track is wired with at least one feeder wire.*
5.2.2	Double-track modules have separate bus wires for each track	*Makes operation on large layouts with two DCC command stations and switchable double-track crossovers possible.*



5.2.1 Module wiring

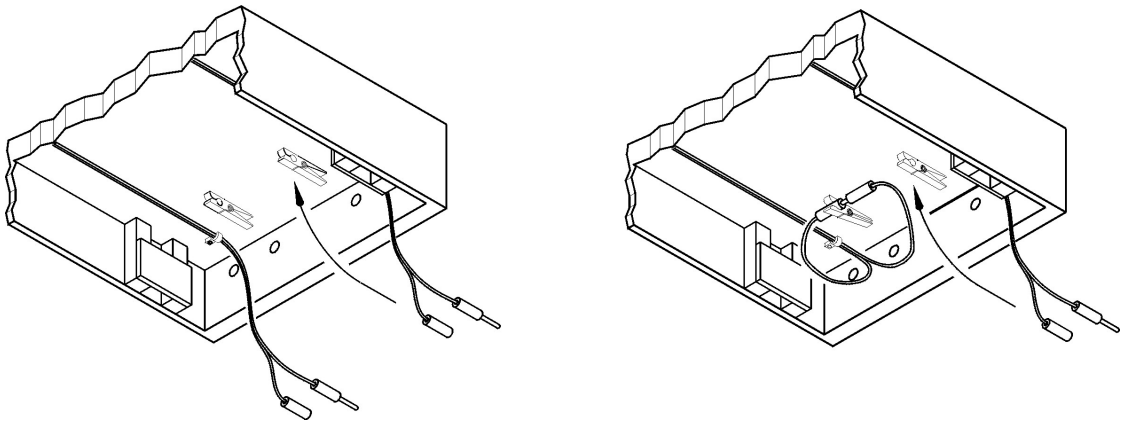
5.2.3	Bus wire gauge should not be smaller than 1.0 mm^2	*Use flexible paired wires or speaker wires. A wire gauge of 1.5 mm^2 is recommended.*
5.2.4	Use DCC-friendly turnouts with power-routed frog	*Points powered through the outer rails are not permissible since they are susceptible to shorting.* *Frogs need to be insulated and powered through a switch connected to the point lever.*



5.2.4 Schematic of a DCC-friendly turnout

5.3 Electrical, Modules – Standard Practices

	Standard	Description
5.3.1	Wires should be identifiable by their location	*Bus wires must be located under the rail it is connected to. Makes proper electrical connection between modules easy even especially when people other than the owner set up modules.*
5.3.2	Use 4 mm banana plugs to connect wires.	*Hirschmann 4 mm male and female plugs have proven reliable.*
5.3.3	There are two ways to connect modules electrically: 1) Hetero connection according to drawing 5.3.5 2) Female plugs built into the module connected through a separate cable	*Both systems have their advantages:* *1) Male to female connectors make wrong connections virtually impossible.* *2) Separate cables do not need to be fastened under modules. There is a risk of connecting modules incorrectly when setting up a layout.* *Do not use plugs with transverse holes to avoid shorts.*
5.3.4	Permanently mounted wires need to extend 150 mm beyond the module end plate	*This wire length is needed to successfully connect two modules. Modules with high end plates should use longer cable overhangs.*
5.3.5	Modules need to be equipped with cable fasteners for transport and operation.	*Wooden clothespins have proven suitable as fasteners. Wires can be connected and fastened with the pin for transport thus avoiding the risk in inadvertently ripping the wires out from under the module. During operation, wires can be tightened with the pin avoiding low hanging connections, which can get in the way when switching sides under modules.*



5.3.5 Electrical module connections (In most cases one pair of wires will suffice)

	Standard	Description
5.3.6	Additional fasteners with a minimum diameter of 10 mm are used to string LocoNet bus and telephone wire underneath modules	*Screw hooks can serve as fasteners*
5.3.7	Cut both rails when isolating sections of track	*With the exception of frogs, isolated sections are not necessary when using DCC*

5.3.8 Locally controlled turnouts

Locally controlled turnouts are suitable for most stations. Experience has shown, that locally controlled turnouts in small stations are less susceptible to problems than turnouts operated remotely via a control panel.

Further, many stations do not have personnel and increasingly use lock mechanisms in connection with central dispatch.

Locking mechanisms make it impossible to operate stations from both sides, which in turn decreases flexibility when planning layouts.

5.4 DCC and LocoNet – Minimum Requirements

	Standard	Description
5.4.1	The NMRA DCC standard is exclusively used.	*Digitrax's LocoNet bus is required for cabs and boosters. Track voltage is 14 V, which ensures that programmed speed curves can be reproduced accurately. Boosters and command stations need to be set to this voltage to avoid abrupt changes in speed when engines move from one booster block to the next.*
5.4.2	LocoNet must be routed through stations; stations may only fork off the main bus	*Makes troubleshooting easier and reduces contact resistance.*
5.4.3	Every station including large sidings need to be equipped with a DCC booster	*Boosters may not have a galvanic connection to LocoNet and track. Furthermore, runaway protection is required, which detects dropped DCC packages and prevents engines from moving uncontrollably on the layout. A suitable transformer that complies with safety standards needs to be provided. It cannot be mounted in a module.* *For modern engines, an output current of 3 A is sufficient.*
5.4.4	DCC command stations may only be connected to a layout via a potential-free booster; a direct connection is not permissible	*Prevents DCC command stations from being damaged.*
5.4.5	Use of DCC boosters needs to be coordinated with the member responsible for the LocoNet setup	*Not all boosters are approved because certain combinations of command stations and boosters can lead to problems.*
5.4.6	LocoNet may only be used for train operation; stationary decoders may not be operated using the common LocoNet	*Operate stationary decoders in stations etc through a separate bus.*

5.5 DCC and LocoNet – Standard Practices

	Standard	Description
5.5.1	Use FREMO FRED and FREDI DCC cabs	*It's ok to use other throttles but not all can be used universally, some draw more power, or can only be used after receiving special instructions.*
5.5.2	Stations must have sufficient plugs on both sides of the module to connect FRED and FREDI cabs as well as LocoNet	*Use LocoNet boxes for connections that can be freely positioned.*
5.5.3	Stations need to provide a LocoNet cables in sufficient numbers	*All LocoNet cables need to be tested for correct polarity. Testers are available from fellow members and can be used at no cost. Cables should be labelled with the name of the owner and their respective length.*
5.5.4	Each station should provide FRED/FREDI holders in sufficient numbers	*Holders provide a place for throttles during shunting so that they don't have to be put down on the module landscape.*

6 Safety Technology

6.1 Safety Technology – Minimum Requirements

	Standard	Description
6.1.1	Safety technology I	*At meetings, engineers usually run valuable trains owned by fellow members. Damage to third party property should be prevented.*
	Operating procedures I	*Members have to be familiar with basic prototypical safety technology and operating procedures, such as direct traffic control.*
6.1.2	Operating procedures II	*Members not familiar with operating procedures are encouraged to ask more experienced members for guidance.*
6.1.3	Safety technology II Signalling	*Members need to be familiar with signalling and are to obey signals and train orders.*
6.1.4	Safety technology III Familiarity with layout	*At the beginning of an operating session, participants will take part in an orientation to familiarise themselves with the layout and stations.*

6.2 Safety technology – Standard Practices

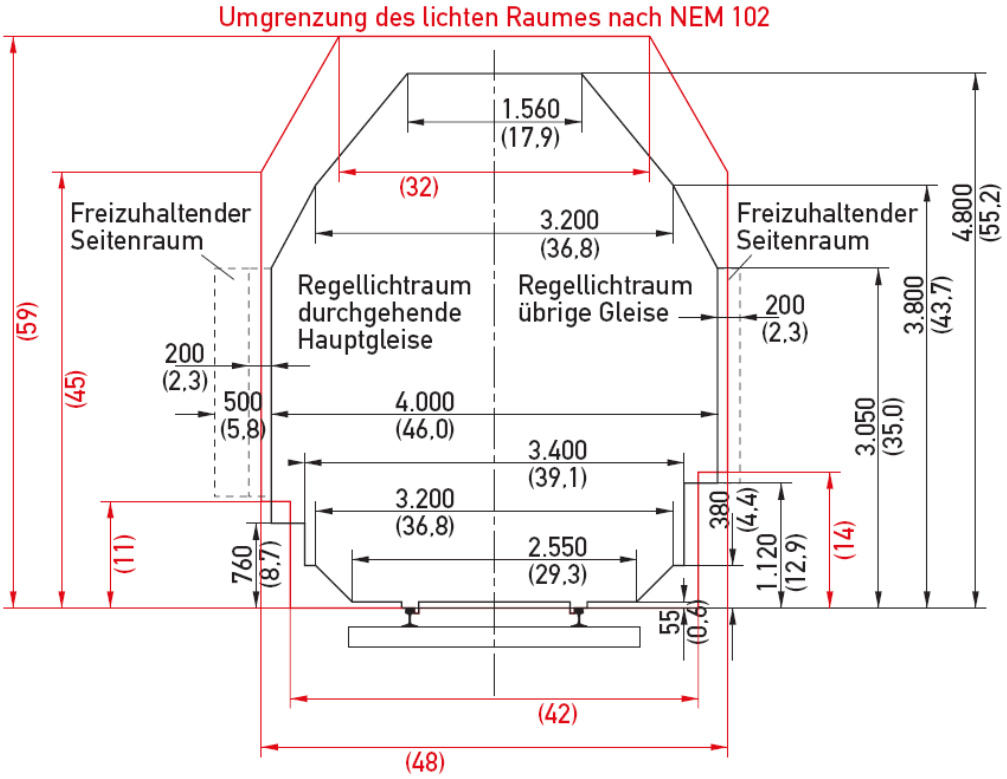
	Standard	Description
6.2.1	Each station needs to be protected with at least a home signal	*Home signals protect stations from unintended entering of trains and are therefore indispensable.* *Small stations prototype German are equipped with trapezoid boards; colour light signals and semaphores can be used of course; the latter are preferred, however, because they can be read more easily at an angle as well as from a distance.* *Until an international FREMO signalling guide is published, specific national differences need to be pointed out by the meeting organiser during orientation.*
6.2.2	Home signals should be set up in Wattenscheid signal slots to allow free placement on the layout	*Wattenscheid slots are standardized slots in which a signal can be inserted; if necessary, short signal modules should be available in stations.*
6.2.3	Block signalling is under development	*Before venturing into block signalling, members are encouraged to contact fellow enthusiasts who have already started developing such systems.*
6.2.4	Each trains needs to be equipped with rear end markers	*Rear end markers are to be installed by the engineer on the last car prior to departure so that it can be inspected for completeness at the next station.*

6.2.4 Examples of rear end markers

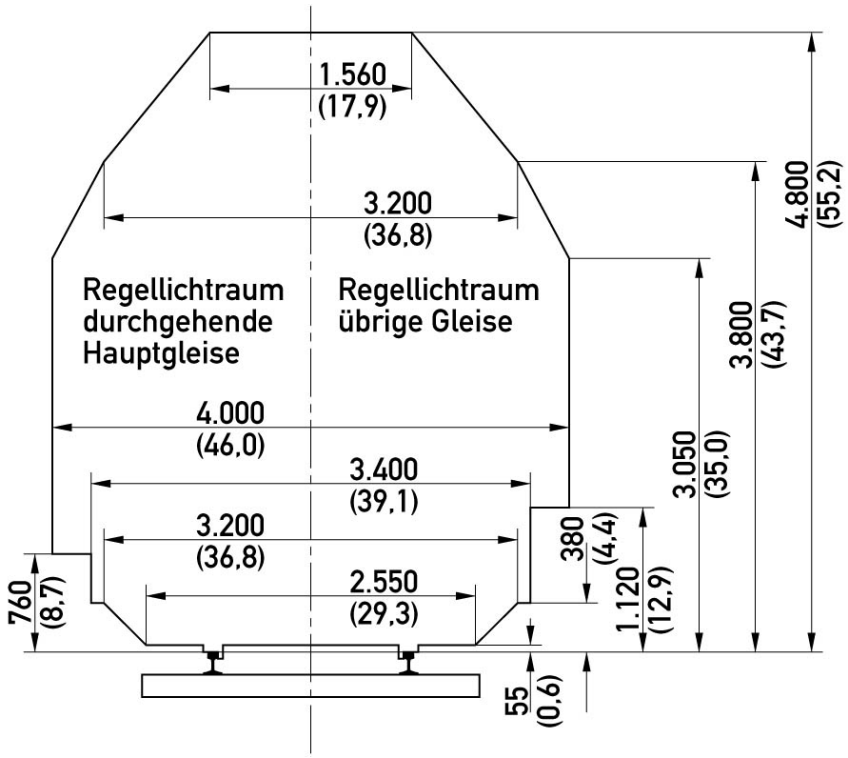
7 Locomotives und Rolling Stock

7.1 General – Minimum Requirements

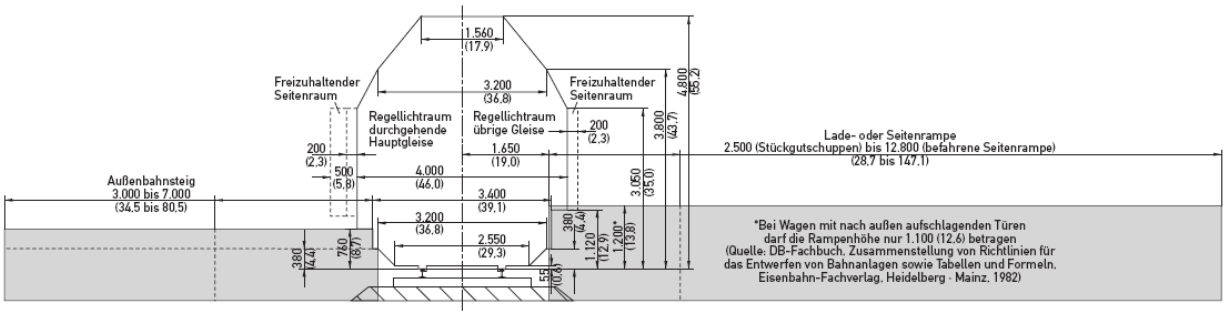
	Standard	Description
7.1.1	Vehicles should be prototypical	
7.1.2	Vehicles must be visually and technically flawless	*Unfinished vehicles can be tested on consultation with module owners.*
7.1.4	Observe NEM loading gauge	*The NEM loading gauge is shown compared to the prototype loading gauge; due to wide-tread wheels and cylinder blocks located too far apart, the prototype loading gauge cannot be used except in H0fine and FREMO:87.*
7.1.5	FREMO-E uses the wider loading gauge for operation with catenary	*It has yet to be determined, if this group will use the prototypical or the NEM gauge.*
7.1.6	H0fine and FREMO:87 use prototypical loading gauge	*In contrast to vehicles adhering to NEM, FREMO:87 observes the prototype measurements of the loading gauge.* *The standard loading gauge profile shown below applies to prototype radii greater than 250m; for smaller radii, slightly increased width measurements apply; in a 180m radius, for example, the inside of the curve is 80mm and the outside of the curve is 90mm.* *A test gauge should be available.*



7.1.4 Standard gauge according to NEM 102



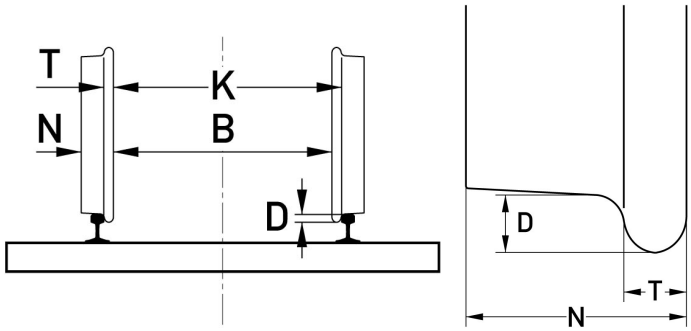
7.1.6a Standard loading gauge for H0fine und FREMO:87



7.1.6b Standard loading gauge for H0fine und FREMO:87

7.2 Wheels – Minimum Requirements

	Standard	Description
7.2.1	Wheel set and wheel measurements are indicated in the table below	*Only wheel sets conforming to the measurements in the table are permitted.* *Wheels shall run free and true.*



	Prototype EBO* [mm]	1:87 [mm]	NEM [mm]	RP25/110 [mm]	H0fine [mm]	FREMO:87 [mm]	
Wheel dimensions							
K			15,30	15,40	15,60	15,92 – 16,00	Check gauge
B	1357 - 1363	15,59 – 15,67	14,30	14,40	14,80	15,55 (+0,05)	Back-to-back
B+ 2N	1617 - 1663	18,59 – 19,11	19,90	19,88	19,20	18,65 - 19,04	Outer width
N	130 - 150	1,49 - 1,72	2,80	2,79	2,20	1,55 - 1,72	Wheel width
W	110 - 117	1,11 - 1,49	1,90 – 2,00	2,03	1,60	1,15 - 1,35	Thread width
T	20 - 33	0,23 - 0,38	0,80 – 0,90	0,76	0,60	0,37 - 0,40	Flange width
D	25 - 38	0,29 - 0,44	1,20	0,64	0,60	0,32 - 0,35	Flange depth
FR	12 – 15	0,14 –0,17	0,40	0,36	0,25	0,15	Filet radius
TC	1:20 / 1:10	3,2° / 6,4°	3,0°	3,0°	3,0°	2,5°	Tread taper

7.2.1 H0 wheel dimensions

7.2.2	Wheel insulation	*Insulation on the axles needs to leave 13.0 mm space to allow for rollbock operation.* *Axle diameter should be between 1.6 and 2.0 mm.*

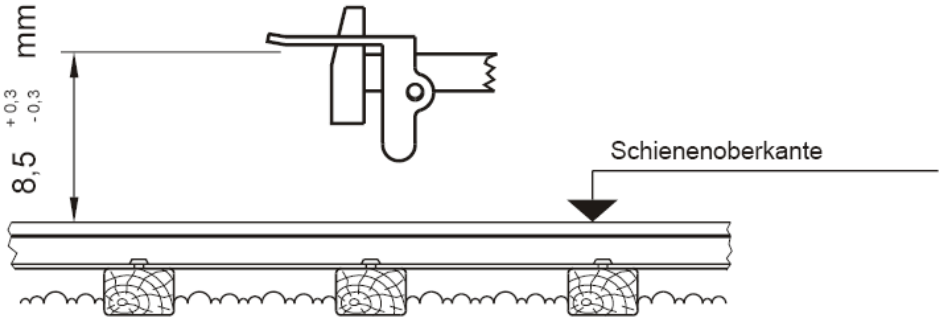
*Eisenbahn-Bau- und Betriebsordnung – German Ordinance on the Construction and Operation of Railways

7.3 Wheels – Standard Practices

	Standard	Description
7.3.1	Wheel insulation	*Insulation on the axles need to leave 13.0 mm space to allow for rollbock operation.* *Axle diameter should be between 1.6 and 2.0 mm.*
7.3.2	FREMO:87 wheels require profiles on both sides	*FREMO:87 wheels must have profiles on both sides to look attractive from a prototypical viewing angle.*

7.4 Couplers and Buffers – Minimum Requirements

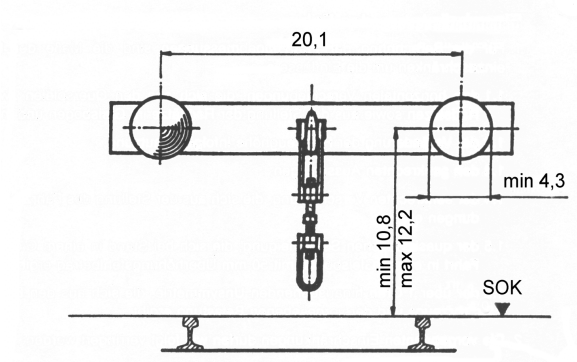
	Standard	Description
7.4.1	H0 Europa Coupler according to NEM 360	*Compatibility with NEM 360 is necessary to make joint operation possible.*
7.4.2	H0 Europa Coupler height over rail, relation to buffers	*Coupler height measured from the top of the rail is 8.5 mm; a FREMO coupler gauge is available.*
7.4.3	H0 Europa Position of buffers	*When using fixed buffers, the impact plate of the coupler should extend circa 0.5 to 1.0 mm past the buffer; when using spring buffers, the impact plate can be in line with the buffers.*



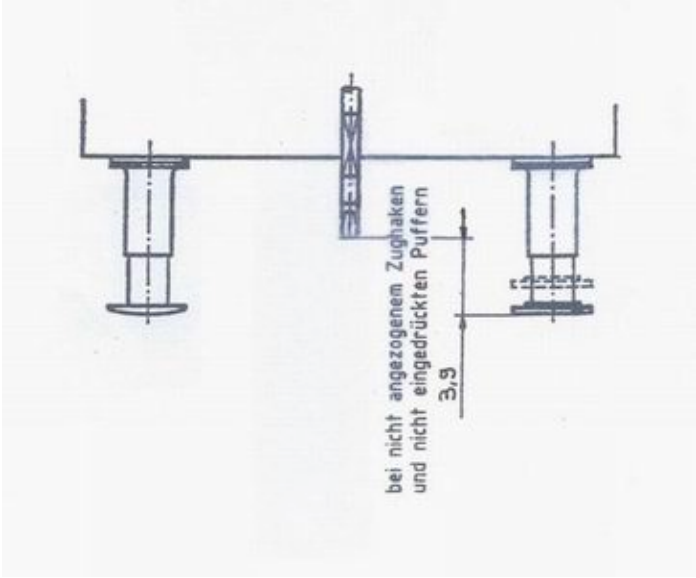
7.4.2 Coupler height for coupler according to NEM 360

7.4.4	FREMO Norway Special coupler made from 0.3 mm steel wire	*The coupler works like the old Fleischmann fall-hook coupler. A wire is mounted in-between the buffers and a hook made from the same material falls over it to connect to vehicles. Assembly and functionality are outlined in FREMO HP1 1/2003, pages 24-28.* *Because the coupler uses very thin wire, it is very inconspicuous.*

	Standard	Description
7.4.5	FREMO:87 Representation of the prototype buffers and couplings, height over rail	*FREMO:87 uses the buffers and screw/3 link coupler. Preferably, both should be spring-loaded. Height over the top of the rail as indicated in the drawing.*
7.4.6	FREMO:87 Sprung buffers are mandatory; height over rail; coupler centred between buffers	*The use of spring buffers is required, especially for cars used for rollbock operation. Height of the sprung buffers over top of the rail as indicated in drawing.* *The coupler needs to be assembled in a way so that all joints between the parts be can moved easily. Gravity alone should suffice to align the coupler chain into a straight vertical line. It is necessary to widen the hook and eyes. At least the first two joints from the hook need to be freely moveable.* *The opening of the hook needs to carefully de-flashed and polished so that the opening measures 0.6 mm. The diameter of the outer link should not measure more than 0.4 mm. A FREMO:87 gauge to set the distance between hook and buffer to 3.9 mm is available.*



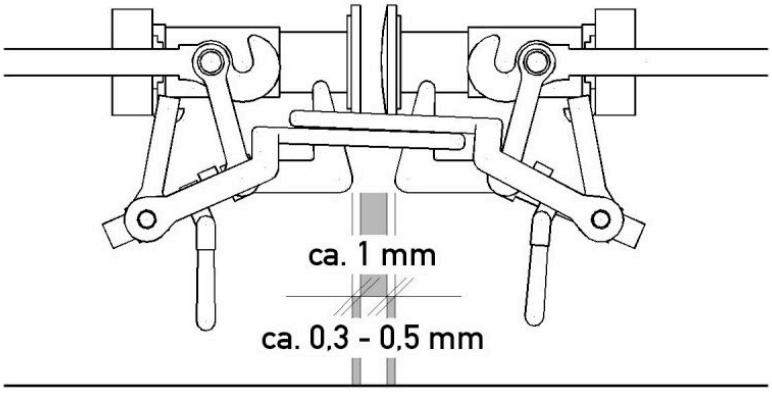
7.4.3a Position of the buffers (in mm) according to NEM 303



7.4.3b Push and pull equipment (in mm)

7.5 Couplers and Buffers – Standard Practices

	Standard	Description
7.5.1	HO Europa Coupler according to NEM 360	*Use of GFN "swallow-tail" coupler (item #6511) is recommended; short coupler pockets need to be fixed using a bolt or screw.*
7.5.2	H0 Europa -> H0fine GFN coupler or imitation of the buffers-and-chain coupler (system M. Weinert)	*Experiments with H0fine couplers are still ongoing; it is planned to use a coupler, located in-between buffers for appearance, that is still compatible with NEM 360 and couples very close (requires spring buffers).*
7.5.3	H0 Europa -> H0fine Height of coupler (system M. Weinert) over rail, relation to buffers	*Height over the top of the rail in the centre of the coupler as indicated in the drawing. Coupler is compatible with NEM 360.*



7.5.3 Coupler system M. Weinert

7.6 Locomotive Electrical – Minimum Requirements

	Standard	Description
7.6.1	Locomotives and other motive power need to be equipped with a DCC decoder	*Only motive power with DCC decoders may be used.* *Decoders should be able to handle long addresses and 128 speed steps.*
7.6.2	Use long addresses exclusively	*For safety, addresses are assigned centrally*
7.6.3	Before a locomotive is used for the first time, the assignment of a unique address is required	*Makes sure that all locomotives are assigned a unique address.* *Members can contact the DCC administrator to reserve an address.*
7.6.4	Addresses need to be indicated on the locomotive card attached to the respective throttle	
7.6.5	Couplers and buffers need to be insulated	*Buffers and couplers can serve as electrical conduits between vehicles. Brass models with wheels that are only insulated on one side, e.g. Weinert and etched scratch-built models, require wheels with double insulation. Where this is not possible, coupler and buffer need to be mounted so that they are insulated.*

7.7 Locomotive Electrical – Standard Practices

	Standard	Description
7.7.1	Sounds decoders are recommended to so that necessary sound signals can be given	*The installation of sound decoders is allowed. Contact the DCC administrator before using sound decoders on the layout.*
7.7.2	If possible, all wheels should be used for electrical pick-up.	*Experience has shown that even when using DCC with brushless motors and flywheel, a good and easy to clean electrical pick-up is necessary since the accumulation of dirt at large meetings is greater than on a home layout.* *Improvements to power pick-up can further increase reliability.*

7.8 Running Gear – Standard Practices

	Standard	Description
7.8.1	Gears	*As a rule of thumb, motive power should be geared so that it does not exceed its prototypical maximum speed by more than 20% at 12 V.*
7.8.2	FREMO:87 Three-point bearing and suspension of motive power and long two-axle and three-axle cars	*Even prototype track isn't always laid perfectly – module connections, differences in temperature, and sprung floors in gymnasiums sometimes cause severe buckling that has to be negotiated by rolling stock.* *Due to the low flange depth in FREMO:87, a three-point bearing – and where appropriate – a suspension on all motive power and rolling stock is indispensible to ensure safe operations. This applies in particular to long two-axle and three-axle cars.* *Small and short rolling stock without three-point bearing can certainly operated safely – these vehicles will only be approved upon passing a safety test.* *Optimal traction and derailment-free operation can be achieved on basically any track by using swivel suspensions – especially on multi-axle steam locomotives.*
7.8.3	Freight cars need to be able to coast for at least 50 cm from a 50 cm long ramp with an incline of 1:8	*Hump yards and gravity yards are used in FREMO. Rolling stock with poor coasting capabilities interfere with operation and may be removed from the layout.*

7.9 Weight – Standard Practices

	Standard	Description
7.9.1	Minimum car weight	*Cars should not be too light because they may derail more easily.* *The following minimum weights have been well-proven and basically correspond to the NEM 302 standard of 0.4g/mm car length:* *Four-axle cars 80 g* *Two-axle cars 60 g*

Initial weight	[g]	30
Additional weight (per mm of car body length)	[g]	0,5
Minimum length	[mm]	100
Maximum length	[mm]	180
Correction factor for cars shorter than the minimal length		0,9
Correction factor for cars longer than the maximum length		1,2

Examples:	Car length 140 mm:	30 g + 140 x 0,5 g	= 100 g
	Car length 80 mm:	(30 g + 80 x 0,5 g) x 0,9	= 63 g
	Car length 200 mm:	(30 g + 200 x 0,5 g) x 1,2	= 156 g

Recommendations according to NMRA RP 20 (see HP1 III/95, p. 24)

7.9.2	Centre of gravity	*Cars used on rollbock trains with additional weight need an especially low centre of gravity.*

8 FREMO – Operation

8.1 Operation – Standard Practices

	Standard	Description
8.1.1	Track module and station drawings need to be drafted and registered centrally	*Every module requires a drawing for layout planning. These CAD drawings will be drafted centrally to ensure uniformity.* *Station drawings need to indicate necessary space for personnel.*
8.1.2	Station data sheet	*Every station requires a data sheet indicating freights that operator can request.*
8.1.3	Module owners clean their own track	*Track should be cleaned by the module owner or by other members with express permission to do so.*
8.1.4	Rolling stock operated on layout requires a card	*Freight and passenger cars require car cards as well as waybills, which are supplied by station owners.* *Cards are also required for motive power.*
8.1.5	Signals and derails	*Derails and signals need to be observed during operation.* *Disregarding a derail carries a fine of €5 for engineers and €2.50 for conductors. Proceeds benefit the FREMO youth programme.*
8.1.6	Timetable	*Timetables need to be observed.*
8.1.7	Train formation	*Train formation guidelines need to be observed.*
8.1.8	Station signage	*Stations should be outfitted with a sign bearing the name of the station to ease orientation on the layout. The sign should be mounted on a post measuring 2.2 m in height.*

8.2 Phones, Clocks and RUT – Standard Practices

	Standard	Description
8.2.1	Every station needs to provide a phone	*Groups within FREMO have their own analogue or DECT phones systems.*
8.2.2	Clocks	*Fast clocks should be installed within eyesight of every station.* *Clocks are operated with 24 V pulses.*
8.2.3	RUT – Clock and phone bus	*The FREMO RUT bus was developed to avoid running wires to each individual phone on the layout. In addition to the phone signal it also transmits the clock pulse.* *Several members have RUT systems, which can be used for meetings.*
8.2.4	RUT – Box	*Each station needs to be equipped with its own RUT box and provides a matching 25-pin sub d connector.*

8.3 Criteria for Exclusion – Standard Practices

	Standard	Description
8.3.1	Modules and/or rolling stock that do not adhere to the standards and interfere with operations may be excluded from participation by the meeting organizer	*Smooth operations that is satisfying for everyone is only possible with modules and rolling stock that is working reliably. It is required that **all** parts are compatible and in working condition.* *These requirements and recommendations, which are based on practical experience, define the common ground. The entire module philosophy is based on the active collaboration of everyone. It only through teamwork that model train operation on modules is possible.* *More and more larger meetings with long travel distances and an increasing quality of landscaping and construction require a significant commitment from the modeller–both financially and in terms of time invested. It is necessary to set criteria defining when a module or piece of rolling stock can no longer be operated as part of a layout.* *Flawless operation can only be achieved by applying these standards and recommendations consequently. If someone thinks he or she can disregard these rules in whole or in part, they should not be surprised if their module or piece of rolling stock is excluded. There are no inspections, or assessments based on quality or taste. Exclusion will be solely based on a permanent problem with functionality.*
8.3.2	Special requirements for meetings such as the exclusive use of RP25/100 wheels need to be announced by organizers well in advance	*Exclusions are only allowed when modules and rolling stock do not adhere to the published standards.*

9 Recommendations and Attachments

9.1 Theme / Era

	Standard	Description
9.1.1	Module themes may include standard gauge secondary railways, private railways and single or double track mainline including operation with catenary	*Most modules depict a standard gauge secondary railway. Over the years, a variety of other themes have been introduced including private railways, double track modules (mainline) or modules with catenary.*
9.1.2	Flat, rural areas and low mountain ranges	*Track modules only represent a limited section of landscape of about 45 to 50 m width. Flat or small slopes are prototypical for modules depicting Central Europe. Hills, bridges, underpasses can of course be part of such a module.* *FREMO members from countries with more alpine landscapes have developed their own standards with steeper slopes.* *To ensure compatibility, module should use standard end plates.*
9.1.3	Landscaping	*Any prototypical or convincing landscape or facility can be modelled provided that the module width and features do not interfere with operation. It should be for possible to uncouple trains from the edge of the module without causing damage. (See module width in stations.)*
9.1.4	Period: 1955 to1970 (Era IIIb to IVa)	*Modules can be based on prototypes of any European railway and era with the exception of era II in Germany and territories occupied by Germany between 1933 and 1945.*
9.1.5	Season: Late summer	*This season can be easily modelled convincingly and is a preferred choice among modellers.*
9.1.6	Passenger and freight traffic	*FREMO operations put an emphasis on freight traffic.*
9.1.7	Steam, diesel and electric locomotives	*In the 1950s, European railroads attempted to increase efficiency through diesel engines. Steam engines often continued to operate simultaneously.* *Most modules are built for diesel and steam operation because outfitting modules for operation with catenary requires significant efforts.* *In countries such as Norway and Switzerland electric engines were used much earlier and it is to be expected that more and more modules based on these prototypes will be outfitted with catenary. In principle, modules with catenary are possible.*
9.1.8	Signalling and direct traffic	*Signalling is required on mainlines.*

	control	*If there are no signals, operation should follow direct traffic control. This should be determined before meetings.*
9.1.9	Industry sidings, private railways, and harbour railways	*Modules depicting other themes and eras are permissible and can be integrated in a layout. They must fit into the overall look and form a believable part of the layout.*
9.1.10	Goods	*Station builders should consider what kind of goods and what quantities will be dispatched and received. These parameters form the bases for a FREMO timetable.*

9.2 Miscellaneous

The following recommendation are not set standards because module operation is possible without them and also because other solutions are available. The list includes things that have proven useful in making operations better and members are encouraged to use the described techniques.

	Recommendation	**Description**
9.2.1	Trackbed	*Trackbeds have often been mounted in between the end plates; in addition to that, cork has been used as roadbed, which after drying out causes kinks that impede operational safety. Making a cutout for the track bed on the end plate so that it matches the full length of the module helps prevent this.*
9.2.2	Roadbed	*Using cork as roadbed is not recommended because the material may shrink uncontrollably, which causes kinks in track.* *Modern rolling stock with quiet gears doesn't require additional sound proofing on modules. Track can be simply mounted directly on plywood or on separate plywood strips, which has the advantage that turnouts can be built offline and later mounted on the module.*
9.2.3	Keep module height as low as statically possible	*Low module frames maximize transportability and make it easier to duck under modules. The skills of the individual builder will determine the minimum frame height.*
9.2.4	Landscaping should not extend beyond individual track modules	*Only track and drainage channels should extend from module to module. Module ends should feature flat vegetation. Paths, roads, streams and other landscaping elements need to end or exit on the side of the module.* *Module sections that always need to be set up together make layout planning more difficult, may make an efficient use of space impossible and is contrary to the philosophy of freely combinable modules.* *The FREMO:87 standard for example suggests the use of SILFLOR material. Other materials can be used of course. See the module building handbook.*

	Recommendation	Description
9.2.5	Stations should be designed spaciously	*If not built exactly following a prototype, stations should be designed with realistic operations in mind and extend over several modules.*
9.2.6	Stations should be designed so that they can be used in several eras	*This allows operating sessions set in other eras if enough rolling stock is available.*
9.2.7	"Golden" rule	*Stations are naturally more interesting than simple track modules; station owners should contribute track modules double the length of their station to avoid that the layout just consists of stations.*
9.2.8	Locomotives should be equipped with flywheels and brushless motors	*It is recommended to equip locomotives with brushless motors (e.g. Faulhaber an Maxon) and large flywheels. Brushless motors allow for careful adjustment of speed and in conjunction with adjusted gearing operate well in slow speeds. Flywheels help to achieve prototypical acceleration and deceleration and helps locomotives get over areas with contact problems.* *Note that locomotives with poor drive mechanisms usually cannot achieve good driving characteristic using electronic flywheels.*
9.2.9	Couplers with prototypical appearance may be used for operation except for FREMO:87 where an original coupler is required	*See the latest coupler developments by M. Weinert and M. Hellmann.* *The Alex Jackson coupler, which is used widely in the UK and is favoured by T. Becker, has not found widespread acceptance except among members of FREMO Norway*

9.3 Modules with Catenary

The discussions about the standard are not completed as various articles in Hp1 show.

It is yet to be determined:

- Prototype catenary and masts
- Wire position based on NEM or to scale
- Wire zigzag according to German, Swiss or Austrian prototype, which affects mast spacing in curves significantly
- Mast spacing based on track centre or module end
- Wire gauge and module connector
- Tensioning
- Colour

9.4 References and Further Reading

1. Module und Segmente, Miba Spezial 78, Miba, Verlag, Nürnberg, 2008
2. Module & Segmente, Modellbahn Kurier 25, EK-Verlag, Freiburg, 2007
3. Turnout kits and track
   Willy Kosak: http://www.h0pur.de/
   RST Modellbau: http://www.rst-modellbau.de/rstshop/index.php/gleisbau.html
   Tillig: http://tillig.com
   Weinert Mein Gleis: http://www.mein-gleis.de
4. Module database administrator: Moritz Hebert
5. Couplers
   Michael Weinert coupler: http://www.mw-modellbau.de/06_OBK/OBK1.htm
   OBK coupler: http://bit.ly/184IDFj
   Thomas Becker wire coupler: http://www.drahtkupplung.de/gtbhb244.html
6. LocoNet box and digital accessories
   Fine H0 Parts http://bit.ly/1cTLZZc
7. FRED und FREDI
   FRED: http://fremodcc.sourceforge.net/diy/fred/fred_d.html
   FREDI: http://fremodcc.sourceforge.net/diy/fred2/fredi_d.html
8. Booster
   http://wiki.rocrail.net/doku.php?id=ord3-cs-en
9. Wattenscheid signal slots
   http://www.fremo-net.eu/index.php?id=339
10. Signal block
    http://fremo-block.sourceforge.net/
    http://fremo-block.sourceforge.net/Lastenheft/index.html
11. Direct traffic control
    http://de.wikipedia.org/wiki/Zugleitbetrieb
    http://www.fremo-net.eu/index.php?id=1661
12. Manual turnout controls with and without locks
    http://www.outbus.de/
13. FREMO car cards
    http://www.bf-vln.de/wagenkarten/formular.php?lang=english
    http://bit.ly/18fBFIo
14. Station data sheet
    http://www.fremo-net.eu/index.php?id=311
    http://wiki.modellbahnfrokler.de/index.php/Bahnhofsdatenblatt
    http://www.westportterminal.de/naubf_datenblatt.html
15. FREMO shop (module end plates and more)
    http://www.williwinsen.de

9.5 Attachments

Attachment 1 - Requirements for Meeting Attendees (2006 Version)

FREMO meetings are community events of the members. Meetings can only be successful if all participants adhere to certain ground rules. Adherence is everyone's personal responsibility.

1. General Requirements

Participate in the meeting	*It's team work not a contest*
Adhere to rules set by landlords and organizers	*E.g. smoking ban, sneaker requirements, meeting schedule*
Cleanliness and order	*Dispose of trash, food leftovers, packaging, and empty bottles*
Hall sleepers: obey the rules	*Who keeps the keys at night?, Quiet hours, etc.*

2. Fire Safety

Keep fire lanes free	*Clear fire lanes after loading and unloading; use parking lots*
Keep emergency exits free	*Store module transport boards and cases as well as rolling stock packaging under modules; do not block module duck-unders*
Keep fire extinguishing equipment accessible	*Do not block wall hydrants and fire extinguishers*
Familiarize yourself with fire protection installations	*Escape routes, location of extinguishing equipment*
Do not store large quantities of flammable fluids in the venue	*Rule of thumb 100 ml max of lighter fluid or rubbing alcohol*
Do not leave hot soldering irons unattended	*Applies to both electric and gas soldering irons*
Only run electrical devices necessary for layout operation	*E.g. no coffee makers, refrigerators, etc.*

3. Electrical Safety (230V)

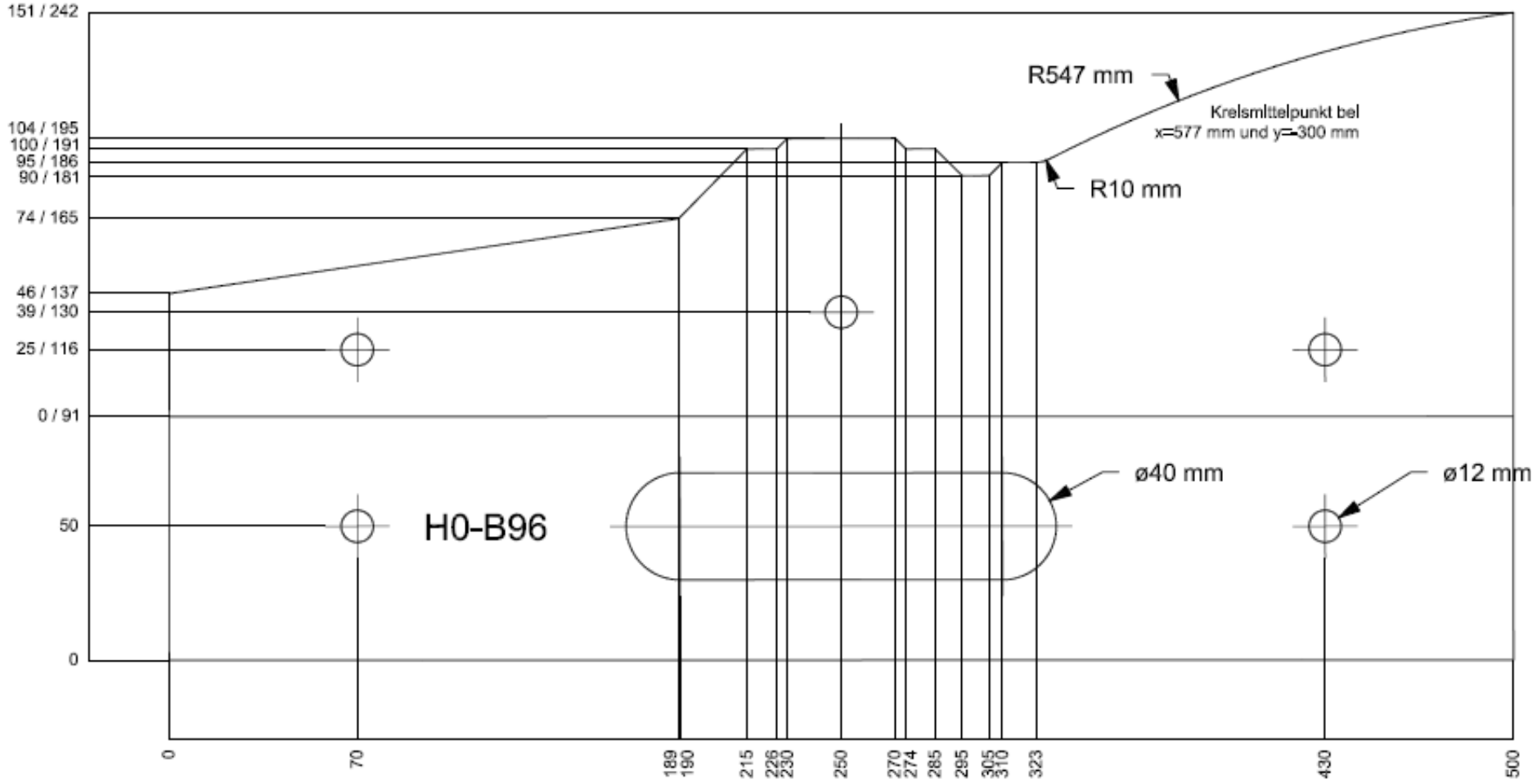
Check electrical equipment (230 V) for damage and function; do not use faulty equipment	*e.g. power distribution (plugs and power strips), transformers, soldering irons, lamps*
Do not use home made 230 V power distribution accessories	*e.g. power strips*
Unroll hooked up cable drums entirely	*Use appropriate lengths; avoid trip hazards*
Use transformers designed for model railway use	*Power supplies from reputable manufacturers and electronics suppliers*
Home made 230 V equipment must comply with VDE* standards	*Requires special knowledge e.g. safety contacts; touch protection of all blank cables and connectors*
Transformers and power strips (230 V) must not be installed in modules	*Heat accumulation; visual contact with transformers*
Recommendation: Provide RCD adaptors if using 230 V in stations	*Personal safety; detect fault currents; limit disruption*
Secure 230 V cables in gangways and module duck-unders	*Danger of tripping; Use on floor cord covers or use tape to secure cables*
Adhere to local requirements for electrical safety	*Meeting hosts should inform attendees about requirements that differ from the VDE standard.*

4. Operations

Modules, rolling stock, etc. need to be in working condition	*e.g. safe traction; adjusted couplers*
Clean track, locomotives, wheels, and adhere to quality requirement of organisers	*e.g. RP25, H0fine*

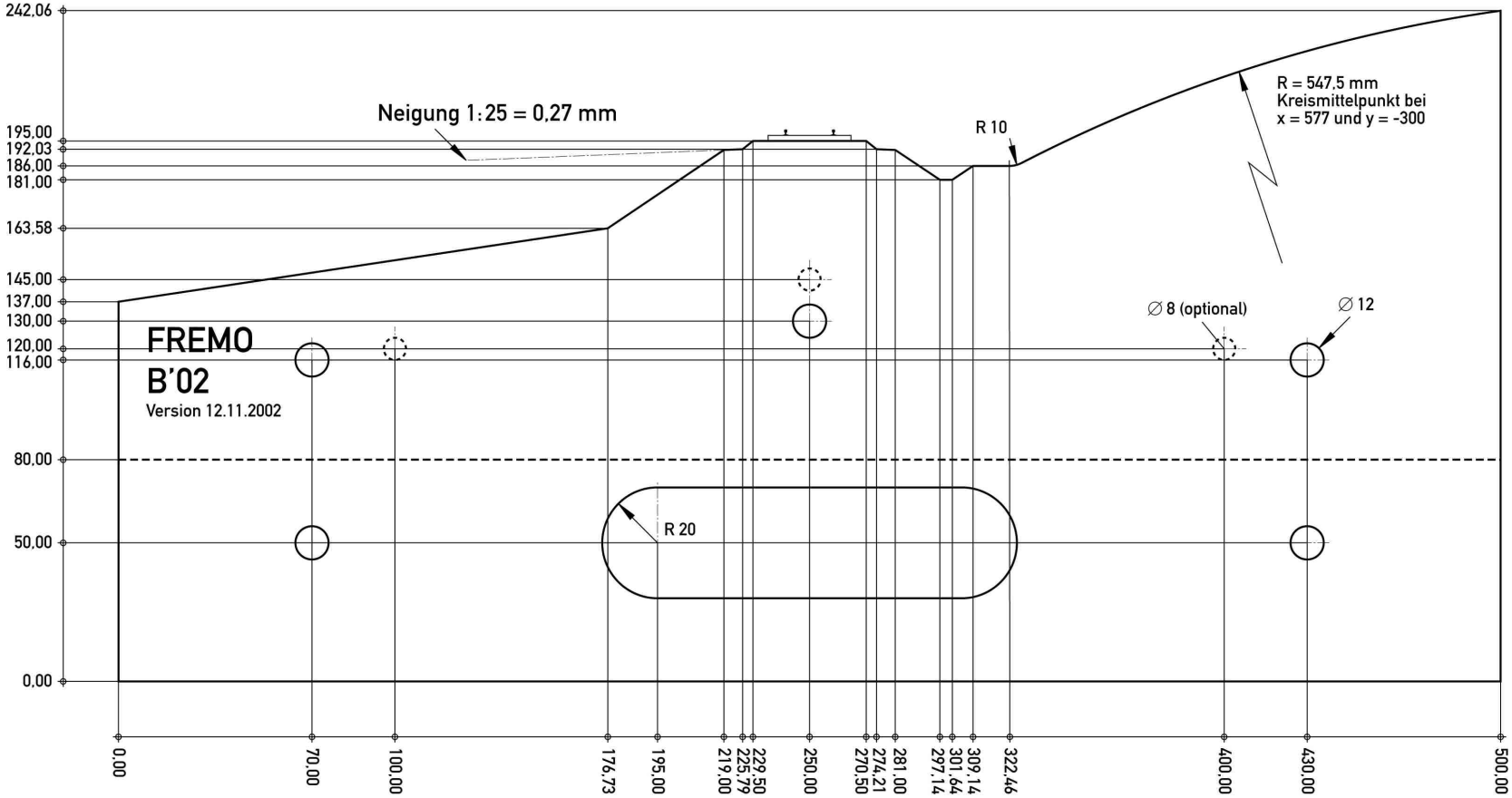
* VDE = Association for Electrical, Electronic and Information Technologies e.V.

Attachment 2 – Module End Plates



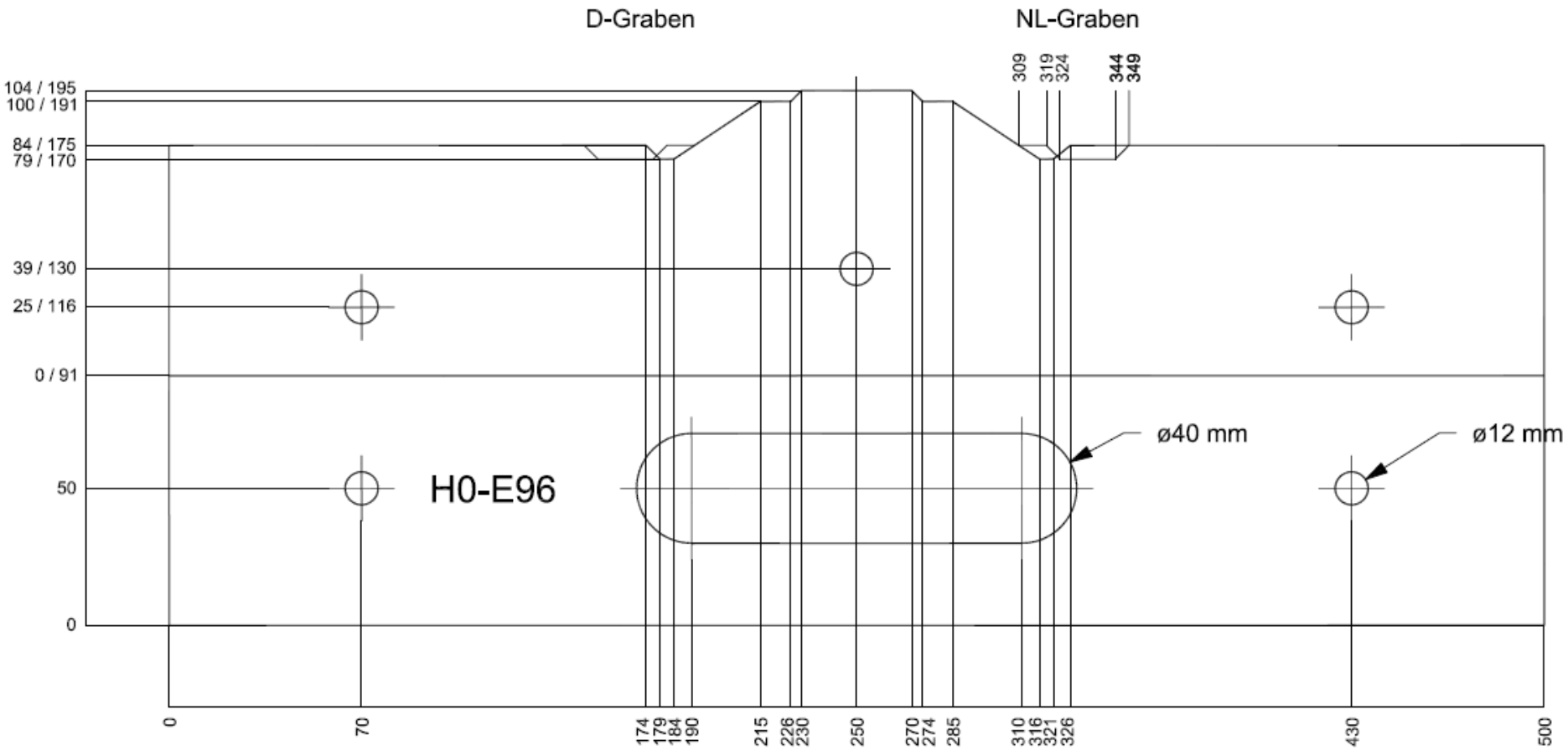
End plate H0-B96

Attachment 2 – Module End Plates



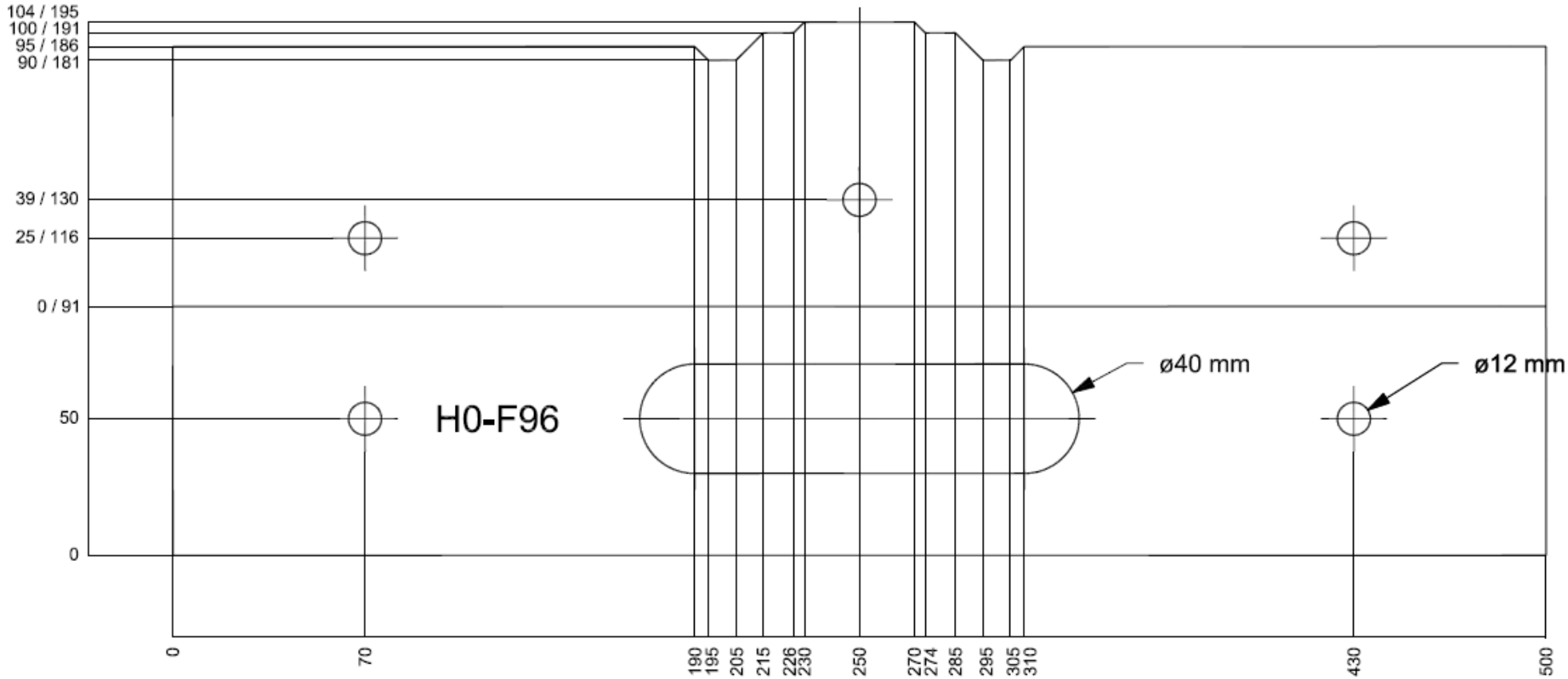
End plate H0-B02

Attachment 2 - Module End Plates



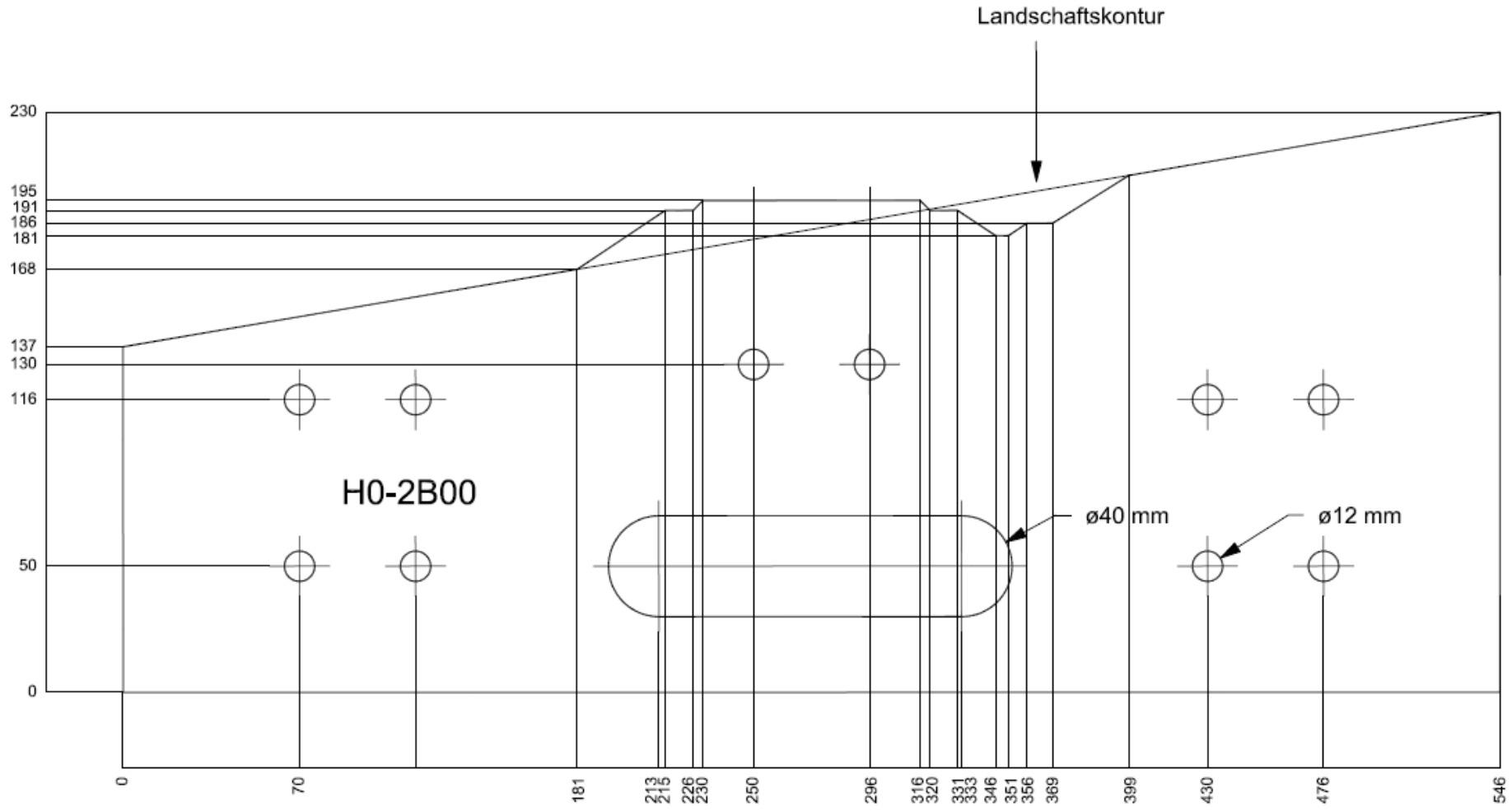
End plates H0-E96

Attachment 2 - Module End Plate



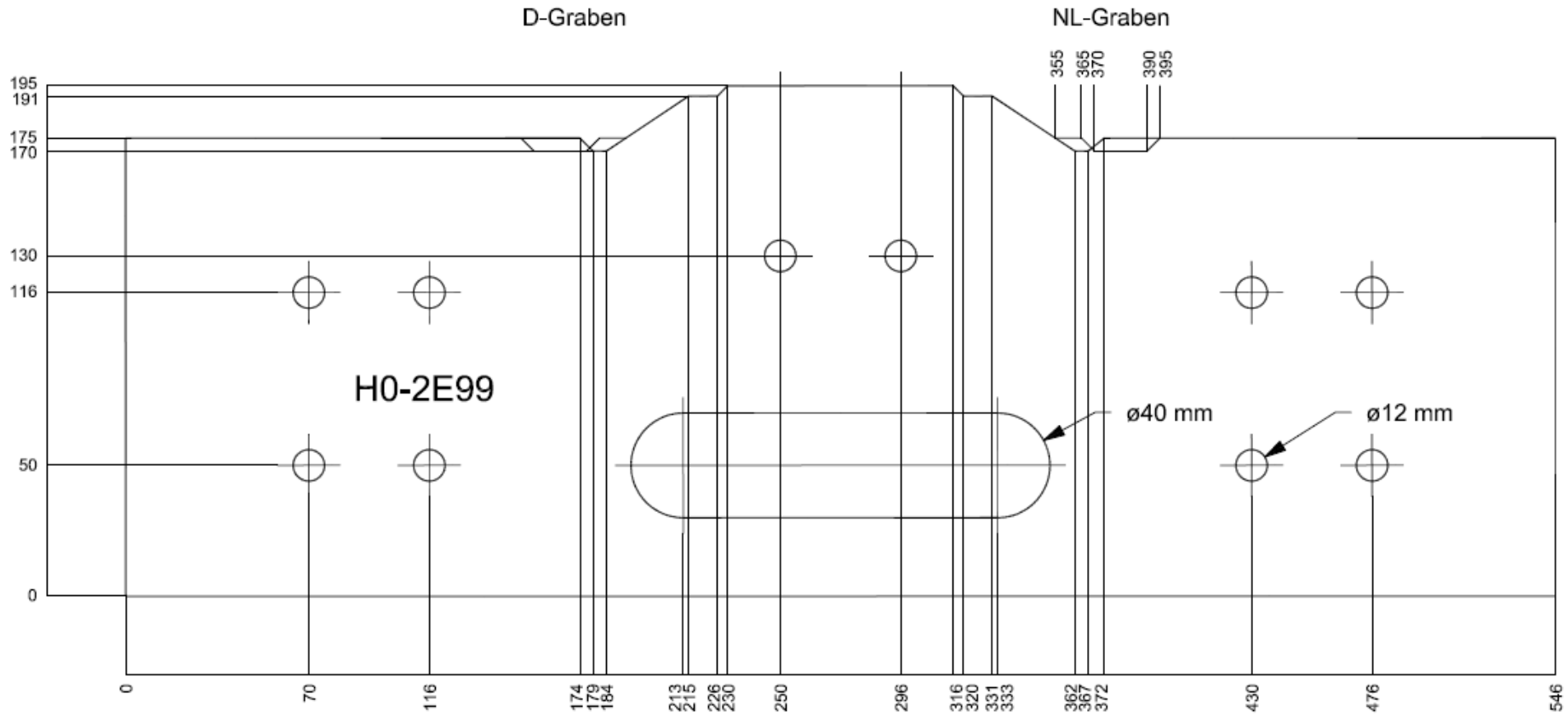
End plate H0-F96

Attachment 2 - Module End Plates



End plate H0-2B00

Attachment 2 - Module End plates



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