EURORACK INTERFACE SPECIFICATION (EIS)

EIS is a free, open specification for Eurorack hardware. It says what modules, enclosures, bus boards, power supplies, and cables owe each other so that products from different makers fit, power up, and patch together. A rule is a shall only where two products would otherwise fail to work together; everything else is written "EIS recommends". Every requirement has an identifier, the product types it applies to, and a machine-readable model behind it.

Read it: lzxindustries.net/eis has the PDF, the machine-readable models, and every clause as a web page with a URL for each requirement. In this repository, start at Scope, or, to design a product, at the designer's guide.

Claim it: a product states its product type on one line, `EIS draft, module`, and can keep what it publishes in a claim file, which `eis claim eis-claim.yaml` validates.

Change it: open an issue or a pull request at git.lzxindustries.net/lzx/eurorack-specification. CONTRIBUTING.md says what belongs in EIS and how a change is made; a proposal for a new shall names the two products that would stop working together without it.

Identifier	EIS
Status	Working draft
Edition	v0.1.0
Maintainer	LZX Industries
License	CC BY 4.0 on the specification, MIT on the tooling; details in COPYRIGHT.md
SPDX	`CC-BY-4.0` (specification), `MIT` (code)

DOCUMENT MAP

CLAUSE	PAGE	READ IT WHEN YOU DESIGN
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1 Scope	`spec/scope.md`	

CLAUSE	PAGE	READ IT WHEN YOU DESIGN
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3 Terms	spec/terms.md	The words with a special meaning
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4.4 Requirements register	spec/requirements.md	Every requirement, generated
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6.5 Bus boards	spec/bus-boards.md	Capacity, links, ribbons
6.6 Bus CV and gate	spec/bus-cv-gate.md	The 16-pin CV and gate nets
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7.2 Signal classes	spec/signal-classes.md	The seven signal classes, AUDIO, CV, VIDEO, PITCH, GATE, TRIG, and CLOCK, and their ranges
7.3 Video signals	spec/video-signals.md	VIDEO on patch jacks: levels, impedances, path kinds, and bandwidth
8.1 12 V DC power (PWR-DC12)	spec/dc-12.md	PWR-DC12: a barrel or multi-pin DC entry and the DC rail it feeds
8.2 Video on 75 Ω coaxial jacks (VID-75)	spec/video-75.md	The 75 Ω coaxial interface: the video sync ports COAX-IN, COAX-OUT, COAX-THRU, the video sync tree, and the coaxial cable
8.3 Video timing	spec/video-timing.md	The formats a video sync port lists
9 Assembling a system	spec/assembly.md	The rules for whoever fits a row together
Annexes A to M	annex/	Informative: verification, planning aids, worked examples, and the Doepfer comparison
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MACHINE-READABLE MODELS

`data/` holds the register and every normative number: `requirements.json`, the mechanical models, `signals.json`, `video_timings.json`, `video_75.json`, `power_interfaces.json`, `power_ribbon.json`, and `dc_12.json`. A product's claim file follows `data/claim.schema.json`; the examples are in `data/examples/`.

The market survey and the catalog rail sections and inserts are in the separate eis-reference repository. They are informative and size nothing EIS requires. Third-party documents are not stored here; `data/sources.json` records where each cited one was retrieved.

TOOLING

`pip install -e ".[build,test]"` installs one command, `eis`:

COMMAND	DOES
`eis check`	Runs every generator and check (`python -m pytest tests`)
`eis gen`	Rewrites the generated pages, tables, and figure cards
`eis build pdf`, `site`, or `all`	Builds `build/eis.pdf` and the static site
`eis claim FILE`	Validates a claim file and prints its claim line and the register rows the product owes
`eis claim --mark OUT.svg FILE`	Also writes the product's EIS mark

Every subcommand is a script under `tools/`. The figure cards in `figures/` share one house style, `tools/card.py`. CI builds the PDF and the site on every push; a tag `vX.Y.Z` (an edition) or `vX.Y.Z-rc.N` (a review candidate) publishes them at lzxindustries.net/eis (CONTRIBUTING.md).

FOREWORD

This page is informative. It gives the edition, its status, and the terms of its public review.

Edition	v0.1.0
Status	Working draft
Date	2026-10-20

Maintainer	LZX Industries
Public review	2026-10-26 to 2026-12-07; comments as issues at https://git.lzxindustries.net/lzx/eurorack-specification/issues or to support@lzxindustries.net
Claims against this edition	`EIS draft` until `v0.1.0` is tagged; a claim then names the tag (4.2)

From the first tagged edition, requirement identifiers are frozen: an identifier is never reused, and a requirement whose meaning changes gets a new one (CONTRIBUTING.md). Until the tag, every example claim names `EIS draft`, and the claim tool refuses to print a claim line that names a release.

The clauses describe EIS as it is. The repository's history records what an edition changed.

PART 1 — FRAMEWORK

What EIS covers and how a product conforms to it:

- Scope: what the specification covers and where its values come from;
- Normative references: the publications it applies;
- Terms: the words with a special meaning;
- Conformance: Core, the product types, and the claim;
- Requirements register: every requirement with its identifier.

Parts 2 and 3 hold the product requirements; Part 4 holds the installer's:

- *Core* (Part 2), which every product meets and none claims: the rack, the panel, and the rail; power, from the supply through the bus to a module's power header; and the patch jacks with their seven signal classes, AUDIO, CV, VIDEO, PITCH, GATE, TRIG, and CLOCK.
- *Optional interfaces* (Part 3), which a product meets only where it has them: the 12 V DC rail and the video sync behind the panel.

A maker reads Core, and only the optional interfaces the product has. Part 4 binds the person who assembles a system.

1 SCOPE

1.1 PURPOSE

The Eurorack Interface Specification (EIS) defines the mechanical and electrical interface between Eurorack modules, enclosures, bus boards, power supplies, and the cables that join them.

A requirement is a shall only where, without it, a conforming product from one maker could fail to fit, power up, or work with a conforming product from another: mechanical fit, power entry and distribution, published supply figures, and declared signal classes. Construction choices that do not change interoperability, such as board material, module depth, rail section, or screw finish, are described and recommended, not required.

1.2 APPLICABILITY

EIS applies to five product types (Conformance):

- A *module*: front panel, board clearance, patch jacks and their safety, power entries and header current, and the port list with signal classes and the formats of its rear video sync ports. A DC entry panel or a video sync distributor in module form keeps the rules of what it carries (5.1, 5.2, 6.1, 6.3, 6.4, 6.6, 7.1, 7.2, 7.3, 8.1, 8.2, 8.3).
- An *enclosure*: rack frame, rails, inserts, mounting screws, and the published width and depth of each row. A built-in supply plays the power supply role and a built-in bus board the bus board role; a case DC entry keeps the PWR-DC12 entry rules (5.1, 5.2, 5.3, 5.4, 6.1, 6.3, 6.5, 7.1, 8.1, 8.2, 8.3).
- A *bus board*: headers, links, published capacity, one 0 V, and row wiring terminals, and the rules of anything else it carries behind the panel: a DC rail or the video sync tree (6.1, 6.3, 6.4, 6.5, 7.1, 8.1, 8.2, 8.3).
- A *power supply*: rails, output connector, protection, published ratings and ripple, the earth bond of 0 V, and row wiring terminals, for a row or for the one product it is mounted on. A supply may also make the 12 V DC rail (6.1, 6.2, 6.3, 6.4, 6.5, 7.1, 8.1).
- A *cable*: the interface it mates: power ribbon, video, or DC (6.4, 6.5, 8.1, 8.2).

Every product meets *Core* (Part 2), which is never claimed: the rack, the panel, and the rail; power on the bus; and patch jacks with their signal classes, AUDIO, CV, and VIDEO among them. A product may also have the optional interfaces of Part 3, the 12 V DC rail and the video sync behind the panel. A requirement about a power header, a DC entry, or a video sync port applies to a product that has one, and its claim file lists them. Distributing a rail or the video sync is a capability of whatever product has the outlets or ports, not a product type. Chapter 9 binds the person who assembles a system, not a product.

1.3 EXCLUSIONS

EIS does not specify:

- product catalogs, mains wiring or earthing, or the safety or EMC certification of a product;
- the internal protocol of digital video or data streams;

- ports other than patch jacks, video sync ports, and power entries, such as coaxial picture video, line and microphone audio, MIDI, DMX512, word clock, and the ILDA connector; EIS asks nothing of them beyond SIG-001 and SIG-017, and Annex C gives an informative vocabulary for naming them;
- power rails outside the power interfaces of 6.1, such as a maker's own entry at other rails;
- a precision control-voltage class beyond *PITCH* pitch tracking; the stability of a DC reference and the accuracy of a quantizer are product figures;
- factory test procedures (4.3).

1U in EIS is the Intellijel 1U format: a 39.65 mm panel with a 33.65 mm hole span. Pulp Logic 1U tiles, 43.18 mm high, are a different format, physically incompatible with it, and outside EIS.

1.4 WHERE THE VALUES COME FROM

Every requirement records the origin of its value, its *provenance* (Terms):

- *Quoted* from a dated publication. Rack geometry comes from IEC 60297-3-101:2004 and IEC 60297-3-100:2008: the HP and the rack unit (RACK-001, RACK-002), and the frame dimensions a rack-mount enclosure meets (RACK-003). The M3 thread pitch and major diameter come from ISO 261:1998 (RAIL-006, RAIL-007).
- *Inherited* from the Doepfer A-100 and restated in EIS words: the 3U panel height, the hole inset and drill, the patch jack, the panel width and thickness ceilings, the power header pinout, marking, and keying, the ±12 V and +5 V rails, the gate thresholds, and the bus CV and gate levels, regions, and links. The 1U panel height is inherited from the Intellijel 1U format, and the 5 mΩ limit of a row wiring conductor and the 2 mΩ 0 V link from Hinton Instruments' power distribution.
- *Calculated* from other EIS figures: the hole spans and offset (PANEL-009, PANEL-011), and the insert pitch, thread, and thickness and the screw length window that follow from them (RAIL-001 to RAIL-004, RAIL-009).
- *Set by EIS*: the M3 mounting screw, board edge clearance, the published width, depth, and current of a module, the power header form and its current limit, the signal classes and their ranges, patch safety, the 0 V reference and its earth bond, bus-board capacity,

supply protection, published ripple and the ripple limit, the rest of the rail and enclosure geometry.

The patch levels are EIS figures, not inherited ones. Doepfer publishes typical ranges (audio 10 Vpp, LFOs ±2.5 V, envelopes 0 to +8 V) and no impedance. Modules in use exceed those ranges, and an input has to accept what an output may send, so EIS sets audio at ±10 V peak (B10) and control CV by the range a port claims: B5 when none is named, up to B10 (Annex J).

Where EIS states a value, that value governs a conformance claim. Annex J lists every difference from what Doepfer publishes, and the tests compare EIS with the published A-100 figures.

2 NORMATIVE REFERENCES

EIS applies the following publications by dated reference; only the editions listed apply. Rack dimensions quotes the figures EIS takes from the IEC publications.

DESIGNATION	TITLE	PUBLISHER	USED BY EIS FOR
IEC 60297-3-101:2004	Dimensions of mechanical structures of the 482,6 mm (19 in) series — Part 3-101: Subracks and associated plug-in units	IEC	HP (5.08 mm) and rack-unit height (44.45 mm), RACK-001 and RACK-002; flange width and the 84 HP row width for a rack-mount frame, RACK-003
IEC 60297-3-100:2008	Dimensions of mechanical structures of the 482,6 mm (19 in) series — Part 3-100: Basic dimensions of front panels, subracks, chassis, racks and cabinets	IEC	3U front panel height H1, flange mounting-hole span H2 and end distance H3, the oval mounting slot, and the rack mounting grid, RACK-003
ISO 261:1998	ISO general purpose metric screw threads — General plan	ISO	M3 pitch and major diameter, RAIL-006 and RAIL-007
ITU-R BT.601-4 (1994)	Encoding parameters of digital television for studios	ITU	The placement of the digital active line against OH for the interlaced SD formats, VID-002
SMPTE ST 170:2004	Composite analog video signal — NTSC for studio applications	SMPTE	525i59.94 timing, VID-002
ITU-R BT.470-7 (2005)	Conventional analogue television systems	ITU	625i50 timing, VID-002
CTA-861-H (2021)	A DTV Profile for Uncompressed High Speed Digital Interfaces	CTA	480p59.94 and 576p50 rasters (video format timings 2 and 3, and 17 and 18), VID-002

DESIGNATION	TITLE	PUBLISHER	USED BY EIS FOR
SMPTE ST 296:2012	1280 × 720 progressive image 4:2:2 and 4:4:4 sample structure — Analog and digital representation and analog interface	SMPTE	720p timings, VID-002
SMPTE ST 274:2008	1920 × 1080 image sample structure, digital representation and digital timing reference sequences for multiple picture rates	SMPTE	1080-line rasters and digital timing reference sequences, VID-002
SMPTE ST 240:1999	Television — 1125-line high-definition production systems — Signal parameters	SMPTE	The analog tri-level video sync waveform, ±300 mV, behind the line level of 8.2, V75-010

`data/video_timings.json` names the publication behind each format. The raster figures of 8.3 agree with those publications and, where a row has a contract entry, with a hardware-verified timing contract, which `tests/video_timings_contract.py` checks.

INHERITED CONVENTIONS

EIS restates these conventions in its own words. The pages are not normative references, and a change to them does not change EIS; they are cited so that every `inherited` requirement in the register names its origin.

SOURCE	RETRIEVED	INHERITED BY EIS
Doepfer, Construction Details A-100	2026-10-09	3U panel height 128.5 mm (PANEL-006), hole inset 3.0 mm (PANEL-008), hole drill Ø3.2 mm (PANEL-010), width and thickness ceilings (PANEL-002, PANEL-004)
Doepfer, Technical Details A-100	2026-10-16	Rails (BUS-001, BUS-006), pinout and marking (BUS-003, BUS-004), bus CV and gate jumper (BUS-016), bus CV and gate levels (BUS-017, BUS-018), gate thresholds (the GATE row of 7.2), 3.5 mm mono jacks (PANEL-005), the 10-pin header (BUS-007), split CV and gate regions and links (BUS-013, BUS-014), one CV and one gate transmitter per line (ASM-002). The patch audio and CV levels are EIS figures (Scope 1.4).
Doepfer, A-100 Accessories, A-100BUS V6 technical note	2026-10-14	Shrouded header keying (BUS-005) and module cable keying (BUS-010)
Doepfer, FAQ A-100, notes concerning bus boards with boxed pin headers	2026-10-14	Shrouded bus headers (BUS-005), with the row above
Intellijel, 1U technical specifications	2026-10-16	1U panel height 39.65 mm (PANEL-007)

SOURCE	RETRIEVED	INHERITED BY EIS
Hinton Instruments, Power Distribution, last updated 2021-06-10	2026-10-24	The 5 mΩ limit of a supply cable (PWR-007); M4 ring terminals on the bars, which PWR-005 takes up as an EIS rule; one common 0 V for several supplies and the 2 mΩ ZeroVolt link (ASM-009, 6.3)

3 TERMS AND DEFINITIONS

This clause defines only the words EIS uses in a sense a reader could not guess. Module, enclosure, bus board, power supply, cable, rail, rail insert, and mounting screw have their usual Eurorack meaning; chapters 5 to 9 say what EIS requires of each.

PRODUCT TYPE AND ROLE

A *product type* is what a requirement applies to: `module`, `enclosure`, `bus board`, `power supply`, or `cable`. A *role* is what a product does and publishes. A product's product type names its main role; whatever is built in plays its own role and owes that role's requirements, so a case with a built-in supply and bus board plays enclosure, power supply, and bus board (4.1).

CORE

Core is the part of EIS every product meets, Part 2; it is never claimed. The optional interfaces of Part 3 apply only to a product that has them.

CLAIM LINE, CLAIM FILE, AND EIS MARK

The *claim line* is a product's conformance claim in one line, such as `EIS draft, module`: the edition, and the product type and every other role (4.2). The *claim file*, `eis-claim.yaml`, holds the claim and the figures the product publishes, and lists the product's power entries, outlets, and video sync ports (4.2). The *EIS mark* is the claim line drawn as a nameplate for a label, panel, or board (4.2).

PORT AND PORT LIST

A *port* is one jack or connector on a product. The *port list* is the part of a product's documentation that gives, for every port, its signal class or `unclassified`, its range when that is not the class default, and, for a port that generates or locks to video sync, the formats it supports, and for a video sync port its mode (SIG-001, VID-001). For a bus board or an enclosure, the port list is the `video_75` block of its claim file. It is published in the manual or in the claim file.

SIGNAL CLASS AND RANGE

A *signal class* is a named set of level and impedance limits for a port, such as *CV* (7.2), *AUDIO* (7.2), or *VIDEO* (7.3). A *range* is the full-scale swing a port is built for, such as B10 (−10 to +10 V) or U1 (0 to +1 V). Each class lists the ranges it takes and its default.

PATCH JACK

A 3.5 mm mono socket on a module's front panel that takes a patch cable from another module and carries a class of 7.2 or 7.3, or is `unclassified`. A 3.5 mm TRS socket for MIDI, headphones, or a stereo pair is a port but not a patch jack; EIS recommends that it survive a mono patch plug all the same (7.1).

CLASS CEILING AND DAMAGE LIMIT

The levels of a signal class:

- *nominal*: the level an output puts on the port, such as ±5 V for audio;
- *full scale*: the swing the port's range allows, ±10 V at B10;
- *thresholds*: the levels a gate, trigger, or clock input reads;
- *class ceiling*: the largest signal still in class; an output that claims the class does not exceed it;
- *damage limit*: the level an input withstands indefinitely. On every patch input it is ±12 V (SIG-002), whatever the class ceiling: a *VIDEO* input has a +1.2 V class ceiling and a ±12 V damage limit.

Line level, in 8.2, is the level that a coaxial signal's own standard sets at a terminated input. It is a different quantity from the line

levels of external audio in Annex C.

VIDEO PATH, BANDWIDTH, AND BANDWIDTH MARK

A *VIDEO path* is what lies between a VIDEO input jack and an output jack of one module: linear, shaped, variable, or a generator (7.3). Its *bandwidth* is the –3 dB frequency relative to 100 kHz, measured as 7.3 states, from a 75 Ω source into 100 kΩ in parallel with 30 pF. A *bandwidth mark* writes that figure as BW and the whole megahertz, BW35. A format's *picture bandwidth* is the luma bandwidth its publication specifies (8.3).

COVER, MOUNTING FACE, THROAT, SEAT, AND D

The parts of a rail section:

- *cover*: the amount of panel face the rail hides; it limits the board clearance (5.2.2);
- *mounting face*: the face the panel bears on;
- *throat*: the opening in front of the insert that the screw passes through;
- *seat*: the depth of the insert's front face behind the mounting face;
- *D*: the depth behind the mounting face at which metal closes the cavity a screw tip enters.

Seat and D set the screw length window (5.3).

VIDEO SYNC

Video sync is the horizontal and vertical timing of a video signal: black burst, or bi-level or tri-level video sync, of one 8.3 format, alone or within a composite picture. A row distributes it so that its video modules lock their timing to one source. It travels behind the panel on the 75 Ω coaxial interface (8.2), from a COAX-OUT to each COAX-IN, and never on a patch jack (7.1). EIS always writes video sync in full.

A *video sync port* has one of three modes:

- *COAX-IN* takes video sync;
- *COAX-OUT* gives video sync the product generates;
- *COAX-THRU*, marked *THRU*, passes the COAX-IN's video sync on, either *buffered*, driving one input, or *looped*, bridged to the input

on one line with a termination switch marked TERM.

A *video sync distributor* is any product, usually a bus board, with buffered COAX-THRU ports beside its COAX-IN. The *tree* is the star of 75 Ω cables from its THRU ports to each module's COAX-IN.

POWER INTERFACE, POWER ENTRY, AND OUTLET

A *power interface* is a set of rails with its own connectors, distribution, and limits: *PWR-BUS*, the bus (+12 V, −12 V, optional +5 V), or *PWR-DC12*, 12 V DC (6.1). In a designator the word names the topology and the number the rail voltage: BUS is the Eurorack bus, DC12 a single 12 V DC rail. PWR-BUS is Core and PWR-DC12 an optional interface; their rules apply to a product that has an entry or an outlet of them.

- A *power entry* is where a power interface enters a product: a module's power header, or a DC entry.
- An *outlet* is where a power supply or a distribution product delivers it: a supply's output terminals, a bus board's headers, a product's PWR-DC12 outlets.

0 V AND PROTECTIVE EARTH

0 V is the reference every rail and signal of a row is measured from: the 0 V pins of the power header, the sleeve of a patch jack, the shell of a coaxial jack, and the −V of a DC rail. *Protective earth* is the mains safety conductor. They are different conductors, joined at one point in a system, its chassis tie at the power entry, which a supply (GND-003) or a case DC entry (DC-014) publishes (6.3).

DC ENTRY AND DC RAIL

A *DC entry* is the inlet where nominal 12 V DC enters a product, from an external adapter or on row wiring from another product: a center-positive barrel (*DC-BAR21* or *DC-BAR25*), a multi-pin connector (*DC-VH2* from a DC distribution product, or, above 10 A, *DC-DIN4*, *DC-MF6*, or *DC-MF8*), or a pair of M4 row wiring terminals (*DC-M4*), the default inside a case. The *DC rail* is the 12 V DC that a DC entry feeds, one +V and −V pair, carried to modules directly or through a *DC distribution* product on DC-BAR21 or DC-VH2; each module filters or regulates it locally. The DC rail is not the ±12 V bus (8.1).

VIDEO TIMING FORMAT

A named raster, such as `525i59.94` or `1080p30`, with its line count, sample clock, and video sync structure tabulated in `data/video_timings.json`. 8.3 lists the formats EIS defines.

PROVENANCE

The origin of a requirement's value, recorded per row in `data/requirements.json` (1.4):

- *quoted* from a dated external publication;
- *inherited* from a Doepfer A-100 convention, Hinton Instruments' power distribution, or the Intellijel 1U format, with the page and the date it was retrieved;
- *measured* on a named vendor part;
- *calculated* from other EIS requirements, which the record names;
- *eis*: set by EIS itself.

REQUIREMENT LANGUAGE

TERM	MEANING
shall	Mandatory requirement
shall not	Mandatory prohibition
may	Permission
EIS recommends	Advice; a product that does otherwise still conforms, and its claim records nothing
can	Capability or possibility; not a requirement

EIS does not use the RFC 2119 MUST, SHOULD, or MAY, and has no "should" level.

Every shall statement in a normative clause carries a requirement identifier, written in prose without the `EIS-` prefix (`PANEL-009`), and the requirements register lists it. A may statement need not carry one; a recommendation carries none. Text in a normative clause that uses none of these words is informative: it explains, gives an example, or restates a requirement made elsewhere. Sections, tables, and annexes marked informative impose no requirements. The register and the data models are the specification; where a clause differs from them, the clause is in error (4.4).

4 CONFORMANCE

4.1 CORE AND PRODUCT TYPES

A product conforms to EIS when it meets every shall that applies to it. Two things decide which apply:

1. *Its product type and roles.* Each requirement names the product types it applies to. A product owes those of its product type and of every other role it plays, such as a supply built into a case (roles).
2. *What it has.* A requirement about a power entry, an outlet, a port of a class, or a video sync port applies only to a product that has one. The product lists these in its claim file.

Core, Part 2, is what every product meets; it is never claimed. The optional interfaces of Part 3, the 12 V DC rail and the video sync, apply only to a product that has them. A module's patch jacks each name a signal class, AUDIO, CV, VIDEO, and the rest (7.2), or `unclassified`, and a module mixes them freely. A bus board's or an enclosure's port list is the `video_75` block of its claim file.

`eis claim` applies exactly this rule: it lists the shalls that bind one of the product's roles and whose condition, if the register names one, the product meets.

PRODUCT TYPES

PRODUCT TYPE	WHAT ITS REQUIREMENTS COVER	CLAUSES
module	Front panel, board clearance, patch jacks and their safety, power entries and header current, and the port list with signal classes and the formats of its rear video sync ports. A DC entry panel or a video sync distributor in module form keeps the rules of what it carries	5.1, 5.2, 6.1, 6.3, 6.4, 6.6, 7.1, 7.2, 7.3, 8.1, 8.2, 8.3
enclosure	Rack frame, rails, inserts, mounting screws, and the published width and depth of each row. A built-in supply plays the power supply role and a built-in bus board the bus board role; a case DC entry keeps the PWR-DC12 entry rules	5.1, 5.2, 5.3, 5.4, 6.1, 6.3, 6.5, 7.1, 8.1, 8.2, 8.3
bus board	Headers, links, published capacity, one 0 V, and row wiring terminals, and the rules of anything else it carries behind the panel: a DC rail or the video sync tree	6.1, 6.3, 6.4, 6.5, 7.1, 8.1, 8.2, 8.3
power supply	Rails, output connector, protection, published ratings and ripple, the earth bond of 0 V, and row wiring terminals, for a row or for the one product it is mounted on. A supply may also make the 12 V DC rail	6.1, 6.2, 6.3, 6.4, 6.5, 7.1, 8.1
cable	The interface it mates: power ribbon, video, or DC	6.4, 6.5, 8.1, 8.2

EIS · Product types and the clauses that bind them: Core, the optional interfaces, assembly

	Core													Optional interfaces			Assembly
	5.1 rack	5.2 panel	5.3 rails	5.4 case	6.1 power	6.2 PSU	6.3 0 V	6.4 bus	6.5 board	6.6 CV	7.1 ports	7.2 class	7.3 video	8.1 DC	8.2 coax	8.3 timing	9 fit
module	2	15			8		2	1+10		3	7	1	4	11	10	2	
enclosure	3	3	11	1	6		3		1		2			11	10	2	
bus board					6		3	6	2+4		2			11	10	2	
power supply					7	10	3	8	1		1			11			
cable								4	2					3	1		
installer (9)																	9

■ every product of the type ☐ only with what it has: a power header, a DC entry, a video sync port

Each number counts the requirements of that clause that bind the product type (data/requirements.json). Every product meets Core; an outlined count, and every optional interface, applies only to what its claim file lists.

Figure 1. How many requirements each clause places on each product type

WHAT A PRODUCT HAS

A product does not claim its power entries or video sync ports; it lists them in its claim file. A requirement about one applies to a product that has one: the PWR-BUS entry rules to a product with a power header, the PWR-DC12 outlet rules to a product with DC outlets, the COAX-THRU rules to a product with a video sync through. A passive module has no power entry and owes no rule of the bus but BUS-011, which binds every module (6.4). The register names the condition in brackets after a row's product types:

IN BRACKETS	THE ROW APPLIES WHEN	ROWS
PWR-BUS	The product has a power header, or bus outlets, or is a power ribbon	7
PWR-BUS entry	The product takes the bus at a power header (power.entries, interface PWR-BUS)	8
PWR-BUS outlet	The product gives the bus at outlets: a supply's terminals, a bus board's headers (power.outlets, interface PWR-BUS)	4
PWR-DC12	The product has a DC entry or PWR-DC12 outlets, or is a DC cable	4
PWR-DC12 entry	The product takes 12 V DC at a DC entry (power.entries, interface PWR-DC12)	7
PWR-DC12 outlet	The product gives 12 V DC at PWR-DC12 outlets to modules (power.outlets, interface PWR-DC12)	3
VID-75	The product has a video sync port behind the panel, or is a coaxial cable	9
COAX-IN	The product takes video sync at a rear COAX-IN (video__75.ports)	1

IN BRACKETS	THE ROW APPLIES WHEN	ROWS
COAX-OUT	The product gives video sync it generates at a rear COAX-OUT (video__75.ports)	1
COAX-THRU	The product passes the video sync on at a rear COAX-THRU, buffered or looped (video__75.ports)	2
VIDEO	The module has a VIDEO patch jack (module.ports)	4

`VID-75` covers only the video sync ports behind the panel and the coaxial cable. A coaxial picture port on the front is listed in the port list by its Annex C class.

ROLES AND INTERFACES

Every register row also names the role or interface it binds:

- An *interface* is where two products mate: the front panel (PANEL), the rail and its screw (RAIL), the bus (PWR-BUS), a DC entry (PWR-DC12), a patch jack (PATCH), a coaxial video port (VID-75).
- A *role* is what a product does and publishes: module, panel, enclosure, bus board, power supply, cable, and the installer of chapter 9, who assembles a system and is not a product.

A product is a composition of roles. Its product type names the main one; whatever is built in or added plays its own role and owes every requirement of it. An enclosure with a built-in supply and bus board plays enclosure, power supply, and bus board.

Distribution is a capability, not a product type. A product with PWR-DC12 outlets distributes the DC rail, and a product with buffered COAX-THRU ports beside its COAX-IN distributes the video sync, whether it is a bus board, a module, or an enclosure with these built in. It meets the outlet or port rules of what it carries, beside those of its own role: a bus board keeps the rules of its headers as well (BUS-020).

WRITING THE IDENTIFIERS

- A product type is written in lower-case words, as it reads in a sentence (`power supply`), and never as a code.
- Every other EIS identifier is written in capitals with a hyphen: interfaces (PWR-BUS), signal classes (CV), port modes (COAX-IN), and connector variants (DC-BAR21). DC keeps its capitals as an abbreviation.

4.2 CLAIMS

A claim is one line, `EIS <edition>, <roles>`:

- *edition*: a tag of the specification's repository, or `draft` until the edition in work is tagged. A claim names one edition and stays valid for it when later editions change.
- *roles*: the product type, then every other role the product plays, joined by `+`.

A statement that omits any of these is not an EIS claim. The claim applies to the product as a whole. Core is never written: every product meets it.

CLAIM LINE	PRODUCT
`EIS draft, module`	Any module: an oscillator, a filter, a video keyer or mixer, an encoder locked to a rear video sync port, a blank panel, or a DC entry panel; its claim file lists each port by class, and its power entries and video sync ports
`EIS draft, power supply`	Any supply: of the bus, of the DC rail (SUP-009), or both, fed from the mains or at a DC entry, including one on the back of a module that makes the bus for it from a DC rail
`EIS draft, bus board`	A bus board, with or without PWR-DC12 outlets beside its headers or the video sync tree (6.5)
`EIS draft, enclosure`	A case with nothing built in
`EIS draft, enclosure + power supply + bus board`	A case with a built-in supply and bus board, such as one fed at a case DC entry
`EIS draft, cable`	A power ribbon, a DC cable, or a coaxial cable; the claim file names the interface the cable mates. A patch cable is not an EIS product and makes no claim

CLAIM LINE GRAMMAR

The claim line in ABNF (RFC 5234), generated from the register by `tools/claim.py` (`eis claim --grammar`):

```
claim        = "EIS " edition ", " roles
edition      = "v" 1*DIGIT "." 1*DIGIT "." 1*DIGIT / "draft"   ; a tag of the
repository, or draft until one exists
roles        = role *(" + " role)                        ; the product type,
then every other role the product plays
role         = "module" / "enclosure" / "bus board" / "power supply" /
"cable"
```

CLAIM FILE

A product publishes its EIS figures in its manual or on its product page: a module's port list (SIG-001, VID-001), width, depth, and rail currents (PANEL-003, PWR-001); a supply's rail ratings and ripple (PWR-002, SUP-001); and so on for each product type. EIS recommends keeping the claim line and all of these figures in one *claim file*, `eis-claim.yaml`, in the form of `data/claim.schema.json`:

- `eis_edition` and `product_type` are the claim; `also_claims` and an enclosure's built-in supply and bus board add roles;
- `power` lists the power entries and outlets by power interface, each with its current on every rail of that interface (6.1);
- `video_75` lists the video sync ports by mode;
- the block of the product type (`module`, `enclosure`, and so on) carries its other figures, such as a module's port list.

The `power` and `video_75` blocks are what bring in the register rows with a condition in brackets (4.1).

`eis claim eis-claim.yaml` checks that the file carries the figures the register requires of its product type that the tool knows how to check, that its classes, ranges, and formats exist, and that its header currents and ripple are inside their limits; it then prints the claim line. `data/examples/` has a worked claim file for every product type.

EIS · Claim line and port list from a claim file

EIS draft, module

Example video sync generator, Example Maker · 3U, 4 HP, 32 mm deep, +12 V 0.22 A, -12 V 0.05 A, +5 V 0 A

Port	Class	Range	Direction	Note
H	VIDEO	U1	out	Horizontal ramp, a patch signal
V	VIDEO	U1	out	Vertical ramp, a patch signal
FIELD	GATE	—	out	—
RATE	CV	B5	in	—

Video sync port	Mode	Jack	Formats (VID-001) or kind (V75-008)
VIDEO SYNC IN	COAX-IN	SMA	525i59.94, 625i50, 720p59.94, and 3 more
VIDEO SYNC THRU	COAX-THRU	SMA	looped, with a TERM switch
VIDEO SYNC OUT	COAX-OUT	SMA	525i59.94, 625i50, 480p59.94, and 12 more

Every port names its signal class or unclassified, its direction, and the range it claims (SIG-001). A video sync port is a rear port listed by mode, never a patch jack.

eis claim FILE validates a claim file and prints its claim line.

Figure 2. The claim line and port list of the example video sync generator claim file

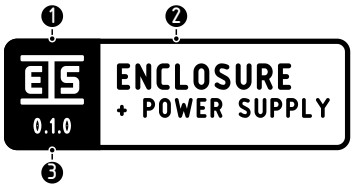
THE EIS MARK

The *EIS mark* is the claim drawn as one block, a nameplate for a product's label, panel, or board. It is written in the claim's own words, so that the claim line reads back from it:

- a solid tab at the left carries the EIS emblem knocked out, E and S hung between two rails with the I bolted to both (`figures/marks/eis.svg`), and under it the edition the claim names;
- the plate beside the tab carries the product type as the claim writes it (MODULE, POWER SUPPLY), with one more line for each role built in.

The letters and the emblem are outlines, so the mark prints without the font. `eis claim FILE --mark OUT.svg` writes the mark of a claim file, and `tools/marks.py` draws the examples in `figures/marks/`.

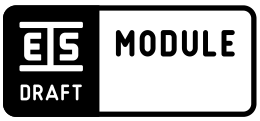
EIS · The EIS mark: a product's claim as one block



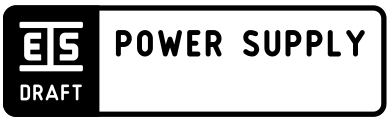
1. the emblem, knocked out of a solid tab
2. the product type as the claim writes it; a role built in adds a line
3. the edition the claim names, at the foot of the tab (DRAFT until v0.1.0)

The claim line reads back from the mark: the edition, then the product type and each role built in. A module lists its ports by class in its claim file, not on the mark.

Four of the example claim files of data/examples as their marks; figures/marks/examples has every one

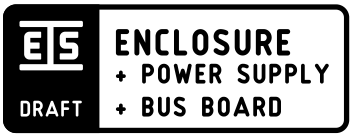


system generator
EIS draft, module



44 W Eurorack power supply
EIS draft, power supply

video bus board
EIS draft, bus board



system enclosure
EIS draft, enclosure + power supply + bus board

The letters are outlines of the house face, so a mark prints without the font; printed 30 mm wide or wider, a mark's smallest capitals are at least 1 mm high. eis claim FILE --mark OUT.svg writes a claim's mark.

Figure 3. The EIS mark: a product's claim as one block

A maker states conformance in the product's documentation, with the claim line and the date; COPYRIGHT.md sets when the statement and the mark may be used.

4.3 VERIFICATION

EIS defines interfaces and limits, not factory test procedures. A maker demonstrates conformance by inspection and measurement against the figures and tables of the normative clauses, or by documented analysis, and documents how. Annex A describes typical measurements and adds no requirements. The tests compare selected EIS figures with external publications; a test does not change a requirement.

4.4 REQUIREMENTS REGISTER (NORMATIVE)

Generated from `data/requirements.json` by `tools/requirements.py`. Do not edit by hand.

Each row is one requirement: its identifier, the product types it applies to in a claim and the condition that brings it in, its text, how it is verified (Annex A gives the methods), and why it exists. Rows are grouped by the part they are written in. Every product owes the

rows of Part 2, Core; a product owes the rows of an optional interface of Part 3 where it has it; Part 4 binds the installer. A row with a bracket applies only to a product that has what the bracket names, such as a PWR-BUS entry or a COAX-IN, which its claim file shows. The register and the data models are the specification; the clause pages and the PDF render them, and a mismatch in a rendering is an error in the rendering. Each row's provenance (quoted, inherited, measured, calculated, or EIS) and the roles and interfaces it binds are recorded in `data/requirements.json`. Roles, interfaces, and product types are defined in Conformance. Clause prose cites identifiers without the EIS- prefix. From the first tagged edition an identifier is never reused, and a requirement whose meaning changes gets a new one.

PRODUCT TYPE	CORE	OPTIONAL INTERFACES
module	52 shall, 1 may	23 shall
enclosure	30 shall	23 shall
bus board	20 shall, 3 may	23 shall
power supply	29 shall, 1 may	11 shall
cable	6 shall	4 shall

Chapter 9 binds the person assembling a system, not a product: 9 rows.

PART 2 CORE

5.1 RACK DIMENSIONS

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-RACK-001	module, enclosure	One HP shall be 5.08 mm.	inspection	Every width in a row is a multiple of the HP, so quoting the IEC value lets panels and rails from different makers line up hole for hole.
EIS-RACK-002	module, enclosure	One rack unit shall be 44.45 mm.	inspection	The rack unit sets the 3U and 1U heights that panels, rails, and 19-inch rack frames share, so quoting IEC keeps them all on one grid.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-RACK-003	enclosure	A rack-mount frame shall meet IEC 60297-3-101:2004 and IEC 60297-3-100:2008 for the flange width, flange mounting-hole positions and slot, the 3U height H1, and the 84 HP row width.	inspection	Meeting the IEC flange, tab, height, and row figures lets a rack-mount frame bolt into any 19-inch rack and hold a full 84 HP row.

5.2 MODULES

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-PANEL-001	module	A module shall be 1U or 3U high.	inspection	These are the only two panel heights EIS defines; a module of any other height fits no conforming row.
EIS-PANEL-002	module	An N HP panel shall be no wider than N × 5.08 mm, where N is a positive whole number.	inspection	A panel at or under its nominal width lets neighbors sit side by side without binding, so N HP of panels always fits an N HP row.
EIS-PANEL-003	module	A module shall publish its width in HP and how far it extends behind the panel's back face.	inspection	A buyer compares these two figures with a row's published width and clear depth to know the module fits before buying it.
EIS-PANEL-004	module	A front panel shall be no more than 2.0 mm thick, +0.1 mm for the sheet's thickness tolerance.	inspection	The mounting-screw length window is computed for a 2.0 mm panel; the +0.1 mm takes in sheet stock at its rolling tolerance (0.080 in, 2.03 mm, among it), and a screw at the window's short end still engages 2.8 threads through 2.1 mm. A thicker panel leaves too few threads engaged in the insert.
EIS-PANEL-005	module	A patch jack shall be a 3.5 mm mono (TS) socket.	inspection	One patch connector across all modules means any patch cable joins any output to any input, whoever made the modules.
EIS-PANEL-006	module	A 3U front panel shall be 128.5 mm high.	inspection	128.5 mm is three rack units (133.35 mm) less 4.85 mm, which fits the panel inside the IEC 3U height H1 of 132.55 mm.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-PANEL-007	module	A 1U front panel shall be 39.65 mm high.	inspection	39.65 mm, one rack unit less 4.80 mm, is the Intellijel 1U panel height, so 1U modules fit the 1U rows already in use.
EIS-PANEL-008	module	Mounting holes shall be 3.0 mm in from the top and bottom panel edges.	inspection	A fixed inset from each edge puts every panel's holes on the same line as the rail inserts, whatever the maker.
EIS-PANEL-009	module, enclosure	The mounting-hole span, on the panel and between the inserts of a row's two rails, shall be 122.5 mm at 3U and 33.65 mm at 1U.	analysis	The span is the panel height less twice the 3.0 mm inset, and the rails must match it or the panel holes miss the inserts.
EIS-PANEL-010	module	Mounting holes shall be drilled Ø3.2 mm, or slotted 3.2 mm wide and no longer than 5.5 mm along the rail, centered on the hole position.	inspection	A 3.2 mm hole clears the 3.0 mm M3 screw with room for small position errors between panel and insert; a short slot along the rail takes up rail position error without letting the panel drop.
EIS-PANEL-011	module	Each mounting hole shall be a whole number of HP plus 2.54 mm from the panel's nominal left edge.	analysis	Offsetting holes by half an HP from the nominal edge puts every hole on an insert hole, whatever the panel width and wherever it sits.
EIS-PANEL-012	module, enclosure	A board shall stay at least 9.25 mm clear of the top and bottom panel edges, and a rail shall cover no more than 9.25 mm of the panel face at each edge.	inspection	(128.5 mm − 110 mm) / 2 is 9.25 mm, so the usual 110 mm board fits between rails that cover no more of the panel.
EIS-PANEL-013	module, enclosure	A dimension of clauses 5.1 to 5.3 shall hold within the tolerance the register states for its requirement; a dimension with no tolerance stated is a limit.	measurement: each dimension of clauses 5.2 and 5.3 against its tolerance or limit	A nominal figure without a tolerance cannot be checked or rejected; one policy makes every mechanical figure measurable the same way.
EIS-PANEL-014	module	A front panel thinner than 1.6 mm shall ship with M3 mounting screws with a head at most 7.0 mm across, whose length fits the window of clause 5.3 for its own thickness on a rail of the section clause 5.3 recommends.	inspection	The screw length window (RAIL-009) keeps the tip off the cavity floor only through a panel 1.6 mm or thicker; through a thinner one an enclosure's screws can bottom out, so the panel brings its own.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-PANEL-015	module	A module shall publish whether its front panel is connected to its 0 V, and whether the panel is bonded to the rails.	inspection	A panel at 0 V that is also bonded to the rails is a second chassis tie, and a panel that touches its neighbors joins two modules' 0 V; the installer can only avoid the loop if each module says what its panel is.

5.3 RAILS, INSERTS, AND MOUNTING SCREWS

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-RAIL-001	enclosure	The holes in a rail insert shall be 5.08 mm apart.	analysis	Insert holes one HP apart line up with panel holes placed on the HP grid, so a panel screws down at any position in the row.
EIS-RAIL-002	enclosure	A rail for an N HP row shall give at least N × 5.08 mm of mounting length.	analysis	N panels at their full nominal width need N × 5.08 mm of rail, so a shorter rail cannot hold the row's published width.
EIS-RAIL-003	enclosure	An insert shall be threaded M3.	analysis	The insert thread has to take the M3 mounting screw that every module hole is drilled to clear.
EIS-RAIL-004	enclosure	An insert shall be at least 1.5 mm thick, three thread pitches.	analysis	An insert three 0.5 mm pitches thick gives the screw the three full threads RAIL-008 needs to hold a panel without stripping.
EIS-RAIL-005	enclosure	A mounting screw shall be M3.	inspection	M3 is the thread of nearly every Eurorack case on sale and of the screws modules ship with, so one screw fits any row.
EIS-RAIL-006	enclosure	A mounting screw's thread pitch shall be 0.5 mm.	inspection	Quoting the ISO 261 coarse pitch means any off-the-shelf M3 screw threads into any conforming insert.
EIS-RAIL-007	enclosure	A mounting screw's major diameter shall be 3.0 mm.	inspection	Quoting the ISO 261 diameter fixes the size that the 3.2 mm panel hole and the rail throat are made to clear.
EIS-RAIL-008	enclosure	A mounting screw shall engage at least three full threads through a 2.0 mm panel.	inspection	Three engaged threads through the thickest allowed panel keep a screw from stripping out as cables are plugged and pulled.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-RAIL-009	enclosure	The mounting-screw length L shall satisfy 2.0 mm + seat + 1.5 mm ≤ L ≤ 1.6 mm + D, with seat and D measured behind the rail's mounting face. The throat in front of the insert shall clear 3.0 mm.	analysis	The lower bound gives three threads through a 2.0 mm panel, and the upper keeps the tip off the cavity floor through a 1.6 mm panel.
EIS-RAIL-010	enclosure	The mounting-screw head shall be at most 7.0 mm across.	analysis	The narrowest catalog rail face reaches 3.7 mm past the hole center (the Vector T-strut, half its 7.391 mm height), so a head up to 7.0 mm across bears on panel and rail face on every catalog rail; an ISO 7045 pan head and the common 7 mm M3 washer fit.
EIS-RAIL-011	enclosure	An enclosure shall publish the mounting-screw length, and shall supply those screws or name them.	inspection	The right screw length depends on the rail's seat and cavity depth, which only the enclosure maker knows.

5.4 ENCLOSURES

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-ENC-001	enclosure	An enclosure shall publish, for each row, its width in HP and the depth it keeps clear behind the panel's back face.	inspection	A buyer compares these figures with a module's published width and depth to know it fits the row before buying.

6.1 POWER ARCHITECTURE

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-PWR-001	module, power supply, bus board, enclosure	A product shall publish, for each power entry, the maximum current it takes on each rail at the entry's nominal voltage, stating 0 for a rail it does not draw.	inspection	An installer sums these figures against the ratings of the source and of each product with outlets (ASM-001), and a buyer sizes a DC adapter from them; a stated 0 shows a rail was not forgotten.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-PWR-002	module, power supply, bus board, enclosure	A power supply, a bus board, and any product with power outlets shall publish the maximum current it delivers on each rail, in total and at each outlet.	inspection	An installer checks a row's summed currents against the source total and each outlet before adding a module (ASM-001); an outlet can be rated below its rail, and an overloaded trace or connector overheats.
EIS-PWR-003	module, power supply	A product whose power entries are alternatives, each able to power it alone, shall not require more than one of them to be connected at the same time.	inspection	The installer connects only one of a product's alternative sources (ASM-003), so the product has to run from any one of them alone; entries that feed different circuits, such as a DC entry for one board and the bus for another, are not alternatives.
EIS-PWR-004	module	A module shall not source current into a rail of any of its power entries.	inspection	A module that drives a rail fights its source's regulator and can back-power other products when the source is off.
EIS-PWR-005	module, power supply, bus board, enclosure	Where a product takes or gives a rail or 0 V on row wiring, the discrete conductors between a power supply, a bus board, a DC entry, and PWR-DC12 outlets, each terminal shall be an M4 screw, stud, or threaded standoff that clamps a ring terminal under a lock washer, rated for at least the current it carries, and the product shall publish the conductor sizes its terminals accept.	inspection	One terminal on every supply, bus board, and DC entry means one ring terminal and one crimp tool for any pair of makers; a bolted ring does not work loose as a push-on tab can, and M4 is the ring the trade stocks from 22 to 10 AWG.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-PWR-006	module, power supply, bus board, enclosure	A row wiring conductor shall be insulated stranded copper rated 105 °C or more, with a crimped ring terminal at each end, of at least 18 AWG (16 AWG above 3 A, 14 AWG above 5 A, 12 AWG above 8 A, 10 AWG above 15 A), and shall carry no more than 30 A; a 0 V conductor carries the larger of the +12 V and +5 V currents together and the −12 V current. A joint shall not rely on solder alone. A 0 V link may instead be a tinned copper braid with crimped or pressed ring ends, or a copper bar, of no more resistance.	inspection	The gauges keep a conductor's heating small in a closed case, the temperature rating suits one, and a crimp holds where a soldered strand fractures. 10 AWG copper carries 30 A even as 60 °C building wire, so 105 °C wire holds it with margin, and 10 AWG is the heaviest gauge the trade's M4 ring terminals take; above 30 A a second pair shares the current.
EIS-PWR-007	module, power supply, bus board, enclosure	Each row wiring conductor shall measure no more than 5 mΩ from ring terminal to ring terminal, and the 0 V conductor between a power supply and a bus board, or between linked bus boards, no more than any rail conductor beside it.	measurement: four-wire resistance of each conductor at 20 to 25 °C, ring terminal to ring terminal; or its gauge and length within the row wiring table of 6.1	Every module in a row returns its current through the row wiring's 0 V, so its resistance couples each module's current into every other module's reference; Hinton Instruments sets 5 mΩ for supply cables for that reason.
EIS-PWR-008	module, power supply, bus board, enclosure	Where a product bonds its 0 V to its chassis or to a protective-earth terminal, the bond shall be a conductor of at least 14 AWG, or copper of its own board of that section, landed by a ring terminal, a bracket, or a standoff on an M4 or larger stud or screw that presses metal GND-004 accepts under a toothed lock washer, or a bus bar of equivalent section.	inspection	A bond through paint or a loose terminal is a bond only until it corrodes; a toothed washer on metal that conducts keeps it low impedance for the life of the case, whether the bond arrives on a wire or on the board's own copper.

6.2 POWER SUPPLIES

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-SUP-001	power supply	A power supply shall publish its ripple and noise on each rail it provides, peak-to-peak, measured as stated in clause 6.2.	measurement: ripple and noise per rail, peak-to-peak, by the 6.2 method	A ripple figure taken one stated way lets a buyer compare supplies and pick a quiet one for video or audio work.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-SUP-002	power supply	A power-supply output on a plug-and-socket connector other than a power header shall not mate with reversed polarity; a power-header outlet meets the marking and keying of clause 6.4 instead.	inspection	A supply connected backwards reverses every rail on the bus and can damage every module in the row at once.
EIS-SUP-003	power supply	A power-supply output on row wiring terminals shall mark each terminal with its rail or 0 V.	inspection	Ring terminals on studs cannot be keyed, so a clear marking is the only guard against wiring a rail to the wrong place.
EIS-SUP-004	power supply	Each output rail of a power supply shall survive an indefinite short to 0 V without damage, and shall return to its rated output when the short is removed, after an input cycle if it latches off.	measurement: each rail shorted to 0 V for at least 1 h, one rail at a time, then the short removed: no damage, and the rail returns to its rating	A short from a miswired ribbon or bus board is a routine fault, and the supply has to outlast it until someone finds it.
EIS-SUP-005	power supply	During power-up, power-down, or a short on another rail, no output rail of a power supply shall be driven more than 0.7 V toward the opposite polarity.	measurement: each rail's swing past 0 V, at power-up, at power-down, and with the other rail shorted to 0 V, with a resistive load between +12 V and −12 V drawing the smaller rail's rated current	A rail pulled past 0 V reverse-biases every module's decoupling and the substrate of every IC on it; 0.7 V is a silicon diode's drop at modest current, and a Schottky clamp across each rail holds it at rated current.
EIS-SUP-006	power supply	At start-up, no output rail of a power supply shall overshoot its nominal voltage by more than 10 %.	measurement: overshoot of each rail at start-up, at most 10 % of nominal	Parts on modules are chosen for the rails they run from, and a large start-up overshoot eats the voltage margin they were sized with.
EIS-SUP-007	power supply	Each output rail of a power supply shall have ripple and noise below the limit tabulated in clause 6.2 for its power interface, 150 mV peak-to-peak on PWR-BUS, measured as clause 6.2 states.	measurement: ripple and noise per rail below the limit of its power interface, by the 6.2 method	A 150 mV ceiling gives modules a worst case to design against, at a level most open-frame switching supplies already meet.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-SUP-010	power supply	Each output rail of a power supply shall stay within ±5 % of its nominal voltage at its output terminals, from the minimum load the supply publishes on each rail to its rated current, whatever the load on its other rails within those limits.	measurement: each rail's voltage at its output terminals at its published minimum load and at its rated current, with the other rails at each end of theirs	A module's regulators, references, and patch levels are designed for ±12 V and +5 V; a rail 10 % off conforms to nothing else in EIS, and a cross-regulated supply drifts that far when one rail is lightly loaded.
EIS-SUP-008	power supply	A power supply mounted on the product it powers shall publish the heat it dissipates at its rated output and how far it extends behind that product.	inspection	A linear regulator turns the difference between its input and output into heat in the case, and it adds to the depth of the module it sits behind; the installer budgets both (Annex H, ENC-001).
EIS-SUP-009	power supply	A power supply may provide the 12 V DC rail of clause 8.1 alongside or instead of the bus; it then has PWR-DC12 outlets, publishes the current of each outlet, and meets the outlet rules of clause 8.1.	inspection	A case supply that gives a DC rail directly saves a brick per module, and its outlets keep the rules of 8.1 like any other PWR-DC12 outlet.

6.3 GROUNDING AND 0 V

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-GND-001	module, power supply, bus board, enclosure	A product shall connect every 0 V pin of its power headers, and the -V of its DC entry, to its 0 V.	inspection	The 0 V pins share the return current of all three bus rails, and using only some crowds it onto fewer contacts; with the DC rail's -V on the same 0 V, a product keeps one reference for its signals whichever entry is connected.
EIS-GND-002	bus board	A bus board shall join the 0 V pins of every header to one 0 V that runs to the supply's 0 V terminal.	inspection	One 0 V back to the supply terminal gives every module in the row the same reference and a defined path for return current.
EIS-GND-003	power supply	A power supply shall publish whether its 0 V output is connected to protective earth, and where.	inspection	A system wants one bond between 0 V and protective earth; a second bond lets mains-frequency current flow in 0 V as hum.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-GND-004	module, power supply, bus board, enclosure	Where a product makes a bond of a metal part to its 0 V, to its CHASSIS terminal, or to another metal part, and publishes it as a bond, the fastener shall press bare, plated, or conversion-coated metal, or a copper land clear of solder mask, not paint, powder coat, anodizing, or solder mask, and the bond shall measure at most 100 mΩ, and a bond of 0 V to the chassis (PWR-008) at most 10 mΩ.	measurement: four-wire resistance at 1 A or more between the two parts, after assembly; this does not replace the protective-bonding test of the safety standard a mains product is certified to	A finish either conducts under a fastener, at a few milliohms, or is a dielectric, so a bond through paint or anodize is only a scratch. 100 mΩ, the protective-bonding figure of IEC 62368-1, is a pass mark every metal-to-metal joint clears by a factor of two or more, most by two orders, and every finished joint fails by five; the 0 V tie is held to 10 mΩ because a rail chafed onto the chassis returns its fault current through it.
EIS-GND-005	enclosure	An enclosure shall publish which of its metal parts, rails, inserts, sides, rear, and lid, are bonded to one another, and where its metalwork takes a bond to the row's 0 V.	inspection	In the common case the chassis is the inserts and the panels, and the anodized rails float; the installer who straps a case needs to know which parts are already one and where the strap lands.

6.4 THE BUS

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-BUS-001	bus board, power supply (with a PWR-BUS outlet)	The bus shall provide +12 V and −12 V, and may provide +5 V, at every power header.	inspection	Every module may count on ±12 V at its header, while +5 V stays optional because many modules regulate their own.
EIS-BUS-002	module, bus board, cable, power supply (PWR-BUS)	A power header on a module or a bus board shall be a 2 × 5 or 2 × 8 pin header on a 2.54 mm grid, and a power cable shall end in IDC ribbon sockets that mate it, the socket at the bus-board end having as many positions as the header it mates.	inspection	Every Eurorack power ribbon and header in use has this form, so any conforming module and bus board connect without an adapter; a 10-position socket on a 16-pin bus header can be fitted one pin pair off and short +12 V to 0 V.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-BUS-003	module, bus board, cable, power supply (PWR-BUS)	A power header on a module, a bus board, or a cable shall follow the pinout of clause 6.4: −12 V on pins 1–2, 0 V on 3–8, +12 V on 9–10, and on a 16-pin header +5 V on 11–12, CV on 13–14, and gate on 15–16.	inspection	Ribbons and bus boards made to a different pin order put +12 V on a module's 0 V pins; one pinout prevents that.
EIS-BUS-004	module, bus board, cable, power supply (PWR-BUS)	The marked conductor of a power ribbon cable shall be −12 V, and on a module, a bus board, or a power supply it shall lie at the −12 V end of the header.	inspection	A marked conductor tied to −12 V lets an installer orient a ribbon by eye at both ends, the only guide on an unshrouded header.
EIS-BUS-005	module, bus board, cable, power supply (PWR-BUS)	A shrouded power header on a module or a bus board shall be keyed so that, viewed from the mating side with the −12 V end at the bottom, the key gap is on the right, and a keyed cable socket shall match it.	inspection	A key in one fixed position lets a keyed socket enter a shrouded header only the right way round, whoever made each part.
EIS-BUS-006	module (with a PWR-BUS entry)	A module powered from the bus shall draw only +12 V and −12 V, and may also draw +5 V.	inspection	These are the only rails a conforming bus delivers, so a module that needs any other rail cannot run from a conforming row.
EIS-BUS-007	module (with a PWR-BUS entry)	A module that uses neither +5 V nor bus CV or gate may use the 10-pin header.	inspection	Pins 11 to 16 carry nothing such a module uses, so the smaller header saves board space without losing any connection.
EIS-BUS-008	module, power supply (with a PWR-BUS entry)	A module or a power supply shall not draw more than 1.5 A on any rail through one power header.	measurement: current on each rail through one header in operation, at most 1.5 A, the charging of its decoupling at power-up excluded	Each rail has two IDC contacts rated 1 A, and they share the current unevenly, up to about 2:1 through a short ribbon; 1.5 A keeps the busier contact at its rating.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-BUS-009	module, power supply (with a PWR-BUS entry)	A module or a power supply shall tolerate reverse polarity at its power header without damage.	measurement: no damage after a ribbon reversed at the module end, and a 16-pin ribbon also reversed at the bus end, from a bench supply current-limited to the module's published currents	A reversed ribbon is the commonest field fault; surviving it keeps one mistake from destroying a module.
EIS-BUS-010	module (with a PWR-BUS entry)	A bus cable supplied with a module shall be keyed so that it enters a shrouded header only with the marked conductor on −12 V.	inspection	A keyed cable makes the shroud do its job, so the ribbon that ships with a module cannot be fitted backwards into a shrouded header.
EIS-BUS-011	module	A header on a module that is not its power header shall either not mate a Eurorack power ribbon socket or tolerate one fitted to it, either way round, without damage.	inspection	Expander and link headers often share the power header's form, and a power ribbon fitted to one puts ±12 V on its signal pins.
EIS-BUS-019	module, bus board, power supply (PWR-BUS)	A module, a bus board, and a power supply shall mark the −12 V end of each power header on the board.	inspection	The marked conductor of a ribbon can only be matched to the header when the board says which end is −12 V; on an unshrouded header the marking is the only guide.

6.5 BUS BOARDS

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-BUS-012	bus board, enclosure, power supply (with a PWR-BUS outlet)	The per-header limit a bus board, a built-in bus board of an enclosure, or a power supply publishes for its power-header outlets shall not exceed 1.5 A per rail.	inspection	A header carries each rail on two IDC contacts of about 1 A, the same limit modules are held to under BUS-008.
EIS-BUS-013	bus board (with a PWR-BUS outlet)	A bus board may split CV and gate into two regions.	inspection	A split lets one long bus board carry two separate CV and gate lines, each with its own transmitter.
EIS-BUS-014	bus board, cable (PWR-BUS)	A link between two bus boards shall join CV to CV and gate to gate.	inspection	A crossed link would send pitch CV to gate listeners and gate pulses to oscillators on the next board.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-BUS-015	cable (PWR-BUS)	A power ribbon from a bus header to a module shall be no longer than 400 mm and shall use conductors of at least 28 AWG.	inspection	At the 1.5 A header limit a 400 mm, 28 AWG ribbon drops about 65 mV in a rail's two conductors and about 30 mV more in its contacts, under 1 % of 12 V; a longer or thinner ribbon eats further into the rails the module receives.
EIS-BUS-020	bus board	A bus board may also distribute a DC rail or the video sync behind the panel; it then meets the rules of what it carries: the PWR-DC12 outlet rules of 8.1, or the video sync ports of 8.2.	inspection	One board behind the panel can carry the bus, the DC rail, and the video sync tree; each outlet and port on it stays under the rule written for its interface.
EIS-BUS-021	bus board	A bus board may carry a 0 V strip: a band of its outer-layer 0 V plane left bare of solder mask along the board's length, with plated holes at its mounting-hole positions, on which a 0 V bus bar is clamped by screws through the bar and the holes; the strip's end holes take M4, and a ring terminal under an M4 screw of the strip or the bar is a 0 V terminal of the board.	inspection	A bar clamped on bare copper the length of the board puts every header's return and every link on one potential with no trace between them, and the strip's M4 holes, two rings on each, give a board in the middle of a chain the positions one stud cannot: its return and a link each way.
EIS-BUS-022	bus board (with a PWR-BUS outlet)	A bus board that splits CV and gate into regions shall mark on the board, and publish, which headers lie in each region.	inspection	ASM-002 allows one transmitter per line up to a region split; the installer can keep to it only if the split is visible and published.

6.6 BUS CV AND GATE

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-BUS-016	module (with a PWR-BUS entry)	A module shall listen to or transmit bus CV or gate only when a jumper or switch on the module is set to do so.	inspection	The bus CV and gate lines are shared across a row, so a module left at its default never fights a transmitter or reacts to stray levels.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-BUS-017	module (with a PWR-BUS entry)	A module that drives or receives bus CV shall meet the BUS-CV limits of clause 6.6.	measurement: BUS-CV scale at the header into 10 kΩ, within ±0.3 %; listener input impedance at least 100 kΩ	Every listening oscillator follows the one bus CV line, so shared levels and impedances keep any transmitter and listener in tune.
EIS-BUS-018	module (with a PWR-BUS entry)	A module that drives or receives bus gate shall meet the BUS-GATE limits of clause 6.6.	measurement: BUS-GATE high at least +4 V and low at most +0.5 V at the header into 4.7 kΩ; listener thresholds +3 V and +1 V	Shared thresholds and impedances let any module's gate on the bus register reliably at every listening module.

7.1 SIGNALS

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-SIG-001	module	A module shall publish a port list naming, for every port, its signal class or unclassified, and for a video sync port its mode (8.2).	inspection	The port list tells a user which class and limits each jack meets, so a patch can be checked before it is made.
EIS-SIG-002	module	A patch input shall withstand ±12 V indefinitely.	measurement: no damage after ±12 V from a source of 1 kΩ or less is held on each patch input	±12 V is the most a bus rail or any conforming output (SIG-004) can put on a jack, so an input that withstands it survives any patch.
EIS-SIG-003	module	A patch output shall withstand an indefinite short to 0 V or to another patch output.	measurement: no damage after each patch output is shorted to 0 V and to another output	Patching an output to 0 V or to another output is a routine mistake on a patch panel, and one cable must not destroy a module.
EIS-SIG-004	module	A patch output shall not drive the patch tip beyond ±12 V.	inspection	Keeping outputs within ±12 V keeps them within what every patch input is built to withstand under SIG-002.
EIS-SIG-015	module	A patch jack shall carry patched signals only: a module shall neither take nor give its video sync at a patch jack, and no patch jack shall list a format of clause 8.3.	inspection	The video sync is system cabling, not a patch: kept on the rear coaxial interface, it is never changed by patching, and no patch cable has to carry it.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-SIG-018	module, bus board, enclosure	A product that generates or locks to an external video sync shall take or give it at a video sync port on its rear.	inspection	The video sync is system cabling: at the rear, on the coaxial interface, it is wired once behind the panel and stays out of the patch field.
EIS-SIG-017	module, bus board, enclosure, power supply	A jack inside the case shall not be a BNC jack: none at the rear of a module, on a bus board, or on a power supply. A BNC jack is on the outside of the case only, on a front panel or an enclosure's wall.	inspection	A BNC's bayonet sleeve needs room for fingers to grip and turn, which the space behind the panels and over a bus board lacks, and its height takes depth a ribbon or a module's board needs; an RCA jack mates with a push and an SMA with a few turns of a small nut. A facility video sync arrives at a BNC on the enclosure's wall and is wired inside to RCA or SMA.

7.2 SIGNAL CLASSES

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-SIG-005	module	A port shall meet the limits of the class it names, at the range it names: an output keeps its full-scale signal within the range's ceiling, and an input accepts the range's full swing without clipping.	measurement: the class's level, impedance, and thresholds at the claimed range, from the class table of 7.2	One table of classes lets a patch between any two modules work at the levels both expect, and the range says which swing an output gives and an input takes.

7.3 VIDEO SIGNALS

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-SIG-009	module (VIDEO)	A VIDEO input shall present 100 kΩ ±1 % to 0 V at the patch tip.	measurement: 100 kΩ ±1 % to 0 V at each VIDEO input	A high, tightly held input impedance takes a 75 Ω output at almost unity gain, so video levels match from module to module. The figure is the resistance at the tip, resistor and stage together; a 1 % resistor costs what a 10 % one does.
EIS-SIG-010	module (VIDEO)	A VIDEO output shall drive the patch tip through a 75 Ω ±1 % series resistor.	measurement: 75 Ω ±1 % series resistor from the buffer output to the tip of each VIDEO output	A 75 Ω series source keeps a short unterminated patch cable from ringing, and one fixed value keeps level and edges alike from module to module.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-SIG-019	module (VIDEO)	A VIDEO input that reads a signal as high or low, such as a comparator, logic, or key input, shall switch at a threshold of +0.5 V: it reads above the threshold as high and below it as low.	measurement: the input reads +0.45 V as low and +0.55 V as high	+0.5 V is the midpoint of the 0 to +1 V VIDEO scale, so any VIDEO output, a picture, a ramp, or another module's logic, drives any VIDEO logic input the same way, and a key or comparator splits a picture at mid-gray.
EIS-SIG-016	module (VIDEO)	A module shall publish, for each VIDEO output, the kind of path behind it and, for a linear or variable path, its -3 dB bandwidth measured as clause 7.3 states.	measurement: the -3 dB bandwidth of each linear or variable VIDEO path, relative to 100 kHz, from a 75 Ω source into 100 kΩ in parallel with 30 pF, by a method of Annex A	The kind says whether a bandwidth describes the path, and the figure, measured one way, says how sharp a picture it passes. EIS sets no minimum: a slow path is a design choice, and the figure says so.

PART 3 OPTIONAL INTERFACES

8.1 12 V DC POWER (PWR-DC12)

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-DC-001	module, bus board, enclosure, power supply (with a PWR-DC12 entry)	A product shall publish its DC entry variant: DC-BAR21, DC-BAR25, DC-VH2, DC-DIN4, DC-MF6, DC-MF8, or DC-M4, as tabulated in 8.1.	inspection	The variant tells a buyer which plug, cable, and distribution product will physically mate with the product.
EIS-DC-002	module, bus board, enclosure, power supply (with a PWR-DC12 entry)	A product shall publish the minimum and maximum DC input voltage its DC entry accepts.	inspection	Nominal 12 V adapters vary in output, so the accepted range tells a buyer which adapters the product can safely use.
EIS-DC-003	module, bus board, enclosure, power supply (with a PWR-DC12 entry)	A DC entry shall not use the pinout of a Eurorack 10-pin or 16-pin power header.	inspection	A DC entry wired like a bus header invites a bus ribbon to be plugged into it, putting 12 V across the wrong pins.
EIS-DC-004	module, bus board, enclosure, power supply (with a PWR-DC12 entry)	A DC-BAR21 or DC-BAR25 barrel DC entry shall be center positive.	inspection	Center positive is the usual convention of 12 V adapters, so fixing it keeps a common adapter from reversing the DC rail.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-DC-005	module, bus board, enclosure, power supply (with a PWR-DC12 entry)	A product with a DC-VH2, DC-DIN4, DC-MF6, DC-MF8, or DC-M4 DC entry shall implement the pin or terminal functions tabulated for that variant in 8.1.	inspection	Fixed pin functions let any cable or distribution product of that variant deliver +V and -V to the right pins.
EIS-DC-006	module, bus board, power supply, enclosure (with a PWR-DC12 entry)	A barrel DC entry, and every case DC entry, shall tolerate reverse polarity without damage.	measurement: no damage after a reversed input at the entry's rated voltage, from a source current-limited to its rated current	Center-negative adapters fit the same barrel, and a computer supply's 8-pin EPS12V cable is a Mini-Fit Jr 2 × 4 like DC-MF8 with its +12 V on the other row; a reversed plug must not damage the product.
EIS-DC-007	cable (PWR-DC12)	A straight DC barrel cable shall connect tip to tip and sleeve to sleeve at both ends.	inspection	A straight cable has to keep the center-positive polarity of both ends, or it reverses the DC rail it carries.
EIS-DC-008	cable (PWR-DC12)	A cable for a DC-VH2, DC-DIN4, DC-MF6, or DC-MF8 DC entry shall connect each pin to the same pin and function at both ends.	inspection	Pin-for-pin wiring keeps +V and -V where the far end expects them, so the cable never reverses or shorts the DC rail.
EIS-DC-009	module, bus board, power supply, enclosure (with a PWR-DC12 outlet)	A product with PWR-DC12 outlets to modules shall feed them only through DC-BAR21 jacks or DC-VH2 headers, and shall not use DC-BAR25 for an output to a module.	inspection	A DC-BAR25 plug enters a DC-BAR21 entry with unreliable contact, so outputs to modules use only connectors that fit module entries properly.
EIS-DC-010	cable (PWR-DC12)	A cable from a PWR-DC12 outlet to a module shall end in DC-BAR21 plugs or DC-VH2 housings and connect +V to +V and -V to -V, tip and pin 1 being +V.	inspection	Module entries are center positive with pin 1 at +V, so a distribution cable has to keep that polarity at both ends.
EIS-DC-011	module, bus board, enclosure, power supply (PWR-DC12)	A DC entry and each PWR-DC12 outlet shall be marked beside it with its polarity, a barrel by its polarity symbol and a multi-pin or DC-M4 entry by its +V and -V pins or terminals, its nominal voltage, and its maximum current, and a DC entry also with the minimum and maximum input voltage it accepts.	inspection	An adapter is chosen at the entry and a cable at the outlet, so the marking beside the port is what keeps a wrong adapter or an overloaded outlet off a product.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-DC-012	module, bus board, power supply, enclosure (with a PWR-DC12 outlet)	A product with PWR-DC12 outlets to modules shall protect each output separately and shall publish the current at which the protection acts.	inspection	One shorted cable on an unprotected output takes every module on the rail down; a limit per output keeps the fault to one module.
EIS-DC-013	module, bus board, power supply, enclosure (with a PWR-DC12 outlet)	A DC entry that feeds PWR-DC12 outlets shall tolerate reverse polarity without damage and shall not pass the reversed voltage to its outlets.	measurement: no damage after a reversed input, and no reversed voltage at any outlet	An entry that feeds a row is plugged by whoever assembles the case; a reversed adapter must not take the row with it.
EIS-DC-014	module, bus board, power supply, enclosure (with a PWR-DC12 entry)	A product with a case DC entry, a DC entry that takes an external adapter's output for a row: any DC entry of an enclosure, a power supply, or a bus board, or of a module with PWR-DC12 outlets or row wiring outputs, shall publish whether its 0 V is bonded to the chassis at the entry, and where.	inspection	The case DC entry is where a system fed from an adapter makes its one chassis tie; an installer who cannot tell whether the entry bonds 0 V to the chassis either leaves the case floating or ties it twice.

8.2 VIDEO ON 75 Ω COAXIAL JACKS (VID-75)

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-V75-001	module, bus board, enclosure (VID-75)	Every jack in a VID-75 tree shall be an RCA, BNC, or SMA jack.	inspection	The three jack types are electrically the same here, so any 75 Ω cable with the matching plugs joins any two products.
EIS-V75-002	module, bus board, enclosure (VID-75)	On every jack in a VID-75 tree, the center pin shall carry the video signal and the shell shall be 0 V.	inspection	One center and shell convention lets any coaxial cable carry the signal and join the 0 V of the products it connects.
EIS-V75-003	module, bus board, enclosure (VID-75)	A COAX-OUT or a buffered COAX-THRU shall drive one COAX-IN load, and an output shall not be split passively to several terminated ports.	inspection	A second termination on one output drops the level to two thirds and a third drops it to half.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-V75-004	cable (VID-75)	A VID-75 cable shall be a 75 Ω coaxial cable, or a 50 Ω coaxial cable no longer than 1.5 m, with RCA, BNC, or SMA plugs, that connects center pin to center pin and shell to shell at both ends.	measurement: cable impedance 75 Ω, or 50 Ω and length 1.5 m or less; center to center and shell to shell at both ends	A 75 Ω cable keeps the line impedance continuous from source to termination, so the tree stays matched and free of reflections. A 50 Ω cable reflects a fifth of the edge at each 75 Ω end; within 1.5 m its round trip, about 15 ns, is shorter than the fastest tri-level edge, so the steps settle inside the edge, add under 7 ns of rise, and leave the terminated level unchanged.
EIS-V75-006	module, bus board, enclosure (with a COAX-IN)	A product with a video sync input shall take the video sync at a COAX-IN on its rear, lock any video timing of its own to it, and list the formats it accepts.	measurement: the module's video timing follows the video sync at its COAX-IN in each listed format	A COAX-IN says what a buyer needs to know first: this module follows the row's video sync, through this rear port, in these formats.
EIS-V75-007	module, bus board, enclosure (with a COAX-OUT)	A product with a video sync output shall generate video sync of a listed format itself and give it at a COAX-OUT on its rear; a copy of the video sync it takes at its COAX-IN is a COAX-THRU, not a COAX-OUT.	measurement: video sync of each listed format at the COAX-OUT, with nothing connected at the COAX-IN	An output means the module can be the row's video sync; a THRU cannot, and the two are easy to confuse on a panel marked OUT.
EIS-V75-008	module, bus board, enclosure (with a COAX-THRU)	A product shall have a video sync through only if it also has a video sync input, and each through shall be a COAX-THRU marked THRU. Its port list shall say which kind: buffered (a copy of the video sync at the COAX-IN, driven as a COAX-OUT into one COAX-IN load) or looped (a jack bridged to the COAX-IN jack on one line).	measurement: buffered: the video sync at the COAX-IN appears at the COAX-THRU at line level into 75 Ω; looped: the THRU jack is the COAX-IN line; the mark THRU beside the port	A THRU chains video sync through modules without a distribution product. Buffered, each THRU drives the next input; looped, one cable run passes every module with one termination at its end. The mark keeps either from being cabled as a source.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-V75-009	module, bus board, enclosure (with a COAX-THRU)	A product with a looped COAX-THRU shall give its COAX-IN a termination switch, marked TERM, that presents 75 Ω to 0 V across the line when on and no load when off, and shall lock the same with the switch on or off.	measurement: 75 Ω to 0 V across the line with TERM on, no load with TERM off; the module locks either way	A looped line is terminated once, at its far end; the switch is what lets the last module on the run terminate it and every other module bridge it.
EIS-V75-010	module, bus board, enclosure (VID-75)	Every video sync port shall be a COAX-IN (75 Ω ±5 % to 0 V at the jack), a COAX-OUT (a 75 Ω ±5 % series source driven at twice the line level), or a COAX-THRU, buffered or looped, never a patch jack.	measurement: 75 Ω ±5 % to 0 V at each COAX-IN; twice the line level open-circuit, from 75 Ω ±5 %, at each COAX-OUT	The video sync tree works only when every port in it is terminated once and driven once; the port modes say what each jack does. A picture port on the front is listed in the port list by its Annex C class.
EIS-V75-011	module, bus board, enclosure (VID-75)	A video sync port shall be marked beside it as an input (IN), an output (OUT), or a through (THRU), and a termination switch shall be marked TERM.	inspection	The installer cables the video sync once, behind the panel, and reads the marking, not the manual.
EIS-V75-012	module, bus board, enclosure (VID-75)	A COAX-OUT port or a buffered COAX-THRU port shall pass the video sync into a 75 Ω load with a -3 dB bandwidth of at least 30 MHz, or, at a COAX-OUT whose video sync is synthesised from samples, with every edge of each format it lists inside the rise time tolerance of that format's publication.	measurement: -3 dB bandwidth of at least 30 MHz at each COAX-OUT and buffered COAX-THRU, into 75 Ω; at a synthesised COAX-OUT, the 10–90 % rise of each edge of each listed format inside its publication's tolerance, into 75 Ω	A tri-level video sync edge is 54 ns ± 20 ns (SMPTE ST 274 and ST 296); a 30 MHz path keeps it inside that tolerance through a chain of buffered THRUs, and the buffers the trade uses for video sync distribution clear it with margin. A generator that synthesises its video sync from samples reconstructs them below half its sample rate; a 30 MHz path there passes the sampling images and scatters the edge timing between samples, so its output is held to the edge the THRUs downstream then carry.

8.3 VIDEO TIMING

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-VID-001	module, bus board, enclosure (VID-75)	A product's port list shall name, for each video sync input (COAX-IN) and output (COAX-OUT), every format of clause 8.3 the port accepts or generates, by its format ID.	inspection	Listing formats by ID on the video sync ports lets a buyer check that a video sync generator and the modules that lock to it share a format; a patch jack lists none, because it is never the video sync.
EIS-VID-002	module, bus board, enclosure (VID-75)	For each format a port lists, the video timing a product generates at a COAX-OUT, and the video timing it locks to at a COAX-IN, shall match the format's publication within the tolerances that publication states; for a progressive format, and along the line for a high-definition interlaced format, the row of clause 8.3 is that publication's raster, sample for sample.	measurement: line and frame timing and the video sync structure of each listed format, within the publication's tolerances	Two products locked to one format have to agree on its raster. An analog interlaced format can be held only to its publication's tolerances, not to a clock-exact row; a sample-defined format is exact.

PART 4 ASSEMBLY

9 ASSEMBLING A SYSTEM

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-ASM-001	installer	A module shall be added to a row only while, on each rail of each power interface, the sum of the published currents stays within the published totals of every source and every product with outlets that feeds it, and the current through each outlet stays within that outlet's limit.	inspection	Exceeding a bus board, header, or supply rating overheats contacts or trips the supply; the published currents exist so it can be checked first.
EIS-ASM-002	installer	At most one module shall transmit on each CV line and at most one on each gate line, where a line runs across linked bus boards up to a region split.	inspection	Two transmitters on one line drive against each other, leaving a level that is neither and stressing both outputs.

ID	APPLIES TO	REQUIREMENT	VERIFIED BY	WHY
EIS-ASM-003	installer	Installation shall connect only one of a product's alternative power entries at a time.	inspection	Two sources on one product can feed current from one into the other through its power circuit.
EIS-ASM-004	installer	Installation shall not insert a DC-BAR25 plug into a DC-BAR21 DC entry.	inspection	A DC-BAR25 plug enters a DC-BAR21 entry but makes unreliable contact, which can run hot or drop power under load.
EIS-ASM-005	installer	Each DC rail shall be fed from one adapter or one case DC entry at a time.	inspection	Two adapters or entries on one DC rail fight each other's regulation and can feed current back into each other.
EIS-ASM-006	installer	A DC-VH2, DC-DIN4, DC-MF6, or DC-MF8 DC entry shall be mated only with that variant's plug.	inspection	Each multi-pin variant has its own pin functions and contact rating, so only its own plug puts +V and -V on the right pins at its rated current.
EIS-ASM-007	installer	Each video sync tree in a row shall have exactly one source, a COAX-OUT or an external video sync at one COAX-IN, and each COAX-IN shall be fed by one output.	inspection	Two sources on one tree fight; an input fed by two outputs has two drivers on one line.
EIS-ASM-008	installer	Row wiring an installer adds between a power supply, bus boards, a DC entry, or PWR-DC12 outlets shall meet PWR-006 and PWR-007, with each ring terminal clamped on the product's M4 terminal under a lock washer, and a bond an installer adds shall meet PWR-008.	inspection	A supply and a bus board from different makers are joined by the installer; the wiring rules travel with the installer, not with either product.
EIS-ASM-009	installer	Where the bus boards of one enclosure are fed by more than one power supply, installation shall link their 0 V so that every bus board reaches, directly or through other boards' links, a bus board fed by each other supply, each 0 V link at most 2 mΩ terminal to terminal, and each bus board shall keep its own 0 V conductor to the supply that feeds it.	measurement: four-wire resistance of each 0 V link, terminal to terminal, at 20 to 25 °C	Two supplies joined only at their outputs put the drop of each one's conductors between two rows' references; a link between the bus boards holds every board's 0 V at one potential whatever each return carries. Hinton Instruments runs one common 0 V bar and links cases at under 2 mΩ for the same reason; between cases the 2 mΩ cannot be held past about 0.44 m on 10 AWG, so there EIS recommends the link instead.

PART 2 — CORE

What every Eurorack product shares, whoever makes it. Core binds every product and is never claimed; a product may add the optional interfaces of Part 3. A Core requirement applies to what a product has: the bus rules bind a product with a power header, and a product without one owes none of them, but for BUS-011, which binds every module (6.4).

Mechanical (chapter 5). What makes a module fit a row and a row fit a rack: the HP and the rack unit (5.1), the front panel and the boards behind it (5.2), the rails, inserts, and mounting screws (5.3), and the enclosure (5.4). The requirements restate the Doepfer A-100 conventions, fix the few figures they leave open, and take the Intellijel 1U format for 1U rows.

Power (chapter 6). Two *power interfaces*, each with its own connectors, distribution, and limits (6.1); the bus is Core, and the 12 V DC rail an optional interface (Part 3):

- *PWR-BUS*, the Eurorack bus: ±12 V and optional +5 V from a supply, through bus boards and ribbons, to a module's power header (6.4 to 6.6).
- *PWR-DC12* (8.1): nominal 12 V DC from an external adapter or a supply into a product's DC entry. It serves a product that draws more than one power header carries, and a product that runs on a desk, or in a case with no bus, from a wall adapter. Each product filters or regulates its DC rail, so the rail's noise does not reach a signal.

What both share is in 6.1 to 6.3: the currents a product publishes, a source's protection and ripple, and the one 0 V a row's signals are measured from.

Patch signals (chapter 7). What travels on a port, and what every patch jack owes whatever it carries: the port list, patch safety, and the jacks inside the case (7.1); the seven signal classes, AUDIO, CV, VIDEO, PITCH, GATE, TRIG, and CLOCK, with their ranges (7.2); and VIDEO's interface, paths, and bandwidth (7.3).

5.1 RACK DIMENSIONS

One HP shall be 5.08 mm (RACK-001) and one rack unit shall be 44.45 mm (RACK-002), quoted from IEC 60297-3-101:2004. Both bind modules and enclosures.

A rack-mount frame, one that fastens into a 19-inch rack, shall meet IEC 60297-3-101:2004 and IEC 60297-3-100:2008 for the flange width, the flange mounting-hole positions and slot, the 3U height H1, and the 84 HP row width (RACK-003). A desktop or portable case needs no flanges; its rows keep the same HP, rack unit, and mounting-hole span (PANEL-009).

The figures RACK-003 applies:

QUANTITY	VALUE	SOURCE
Panel width over mounting flanges	482.6 mm, ±0.4 mm	IEC 60297-3-101:2004, Figure 3; IEC 60297-3-100:2008, Figure 2
Mounting-hole centers across flanges	465.1 mm	IEC 60297-3-100:2008, clause 6.2 rack mounting grid
Mounting hole from outer edge	8.75 mm	derived
Mounting-hole vertical steps	12.7 mm and 31.75 mm	IEC 60297-3-100:2008, clause 6.2 rack mounting grid
3U flange mounting-hole span H2	57.15 mm	IEC 60297-3-100:2008, Table 1
3U flange hole from each end H3	37.70 mm	IEC 60297-3-100:2008, Table 1
Oval mounting slot	6.8 mm high, 14.7 mm deep	IEC 60297-3-100:2008, detail A
3U front panel and subrack height H1	132.55 mm, ±0.4 mm	IEC 60297-3-100:2008, Table 1
19-inch row width	84 HP	IEC 60297-3-101:2004, Figure 3 (84 × 5.08 mm)
Three rack units	133.35 mm	3 × 44.45 mm
Mounting flange, each side	narrower than 27.94 mm	(482.6 − 84 × 5.08) / 2

EIS · IEC 60297-3-101

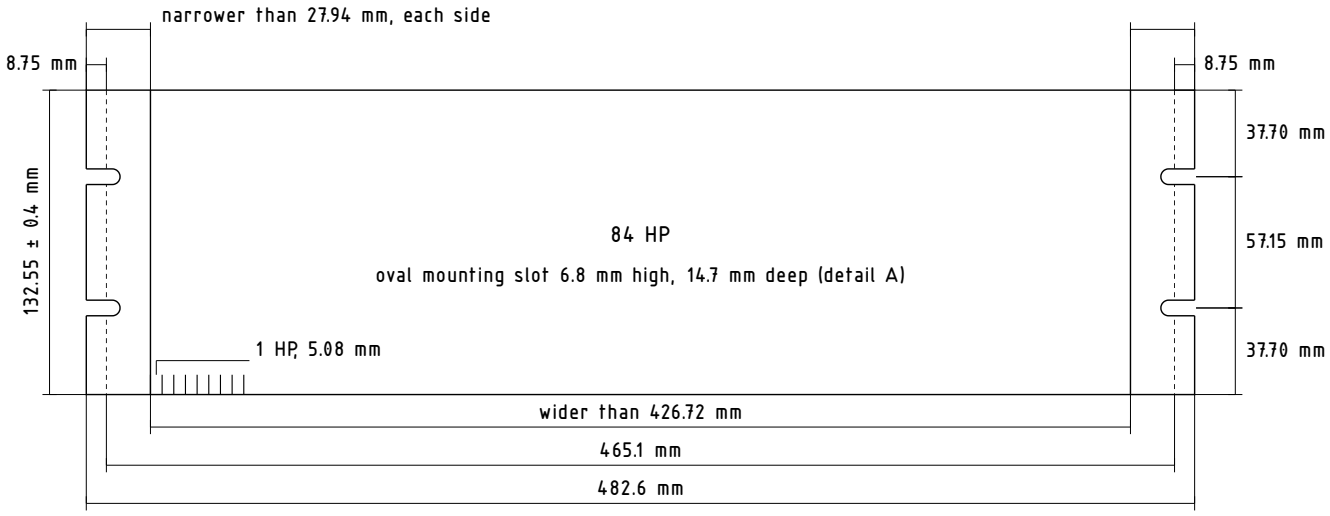


Figure 4. A 3U, 84 HP rack-mount panel: flanges, mounting holes, and slots

IEC 60297-3-100 applies H1, H2, and H3 to front panels, chassis, and subracks alike (its clause 5.1). Its detail A draws the slot as an oval open at the outer edge, 6.8 mm high (+0.5 / 0) and 14.7 mm deep (±1.2), and also permits a second hole type; the figure draws the open oval.

A front panel sits within H1, between the rails. The IEC publications do not set rail depth; 5.3 gives the recommended section.

The figures are in `data/standards.json`. The panel and flange figures (482.6 mm, H1, H2, H3, detail A, 1U, 84 × 5.08 mm) are read from the publications' own pages in the IEC's public preview: IEC 60297-3-100:2008 clause 5, Figure 2, and Table 1, and IEC 60297-3-101:2004 Figures 3 and 5 (bibliography). The rack mounting grid (465.1 mm centers, 12.7 mm and 31.75 mm steps) is in IEC 60297-3-100:2008 clause 6, beyond the preview, and is transcribed from the Schroff standards summary; where the two differ, the publication governs. The IEC publications are not stored in this repository.

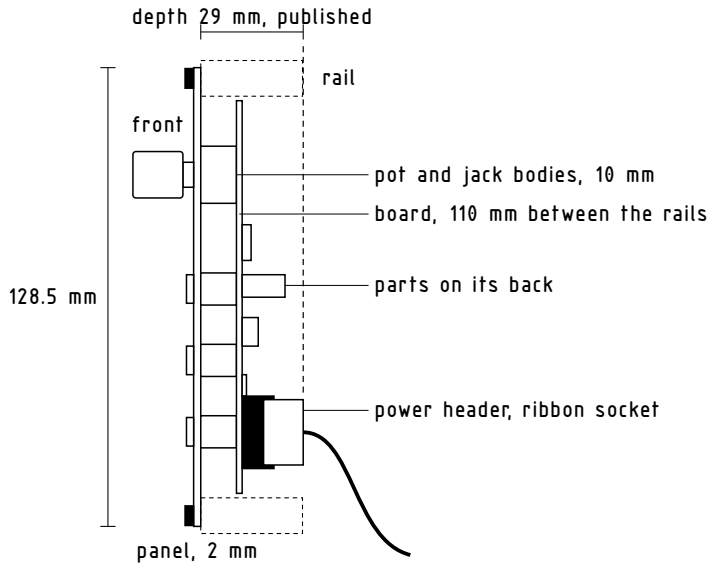
5.2 MODULES

A module fills HP in a row: a front panel, the boards behind it, and the parts on them. It screws to the rails of an enclosure and,

unless it is passive, takes power at a power entry (6.1), for most modules its power header, cabled to the row's bus board.

A module shall be 1U or 3U high (PANEL-001); the panel height, the mounting holes, and the board clearance follow from that choice. Its width is any positive whole number of HP (PANEL-002). A module shall publish its width in HP and how far it extends behind the panel's back face (PANEL-003), so that a buyer can check it against the width and depth a row publishes (ENG-001).

EIS · A module: what it is, and what it publishes



5.2 Size
1U or 3U (PANEL-001); N HP, no wider than N × 5.08 mm (PANEL-002); publishes width and depth (PANEL-003)

5.2 Holes
Ø3.2 mm on the HP grid (PANEL-010, PANEL-011)

6.1 Power
Publishes its rail currents (PWR-001); survives a reversed ribbon (BUS-009)

6.3 0 V
Every 0 V header pin tied to its 0 V (GND-001)

7.1 Ports
A port list with each port's class (SIG-001); patch inputs survive ±12 V (SIG-002)

The claim line names the edition and the product type with its roles: EIS draft, module. The claim file lists the power entries and the video sync ports.

Figure 5. A module from the side: what it is, and what it publishes

A MODULE'S	CLAUSE
Panel height, width, thickness, holes, patch jacks	5.2.1 Front panels
Board clearance and depth	5.2.2 Boards
Power entries and published current	6.1 Power architecture
Power header and draw	6.4 The bus
0 V and protective earth	6.3 Grounding and 0 V
Port list, signal classes, patch safety	7.1 Signals, 7.2 Signal classes

Fitting a module into a row, current check first, is in Assembling a system.

TOLERANCES

A dimension of clauses 5.1 to 5.3 shall hold within the tolerance the register states for its requirement, and a dimension with no tolerance stated is a limit (PANEL-013). The tolerances are in `data/requirements.json`:

ID	REQUIREMENT	TOLERANCE
RACK-001	One HP shall be 5.08 mm.	exact: the grid value
RACK-002	One rack unit shall be 44.45 mm.	exact: the grid value
PANEL-002	An N HP panel shall be no wider than N × 5.08 mm, where N is a positive whole number.	ceiling; −0.3 mm recommended
PANEL-004	A front panel shall be no more than 2.0 mm thick, +0.1 mm for the sheet's thickness tolerance.	ceiling, +0.1 mm as made
PANEL-005	A patch jack shall be a 3.5 mm mono (TS) socket.	none: a connector type
PANEL-006	A 3U front panel shall be 128.5 mm high.	±0.2 mm
PANEL-007	A 1U front panel shall be 39.65 mm high.	±0.2 mm
PANEL-008	Mounting holes shall be 3.0 mm in from the top and bottom panel edges.	±0.1 mm
PANEL-009	The mounting-hole span, on the panel and between the inserts of a row's two rails, shall be 122.5 mm at 3U and 33.65 mm at 1U.	±0.1 mm
PANEL-010	Mounting holes shall be drilled Ø3.2 mm, or slotted 3.2 mm wide and no longer than 5.5 mm along the rail, centered on the hole position.	+0.1 / −0 mm on the 3.2 mm width
PANEL-011	Each mounting hole shall be a whole number of HP plus 2.54 mm from the panel's nominal left edge.	±0.1 mm
PANEL-012	A board shall stay at least 9.25 mm clear of the top and bottom panel edges, and a rail shall cover no more than 9.25 mm of the panel face at each edge.	minimum and maximum
PANEL-013	A dimension of clauses 5.1 to 5.3 shall hold within the tolerance the register states for its requirement; a dimension with no tolerance stated is a limit.	the policy itself
RAIL-001	The holes in a rail insert shall be 5.08 mm apart.	±0.05 mm per pitch; ±0.1 mm over any ten holes
RAIL-002	A rail for an N HP row shall give at least N × 5.08 mm of mounting length.	minimum
RAIL-004	An insert shall be at least 1.5 mm thick, three thread pitches.	minimum
RAIL-006	A mounting screw's thread pitch shall be 0.5 mm.	ISO 965-1 class 6g on the screw, 6H in the insert
RAIL-007	A mounting screw's major diameter shall be 3.0 mm.	ISO 965-1 class 6g on the screw, 6H in the insert

ID	REQUIREMENT	TOLERANCE
RAIL-008	A mounting screw shall engage at least three full threads through a 2.0 mm panel.	minimum
RAIL-009	The mounting-screw length L shall satisfy 2.0 mm + seat + 1.5 mm ≤ L ≤ 1.6 mm + D, with seat and D measured behind the rail's mounting face. The throat in front of the insert shall clear 3.0 mm.	a window: both bounds are limits
RAIL-010	The mounting-screw head shall be at most 7.0 mm across.	maximum

5.2.1 FRONT PANELS

A front panel is the plate on the front of a module, or a blank panel that fills unused width in a row. It screws to the rails through a rail insert.

A front panel shall be no more than 2.0 mm thick, +0.1 mm for the sheet's thickness tolerance (PANEL-004). As made it is then at most 2.1 mm, which takes in the common 0.080 in (2.03 mm) aluminum sheet; the mounting-screw window still counts its threads through 2.0 mm (RAIL-008), and at 2.1 mm a screw at the window's short end engages 2.8 threads. EIS recommends 5052 aluminum or FR-4 circuit board, 1.6 mm to 2.0 mm thick. FR-4 is less stiff, so an FR-4 panel needs extra mounting holes at a narrower width than aluminum (Extra mounting holes).

A front panel thinner than 1.6 mm shall ship with M3 mounting screws with a head at most 7.0 mm across, whose length fits the window of 5.3 for its own thickness on a rail of the section 5.3 recommends (PANEL-014). The enclosure's screws are sized for panels of 1.6 mm to 2.0 mm and can bottom out through a thinner one.

A patch jack shall be a 3.5 mm mono (TS) socket (PANEL-005). 7.1 recommends insulating jacks from the panel; the panel and 0 V says how.

A blank panel plays the panel role of 4.1 and meets the same height, width, thickness, and hole requirements as a module's panel.

THE PANEL AND 0 V

A panel makes two choices, and they are independent. A module shall publish both: whether its front panel is connected to its 0 V, and whether the panel is bonded to the rails (PANEL-015).

	BONDED TO THE RAILS (BARE METAL UNDER THE SCREW HEADS, 6.3)	FLOATING FROM THE RAILS (COATED OR MASKED UP TO THE HOLES)
Insulated from 0 V (no jack sleeve, pot body, or switch frame reaches the panel)	The panel is chassis: it shields and drains static, and carries no signal. What EIS recommends for a metal panel.	The panel is inert. Fine; the usual result of an anodized panel or an FR4 panel masked everywhere.
Connected to 0 V (the panel bonded to the module's 0 V at a jack bushing or a screw, through bare metal, GND-004)	A 0 V to chassis tie at this module. With the system's tie at its power entry this is a second tie, and EIS recommends against it; only the product at the tie does this.	The Eurorack convention. The panel sits at the module's 0 V, and two panels butted edge to edge join two modules' 0 V through their bare cut edges; one butted against a chassis panel is a second chassis tie. Tolerable; the loops it makes are why EIS recommends insulating.

EIS recommends the first row: a panel insulated from 0 V, bonded to the rails if it is metal and the maker wants a shield, floating otherwise. Insulated means that nothing at 0 V touches the panel: not a jack's sleeve, a pot's bushing, a switch's frame, or an encoder's body.

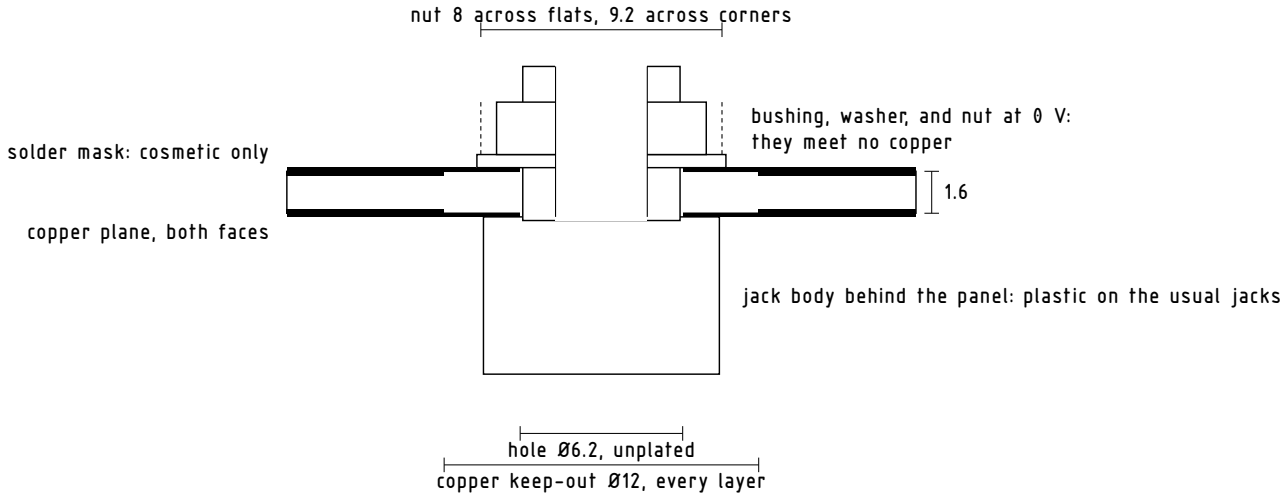
INSULATED JACKS ON AN FR4 PANEL

The usual 3.5 mm jack has a metal threaded bushing, about 6 mm across, a hex nut of 8 mm across the flats (9.2 mm across the corners) and a washer of about 9.5 mm. On an FR4 panel the board itself is the insulator, and the jack is insulated by keeping the panel's copper away from everything the jack touches:

- the hole is unplated (NPTH), to the jack's drawing, about 6.1 mm to 6.4 mm for a 6 mm bushing;
- no copper on any layer within a circle at least 1 mm beyond the nut's corners and the washer: Ø12 mm for the jack above, centered on the hole, so that the hole's bore, the nut, and the washer meet no copper;
- solder mask may run over the panel's copper up to the keep-out and across it; it is cosmetic, not the insulation: 15 µm to 30 µm of mask under a nut turned to torque may or may not be cut through, which is also why GND-004 refuses it as a bond surface;
- the same keep-out on the back face, where the jack's body sits; the usual jacks have plastic bodies, and a metal-cased jack or a pot's bushing needs the keep-out to cover whatever it touches.

The jack's sleeve is then at the module's 0 V on the board behind the panel and nowhere else, and the panel's copper is free to be bonded to the rails through finished lands at the mounting holes, or left floating.

EIS · An insulated jack on an FR4 panel: the copper keeps away from everything the jack touches



The board is the insulator. Nothing the jack touches, the hole's bore, the washer, the nut, the body, meets copper, so the sleeve stays at the module's 0 V on the board behind and the panel's copper is free to be chassis or to float (PANEL-015, 6.3). Mask is allowed over the copper; a nut turned to torque cuts through it, so it is not the insulation. The same keep-out serves a pot or switch with a metal bushing.

Figure 6. A threaded-bushing jack through an FR4 panel: the unplated hole, the copper keep-out on every layer, mask over the copper, and the nut and washer meeting no copper

INSULATED JACKS ON A METAL PANEL

A metal bushing through a bare metal panel is a connection, and through an anodized one it may or may not be: anodize in a hole's bore is thin, and a bushing turned into it cuts through or does not. To insulate a jack on a metal panel, use a jack whose bushing is plastic, or an insulating shoulder washer in an oversized hole with a flat insulating washer under the nut. Pots, switches, and encoders with metal bushings take the same treatment. Otherwise the panel is published as connected to 0 V, and EIS recommends that the connection be made a bond, bare metal under at least one bushing's nut or washer, rather than whatever a bushing scratches through anodize.

HEIGHT

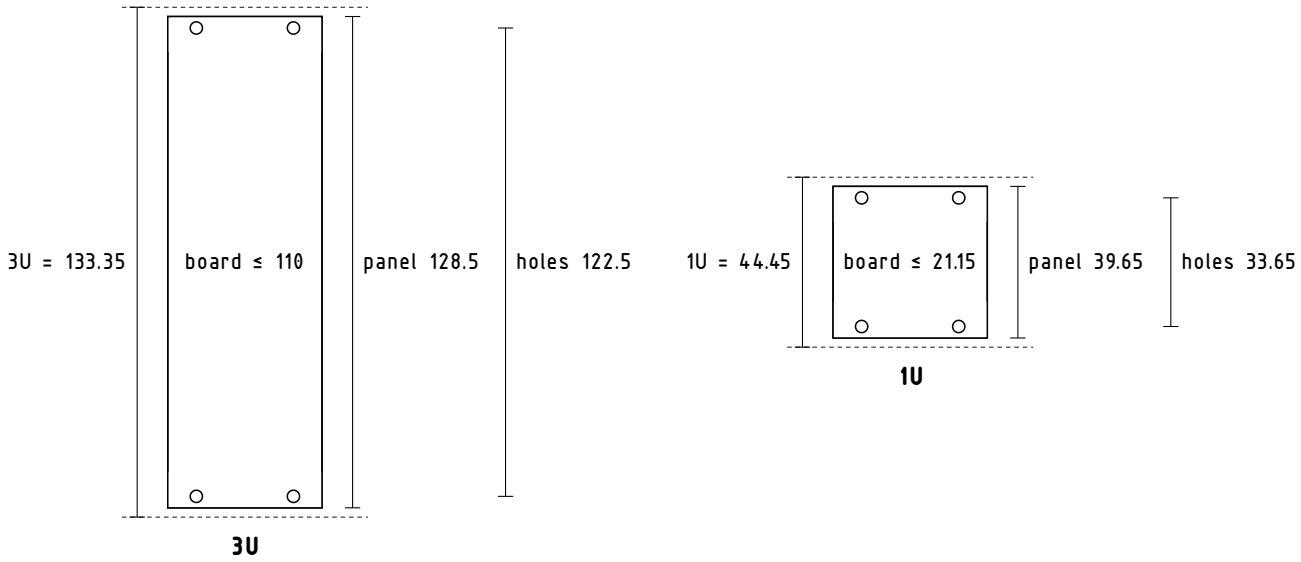
FORMAT	PANEL HEIGHT	HOLE SPAN	HOLES FROM PANEL CENTER	PROVENANCE
1U	39.65 mm	33.65 mm	±16.825 mm	inherited: Intellijel 1U
3U	128.5 mm	122.5 mm	±61.25 mm	inherited: Doepfer A-100

A 3U front panel shall be 128.5 mm high (PANEL-006): 4.85 mm under three rack units (133.35 mm), so it fits within the 132.55 ± 0.4 mm 3U height H1 of 5.1. The 4.85 mm is clearance, not a rail lip; where a rail has a lip, EIS recommends at most 1.5 mm (5.3).

A 1U front panel shall be 39.65 mm high (PANEL-007), the Intellijel 1U format, 4.80 mm under one rack unit. EIS defines no other panel height.

Mounting holes shall be 3.0 mm in from the top and bottom panel edges (PANEL-008). A panel that is to be chassis is bonded to the rails only by what is under its screw heads (6.3): EIS recommends a bare 7 mm disc at each hole on a coated panel, or a finished copper land on an FR4 one. The hole span is then the panel height less 6.0 mm, and it shall be 122.5 mm at 3U and 33.65 mm at 1U, the same on the panel and between the inserts of a row's two rails (PANEL-009).

EIS · The 3U and 1U vertical budget, at one scale



Millimeters, on 8 HP panels. Panel heights PANEL-006 (3U) and PANEL-007 (1U); holes 3.0 mm in from each edge (PANEL-008), span PANEL-009. Grey: the most a rail may cover, 9.25 mm at each edge; blue: the board, at least 9.25 mm clear of each edge (PANEL-012).

Figure 7. The 3U and 1U vertical budget at one scale

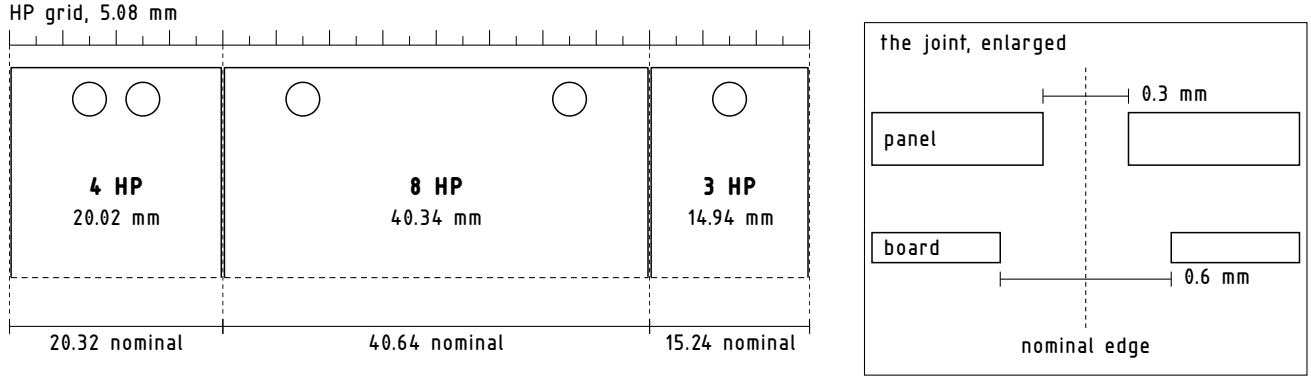
WIDTH

The nominal width of an N HP panel is N × 5.08 mm, where N is any positive whole number. An N HP panel shall be no wider than its nominal width (PANEL-002). EIS recommends making it 0.3 mm narrower, so that neighboring panels do not bind:

```
panel width = N × 5.08 − 0.3 mm
```

The board behind the panel is 0.6 mm under the nominal width (5.2.2). A rail gives at least the nominal width of its row (RAIL-002), so a row of panels at either width fits it.

EIS · Panel and board widths on the HP grid



An N HP panel is no wider than N × 5.08 mm (PANEL-002). EIS recommends a panel N × 5.08 − 0.3 mm wide, so that neighbors do not bind, and a board N × 5.08 − 0.6 mm wide.

Each panel is centered between its nominal edges, so the clearance splits evenly between neighbors. The joint is drawn about 27 times larger than the row.

Figure 8. Panels on the HP grid, and the joint between two panels enlarged

HP	NOMINAL (mm)	PANEL (mm)	BOARD (mm)
1	5.08	4.78	4.48
2	10.16	9.86	9.56
3	15.24	14.94	14.64
4	20.32	20.02	19.72
6	30.48	30.18	29.88
8	40.64	40.34	40.04
10	50.80	50.50	50.20
12	60.96	60.66	60.36
14	71.12	70.82	70.52
16	81.28	80.98	80.68
18	91.44	91.14	90.84
20	101.60	101.30	101.00
24	121.92	121.62	121.32
28	142.24	141.94	141.64

HP	NOMINAL (mm)	PANEL (mm)	BOARD (mm)
32	162.56	162.26	161.96
36	182.88	182.58	182.28
42	213.36	213.06	212.76
84	426.72	426.42	426.12
104	528.32	528.02	527.72

MOUNTING HOLES

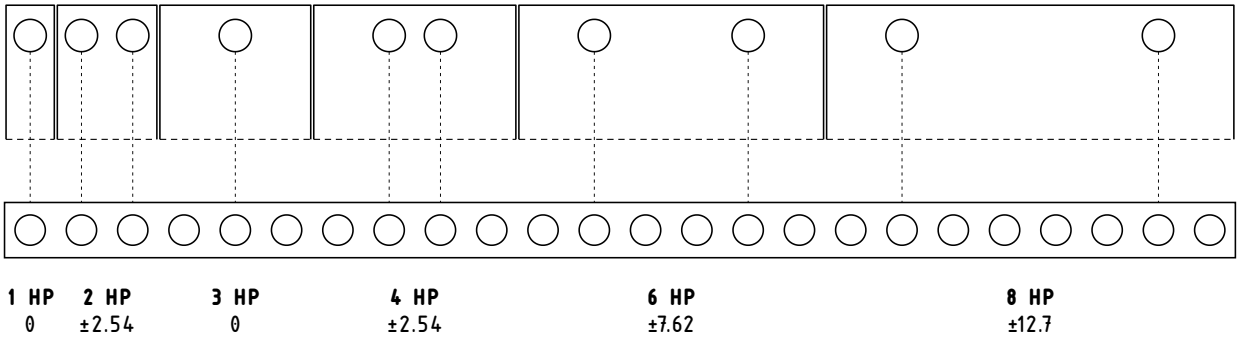
Mounting holes shall be drilled Ø3.2 mm, or slotted 3.2 mm wide and no longer than 5.5 mm along the rail, centered on the hole position (PANEL-010). Either clears the M3 mounting screw; a short slot takes up a rail's position error without letting the panel drop.

Along the rail, each mounting hole shall be a whole number of HP plus 2.54 mm from the panel's nominal left edge (PANEL-011). The nominal edges are N × 5.08 mm apart and centered on the panel, so every hole meets a hole in the rail insert, whatever the panel's width and wherever it sits in the row. The top and bottom rows of holes are the same.

Measured from the panel center:

- an odd-HP panel has its holes a whole number of HP out, an even-HP panel a whole number of HP plus 2.54 mm;
- from 3 HP up, the outer holes are 7.62 mm in from each nominal edge, which puts the one hole of a 3 HP panel on its center;
- a 1 HP panel has one hole, on its center, and a 2 HP panel has its holes at ±2.54 mm.

EIS · Mounting holes from 1 to 8 HP, over one rail insert



rail insert: a hole every 5.08 mm, 2.54 mm in from each HP boundary

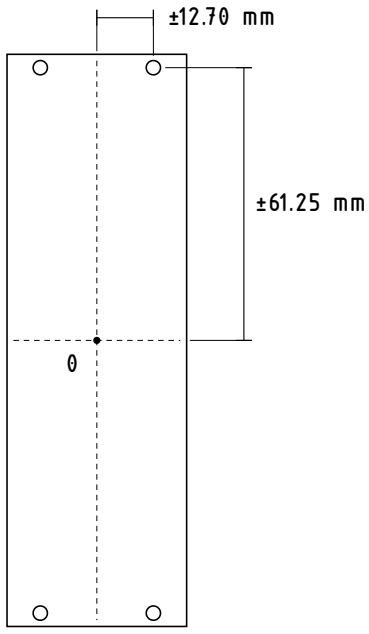
Each hole is a whole number of HP plus 2.54 mm from the panel's nominal left edge (PANEL-011), so it meets an insert hole wherever the panel sits in the row. Holes are Ø3.2 mm or slotted (PANEL-010), 3.0 mm in from the top and bottom edges (PANEL-008).

Under each width: the hole positions from the panel's center, in millimeters. From 3 HP up, the outer holes are 7.62 mm in from the nominal edges.

Figure 9. Hole patterns from 1 to 8 HP over one rail insert

The two cards below show an 8 HP panel.

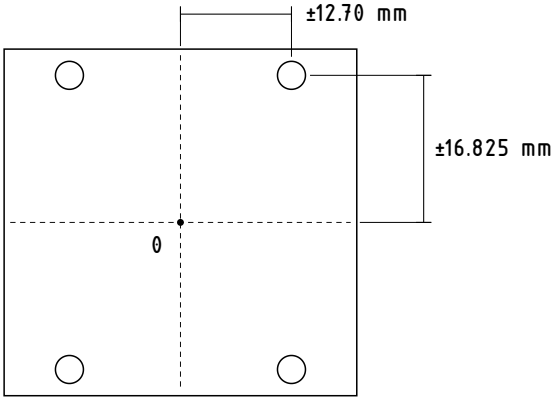
EIS · 3U front panel, 8 HP



40.34 × 128.50 mm (PANEL-006). Holes Ø3.20 mm (PANEL-010), dimensioned from the panel center; the other three mirror the one dimensioned.

Figure 10. 3U front panel, 8 HP

EIS · 1U front panel, 8 HP



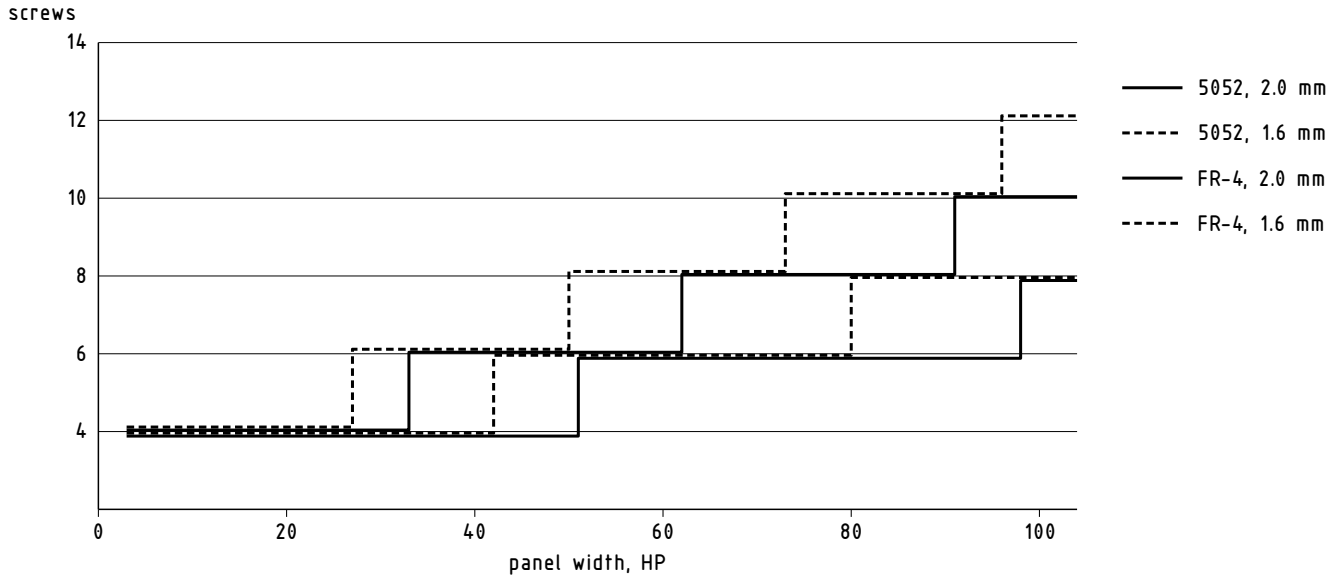
40.34 × 39.65 mm (PANEL-007). Holes Ø3.20 mm (PANEL-010), dimensioned from the panel center; the other three mirror the one dimensioned.

Figure 11. 1U front panel, 8 HP

EXTRA MOUNTING HOLES

EIS sets no hole count; four holes are the usual pattern. A wide panel needs more so that a 10 N push at midspan, about the force of seating a plug, bows it no more than 0.5 mm between screws. On four screws a 3U panel reaches 41 HP in 1.6 mm 5052 and 26 HP in 1.6 mm FR-4, the most flexible recommended sheet; past that, a hole is added on each rail, a middle hole first, until every gap is inside the span. On an even-HP panel the middle hole sits 2.54 mm to one side of the center, on the hole grid.

EIS · Screws a 3U panel needs as it gets wider, per sheet



Extra mounting holes (5.2.1): each gap short enough that a 10 N push at midspan bows the panel no more than 0.5 mm; each step is the first whole HP that needs more screws.

Figure 12. Screws a 3U panel needs as it gets wider, per sheet

The numbers are in `data/module.json`. `tools/module.py` derives the hole spans and widths and computes the extra-hole patterns; `tools/cards_system.py` draws the span card.

5.2.2 BOARDS

The circuit boards behind a front panel. A module has a parallel board, a right-angle board, or both.

EDGE CLEARANCE

A board shall stay at least 9.25 mm clear of the top and bottom panel edges, and a rail shall cover no more than 9.25 mm of the panel face at each edge (PANEL-012). The rails' inner faces are then at least 110 mm apart at 3U and 21.15 mm at 1U. A 110 mm board is the tallest that fits at 3U; the usual 1U board is 21.10 mm, two rack units shorter.

FORMAT	USUAL BOARD HEIGHT	CLEAR OF EACH PANEL EDGE
1U	21.10 mm	9.275 mm

FORMAT	USUAL BOARD HEIGHT	CLEAR OF EACH PANEL EDGE
3U	110.00 mm	9.25 mm

On a rail whose inner face is 5.075 mm from the hole center, such as Schroff 34560-184, the 3U opening is 112.35 mm and a 110 mm board has 1.175 mm to spare on each side. 5.3 gives the inner-face measurements of catalog rails.

The rest of this clause describes common construction and sets no requirement. The numbers are in `data/module.json`.

PARALLEL BOARDS

A parallel board faces the panel. Its front face is usually 10 mm behind the panel's back face, the height of a jack body. Its width is 0.6 mm under the panel's nominal width, twice the panel clearance:

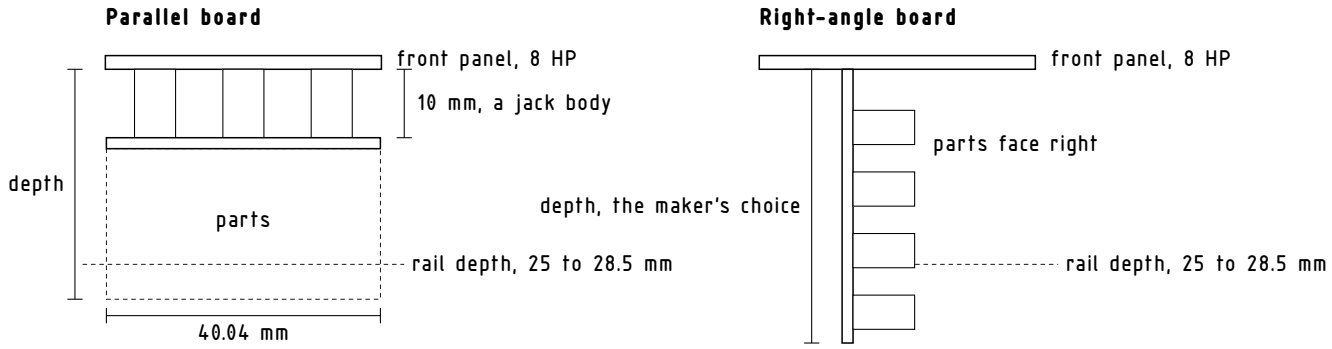
```
board width = N × 5.08 − 0.6 mm
```

An 8 HP parallel board is 40.04 mm wide, and 110 mm tall at 3U or 21.10 mm at 1U. 1.6 mm FR-4 is the usual material.

RIGHT-ANGLE BOARDS

A right-angle board stands square to the back of the panel, with no gap. Its left edge meets the panel, and its parts face right. Its height is the board height above. Its depth is the maker's choice, and the module publishes how far it reaches (PANEL-003). Even a 30 mm deep right-angle board reaches past a rail of the recommended section (5.4).

EIS · Parallel and right-angle boards, seen from above



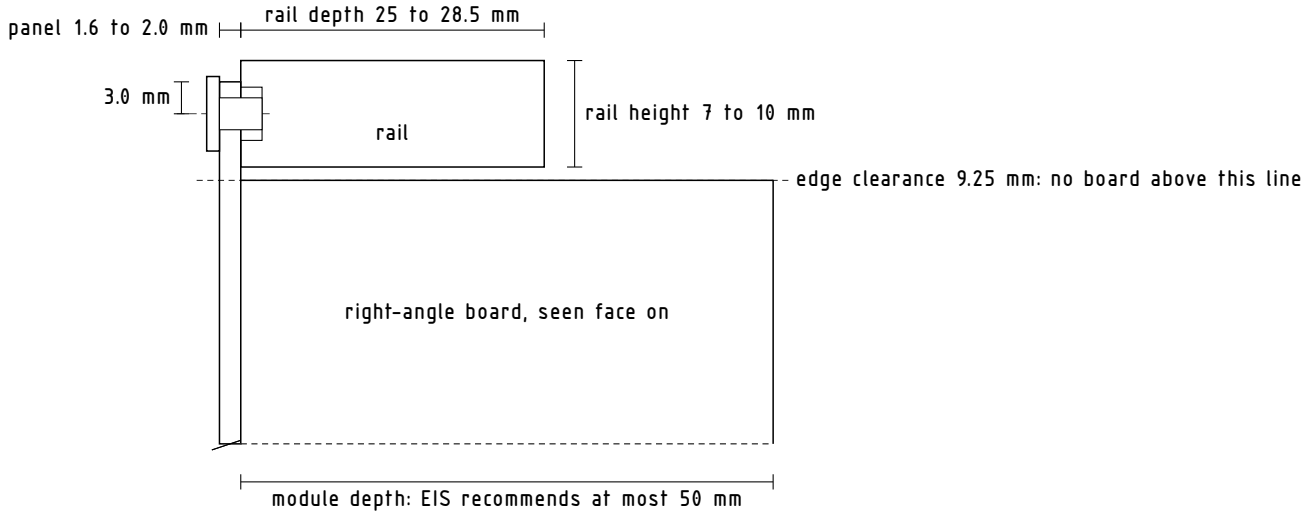
A parallel board stands about 10 mm behind the panel, the height of a jack body, and is N × 5.08 − 0.6 mm wide. A right-angle board stands square to the panel, its front edge on the panel's back. Either way the module publishes how far it reaches behind the panel (PANEL-003); EIS recommends at most 50 mm.

Figure 13. Parallel and right-angle boards seen from above

MODULE DEPTH

EIS recommends that a module extend no more than 50 mm behind the panel's back face, measured to its deepest point. A deeper module still conforms; its published depth (PANEL-003) is checked against the row's (ENC-001). In the eis-reference survey, 94.8 % of 270 modules are within 50 mm and the median is 35 mm.

EIS · Module cut at the top rail, seen along the rail



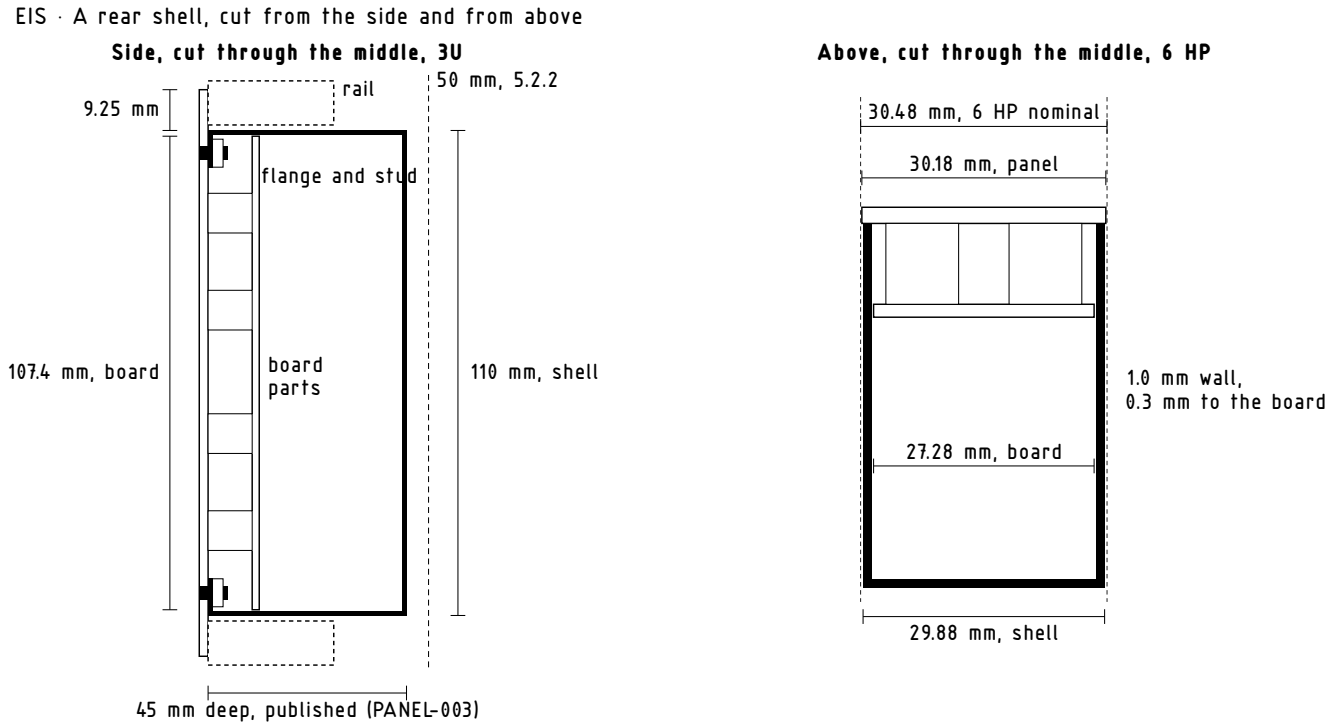
The rail is drawn at its tallest, 10 mm, centered on the hole as catalog rails are: its inner face is 8 mm below the panel's top edge, inside the 9.25 mm a board keeps clear (PANEL-012). The hole is 3.0 mm from the edge (PANEL-008), Ø3.2 mm (PANEL-010), for an M3 pan-head screw with a head at most 7.0 mm across (RAIL-010).

A parallel board keeps the same clearance. Depth runs from the panel's back face to the module's deepest point (PANEL-003).

Figure 14. Module cut at the top rail: panel, rail, screw, board, edge clearance, and depth

REAR SHELLS

A rear shell is a cover behind the panel that closes the module's boards in: sheet metal folded into a can, an extrusion cut to length, or circuit boards soldered into a box. The panel is its sixth side. EIS requires no shell. A shell is part of the module: what the module publishes (PANEL-003) includes it, and a shell that is metal shares the panel's answers to PANEL-015. EIS recommends the rest of this section for a module that has one.



A rear shell stays inside the board's envelope over its whole depth: N × 5.08 − 0.6 mm wide, 110 mm tall at 3U, clear of the 9.25 mm the rails cover (PANEL-012). The board inside is narrower and shorter by a wall and 0.3 mm each side.

Figure 15. A rear shell cut from the side at 3U and from above at 6 HP: the band it stays in, the flanges that hold it, and the board inside

THE ENVELOPE

EIS recommends that a rear shell stay inside the board's envelope over its whole depth:

- no wider than the board, N × 5.08 − 0.6 mm, so that two shelled modules side by side keep 0.6 mm between them, as their panels do;
- no taller than the board, 110 mm at 3U and 21.10 mm at 1U, so that it stays clear of the 9.25 mm the rails cover at each panel edge (PANEL-012). The band holds behind the rails too, not only over the 25 mm to 28.5 mm of the rail section: a bus board, a stiffener rail, or a supply can sit there;
- nothing on the panel's back within 9.25 mm of its top or bottom edge, the shell's fasteners included;
- within the 50 mm of Module depth, the shell and everything it covers.

A shell fastens to the panel inside the band. A stud pressed into a metal panel flush with its face, or a surface-mount nut soldered to the back of an FR-4 panel, keeps the face clear; a screw from the

front works as well and shows. The panel's mounting screws then carry the shell, and Annex H asks a heavy module to publish its mass.

BOARDS INSIDE A SHELL

The board inside a shell is narrower and shorter than the usual board by a wall and a clearance on each side. EIS recommends 0.3 mm between a board and the shell's inner faces:

```
board width  = N × 5.08 − 0.6 − 2 × (wall + 0.3) mm
board height = 110 − 2 × (wall + 0.3) mm at 3U, 21.10 − 2 × (wall + 0.3) mm
at 1U
```

HP	SHELL, OUTSIDE (mm)	BOARD INSIDE 1.0 mm SHEET METAL (mm)	BOARD INSIDE 1.6 mm FR-4 (mm)
3	14.64	12.04	10.84
4	19.72	17.12	15.92
6	29.88	27.28	26.08
8	40.04	37.44	36.24
10	50.20	47.60	46.40
12	60.36	57.76	56.56
16	80.68	78.08	76.88
20	101.00	98.40	97.20
24	121.32	118.72	117.52
42	212.76	210.16	208.96
84	426.12	423.52	422.32

FORMAT	SHELL, OUTSIDE (mm)	BOARD INSIDE 1.0 mm SHEET METAL (mm)	BOARD INSIDE 1.6 mm FR-4 (mm)
3U	110.00	107.40	106.20
1U	21.10	18.50	17.30

A parallel board still stands about 10 mm behind the panel. Behind it, a shell D mm deep leaves D − 10 − 1.6 − wall − 0.3 mm for the parts on the board's back: 32.1 mm in a 45 mm shell of 1.0 mm sheet.

THE NARROWEST MODULE

EIS recommends a rear shell only on a module of 3 HP or more. Two things set the limit: the board inside takes a column of jacks, so it is no narrower than the usual jack's 9.5 mm washer, and the inside takes the nut that holds the shell, 6.35 mm across the corners of an M3 nut, with 1 mm clear each side. At 2 HP the board inside a 1.0

mm sheet shell is 6.96 mm wide; at 3 HP it is 12.04 mm, and 10.84 mm inside 1.6 mm FR-4.

CLOSING THE SHELL

A folded shell has seams where its walls meet, and every shell has the openings it needs: the way power comes in and any vents. EIS recommends closing a seam where the shell is meant to shield or to keep out dust and fingers, with a tab on one wall folded over its neighbor or with walls that overlap, and bringing power in through a header or a DC entry on the shell's rear wall, or through a slot sized to the ribbon. Two bends that meet at a folded corner need a relief between them, so a butt seam stays open by about the sheet's thickness; a return, a flange along one wall's edge folded against its neighbor's inner face, closes it. A return lies inside the shell, so the board inside clears it: its corners notched as far up as the return reaches and one wall's thickness across, or the whole board narrower by one wall each side.

THE SHELL AND 0 V

A metal shell joined to a metal panel is on the panel's node. EIS recommends the panel's first row of the panel and 0 V for both: shell and panel insulated from 0 V, the board inside on insulating standoffs, and nothing at 0 V touching the shell. A shell of FR-4 makes the same choice for its copper.

HEAT IN A SHELL

A shell closes the module's heat in with it. By the method of Annex H, a 6 HP 3U shell 45 mm deep has about 0.016 square meters of outer surface, so 2 W raises the air inside it about 25 °C above the case's air. EIS recommends vents, a thermal path from hot parts to a metal shell joined to the panel, whose face is in the room's air, or publishing the dissipation as Annex H describes.

5.3 RAILS, INSERTS, AND MOUNTING SCREWS

A front panel screws to a pair of rails through a threaded rail insert in each. Five things make a module fit any conforming row:

WHAT	VALUE	REQUIREMENT
Hole span	122.5 mm at 3U, 33.65 mm at 1U, between the inserts of a row's two rails	PANEL-009

WHAT	VALUE	REQUIREMENT
Cover	At most 9.25 mm of the panel face at each edge	PANEL-012
Hole pitch	5.08 mm along the insert	RAIL-001
Thread	M3, in the insert and on the screw	RAIL-003, RAIL-005
Screw length	Inside the length window below	RAIL-009

RAILS AND INSERTS

The holes in a rail insert shall be 5.08 mm apart (RAIL-001), so that every panel hole meets one. A rail for an N HP row shall give at least N × 5.08 mm of mounting length (RAIL-002).

An insert shall be threaded M3 (RAIL-003) and shall be at least 1.5 mm thick, three thread pitches (RAIL-004).

MOUNTING SCREWS

A mounting screw shall be M3 (RAIL-005): its thread pitch shall be 0.5 mm (RAIL-006) and its major diameter 3.0 mm (RAIL-007), as ISO 261:1998 gives them. M3 is the thread of the Doepfer A-100 frame, of nearly every Eurorack case on sale, and of the screws modules ship with. A case built on M2.5 IEC subrack hardware, or on #4-40 groove nuts in a Vector T-strut, is not an EIS row, though a module's Ø3.2 mm hole (PANEL-010) clears those screws.

A mounting screw shall engage at least three full threads through a 2.0 mm panel (RAIL-008). Its length L shall fall inside this window, and the throat in front of the insert shall clear the 3.0 mm major diameter (RAIL-009):

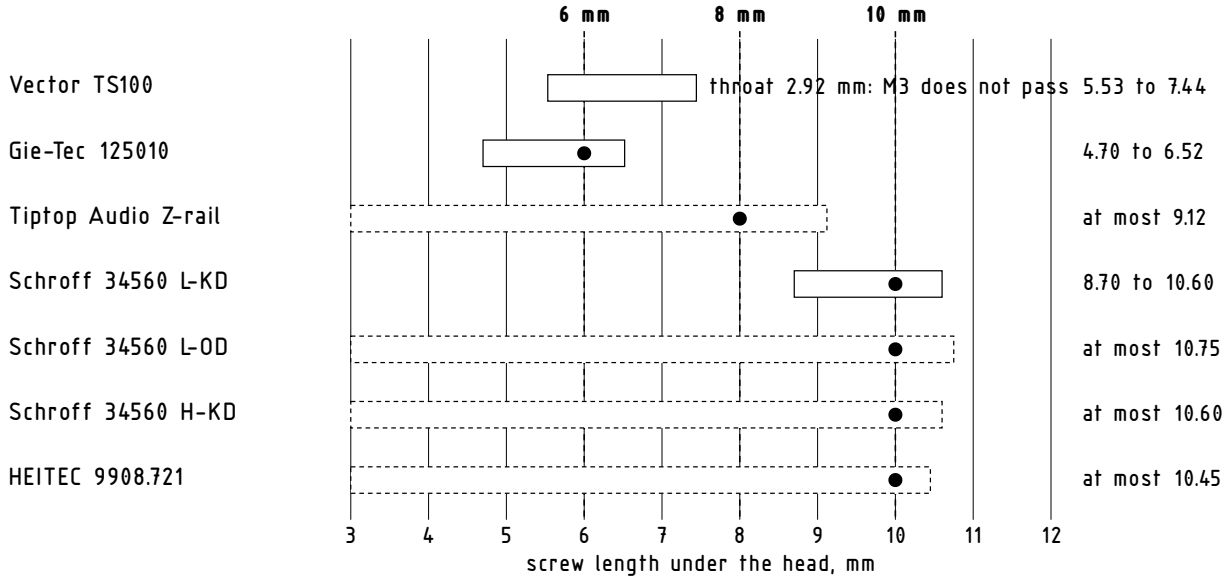
$$2.0\ \text{mm} + \text{seat} + 1.5\ \text{mm} \;\le\; L \;\le\; 1.6\ \text{mm} + D$$

Seat is the depth of the insert's front face behind the rail's mounting face, and D is the depth of the screw cavity behind it (Terms). The upper bound keeps the tip off the cavity floor through a 1.6 mm panel, the thinnest EIS recommends.

The screw head shall be at most 7.0 mm across (RAIL-010). The narrowest catalog rail face reaches 3.7 mm past the hole center (the Vector T-strut, half its 7.391 mm height), so a head of that size bears on the panel and on the rail face of every catalog rail; an ISO 7045 pan head or a 7 mm washer fits.

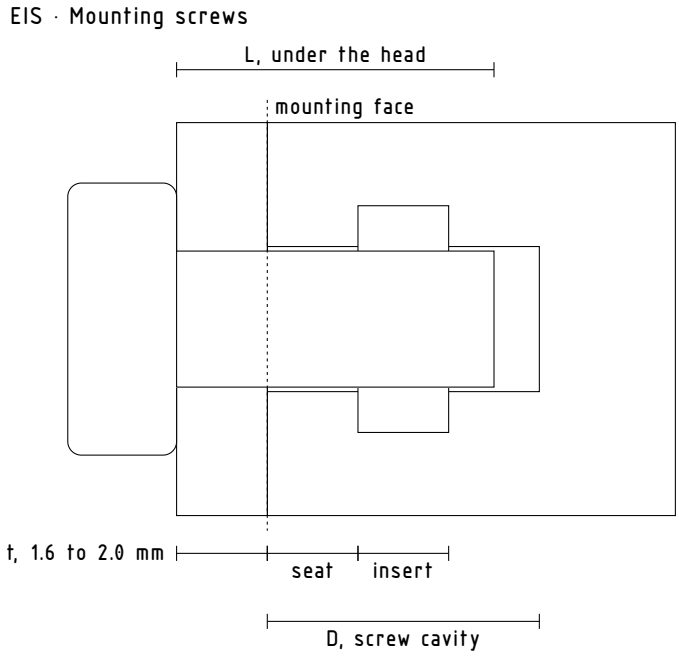
An enclosure shall publish the mounting-screw length, and shall supply those screws or name them (RAIL-011). A module need not ship with screws unless its panel is thinner than 1.6 mm (PANEL-014).

EIS · The M3 screw length window of each catalog rail



Shortest: 2.0 mm panel + seat + three 0.5 mm threads; longest: 1.6 mm panel + D (RAIL-009). A dashed bar is a rail whose insert seat is not published, so only the longest length is known. The dot is the screw EIS picks for that rail: the shortest stock length inside the window, or the longest that does not bottom out.

Figure 16. The M3 screw length window of each catalog rail



Thread	Lengths under the head
M3	6 mm, 8 mm, 10 mm

2.0 mm + seat + 1.5 mm ≤ L ≤ 1.6 mm + D (RAIL-009)

The throat clears 3.0 mm (RAIL-009)

Pan head, at most 7.0 mm across (RAIL-010)

Seat and D are measured behind the mounting face. Through a 2.0 mm panel, at least three 0.5 mm threads engage (RAIL-008).

Figure 17. The mounting-screw stack: panel, seat, insert, and screw cavity

RECOMMENDED PRACTICE

Everything else about a rail, an insert, and a screw is construction: the extrusion section and its lip, the groove, the insert width and ends, the screw lengths, the tap drill, the head form, and the finish. EIS recommends the following for a new rail; a rail built another way conforms if it meets the requirements above.

RECOMMENDED RAIL SECTION

Two vendor figures recur in EIS. The Vector T-strut height (drawing 5280006) is the small end of the recommended height below. The inner face of the Schroff 34560-184 section, with the mounting hole on the cavity center, sets the board opening in 5.2.2: 112.35 mm at 3U, 1.175 mm more on each side than a 110 mm board.

CONSTANT	VALUE	SOURCE
T-strut height across the panel	7.391 mm	Vector, drawing 5280006
Inner face, in from the mounting hole	5.075 mm	Schroff, 34560-184

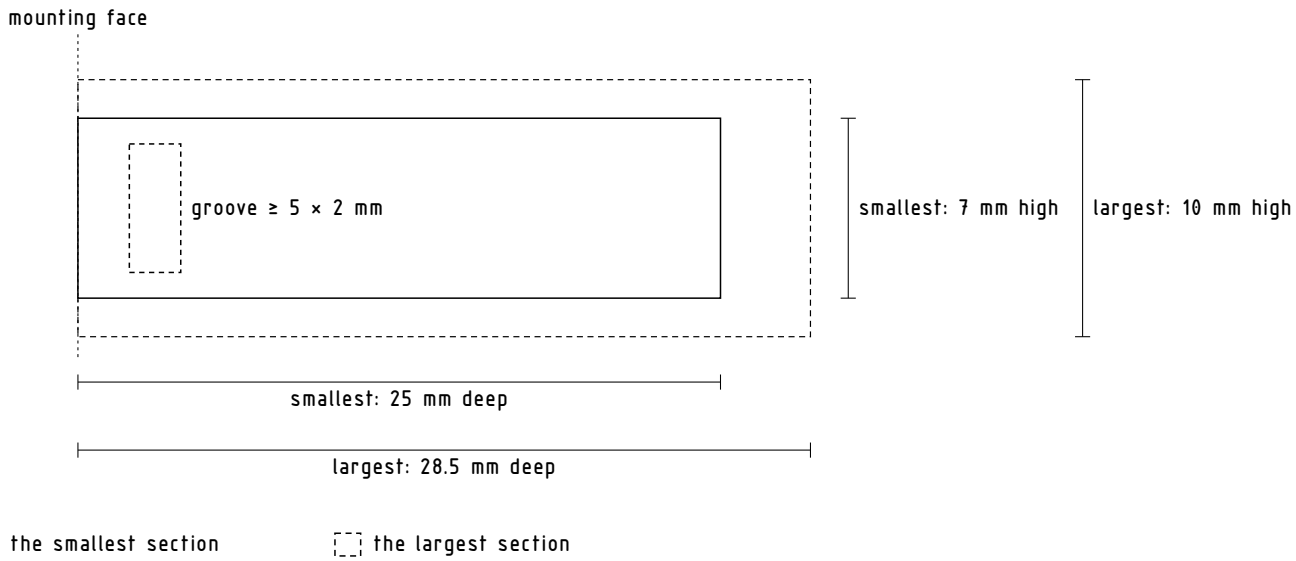
A new rail inside these limits takes the 5.0 mm × 2.0 mm M3 strip most Eurorack cases use, and a 6, 8, or 10 mm screw. The limits are the envelope of the two extrusions EIS measured, rounded: the

Vector T-strut at the small end, the Schroff L-KD at the large. A rail built another way conforms if it meets 5.3.

RAIL SECTION	MILLIMETERS
Height, across the panel	7.0 to 10.0
Depth, front face to back face (F + D + G)	25.0 to 28.5
Lip, if present, across the panel	at most 1.5
Lip, if present, in front of the mounting face (F)	at most 3.1
Groove, across	at least 5.0
Groove, into the rail	at least 2.0

A lip is optional; its two limits include its corner radius. The groove admits a rectangular insert 5.0 mm across and 2.0 mm thick; a larger groove is fine if that rectangle enters and stays. The throat in front of the insert clears 3.0 mm (RAIL-009). EIS recommends that a rail maker publish the insert seat, the screw-cavity depth D, and a screw length that fits the window (RAIL-009).

EIS · The recommended rail section



A rail whose section lies between the two takes the 5.0 mm × 2.0 mm insert and a 6, 8, or 10 mm screw. A lip is optional: at most 1.5 mm across the panel and 3.1 mm into the case.

Figure 18. The recommended rail section, smallest and largest

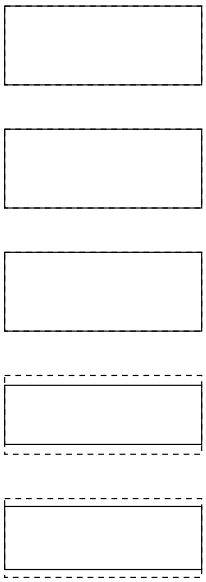
THREADED STRIP	MILLIMETERS
Across the groove	5.0
Thickness	1.5 to 2.0
Hole pitch	5.08 (RAIL-001)

THREADED STRIP	MILLIMETERS
First hole, from one end	3.58
Margin past the last hole	6.08

An N HP strip is N × 5.08 + 4.58 mm long with N holes, or is cut from a longer strip; the first-hole and end-margin figures are measured on the Schroff 34561-484 model. A slide nut fits the same 5.0 mm × 2.0 mm section. M3 slide nuts for Eurorack rails are made to the groove; a DIN 562 M3 square nut, 5.5 mm across flats, does not fit it.

EIS · Rail inserts

End sections, to scale. Dashed: the 5.0 mm × 2.0 mm groove. An EIS insert is M3 (RAIL-003) and at least 1.5 mm thick (RAIL-004); the M2.5 parts, in grey, are subrack hardware of the same section.



	Thread	Form
nVent Schroff 34561-484, tap 2.5 mm	M3	strip
nVent Schroff 34561-3xx and 34565-196, tap 2.05 mm	M2.5	strip
Gie-Tec 138049	M3	strip
apra M2.5, 5 mm × 1.5 mm	M2.5	strip
DIN 562 M2.5, 5.0 mm × 1.6 mm	M2.5	slide nut

Figure 19. Rail inserts

SCREW	
Lengths	6, 8, or 10 mm, measured under the head; each is the pick for at least one catalog rail (eis-reference)
Insert tap drill	2.5 mm, the Schroff figure
Head	Pan head with an H, Z, or hexalobular recess (ISO 7045:2011, ISO 14583:2011); at most 7.0 mm across (RAIL-010)
Finish	Zinc-plated steel, black-finished steel, or A2 stainless steel
Pick	The shortest length inside the window; where a catalog rail's seat is not published, the longest that does not bottom out through a 1.6 mm panel, then confirm three threads engage (RAIL-008)

The numbers are in `data/rail.json`, `data/insert.json`, and `data/screw.json`; `tools/rail.py`, `tools/insert.py`, `tools/insert_card.py`, and `tools/screw.py` check them and draw the cards. The catalog rail sections and inserts measured against these limits, and the screw that fits each, are in the eis-reference repository.

5.4 ENCLOSURES

The case a module screws into. An enclosure is made of rows; each row has a pair of rails with an insert in each, and usually a bus board behind the panels.

ROWS

An enclosure shall publish, for each row, its width in HP and the depth it keeps clear behind the panel's back face (ENC-001).

A row is 1U or 3U, matching the front panels it holds; a 6U case is two 3U rows. A row's usable width is a whole number of HP. 84 HP fits a 19-inch rack; wider rows, such as 104 HP, are the maker's choice.

FRAME

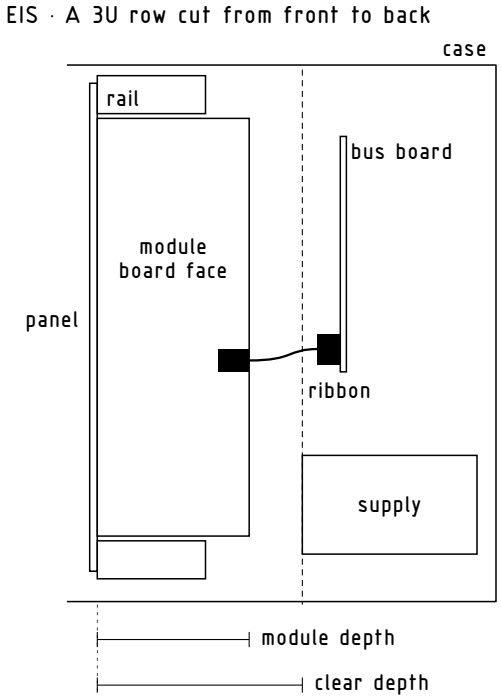
The frame is a 19-inch rack frame, which meets RACK-003 (5.1), or a desktop or portable frame with the same rows and hole span (5.3).

The front rails take the mounting screws of 5.3, whose length the enclosure publishes (RAIL-011). Other rails carry the bus board or stiffen the frame. The enclosure publishes which of its metal parts are bonded to one another and where its metalwork takes a bond to the row's 0 V (GND-005, 6.3): anodized rails and inserts lying in them are not bonded by their fit. Mains inlet, fusing, and the construction of a supply are outside EIS.

DEPTH

EIS recommends that a row keep at least 50 mm clear behind the panel's back face, the module depth 5.2.2 recommends. A rail of the recommended section (5.3) is 25 mm to 28.5 mm deep, front face to

back face. In the case catalog behind the eis-reference survey, 20 of 25 current cases give 50 mm somewhere in the row and 17 give it over the whole row; the shallow part is usually over the supply or the bus board.



Both depths are measured from the panel's back face.

The module publishes its width in HP and its depth (PANEL-003).

The enclosure publishes each row's width in HP and its clear depth (ENC-001): the least depth, across the row, to the nearest thing behind the panels. Here that is the supply; often it is the bus board.

A module fits a row when its depth is no more than the row's clear depth.

EIS recommends rows at least 50 mm clear and modules at most 50 mm deep.

Figure 20. A 3U row cut from front to back: module depth and clear depth

BUILT-IN SUPPLY AND BUS BOARD

An enclosure with a built-in supply is also a power supply, and one with a built-in bus board is also a bus board. Each built-in part claims its own role (4.1), and the enclosure's documentation carries what each publishes:

- a built-in supply publishes its rail ratings and its ripple and noise (PWR-002, SUP-001), meets SUP-002 to SUP-007 (6.2), and publishes how its 0 V meets protective earth (GND-003, 6.3);
- a built-in bus board publishes its totals and its per-header limit (PWR-002), which BUS-012 caps at 1.5 A per rail where it has PWR-BUS outlets.

EIS recommends that an enclosure publish, for each row, the dissipation it carries for a 10 °C rise above room temperature; Annex H gives the method.

The informative row budget is a planning table for one row: header count, bus and supply currents, and video sync distribution.

6.1 POWER ARCHITECTURE

EIS power comes in two *power interfaces*. A power interface is a set of rails with its own connectors, its own way of reaching a module, and its own limits:

- *PWR-BUS*, the bus: +12 V and −12 V, and optionally +5 V, that a power supply feeds through bus boards and power ribbons to each module's power header;
- *PWR-DC12*: nominal 12 V DC from an external adapter or a supply, which enters a product at a DC entry.

PWR-BUS is Core; PWR-DC12 is an optional interface (8.1). A product takes a power interface at an *entry* and gives it at *outlets*, and its claim file lists each (4.2). An interface's rules apply to a product that has an entry or an outlet of it; a passive module, with neither, owes none of them but BUS-011, which binds every module (6.4).

The designators follow one rule: the word after PWR names the interface's topology, and a number its rail voltage. *BUS*, the Eurorack bus, is defined by its header pinout rather than by one voltage, so it has no number; *DC*nn is a single nn V DC rail fed from an adapter, the trade's DC jack.

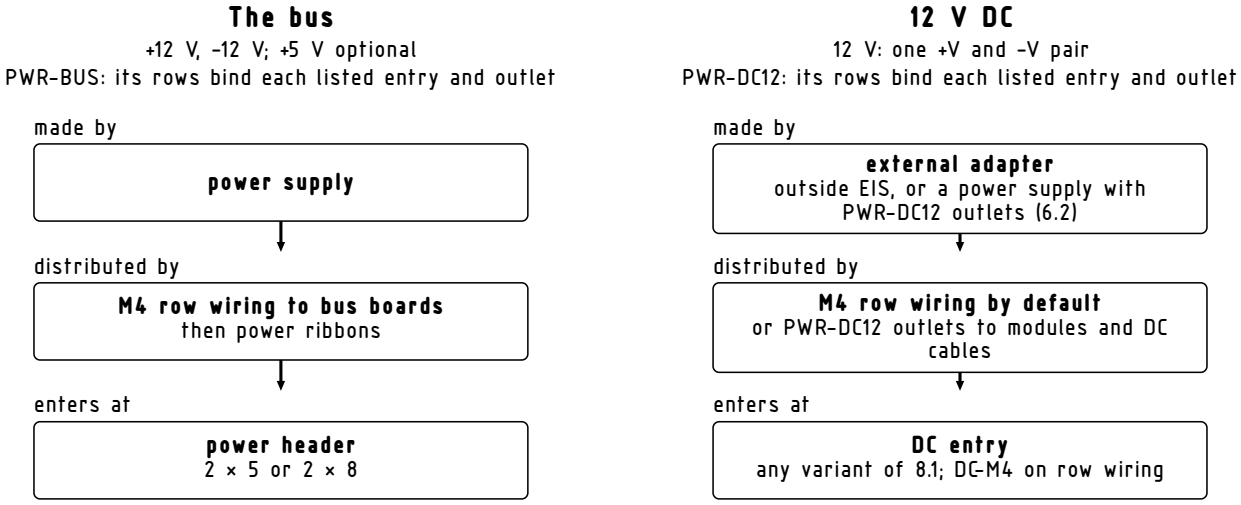
This clause, 6.2 (sources), and 6.3 (0 V) hold what both interfaces share. The bus has 6.4 to 6.6, and PWR-DC12 has 8.1. A maker's own power entry at other rails is outside EIS: the product names it in its claim file as an entry EIS does not cover, and it adds no requirement. Mains voltage, safety certification, and the internal construction of a supply are outside EIS.

POWER INTERFACES

INTERFACE	RAILS	MADE BY	DISTRIBUTED BY	ENTERS A PRODUCT AT	CLAUSES
The bus (PWR-BUS)	+12 V, −12 V; +5 V optional	power supply	M4 row wiring to bus boards, then power ribbons	power header, 2 × 5 or 2 × 8	6.4, 6.5, 6.6

INTERFACE	RAILS	MADE BY	DISTRIBUTED BY	ENTERS A PRODUCT AT	CLAUSES
12 V DC (PWR-DC12)	12 V: one +V and -V pair	external adapter, outside EIS, or a power supply with PWR-DC12 outlets (6.2)	M4 row wiring by default, or PWR-DC12 outlets to modules and DC cables	DC entry, any variant of 8.1; DC-M4 on row wiring	8.1

EIS · Power interfaces: where each is made, how it is distributed, where it enters



On every power interface a product publishes the current at each power entry (PWR-001) and at each outlet (PWR-002); it needs only one of its alternative entries connected (PWR-003) and a module never drives current back into one (PWR-004).

Every entry's 0 V, and the -V of a DC entry, is the product's one 0 V (GND-001).

Figure 21. The power interfaces: where each is made, how it is distributed, and where it enters a module

SOURCES, DISTRIBUTION, AND ENTRIES

On each interface, a *source* makes the power: a power supply, for a row or for the one product it is mounted on. *Distribution* passes it on without converting it. A product takes it at a *power entry*: a module's power header or its DC entry. A source or a distribution product delivers at *outlets*: a supply's output terminals, a bus board's headers, and the PWR-DC12 outlets (DC-BAR21 jacks or DC-VH2 headers) of a bus board, a module, or a supply. Between products, power travels by default on row wiring to M4 terminals; a power ribbon or a DC cable carries the last step to a module.

One product can sit on both interfaces:

- a power supply that takes PWR-DC12 at a DC entry and delivers the bus is a PWR-DC12 entry and a bus source;

- a dual-source module has a power header and a DC entry;
- a supply mounted on one product is an entry of the interface it takes and a source of the one it makes.

RULES FOR EVERY POWER INTERFACE

A product shall publish, for each power entry, the maximum current it takes on each rail at the entry's nominal voltage, stating 0 for a rail it does not draw (PWR-001). A power supply, a bus board, and any product with power outlets shall publish the maximum current it delivers on each rail, in total and at each outlet (PWR-002). The person assembling a system budgets a row with these figures (ASM-001).

A product whose power entries are alternatives, each able to power it alone, shall not require more than one of them to be connected at the same time (PWR-003); the installer connects one (ASM-003). Entries that feed different circuits, such as a DC entry for one board and the bus for another, are not alternatives, and the claim file says which the product needs.

A module shall not source current into a rail of any of its power entries (PWR-004). A module with its own +5 V regulator leaves pins 11 and 12 of its power header undriven, and a module with a DC entry does not feed its DC rail onto the bus.

Every power entry's 0 V, and the -V of a DC entry, is the product's one 0 V (GND-001, 6.3).

A row of modules is a large capacitive load on its source; a supply states the capacitance it starts into (6.2), and EIS recommends that a product limit the inrush its own decoupling draws.

ROW WIRING

Row wiring is the discrete conductors, not a power-interface connector, that join a power supply to its bus boards, linked bus boards to each other, and a case DC entry to the supply, bus board, or PWR-DC12 outlets it feeds. A bond of 0 V to the chassis or earth is not row wiring; it follows PWR-008.

The default. Row wiring on M4 terminals is how EIS carries power between products: from a supply to its bus boards, between linked bus boards, and from a case DC entry to the supply, bus board, or product with PWR-DC12 outlets that it feeds, which takes PWR-DC12

at a DC-M4 entry (8.1). EIS recommends row wiring for each of these connections, and an M4 terminal at each end of it. The other ways are alternatives: a supply output on a plug-and-socket harness, keyed against reversal (SUP-002), and PWR-DC12 on a DC cable into a plug-in DC entry variant (8.1). A power ribbon from a bus header, and a DC cable from a PWR-DC12 outlet, carry the last step to a module; they are not row wiring.

Terminals. Where a product takes or gives a rail or 0 V on row wiring, each terminal shall be an M4 screw, stud, or threaded standoff that clamps a ring terminal under a lock washer, rated for at least the current it carries, and the product shall publish the conductor sizes its terminals accept (PWR-005). That covers a supply's outputs, a bus board's input and its links, a DC entry panel's outputs to the supply, and the input of a product with PWR-DC12 outlets. A supply's terminal is marked with its rail or 0 V (SUP-003); EIS recommends the same marking on every other row wiring terminal.

Conductors. A row wiring conductor shall be insulated stranded copper rated 105 °C or more, with a crimped ring terminal at each end, of at least 18 AWG (16 AWG above 3 A, 14 AWG above 5 A, 12 AWG above 8 A, 10 AWG above 15 A), and shall carry no more than 30 A, a 0 V conductor carrying the larger of the +12 V and +5 V currents together and the −12 V current (PWR-006). A load above 30 A takes a second pair of conductors. A joint shall not rely on solder alone (PWR-006). A 0 V link may instead be a tinned copper braid with crimped or pressed ring ends, or a copper bar, of no more resistance (PWR-006). Metric wire meets the temperature rating as silicone (H05SJ-K) or 105 °C PVC; H05V-K and H07V-K are 70 °C wire and do not. Row wiring from a case DC entry carries what the adapter can deliver into a fault, not only the load: EIS recommends sizing it for the entry's published current, or fusing it at its conductor's rating. A wire nut, an insulation-displacement splice, a soldered strand under a screw, and a bare wire wrapped around a stud are not row wiring.

Resistance. Each row wiring conductor shall measure no more than 5 mΩ from ring terminal to ring terminal, and the 0 V conductor between a power supply and a bus board, or between linked bus boards, no more than any rail conductor beside it (PWR-007). The figure is Hinton Instruments' limit for supply cables, the place where one module's current couples into every other module's 0 V (Normative references). The table gives the longest conductor of each gauge that meets it, stranded copper at 1.05 times the ASTM B258 solid figure, allowing 0.25 mΩ for each crimp and its bolted

joint; a conductor measured at 5 mΩ or less conforms whatever its length.

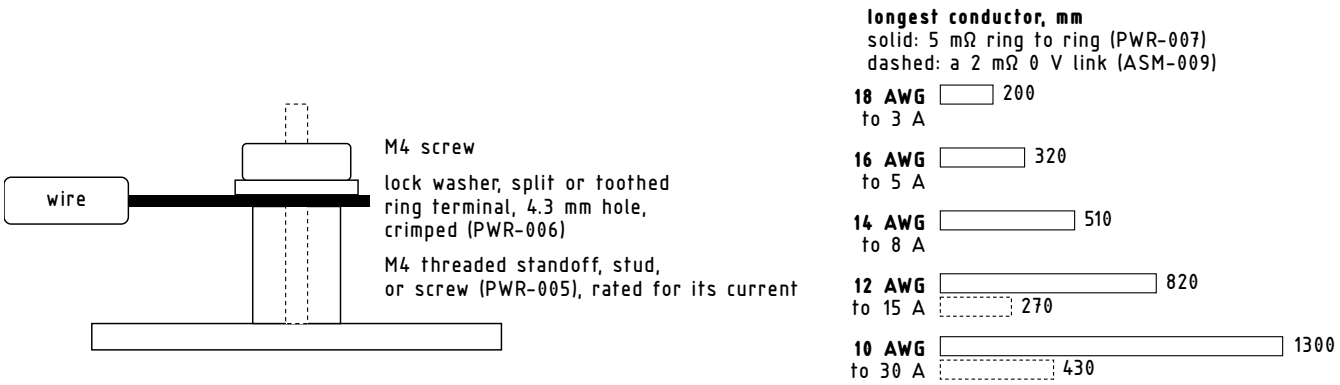
Bonds. Where a product bonds its 0 V to its chassis or to a protective-earth terminal, the bond shall be a conductor of at least 14 AWG, or copper of its own board of that section, landed by a ring terminal, a bracket, or a standoff on an M4 or larger stud or screw that presses metal GND-004 accepts under a toothed lock washer, or a bus bar of equivalent section (PWR-008). A DC entry panel whose board copper reaches its panel through brass brackets and ends at an M4 CHASSIS stud makes the bond that way (6.3).

An installer who joins a supply and bus boards from different makers wires them the same way (ASM-008, 9.1).

TERMINAL (PWR-005)	FOR EXAMPLE	RATED
threaded standoff, vertical, through-hole	Keystone 7795 (snap-in, M4 internal thread)	15 A
threaded standoff, right angle, through-hole	Keystone 7794 (press-fit) or 7769 (solder)	15 A
press-fit or THR power terminal	Würth Elektronik REDCUBE with M4 internal thread, such as WP-BUFU	the maker's rating, far above a row
screw and nut, or a stud, through a bus bar or a chassis	M4 screw, ISO 7045 or ISO 4762, with an ISO 4032 nut	the bar's section

CONDUCTOR (PWR-006)	OR METRIC	CARRIES AT MOST	LONGEST AT 5 mΩ (PWR-007)	LONGEST 0 V LINK AT 2 mΩ (ASM-009)	RING TERMINAL
18 AWG (0.82 mm2)	1 mm2	3 A	200 mm	—	red, 22 to 16 AWG
16 AWG (1.31 mm2)	1.5 mm2	5 A	320 mm	—	red, 22 to 16 AWG, or blue, 16 to 14 AWG
14 AWG (2.08 mm2)	2.5 mm2	8 A	510 mm	—	blue, 16 to 14 AWG
12 AWG (3.31 mm2)	4 mm2	15 A	820 mm	270 mm	yellow, 12 to 10 AWG
10 AWG (5.26 mm2)	6 mm2	30 A	1300 mm	430 mm	yellow, 12 to 10 AWG

EIS · Row wiring: a crimped ring terminal on an M4 terminal, and how far each gauge may run



The same terminal on a supply, a DC entry, and a bus board: one lug, one tool.

A row wiring conductor measures at most 5 mΩ from ring terminal to ring terminal, Hinton Instruments' limit for a supply cable, where one module's current couples into every other module's 0 V; the bars allow 0.25 mΩ for each crimp and its bolted joint. A measured conductor at or under the figure conforms whatever its length.

Figure 22. A crimped ring terminal on an M4 terminal, and the longest run of each gauge at 5 mΩ and at 2 mΩ

EIS recommends:

- an insulated or heat-shrink ring terminal sized to the conductor, with a 4.3 mm hole (M4 or #8), crimped with the ratchet tool its maker names;
- a split or toothed lock washer under the screw head or nut, or a screw with a captive one; at most two ring terminals on one terminal, back to back;
- terminals at least 14 mm apart, center to center, so that the widest ring a terminal accepts turns without touching its neighbor;
- a supply that ships its M4 screws and lock washers, and publishes their length and the torque for its terminals;
- stranded tinned copper, 105 °C PVC (UL 1015 at 600 V or UL 1569 at 300 V), or silicone (UL 3135) where the wire flexes;
- the supply placed close to the bus board's input, so that its conductors stay short, and the bus board's input near the middle of its headers;
- each rail conductor run together with its 0 V, bundled or twisted, to keep the loop small;
- a 0 V link (6.3) of 12 AWG or heavier, or a tinned copper braid or a bar of the same resistance (PWR-006), inside the 2 mΩ ASM-009 sets; the table gives the longest link of each gauge;

- red for +12 V, blue for −12 V, black for 0 V, and green-and-yellow only for an earth bond; EIS names no color for +5 V.

6.2 POWER SUPPLIES

A *power supply* is the source of a power interface: for a row, or for the single product it is mounted on, such as the bus made on the back of a module from a DC rail (6.1). A bus supply feeds the row's bus board with the rails of 6.4: +12 V and −12 V, and +5 V if it provides one. A supply may be built into an enclosure or sold on its own.

The rules of this clause bind every outlet of a supply, whatever its interface; the limits that differ by interface are tabulated under Output quality. A supply that takes 12 V DC at a DC entry also keeps the entry rules of 8.1; fed inside a case from a DC entry panel, its entry is DC-M4 on row wiring by default.

A SUPPLY OF THE DC RAIL

A power supply may provide the 12 V DC rail of 8.1 alongside or instead of the bus; it then has PWR-DC12 outlets, publishes the current of each outlet, and meets the outlet rules of 8.1 (SUP-009): an outlet to a module on a DC-BAR21 jack or a DC-VH2 header (DC-009), each protected separately (DC-012); an outlet to a bus board or to another distribution product's input is an M4 row wiring terminal by default (PWR-005), into that product's DC-M4 entry. Its claim file lists each outlet and each entry with its figures, including the DC entry of a supply fed from an external adapter; its claim line is `EIS draft, power supply`. Otherwise the 12 V of PWR-DC12 comes from an external adapter, which is outside EIS.

WHAT A SUPPLY PUBLISHES

A power supply shall publish its ripple and noise on each rail it provides, peak-to-peak, measured as stated under Output quality (SUP-001). It also publishes the current it delivers on each rail, in total and at each outlet (PWR-002, 6.1).

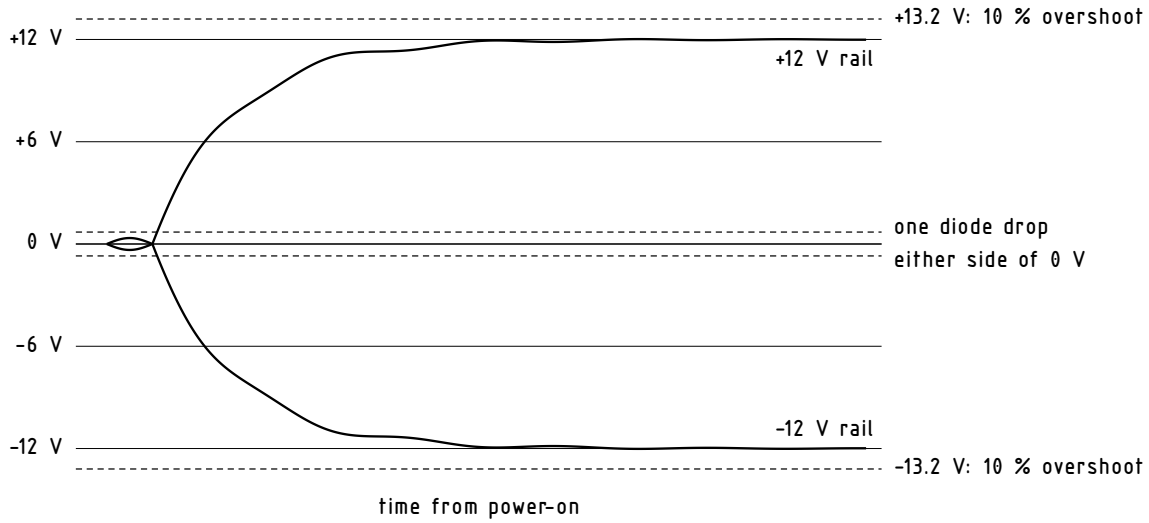
OUTPUT CONNECTOR AND PROTECTION

A supply's outputs to its bus boards are row wiring on M4 terminals by default, and EIS recommends them (6.1). An output on a plug-and-socket connector other than a power header, the alternative, such as a wire-to-board housing or a DC plug, shall not mate with reversed polarity, a power-header outlet meeting the marking and keying of 6.4 instead (SUP-002), since an unkeyed ribbon socket enters any header. An output on row wiring terminals, the M4 terminals of 6.1, cannot be keyed and is exempt; each such terminal shall be marked with its rail or 0 V (SUP-003).

Each output rail of a power supply shall stay within ±5 % of its nominal voltage at its output terminals, from the minimum load the supply publishes on each rail to its rated current, whatever the load on its other rails within those limits (SUP-010): a cross-regulated triple-output supply drifts out of it when one rail is lightly loaded, and then publishes the minimum load that holds it.

Each output rail of a power supply shall survive an indefinite short to 0 V without damage, and shall return to its rated output when the short is removed, after an input cycle if it latches off (SUP-004). During power-up, power-down, or a short on another rail, no output rail shall be driven more than 0.7 V toward the opposite polarity (SUP-005); a Schottky clamp across each rail holds it at rated current. At start-up, no output rail shall overshoot its nominal voltage by more than 10 % (SUP-006). EIS recommends that each rail also survive a short to another rail, and that a supply with +5 V survive +12 V forced onto +5 V, which a 16-pin ribbon reversed at the bus end does (6.4).

EIS · A supply's rails at power-up



At start-up no rail overshoots its nominal voltage by more than 10 % (SUP-006). During power-up, power-down, or a fault, no rail swings more than one diode drop toward the opposite polarity (SUP-005). The traces are illustrative.

Figure 23. The limits a supply's rails keep at power-up

A row is a large capacitive load, and a current limiter that cannot charge it within its on-time never starts. EIS recommends constant-current limiting, or a hiccup or foldback limiter whose maker states the capacitance it starts into, published with the supply's ratings. EIS recommends bringing the rails up in an order that avoids reverse stress on modules; SUP-005 bounds the reverse swing whatever the order.

OUTPUT QUALITY

Each output rail of a power supply shall have ripple and noise below the limit in the table below for its power interface, 150 mV peak-to-peak on PWR-BUS, measured as stated below (SUP-007):

INTERFACE	RIPPLE AND NOISE, PEAK-TO-PEAK	
The bus	below 150 mV	Most open-frame switching supplies meet it.
12 V DC	—	No limit: each product filters or regulates its DC rail (8.1); a supply publishes the figure (SUP-001).

EIS requires no particular topology. EIS recommends a setpoint within ±1 % and load regulation within ±1 % from 10 % to 100 %

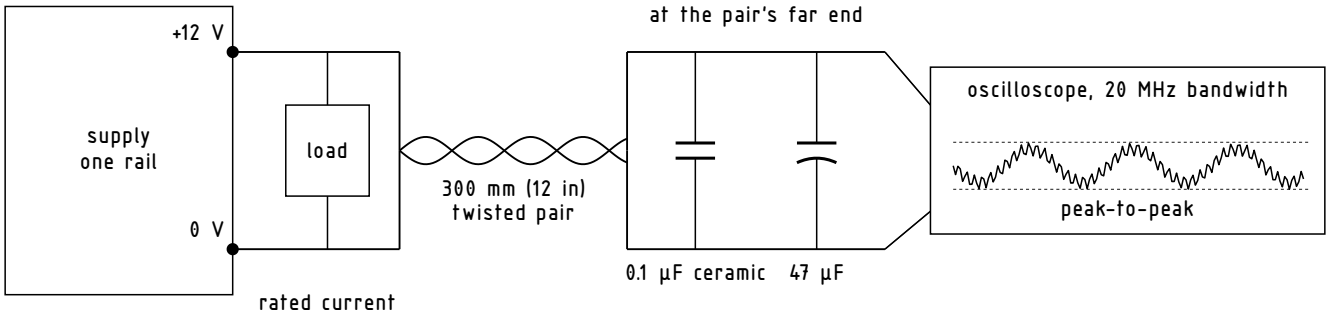
load. A linear or post-regulated supply is typically under 5 mV, which suits a row of modules with VIDEO ports.

Ripple and noise are measured peak-to-peak on each rail:

- every rail at its rated current;
- a 300 mm (12 in) twisted pair from the rail's output terminals, or from test points the product publishes;
- the pair terminated at its far end by a 0.1 µF ceramic capacitor in parallel with a 47 µF electrolytic;
- the probe across those capacitors with a short ground spring, at 20 MHz oscilloscope bandwidth.

This is the method of common supply datasheets, Mean Well's among them, so one maker's figure compares with another's; the pair's inductance against the capacitors is part of it.

EIS · Measuring ripple and noise



Every rail at its rated current; the pair runs from the output terminals, or from test points the product publishes, and the probe, with a short ground spring, sits across the capacitors at its far end, as common supply datasheets measure.

The supply publishes the peak-to-peak figure for each rail (SUP-001); every rail stays below 150 mV (SUP-007). A linear or post-regulated supply, typically under 5 mV, suits a row of modules with VIDEO ports.

Figure 24. How ripple and noise are measured

A SUPPLY FOR ONE PRODUCT

A power supply mounted on the product it powers shall publish the heat it dissipates at its rated output and how far it extends behind that product (SUP-008). Like every power entry, it publishes the current it takes at its input (PWR-001); for a linear regulator on the bus, that is its output current plus its own. A module sold with such a supply publishes the currents and the depth of the pair. A supply

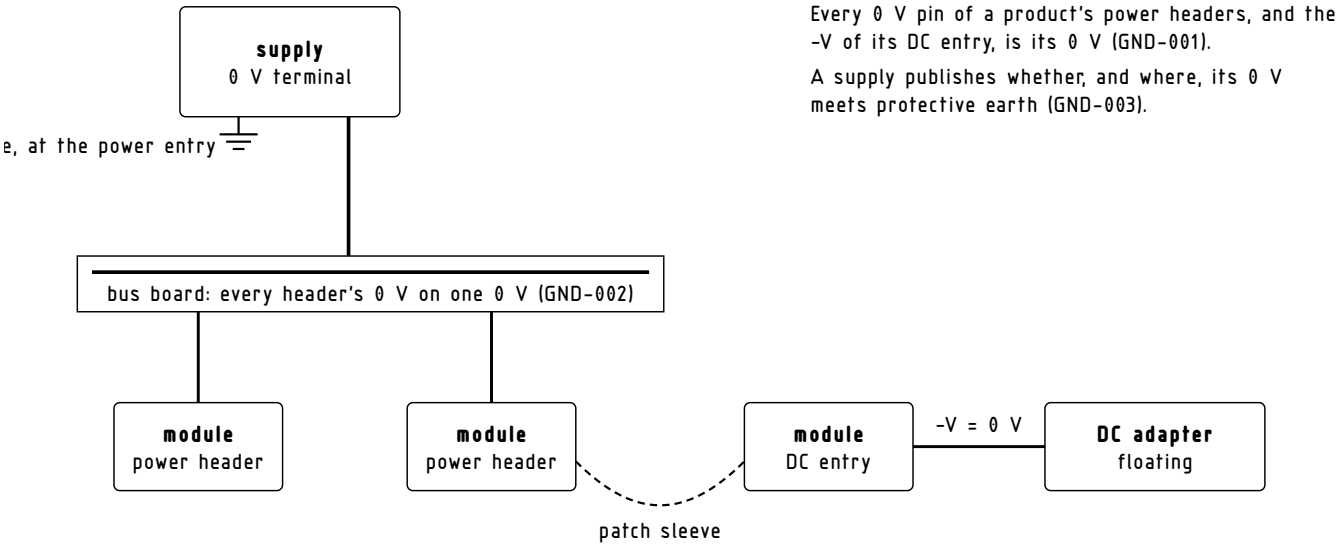
that takes the bus keeps the power-header rules of 6.4 as a module does (BUS-008, BUS-009, BUS-019).

EIS recommends that such a supply's board fit the outline of a 1U module board (5.2.2): a parallel board no taller than 21.10 mm, with the 1U mounting-hole span of 33.65 mm (PANEL-009) behind a 1U panel. The same supply can then be mounted as a 1U module in a row that has one, or behind the product it feeds.

6.3 GROUNDING AND 0 V

Every patch cable and every coaxial cable joins the 0 V of the two products it connects, so the products in a system share one 0 V whether or not anyone planned it. This clause makes that shared reference predictable: where 0 V runs in a row, across its power interfaces, how it meets protective earth, and how it reaches the next case.

EIS · Grounding: one 0 V for the bus, the DC rail, and the jacks; one chassis tie



Every 0 V pin of a product's power headers, and the -V of its DC entry, is its 0 V (GND-001).

A supply publishes whether, and where, its 0 V meets protective earth (GND-003).

Patch sleeves and coax shells join the 0 V of the products they connect. A second earth bond makes a loop: hum on audio, slow bars on a picture.

Figure 25. The 0 V of a row: one bond to earth, one reference for the bus, the DC rail, and the jacks

IN A ROW

A product shall connect every 0 V pin of its power headers, and the -V of its DC entry, to its 0 V (GND-001). The header's 0 V pins share the return current of all three bus rails, and a module that connects only some of them puts that current through fewer contacts. One 0 V gives a dual-source module one signal reference whichever entry is connected, and keeps a supply that takes PWR-DC12 and delivers the bus on one reference. An isolated power supply mounted on the product it powers joins its output 0 V to its input 0 V.

A bus board shall join the 0 V pins of every header to one 0 V that runs to the supply's 0 V terminal (GND-002).

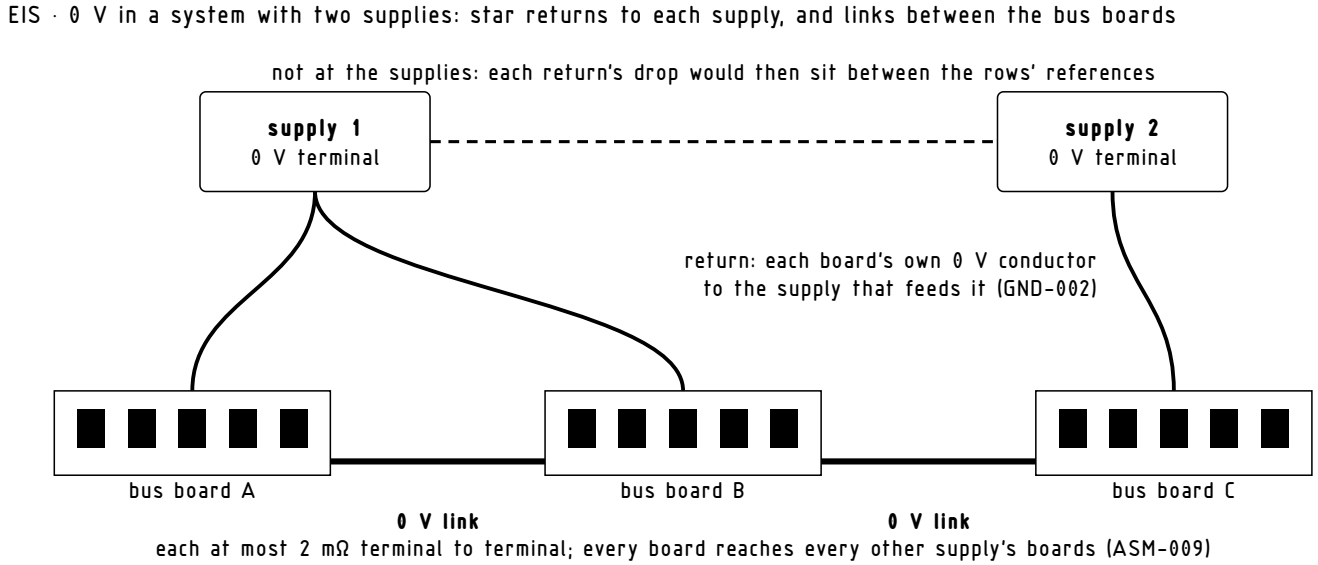
EIS recommends keeping any panel-mounted part whose body touches the panel free of a connection to the module's 0 V; an insulated jack (7.1) meets that.

RETURN AND REFERENCE

The 0 V of a row does two jobs, and EIS wires them differently.

- *Return.* Every module's current comes back to its supply through its bus board's 0 V and the board's 0 V conductor to that supply (GND-002). Each bus board has its own, a star from the supply, and never returns through another board: the drop on a return is that board's alone, and it does not move another board's reference.
- *Reference.* Every bus board's 0 V is the reference of every module on it, and a patch between two rows carries the difference between their references as signal. In a row with one supply, the board's copper and its return are the reference. With more than one supply, the returns end at different supplies, so where the bus boards of one enclosure are fed by more than one power supply, installation shall link their 0 V so that every bus board reaches, directly or through other boards' links, a bus board fed by each other supply, each 0 V link at most 2 mΩ terminal to terminal, and each bus board shall keep its own 0 V conductor to the supply that feeds it (ASM-009, 9.1). A chain of links along the rows does it; EIS recommends a grid, a link between every pair of neighbors, for three rows or more. The links hold every board at one potential whatever each return carries; the drop on a return then costs nothing but headroom.

A 0 V link is row wiring (6.1) on the boards' M4 0 V terminals; EIS recommends 12 AWG or heavier, or a braided strap or a bar, and the table in 6.1 gives the longest link of each gauge. A bus board may carry a 0 V strip, bare copper of its 0 V plane with a bus bar clamped on it, for the purpose (BUS-021, 6.5): its M4 holes, two rings on each, take its return and a link each way.



The return carries the current and may drop tens of millivolts; the links hold every board's 0 V at one potential whatever each return carries, so the drop costs headroom and nothing else. A bus board takes its links on its M4 0 V terminals or on a bare 0 V strip with a bus bar (BUS-021).

Figure 26. Two supplies and three bus boards: each board's return a star to its own supply, the boards' 0 V linked at most 2 mΩ

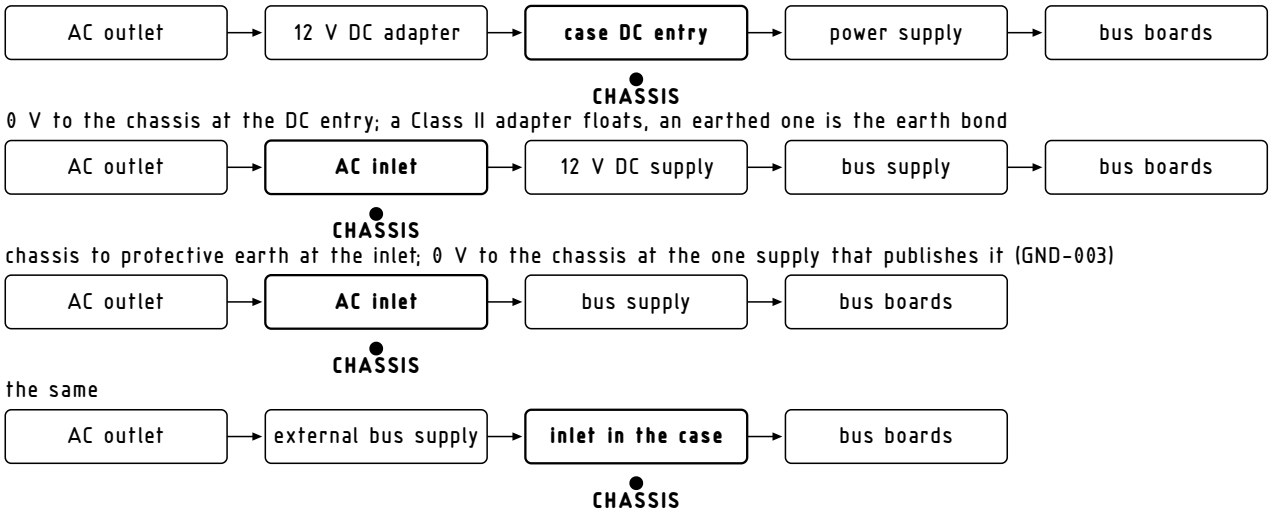
What a row's 0 V gains, in order: a bus board whose 0 V copper is a plane or a wide pour (6.5); 0 V links between the boards, which force one reference across supplies and across makers; a 0 V bar clamped on each board's bare 0 V strip, which takes the board's copper out of the path between its headers and its terminals; and the bar with the links.

ONE CHASSIS TIE

A system bonds its 0 V to the chassis, and the chassis to protective earth where it has one, at one point: the power entry of the case. A second bond gives mains-frequency and switching current a loop through 0 V, which shows as hum on audio and as slow horizontal bars on a picture.

POWER CHAIN	WHERE THE ONE TIE IS
AC outlet, 12 V DC adapter, case DC entry, power supply with a PWR-DC12 entry and the bus at its outlets, bus boards	At the case DC entry: 0 V to the chassis. A Class II adapter's output floats; an adapter whose -V is earthed, a three-pin one, makes the system's earth bond through its cord, and nothing else in the system bonds the chassis or 0 V to earth.
AC outlet, AC inlet in the case, 12 V DC supply, bus supply, bus boards	At the AC inlet: the chassis to protective earth; 0 V to the chassis at the one supply that publishes the bond (GND-003), or 0 V floats inside the earthed chassis when none does
AC outlet, AC inlet in the case, bus supply, bus boards	The same
AC outlet, external bus supply, its rails entering the case at row wiring terminals or an inlet outside EIS, bus boards	At that inlet: 0 V to the chassis; the external supply's earth, if any, is the system's

EIS · One chassis tie: where 0 V meets the chassis in each power chain



One point, the power entry of the case: a second bond gives mains-frequency and switching current a loop through 0 V. The product at the tie carries an M4 CHASSIS terminal for the case's straps; a case DC entry publishes whether it makes the bond (DC-014).

Figure 27. The four power chains and the one place in each where 0 V meets the chassis

A power supply publishes whether its 0 V output is connected to protective earth, and where (GND-003); a built-in supply publishes it in the enclosure's documentation. A product with a case DC entry publishes whether its 0 V is bonded to the chassis at the entry, and where (DC-014, 8.1). Mains safety, including the bonding of a metal case to protective earth, follows the safety standard the supply or case is certified to, not EIS.

EIS recommends that the product at the tie carry an M4 *CHASSIS* terminal, bonded to its 0 V or its earth in PWR-008's form and marked CHASSIS, so that straps to the case's other panels and metalwork land in one place; a DC entry panel is chassis where its screw heads press bare metal (Chassis continuity), and the terminal is for the parts that are not. A DC adapter whose output floats, the usual Class II desktop adapter, adds no second bond. EIS recommends that chassis ground carry only metalwork and screens, and bond to 0 V at the tie alone.

The mounting screws bond a front panel to the rails only where bare metal meets bare metal (Chassis continuity). With insulated jacks (7.1) the panel carries no signal return, and bonding the case metal to the supply's earth terminal, where it has one, is a shielding choice rather than a signal path.

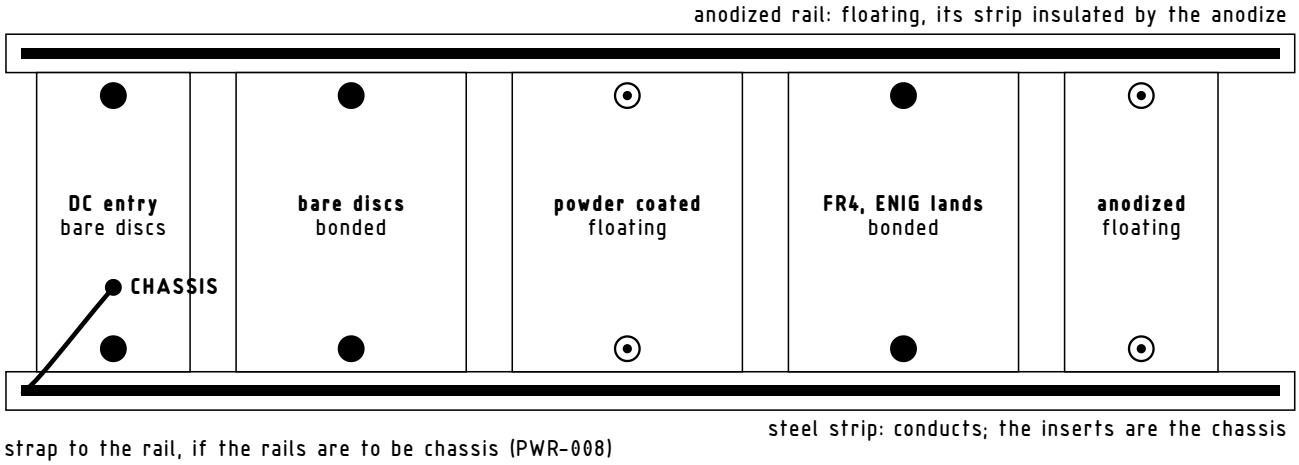
CHASSIS CONTINUITY

Everything metal in a case other than the product at the tie is bonded to the tie only through the fasteners that hold the case together, and a fastener bonds two parts only where it presses conducting metal on conducting metal. Where a product makes a bond of a metal part to its 0 V, to its CHASSIS terminal, or to another metal part, and publishes it as a bond, the fastener shall press bare, plated, or conversion-coated metal, or a copper land clear of solder mask, not paint, powder coat, anodizing, or solder mask, and the bond shall measure at most 100 mΩ, and a bond of 0 V to the chassis (PWR-008) at most 10 mΩ (GND-004). The bonds it means are the ones a product publishes: a PWR-008 bond, a panel published as bonded to the rails, a strap, a link. The four-wire check is not the protective-bonding test of a mains product's safety standard, which a mains product still passes. An enclosure shall publish which of its metal parts, rails, inserts, sides, rear, and lid, are bonded to one another, and where its metalwork takes a bond to the row's 0 V (GND-005).

SURFACE UNDER THE FASTENER	BOND
Bare aluminum, brushed or machined, or a masked disc in a coated panel	Yes; a toothed lock washer keeps it under 5 mΩ as the oxide grows
Aluminum with a chromate conversion coating (MIL-DTL-5541 Type II, trivalent, Class 3; Type I is hexavalent and restricted by RoHS)	Yes; the coating is made for it and reads as bare

SURFACE UNDER THE FASTENER	BOND
Anodized aluminum, any type, on a face or in a hole bore	No; a screw in a hole tapped after anodizing conducts through its thread alone
Painted or powder-coated aluminum, including the hole bore	No
Zinc-plated or stainless steel, brass, nickel- or tin-plated metal	Yes
Copper land on an FR4 panel finished ENIG, immersion silver, or HASL	Yes
Copper under solder mask, OSP, or bare copper with no finish	No; mask and OSP are films, and raw copper oxidizes

EIS · Chassis continuity: a part is bonded only where a fastener presses metal that conducts



A bond presses metal that conducts and measures at most 100 mΩ (GND-004); an enclosure publishes which of its parts are bonded and where a bond lands (GND-005). In the common wooden case the chassis is the strips and the bonded panels; the rails float until a bare pad or a strap joins them.

Figure 28. A row from the front: anodized rails floating, steel strips and bare-disc panels bonded, a coated panel floating, a strap from the CHASSIS stud

A joint either conducts, at a few milliohms, or it does not, at megohms, and no finish is conductive enough to carry a bond through it. The 100 mΩ figure is not a performance limit but a pass mark: the model in the eis-reference bonding page puts every metal-to-metal joint under 50 mΩ after years in a case, most under 10 mΩ, and every finished joint open. What a bond does for static, leakage, and interference depends on its length and width, not on its milliohms; what it needs is to exist.

EIS recommends:

- that a case bond every part a hand or a cable can reach: in the common wooden case with anodized rails and steel inserts the chassis is the inserts and the panels, and the rails float unless a bare pad or a strap joins them;
- that a part whose every path to the tie crosses a surface that does not conduct, or a loose fit such as an insert lying in an anodized groove, get a bare pad at one fastener, a conversion coating in place of anodize, or failing those a strap of PWR-008's form to the CHASSIS terminal or to a part already bonded, by the shortest route;
- that a module whose panel is to be chassis leave its front face bare under each mounting-screw head, a 7 mm disc at each hole on a coated panel or a finished copper land on an FR4 one; a coated panel with no bare spot is held by its screws and bonded by nothing;
- that a bond be checked four-wire at 1 A or more after assembly, from the CHASSIS terminal to the part.

BETWEEN CASES

A patch cable or a VID-75 cable between two cases joins their 0 V through its sleeve or shell: a patch jack's sleeve is 0 V, and so is a VID-75 jack's shell (V75-002). A loop through two earth bonds shows as hum on audio and as slow-moving horizontal bars on a picture. EIS recommends:

- that the cases of one system take their 0 V from supplies that are all bonded to protective earth at the same outlet strip, or all floating;
- that a system spread over several cases, each with its own supply, join their bus boards' 0 V with a 0 V link, 0 V terminal to 0 V terminal, rather than through signal cables alone: 10 AWG or heavier, as short as the cases allow, and at most 2 mΩ where it can be, which on 10 AWG is about 0.44 m; and three or more cases as a grid rather than a chain, as Hinton Instruments' ZeroVolt link does with heavy cable and high-current connectors. ASM-009's 2 mΩ binds inside one enclosure, where a link that short can always be run.

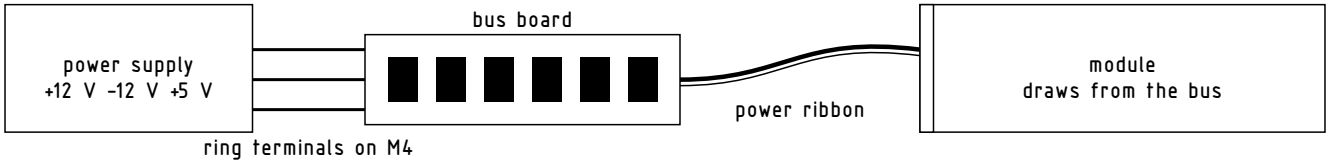
Annex H turns the currents published under 6.1 into the heat of a row.

6.4 THE BUS

The bus (PWR-BUS) is the power interface most Eurorack rows are built on: +12 V and −12 V, and optionally +5 V, made by a power supply, carried by bus boards and power ribbons, and taken by a module at its power header. A product that takes the bus at a power header owes the rules of a PWR-BUS entry, and one that gives it at outlets the rules of a PWR-BUS outlet; a product with neither, such as a passive module, owes nothing in this clause or the two that follow except BUS-011, which binds every module (6.4).

This clause defines the rails, the power header with its pinout, marking, and keying, and what a module owes at its header. 6.5 adds the bus board and the ribbon, and 6.6 the CV and gate lines.

EIS · From the supply to the module: what each part owes



Power supply
Publishes each rail's rating (PWR-002) and its ripple and noise (SUP-001), below 150 mV (SUP-007).

Each rail within ±5 % (SUP-010); survives a short (SUP-004); at most 0.7 V reversed (SUP-005); overshoot ≤ 10 % (SUP-006).

M4 terminals for ring terminals (PWR-005), each marked with its rail (SUP-003).

Bus board
+12 V and −12 V, and optionally +5 V, at every header (BUS-001).

Publishes its rail totals and the limit per header (PWR-002), at most 1.5 A per rail (BUS-012).

A link joins CV to CV and gate to gate (BUS-014).

Ribbon
At most 400 mm, at least 28 AWG (BUS-015).

Marked conductor on −12 V (BUS-004); keyed socket (BUS-005).

Module
Draws only ±12 V, and +5 V if it needs it (BUS-006).

Publishes its maximum current on each rail (PWR-001).

At most 1.5 A per rail through one header (BUS-008); never feeds a rail (PWR-004).

Survives a reversed ribbon (BUS-009).

The installer adds a module only while each rail's sum fits the bus board and the supply (ASM-001).

Figure 29. From the supply to the module: what each part owes

RAILS

The bus shall provide +12 V and −12 V, and may provide +5 V, at every power header (BUS-001).

HEADER AND PINOUT

A power header on a module or a bus board shall be a 2 × 5 or 2 × 8 pin header on a 2.54 mm grid, and a power cable shall end in IDC ribbon sockets that mate it (BUS-002). A power header on a module, a bus board, or a cable shall follow this pinout (BUS-003):

PINS	10-PIN HEADER	16-PIN HEADER
1, 2	−12 V	−12 V
3 to 8	0 V	0 V
9, 10	+12 V	+12 V
11, 12	—	+5 V
13, 14	—	CV
15, 16	—	Gate

Some community tables give a different order, with +12 V on pins 7 and 8 and +5 V on pins 15 and 16. A cable or bus board made to such a table puts +12 V on a module's 0 V pins.

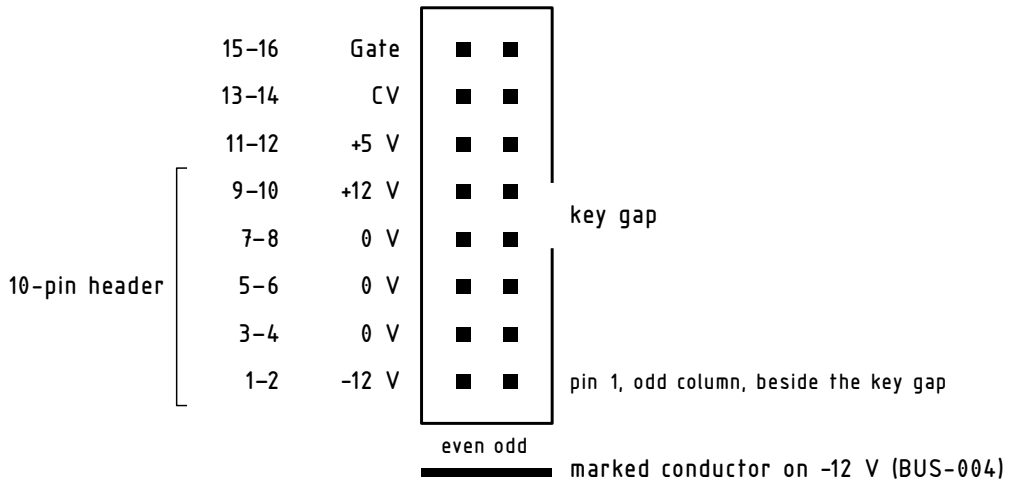
A module need not use the CV and gate lines; their levels and the rules for a module on them are in 6.6.

MARKING AND KEYING

The marked conductor of a power ribbon cable shall be −12 V, and on a module, a bus board, or a power supply it shall lie at the −12 V end of the header (BUS-004). A module, a bus board, and a power supply shall mark the −12 V end of each power header on the board (BUS-019), so that an unshrouded header can be oriented by eye at both ends.

A shrouded power header on a module or a bus board shall be keyed so that, viewed from the mating side with the −12 V end at the bottom, the key gap is on the right, and a keyed cable socket shall match it (BUS-005). The figure below is the reference view, and every header drawing uses it: pins 1 and 2 at the bottom, the gap centered in the right-hand wall. Shrouded headers in the field are keyed both ways, so a keyed cable from a conforming product enters a conforming bus board and may not enter another.

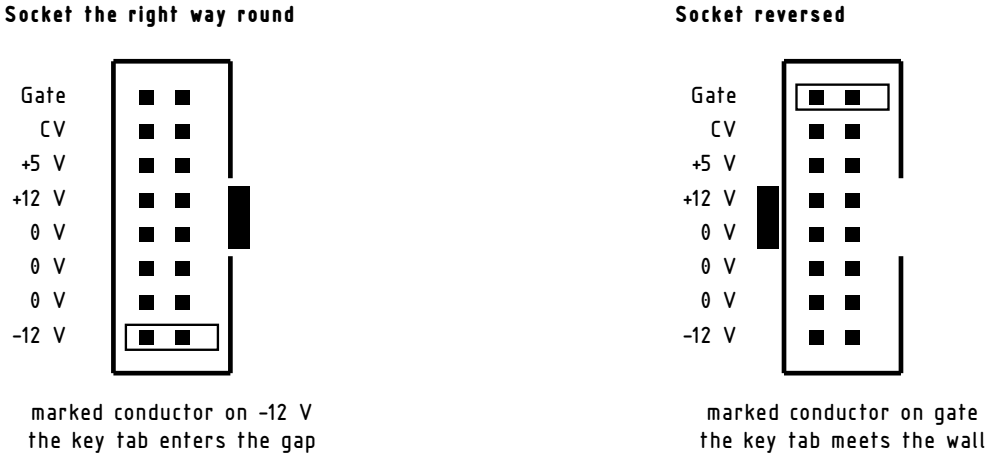
EIS · Power header, 16-pin, from the mating side



The pinout follows BUS-003 and the key gap BUS-005. A module that uses neither +5 V nor bus CV or gate may use the 10-pin header (BUS-007).

Figure 30. The 16-pin power header from the mating side

EIS · The marked conductor and the shroud key



Seen from the mating side with the –12 V end at the bottom, the shroud's key gap is on the right (BUS-005). On a module, a bus board, and a ribbon, the marked conductor is –12 V and points to the –12 V end of the header (BUS-004).

A cable that comes with a module is keyed, so it enters a shrouded header only the right way round (BUS-010). An unshrouded header cannot stop a reversed socket, so every module also survives one (BUS-009).

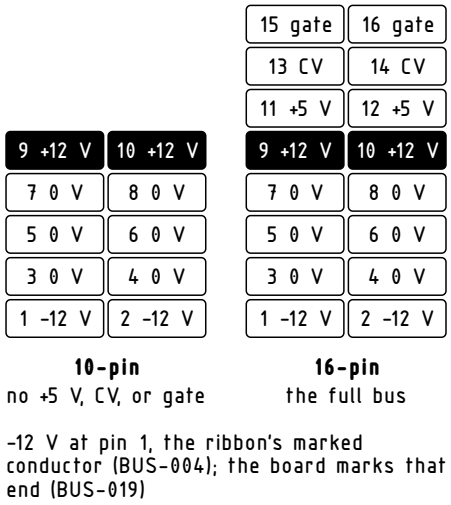
Figure 31. The marked conductor and the shroud key: a socket that fits and a reversed one

A MODULE ON THE BUS

A module powered from the bus shall draw only +12 V and −12 V, and may also draw +5 V (BUS-006). A module that uses neither +5 V nor bus CV or gate may use the 10-pin header (BUS-007). Like every power entry, it publishes its current on each rail (PWR-001).

A module or a power supply shall not draw more than 1.5 A on any rail through one power header (BUS-008), the charging of its decoupling at power-up excluded: each rail has two IDC contacts rated 1 A, and through a short ribbon they share the current up to about 2:1, so 1.5 A keeps the busier contact at its rating. A module that needs more uses a second header or a DC entry.

EIS · Module power entry: what a module may draw, and through which header



- Draws only +12 V and −12 V, and may draw +5 V (BUS-006).
- The 10-pin header is enough when the module uses neither +5 V nor bus CV or gate (BUS-007).
- At most 2 A on any rail through one header (BUS-008), about 1 A on each of its two IDC contacts; a module that needs more takes a second header or a DC entry.
- Never sources current into a bus rail (PWR-004).
- Survives a reversed ribbon (BUS-009) and ties every 0 V pin to its 0 V (GND-001).
- Another header on the module does not mate a power ribbon, or survives one (BUS-011).

Figure 32. What a module may draw, and through which header

A module or a power supply shall tolerate reverse polarity at its power header without damage (BUS-009): a ribbon fitted backwards is the commonest field fault. Reversed at the module end it puts −12 V where +12 V belongs and the reverse, which a module survives with series diodes or a reverse-blocking regulator. Reversed at the bus end, a 16-pin ribbon also joins bus +12 V, +5 V, and CV through the module's 0 V pins, for every module on the board; the module cannot prevent that, and 6.2 recommends a supply that survives it. EIS covers only the pinout above and a reversed ribbon; any other voltage on these pins is outside EIS.

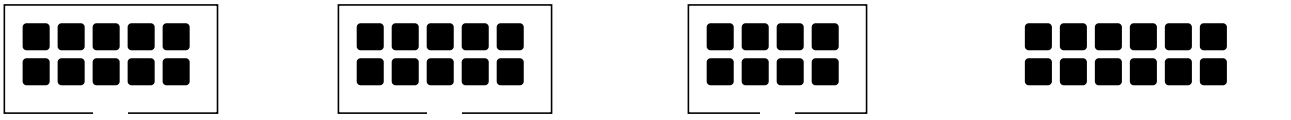
A bus cable supplied with a module shall be keyed so that it enters a shrouded header only with the marked conductor on −12 V (BUS-010). On a bus board whose shroud is keyed the other way, outside EIS, the installer fits an unkeyed cable with the marked conductor on −12 V.

OTHER HEADERS

A header on a module that is not its power header shall either not mate a Eurorack power ribbon socket or tolerate one fitted to it, either way round, without damage (BUS-011). A header of a different pitch or connector family, or a shrouded header too small for the socket, meets it by not mating; a 2.54 mm header a ribbon socket fits, shrouded or not, meets it only by surviving a ribbon either way round, since an unkeyed socket enters any shroud; Annex G covers expanders and links.

Expander and link headers are often 2 × 5 or 2 × 8 pin headers on the same grid, and a power ribbon fitted to one puts ±12 V on its signal pins. A 2 × 7 header mates a 2 × 5 socket as readily as a 2 × 5 header does, so the rule reaches any rear 2.54 mm header, such as an expander link (Annex G).

EIS · An expander header beside the power header



A header that is not the power header either does not mate a power ribbon socket or survives one fitted to it, either way round (BUS-011).

A different pitch or connector family, or a shrouded header too small for the socket, meets the first; protection on every pin meets the second.

Figure 33. Expander headers beside the power header: one a power ribbon fits, one it cannot, and one that must survive it

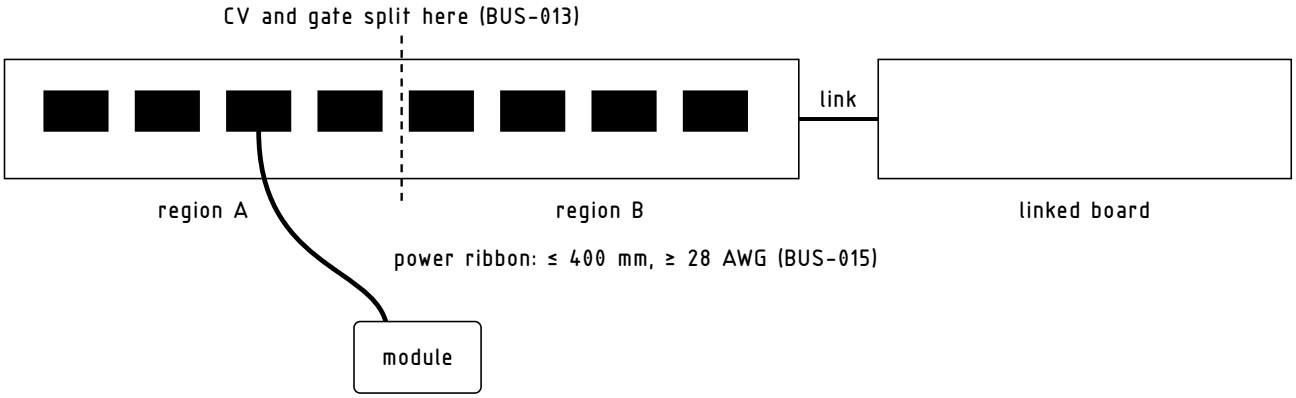
6.5 BUS BOARDS

The board in a row that carries the bus from the supply to the modules that take it at a power header. A row with the bus has one or more behind the panels, and an enclosure may build them in. Every header on a bus board is an outlet of the bus and meets 6.4: the rails, the header form, the pinout, the marked conductor on −12 V, and the shroud key.

CAPACITY

A bus board publishes its maximum current on each rail, in total and at each header (PWR-002). The per-header limit a bus board, a built-in bus board of an enclosure, or a power supply publishes for its power-header outlets shall not exceed 1.5 A per rail (BUS-012), the module limit of BUS-008.

EIS · Bus boards: published totals, the per-header limit, regions, and links



Publishes its maximum current on +12 V, −12 V, and +5 V, in total and per header (PWR-002), never more than 2 A per rail (BUS-012).

A link joins CV to CV and gate to gate (BUS-014); every header's 0 V runs to the supply's 0 V (GND-002).

Figure 34. A bus board: published totals, the per-header limit, regions, and a link

LINKS AND CV AND GATE REGIONS

A bus board may split CV and gate into two regions (BUS-013). A bus board that splits CV and gate into regions shall mark on the

board, and publish, which headers lie in each region (BUS-022). EIS recommends that a module publish whether it can transmit bus CV or gate. A link between two bus boards shall join CV to CV and gate to gate (BUS-014). How many modules may transmit on a line is a rule for assembling a system.

The board's supply input and its links to other bus boards are row wiring by default, and EIS recommends it (6.1): M4 terminals that take ring terminals (PWR-005), on conductors of at most 5 mΩ (PWR-007), and its 0 V runs to the supply's 0 V terminal (GND-002). An input that mates a supply's keyed plug-and-socket harness (SUP-002) is the alternative.

EIS recommends that the 0 V copper from the board's 0 V terminal to its farthest header measure under 10 mΩ, a plane or a wide pour rather than a trace, and that the board take at least two 0 V links, on a second M4 terminal or a bus bar. The row wiring and the board carry the return current of every module on the board; a power ribbon carries the current of the modules on its sockets, through about 25 mΩ of 0 V at its 400 mm limit (BUS-015), its six 28 AWG conductors and the header contacts at each end.

A 0 V STRIP AND BUS BAR

A bus board may carry a 0 V strip: a band of its outer-layer 0 V plane left bare of solder mask along the board's length, with plated holes at its mounting-hole positions, on which a 0 V bus bar is clamped by screws through the bar and the holes; the strip's end holes take M4, and a ring terminal under an M4 screw of the strip or the bar is a 0 V terminal of the board (BUS-021). The bar presses on the copper itself, with nothing between them but the finish, so the board's 0 V is the bar's the whole length of the board; the strip's M4 holes, two rings on each, give a board in the middle of a chain the positions one stud cannot, its return and a link each way (6.3). Without a bar the strip's M4 holes are still the board's link points.

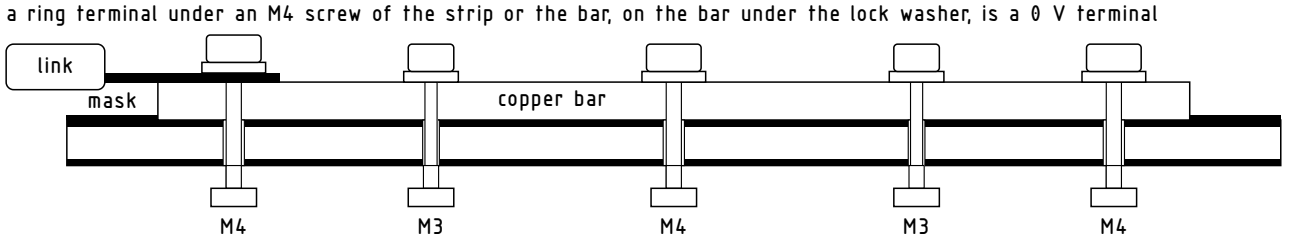
EIS recommends:

- a strip at least 6 mm wide the full length of the board, on the plane's layer, finished as the board's pads are, beside the mounting holes rather than over them, with a plated M3 hole at every mounting-hole position, M4 at the two ends, and one more M4 position near the middle of a board longer than 42 HP;

- a copper bar, C110 or C101, no wider than the strip and under 0.5 mΩ end to end; the table gives the longest bar of each section. Brass is about four times the resistance and is not recommended. The bare strip alone, 70 µm (2 oz) copper 6 mm wide, is about 41 mΩ/m; the bar brings the board's 0 V under 1.5 mΩ/m, and under 1 mΩ/m from 6 × 3 mm up;
- a screw with a lock washer at every strip hole, torqued as the mounting screws are, so the joint stays under 0.1 mΩ for the life of the case; a ring terminal lands under the screw head, on the bar;
- the strip and the bar marked 0 V.

COPPER BAR	SECTION	RESISTANCE	LONGEST BAR AT 0.5 mΩ
6 × 2 mm	12.0 mm2	1.44 mΩ/m	340 mm
6 × 3 mm	18.0 mm2	0.96 mΩ/m	520 mm
6.35 × 3.18 mm (1/4 × 1/8 in)	20.2 mm2	0.85 mΩ/m	580 mm
6 × 4 mm	24.0 mm2	0.72 mΩ/m	690 mm
6 × 5 mm	30.0 mm2	0.57 mΩ/m	870 mm

EIS · A 0 V strip and bus bar: the bar clamps on the bare copper of the board's 0 V plane



The bar presses the copper itself with nothing between them but the finish, so the board's 0 V is the bar's for the whole board (BUS-021). The bare 2 oz strip alone is about 41 mΩ/m; a 6 × 3 mm copper bar is under 1 mΩ/m. The strip's M4 holes, two rings on each, give a board in the middle of a chain the positions one stud cannot: its return and a link each way.

Figure 35. A bus board cut along its 0 V strip: the bare band of the plane, the bar clamped on it by a screw at every hole, a ring terminal under one screw

A set of bus bars, or a flying bus of row wiring, that feeds modules through cables ending in power headers or ribbon sockets is a bus

board for EIS: it meets this clause and 6.4, with its M4 positions as its terminals.

DISTRIBUTION ON A BUS BOARD

A bus board may also distribute a DC rail or the video sync behind the panel; it then meets the rules of what it carries: the PWR-DC12 outlet rules of 8.1, or the video sync ports of 8.2 (BUS-020).

- It takes PWR-DC12 by default at a DC-M4 entry, on row wiring from the case DC entry (8.1).
- Its PWR-DC12 outlets are those of 8.1, each protected (DC-009, DC-012).
- As a video sync distributor, it takes the video sync at a COAX-IN and gives each module a buffered copy at a COAX-THRU (8.2).

The claim line is `EIS draft, bus board` whatever it carries (4.2), and the claim file lists the outlets and ports. A board that carries no bus at all, only a DC rail or the video sync tree, is still a bus board, with no PWR-BUS outlets. Everything on the board shares its one 0 V (6.3).

POWER RIBBON CABLES

A power ribbon from a bus header to a module shall be no longer than 400 mm and shall use conductors of at least 28 AWG (BUS-015), the conductor of standard 1.27 mm pitch ribbon. A longer or thinner ribbon drops more at the header limit, and the drop comes off the module's rails: at 28 AWG (0.21 Ω/m), a 400 mm ribbon carrying 1.5 A on a rail drops about 65 mV in that rail's two conductors and about 30 mV more in their contacts at the two ends, about 95 mV; the 0 V return, six conductors and their contacts, about 25 mΩ, adds about 40 mV per 1.5 A it returns, up to about 75 mV with +12 V and +5 V both at the limit. A power ribbon cable sold on its own meets the marking and keying of 6.4 (BUS-004, BUS-005). The figures are in `data/power_ribbon.json`.

6.6 BUS CV AND GATE

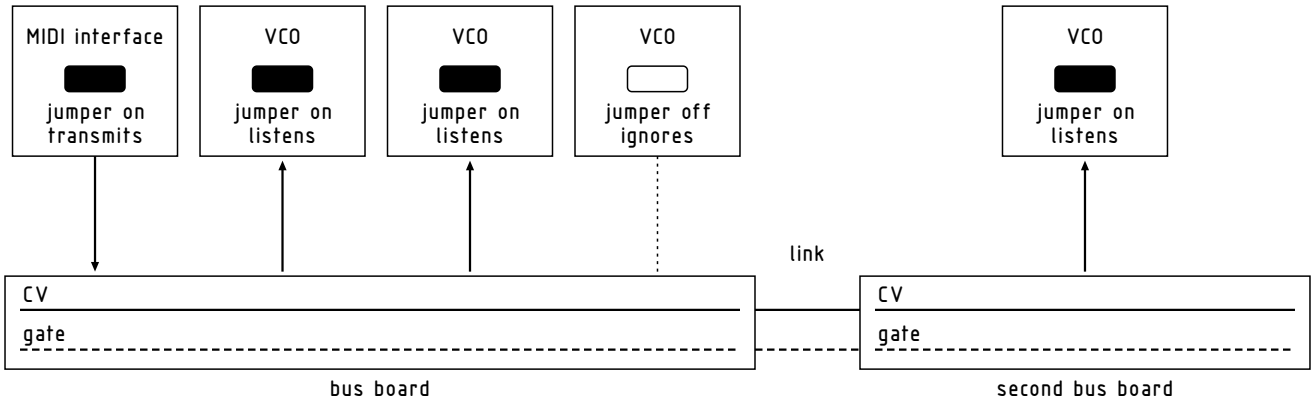
The CV and gate lines of the 16-pin power header (6.4): when a module may use them, and their levels. Both follow A-100 practice.

A module shall listen to or transmit bus CV or gate only when a jumper or switch on the module is set to do so (BUS-016). A module that drives or receives bus CV shall meet the *BUS-CV* limits below (BUS-017), and one that drives or receives bus gate shall meet the *BUS-GATE* limits (BUS-018). At most one module transmits on each line, across linked bus boards (ASM-002). The patch classes are in 7.2.

- *BUS-CV* is 1 V/octave pitch CV, with the scale of *PITCH*, from one transmitter, such as a MIDI interface or a keyboard controller, to the oscillators that listen. It is not general control CV: an LFO or an envelope on it would detune every listening oscillator. The transmitter drives from an op-amp output through at most 100 Ω and holds 1.00 V/octave within ±0.3 % of scale at the header into 10 kΩ, ten listeners; each listener presents at least 100 kΩ.
- *BUS-GATE* is a 0 / +5 V gate that keeps the *GATE* contract: an output high at +4 V to +12 V and low at +0.5 V or less, and a listener that reads +3 V or more as high and +1 V or less as low. The transmitter drives through at most 2 kΩ, high at +4 V or more at the header into 4.7 kΩ, ten listeners; each listener presents at least 47 kΩ.

The lines are multi-drop, so the source impedance matters: ten listeners at 100 kΩ each load a line with 10 kΩ, and a 1 kΩ source into that load loses 9 % of scale, nearly an octave at the top of a 10 V range. Even 100 Ω loses 1 % into that load, so a transmitter meets ±0.3 % only by taking its feedback after the resistor or by using a smaller one; EIS recommends at most ten listeners on a line (9.2).

EIS · Bus CV and gate: one transmitter, many listeners



At most one module transmits on each CV line and one on each gate line, across linked bus boards (ASM-002); a link joins CV to CV and gate to gate (BUS-014), so linked boards share one transmitter.

A module listens or transmits only when its jumper or switch says so (BUS-016). Bus CV is 1 V/octave pitch CV (BUS-017); bus gate is 0 / +5 V, high at +3 V or more (BUS-018).

Figure 36. One transmitter and several listeners on linked bus boards

CLASS TABLE

CLASS	CONNECTOR	COUPLING	NOMINAL	THRESHOLDS	CLASS CEILING	SOURCE Z	LOAD Z
BUS-CV	16-pin Eurorack bus (CV net)	DC	1.00 V/octave pitch CV (bus CV), ±0.3 % of scale, from one transmitter	—	±12 V	≤ 100 Ω	≥ 100 kΩ per listener
BUS-GATE	16-pin Eurorack bus (Gate net)	DC	0 / +5 V gate (bus gate): output high +4 V to +12 V, low ≤ +0.5 V, from one transmitter	Listener reads high at ≥ +3 V, low at ≤ +1 V	±12 V	≤ 2 kΩ	≥ 47 kΩ per listener

7.1 SIGNALS

How a module declares what each port carries, and the rules every patch jack follows whatever it carries.

CLAUSE	APPLIES TO	COVERS
7.2 Signal classes	Every module with a patch jack	The seven signal classes, AUDIO, CV, VIDEO, PITCH, GATE, TRIG, and CLOCK, and their ranges

CLAUSE	APPLIES TO	COVERS
7.3 Video signals	Every module with a patch jack	VIDEO on patch jacks: levels, impedances, path kinds, and bandwidth
8.2 Video on 75 Ω coaxial jacks (VID-75)	A product that has it	The 75 Ω coaxial interface: the video sync ports COAX-IN, COAX-OUT, COAX-THRU, the video sync tree, and the coaxial cable
8.3 Video timing	A product that has it	The formats a video sync port lists
Annex C	Informative	Names for ports that are not patch jacks

PORT LIST

A module shall publish a port list naming, for every port, its signal class or `unclassified`, and for a video sync port its mode (8.2) (SIG-001). A module with no ports publishes an empty list. The port list goes in the manual, on the product page, or in a claim file. For each port it gives:

- its direction: in, out, or in_out for a port that is both, such as a bidirectional expander link;
- its class, or `unclassified`;
- the range it claims, when that is not the class default (7.2);
- for a COAX-IN or COAX-OUT, the formats it locks to or generates (8.3).

A port that claims a class meets that class's limits, in 7.2, and VIDEO's interface in 7.3.

A port that is neither a patch jack nor a video sync port, such as a coaxial picture jack, a line audio port, or MIDI, is listed as `unclassified` or by its Annex C class. EIS places no requirement on it beyond what this clause says of every jack. Its class is no patch class (7.2). EIS recommends that a 3.5 mm audio socket on the panel withstand a mono patch plug (patch safety).

EIS recommends labeling each port with its class, on the panel or in the manual.

PATCH SAFETY

These requirements apply to every patch jack on a module, whatever its class:

- A patch input shall withstand ±12 V indefinitely (SIG-002).

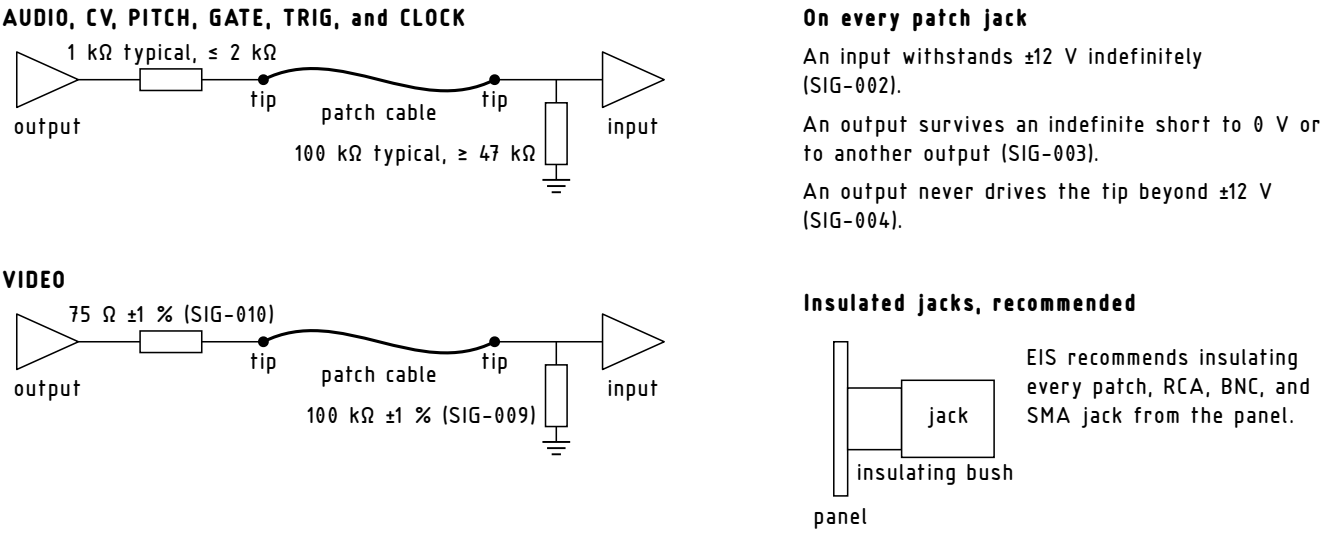
- A patch output shall withstand an indefinite short to 0 V or to another patch output (SIG-003).
- A patch output shall not drive the patch tip beyond ±12 V (SIG-004).

The ±12 V is the rails' nominal figure, applied from a source of 1 kΩ or less. A supply's 10 % start-up overshoot (SUP-006) is a rail figure: no conforming output drives a tip beyond ±12 V while its rails are anywhere inside the supply's limits.

EIS recommends:

- that a patch input withstand ±15 V, the rails of the ±15 V systems a patch cable can reach through an adapter;
- that every other 3.5 mm socket on the panel, such as a TRS MIDI, headphone, or stereo port, withstand ±12 V on its tip and a short from tip to sleeve, since a mono patch plug fits it;
- that every patch jack, and every RCA, BNC, or SMA jack, have its sleeve or shell insulated from the panel metal, so that no signal return runs through the panel and the case; 5.2.1 gives the construction on FR4 and on metal.

EIS · The patch interface and its limits



75 Ω into 100 kΩ passes 99.9 % of the level, so any VIDEO output drives any VIDEO input at unity gain; the audio and control classes lose about 4 %, a 2 kΩ source into a 47 kΩ load.

Figure 37. Source and load of an AUDIO, CV, PITCH, GATE, TRIG, or CLOCK patch link and of a VIDEO link, the ±12 V rules of every patch jack, and a jack insulated from the panel

PATCHED SIGNALS ONLY

A patch jack shall carry patched signals only: a module shall neither take nor give its video sync at a patch jack, and no patch jack shall list a format of clause 8.3 (SIG-015). The video sync is system configuration, wired once behind the panel at the video sync ports of 8.2, so patching never changes a module's timing. A timing pulse on a patch jack is a patched signal like any other (7.3).

A product that generates or locks to an external video sync shall take or give it at a video sync port on its rear (SIG-018), a COAX-IN or COAX-OUT of 8.2; a product with no such port neither generates nor locks to one.

JACKS INSIDE THE CASE

A jack inside the case shall not be a BNC jack: none at the rear of a module, on a bus board, or on a power supply (SIG-017). A BNC jack is on the outside of the case only, on a front panel or an enclosure's wall. A coaxial jack inside the case is an RCA, mated with a push, or an SMA, mated with a few turns of a small nut: a BNC's body and bayonet sleeve need room for fingers to grip and turn, which the space behind the panels and over a bus board does not give.

7.2 SIGNAL CLASSES

Every patch jack names the class of signal it carries, or `unclassified` (port list). EIS has seven classes: *AUDIO*, *CV*, and *VIDEO*, the signals a patch carries, with *PITCH* for calibrated pitch and *GATE*, *TRIG*, and *CLOCK* for timing. A module mixes them freely: a video module may take AUDIO, and an audio module may give VIDEO.

A port shall meet the limits of the class it names, at the range it names: an output keeps its full-scale signal within the range's ceiling, and an input accepts the range's full swing without clipping (SIG-005). The limits are in the class table.

Every patch jack keeps its safety (7.1), so a patch from one class into another damages neither jack; it only meets a level the input was not built for.

THE SHARED INTERFACE

Every class but VIDEO has one interface: a source impedance of 1 kΩ typical and at most 2 kΩ, into a load of 100 kΩ typical and at least 47 kΩ. The worst conforming pair, a 2 kΩ source into a 47 kΩ load, loses 4 %. VIDEO has its own (7.3).

Each class has:

- a *nominal* level, what an output puts on the port;
- a *full scale*, the swing its range allows;
- a *class ceiling* and a *damage limit* (Terms);
- for gate, trigger, and clock, *thresholds*: what an input reads.

In the class table, a cell marked typical or recommended is a guide; every other figure is a limit (SIG-005). The levels are EIS figures; the gate thresholds follow A-100 practice (Scope 1.4).

AUDIO

AUDIO is Eurorack audio on a patch jack.

- *Level*: nominally ±5 V on the patch tip; full scale ±10 V peak at the default range B10, 7.07 V RMS for a full-scale sine. A port may claim B5 or B1 for a quieter signal.
- *Coupling*: AC or DC. An AC-coupled input passes 20 Hz within 1 dB; a DC-coupled output states its offset.

CV

CV is control voltage that is not calibrated for pitch: envelopes, LFOs, offsets, ramps, and the like. Its level is the range the port claims, bipolar or unipolar at 1, 5, or 10 V full scale. The default is B5, -5 to +5 V, which is what most control inputs and outputs are built for. An envelope from 0 to +8 V is CV at U10; a control on the VIDEO scale, 0 to +1 V, is CV at U1. A control port with a stated scaling other than 1 V/octave, such as Hz/V, is CV and names the scaling in its port list.

PITCH

PITCH is precision pitch CV: 1.00 V per octave within ±0.3 % of scale (3.6 cents per octave), over the span the port's range names. The

default is B10; a 0 to +10 V sequencer or MIDI-to-CV output is U10, and a narrower span B5 or U5. The range states the span; the scale stays 1.00 V per octave.

EIS recommends:

- that 0 V correspond to C0 (16.35 Hz, MIDI note 12); every oscillator has a tune control, so the absolute pitch at 0 V is a calibration figure, not a requirement;
- that the manual publish the tracking error of a pitch output;
- that pitch ports be labeled *1 V/oct*, so that they are not mistaken for video ports.

VIDEO

VIDEO is video-rate signal on a patch jack, 0 to +1 V: pictures, ramps, keys, and control at the rate of a picture. Its interface, its paths, and its bandwidth are in 7.3.

GATE, TRIGGER, AND CLOCK

GATE, *TRIG*, and *CLOCK* share one contract:

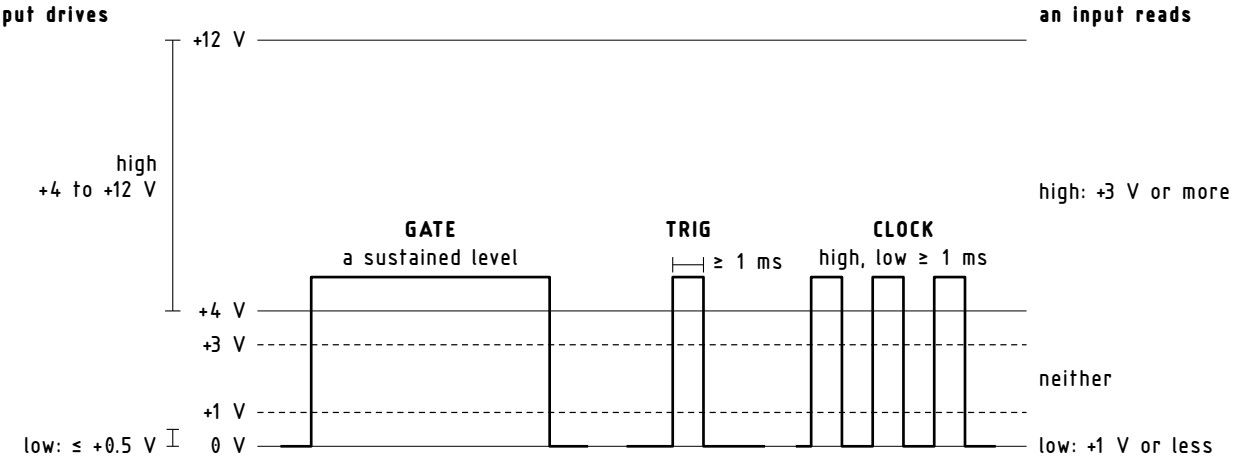
- An output drives high at +4 V to +12 V into 100 kΩ, and low at +0.5 V or less.
- An input reads +3 V or more as high and +1 V or less as low. EIS recommends at least 0.5 V of hysteresis between the two.

They differ in timing:

- *GATE* is a sustained high or low level. A run, reset, or start signal is a GATE.
- *TRIG* is a pulse at least 1 ms high (5 ms recommended). A TRIG input catches a 1 ms pulse.
- *CLOCK* is a repeating wave, high and low each at least 1 ms, at any duty. The product states the rate it accepts or produces and, for a tempo clock, the pulses per quarter note.

The gate line on the 16-pin header is *BUS-GATE* (6.6).

EIS · Gate, trigger, and clock against the receiver thresholds



GATE, TRIG, and CLOCK (SIG-005) share these levels, and so does the bus gate line, BUS-GATE; the input thresholds follow A-100 practice. EIS recommends at least 0.5 V of hysteresis between them.

Figure 38. GATE, TRIG, and CLOCK: output levels and the +3 V and +1 V input thresholds

RANGES

A *range* is the full-scale swing a port is built for, named in the port list beside the class. The class table says which ranges a class takes and which is the default.

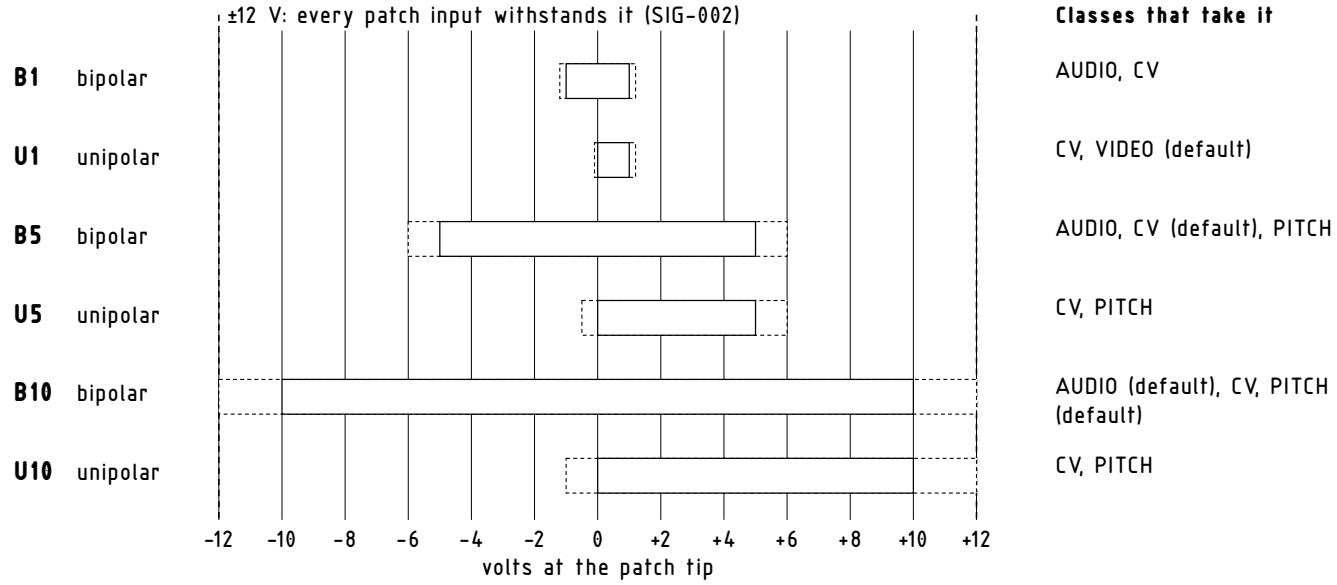
- A port that names no range has its class's default.
- A unipolar ceiling allows 20 % above full scale and 10 % below 0 V; a bipolar ceiling allows 20 % beyond full scale either way.
- An input accepts a swing when its gain at full scale is within 0.5 dB of its small-signal gain.
- Ranges do not relax patch safety.

EIS recommends that an output claim the smallest range that contains its full-scale signal, that an input claim the largest range whose full swing it accepts, and that a range other than the default be printed on the panel next to the jack.

RANGE	POLARITY	FULL SCALE SWING	CEILING
B1	bipolar	1 V -1 to +1 V	±1.2 V
U1	unipolar	1 V 0 to +1 V	-0.1 to +1.2 V
B5	bipolar	5 V -5 to +5 V	±6 V
U5	unipolar	5 V 0 to +5 V	-0.5 to +6 V

RANGE	POLARITY	FULL SCALE SWING	CEILING
B10	bipolar	10 V −10 to +10 V	±12 V
U10	unipolar	10 V 0 to +10 V	−1 to +12 V

EIS · The six ranges, on the ±12 V patch axis



A port claiming a range meets its limits (SIG-005): an output keeps its full-scale signal within the ceiling, and an input accepts the full swing without clipping.

Figure 39. The six ranges on the ±12 V patch axis, and the classes that take each

CLASS TABLE

CLASS	COUPLING	NOMINAL	THRESHOLDS	FULL SCALE	CLASS CEILING	SOURCE Z	LOAD Z	RANGES
AUDIO	AC or DC	±5 V (10 V peak-to-peak), typical	—	±10 V peak (B10)	By range; ±12 V at B10	1 kΩ typical; ≤ 2 kΩ	100 kΩ typical; ≥ 47 kΩ	B10 default; B5, B1
CV	DC	By range: ±5 V or 0 to +5 V for a typical control	—	By range; ±5 V at B5	By range; ±6 V at B5	1 kΩ typical; ≤ 2 kΩ	100 kΩ typical; ≥ 47 kΩ	B5 default; U5, B10, U10, B1, U1
PITCH	DC	1.00 V/octave pitch CV, ±0.3 % of scale over the claimed span	—	By range; ±10 V at B10	By range; ±12 V at B10	1 kΩ typical; ≤ 2 kΩ	100 kΩ typical; ≥ 47 kΩ	B10 default; U10, B5, U5

CLASS	COUPLING	NOMINAL	THRESHOLDS	FULL SCALE	CLASS CEILING	SOURCE Z	LOAD Z	RANGES
GATE	DC	Output high +4 V to +12 V into 100 kΩ, low ≤ +0.5 V; a sustained level	Input reads high at ≥ +3 V, low at ≤ +1 V; hysteresis ≥ 0.5 V recommended	—	±12 V	1 kΩ typical; ≤ 2 kΩ	100 kΩ typical; ≥ 47 kΩ	—
TRIG	DC	Output pulse high +4 V to +12 V into 100 kΩ, low ≤ +0.5 V, at least 1 ms high; 5 ms recommended	Input reads a rising edge through +3 V and accepts a 1 ms pulse; hysteresis ≥ 0.5 V recommended	—	±12 V	1 kΩ typical; ≤ 2 kΩ	100 kΩ typical; ≥ 47 kΩ	—
CLOCK	DC	Output square wave high +4 V to +12 V into 100 kΩ, low ≤ +0.5 V, each state ≥ 1 ms; any duty	Input reads high at ≥ +3 V, low at ≤ +1 V; hysteresis ≥ 0.5 V recommended	—	±12 V	1 kΩ typical; ≤ 2 kΩ	100 kΩ typical; ≥ 47 kΩ	—
VIDEO	DC	0 to +1 V DC; black at 0 V and full scale at +1 V recommended	A comparator, logic, or key input switches at +0.5 V (SIG-019); hysteresis ≤ 0.1 V, centered, recommended	+1 V (U1)	-0.1 to +1.2 V (U1)	75 Ω ±1 % series resistor	100 kΩ ±1 %	U1 default

The table is generated from `data/signals.json`. Every class is on a 3.5 mm mono jack. An impedance cell gives the typical figure and the limit; VIDEO's is a limit alone (SIG-009, SIG-010).

7.3 VIDEO SIGNALS

Video on a patch jack, and the video ports beyond the patch field. *VIDEO* is a signal class like AUDIO and CV (7.2); its jacks are patch jacks and follow patch safety, and its interface is its own.

VIDEO

VIDEO carries video-rate signals on patch jacks: pictures, ramps, keys, and control. It is 0 to +1 V DC, range U1, with a ceiling of -0.1 to +1.2 V:

- A VIDEO input shall present 100 kΩ ±1 % to 0 V at the patch tip (SIG-009).

- A VIDEO output shall drive the patch tip through a 75 Ω ±1 % series resistor (SIG-010).
- A VIDEO input that reads a signal as high or low, such as a comparator, logic, or key input, shall switch at a threshold of +0.5 V: it reads above the threshold as high and below it as low (SIG-019).

+0.5 V is the midpoint of the VIDEO scale, so any VIDEO output drives any VIDEO logic input the same way, and a key or comparator splits a picture at mid-gray. EIS recommends that a VIDEO logic output give 0 V for low and +1 V for high, and a hysteresis of no more than 0.1 V, centered on the threshold, so that a slow ramp switches once and a fine picture is not coarsened. An input whose threshold is set by a control, such as a key level, meets SIG-019 at the control's marked center or default setting.

A 75 Ω source into a 100 kΩ load arrives at almost unity gain. The cable's capacitance and the input's set the bandwidth of the link (below), so EIS recommends an input capacitance of 30 pF or less. A control on the same 0 to +1 V scale is CV at U1, with the shared interface of 7.2; a VIDEO output drives it directly.

VIDEO BEYOND THE PATCH FIELD

Video on a 75 Ω RCA, BNC, or SMA jack is not VIDEO:

- A video sync port on the rear is a COAX-IN, COAX-OUT, or COAX-THRU of 8.2, and lists the 8.3 formats it locks to or generates.
- A picture jack on the front, composite or component video, is listed in the port list by its Annex C class (VID-CVBS, VID-SVIDEO, VID-YPBPR, VID-RGBS, VID-RGSB, or VID-RGBHV) with the formats it carries. A digital port, such as SDI on a BNC jack, is listed by its Annex C class too.

A picture port has no rule of 8.2. EIS recommends that an analog picture port take the COAX-IN termination or the COAX-OUT back-termination of 8.2, so that it drives and loads a 75 Ω line the way a video sync port does.

BLACK, PATHS, AND BANDWIDTH

EIS recommends that a picture on VIDEO place black at 0 V and full scale (white, or a color channel at full saturation) at +1 V, so that a mixer or keyer can treat any two picture sources alike.

A *VIDEO path* is what lies between an input jack and an output jack of one module. A module shall publish, for each VIDEO output, the kind of path behind it and, for a linear or variable path, its −3 dB bandwidth measured as this clause states (SIG-016). The kind says whether a bandwidth describes the path at all:

KIND	WHAT THE PATH DOES	PUBLISHES
linear	A picture or control passes through gain, mixing, offset, inversion, or a buffer; the output follows the input in proportion	bandwidth (SIG-016); delay recommended
shaped	The output is a function of the input that is not proportional: a key, comparator, logic, clip, rectifier, or quantizer	rise time recommended; no bandwidth
variable	The response is set by a control, such as a filter or a slew	bandwidth at the widest setting (SIG-016), and the setting
generator	No VIDEO input feeds the output: an oscillator, ramp, shape, or decoder; a VIDEO input, if any, is a control	bandwidth of the output recommended

In the port list:

- A path is linear when the module has a VIDEO input and the port list says nothing else, and a generator when the module has none.
- When a module has several inputs, the port list names the input a figure is measured from (`from`).
- Linear paths that share one figure publish it once, as a floor for them all (`video.bandwidth_mhz`), with any output that differs listed beside it.

Bandwidth is the −3 dB frequency of the path relative to its response at 100 kHz, measured:

- from a 75 Ω source at the input jack;
- into a load of 100 kΩ in parallel with 30 pF at the output jack;
- with a 0.5 V peak-to-peak signal about +0.5 V;
- with the module's controls at the setting that gives the widest response, which the port list names when it is not the default.

The three measurements of Annex A, a stepped sine, a step, and a multiburst, give the figure; the stepped sine settles a disagreement.

EIS sets no minimum bandwidth: a 1 MHz filter and a 100 MHz buffer both conform, each with its figure beside it. The figure says what the path does, not what a reader may do with it. Compared with a format's picture bandwidth, a path at or above that figure carries the format at full sharpness, and a narrower path carries it softer.

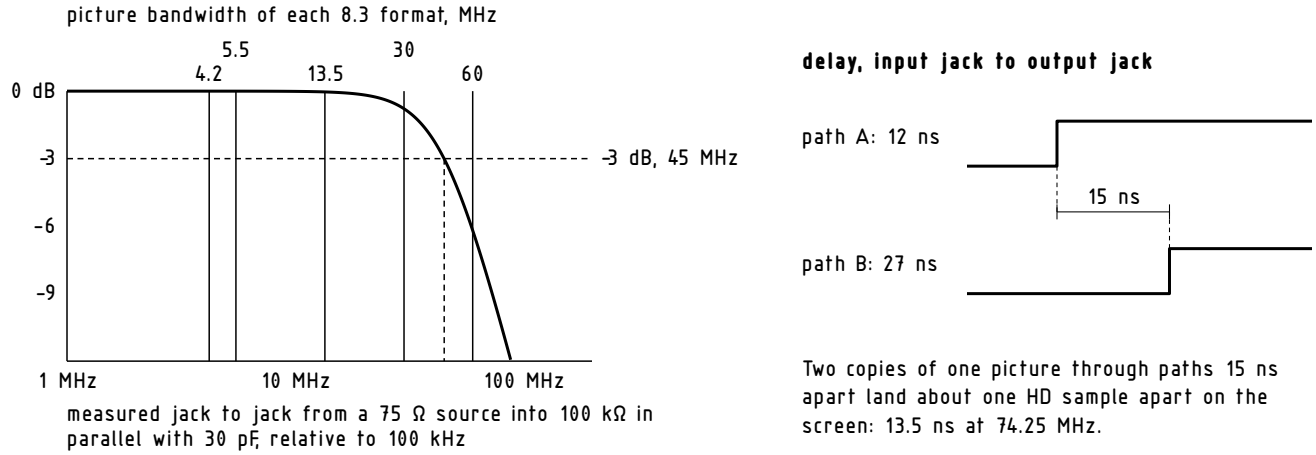
EIS recommends writing a bandwidth, in a port list and on a panel, as its *bandwidth mark*: BW and the figure in megahertz, rounded down to a whole number, so that a 35.7 MHz path is BW35. The mark is a number, never a format name, and two port lists compare at a glance.

EIS recommends that a module also publish, in the same port list:

- the *delay* of each linear or variable path, in nanoseconds, from an edge at the input jack to the same edge at the output jack;
- the *rise time* of each shaped path, 10 % to 90 % at the output jack;
- the bandwidth of each generator output, into the same load, although it has no path to measure;
- the *input capacitance* of each VIDEO input, which with the output's 75 Ω and the cable sets the bandwidth of the link;
- the Annex A method its figures were measured by (`measured_by`).

Delay matters when two copies of one picture reach a mixer by paths of different delay: they land side by side on the screen, offset by the difference, one HD sample per 13.5 ns at 74.25 MHz.

EIS · A VIDEO path: bandwidth and delay



A module publishes the kind of each VIDEO path and, for a linear or variable path, its -3 dB bandwidth (SIG-016), written as its bandwidth mark, BW45. EIS recommends publishing the delay, the rise time of a shaped path, and the input capacitance.

Figure 40. A VIDEO path's response, -3 dB at 45 MHz, against the picture bandwidths of the 8.3 formats; and two paths whose delays differ by 15 ns

THE PATCH LINK

A published bandwidth is the module's own; what arrives at the next module also depends on the cable. The output's 75 Ω, a patch cable of 100 pF/m, and a 30 pF input form one pole, whose −3 dB frequency falls as the cable grows:

CABLE	LINK −3 DB, CABLE ALONE	WITH A 30 PF INPUT
150 mm	141 MHz	47 MHz
300 mm	71 MHz	35 MHz
500 mm	42 MHz	27 MHz
1000 mm	21 MHz	16 MHz
1500 mm	14 MHz	12 MHz
3000 mm	7 MHz	6 MHz

On a cable of ordinary length, above about 30 MHz the link, not the module, is the limit. A stacked cable or a passive multiple adds a second cable and a second input to the same pole.

EIS recommends a patch cable of 100 pF/m or less, and that a maker of patch cables publish the capacitance per metre. A patch cable is not an EIS product; the figure is the cable maker's to publish.

TIMING PULSES ON PATCH JACKS

A video module's timing pulses on patch jacks, horizontal, vertical, field, burst-gate, or composite video sync, are patched signals like any other (7.1):

- a 0 / +5 V field or frame pulse is GATE;
- a line-rate pulse, too fast for CLOCK's 1 ms states, is `unclassified`, or VIDEO at 0 to +1 V;
- a 0 to +1 V composite video sync waveform is VIDEO.

A module may reset a ramp, key, or trigger from such a pulse. Its own raster timing, the formats of 8.3, locks to an external video sync only at a video sync port on its rear (SIG-015, SIG-018). A module that derives its line and field timing from a patch jack locks to a patched signal and does not meet SIG-015; it lists that jack by its class and has no video sync port for it.

PART 3 — OPTIONAL INTERFACES

Interfaces a product may have beyond Core. None is claimed: a product that has one lists it in its claim file and meets its rules, and a product without it owes none of them (4.1). They are LZX's extensions to Eurorack practice, kept apart so that Core stays what every Eurorack product shares.

- *8.1 12 V DC power (PWR-DC12)*: a second power interface beside the bus, a 12 V DC rail taken at a barrel or multi-pin DC entry, for modules that need more current than a power header carries or run without a bus.
- *8.2 Video on 75 Ω coaxial jacks (VID-75)*: the 75 Ω coaxial video sync behind the panel, COAX-IN, COAX-OUT, and COAX-THRU, and the tree that carries one video sync to every module of a system.
- *8.3 Video timing*: the formats a video sync port lists, each matched to its publication.

A module, a bus board, or an enclosure may have any of them; a power supply may have PWR-DC12; a cable mates PWR-DC12 or VID-75. One rule of video sync is Core: a product that generates or locks to an external video sync takes or gives it at a video sync port on its rear (SIG-018, 7.1).

8.1 12 V DC POWER (PWR-DC12)

PWR-DC12 is the power interface of nominal 12 V DC. Its rules apply to the products that have an entry or an outlet of it, and to the cables between them:

- a module with a rear *DC entry*;
- a *DC entry panel* or a bus board with *PWR-DC12 outlets* that feeds several modules from one entry;
- an enclosure with a case DC entry;
- a power supply that takes 12 V DC and delivers the bus.

The 12 V DC comes from an external adapter, outside EIS, or from a power supply with PWR-DC12 outlets (SUP-009). It enters at a DC entry and feeds a *DC rail*, one +V and -V pair that each product filters or regulates locally (Terms). The DC rail is separate from the bus (6.4); the rules common to both power interfaces are in 6.1 to 6.3.

Inside a case, PWR-DC12 travels by default on row wiring (6.1): ring terminals on M4 terminals, from the case DC entry to the power supply, the bus board, or the product with PWR-DC12 outlets that it feeds, which takes it at a DC-M4 entry. EIS recommends row wiring wherever PWR-DC12 passes between a case DC entry, a power supply, a bus board, and a product with PWR-DC12 outlets. The plug-in variants are the alternatives: a barrel, DC-DIN4, DC-MF6, or DC-MF8 where an external adapter's cable plugs in, and DC-BAR21 or DC-VH2 for the last step, from a PWR-DC12 outlet to a module.

A product's filtering, the connectors of its outputs that are not PWR-DC12 outlets, ripple at PWR-DC12 outlets beyond what a power supply publishes (SUP-001), and the adapter it ships with are product documentation, not EIS. The rules for the person fitting a DC entry are in 9.3. The tables are in `data/dc_12.json`.

DC ENTRIES

A product shall publish its DC entry variant: DC-BAR21, DC-BAR25, DC-VH2, DC-DIN4, DC-MF6, DC-MF8, or DC-M4 (DC-001), and the minimum and maximum DC input voltage its DC entry accepts (DC-002). It publishes the current it takes at its DC entry, and the current it delivers at each PWR-DC12 outlet, at 12 V (PWR-001, PWR-002).

The variants are of two kinds:

- A *module DC entry*, DC-BAR21 or DC-VH2, takes the rail for one module, usually from a PWR-DC12 outlet.
- A *case DC entry* is defined by its role, not its connector: it is a DC entry that takes an external adapter's output for a row: any DC entry of an enclosure, a power supply, or a bus board, or of a module with PWR-DC12 outlets or row wiring outputs. DC-BAR25, DC-DIN4, DC-MF6, DC-MF8, and DC-M4 are case entries only; DC-BAR21 serves both, a small case on a 2.1 mm adapter among them. It sits on an enclosure, which then has a PWR-DC12 entry, on a power supply, or on a *DC entry panel*: a module with a PWR-DC12 entry that feeds the supply, the bus board, or its own PWR-DC12 outlets, and then also keeps the outlet rules. The wires from a case DC entry to what it feeds are row wiring (6.1).

A product with a case DC entry shall publish whether its 0 V is bonded to the chassis at the entry, and where (DC-014): in a system fed from an adapter the case DC entry is where the one chassis tie belongs (6.3). EIS recommends that it make the bond, in PWR-008's

form, and carry an M4 CHASSIS terminal for straps to the case's other panels.

A DC entry and each PWR-DC12 outlet shall be marked beside it with its polarity, a barrel by its polarity symbol and a multi-pin entry by its +V and -V pins, its nominal voltage, and its maximum current, and a DC entry also with the minimum and maximum input voltage it accepts (DC-011). The trade marks every DC inlet this way, so an adapter or a cable is chosen at the port.

A DC entry shall not use the pinout of a Eurorack 10-pin or 16-pin power header (DC-003). A barrel DC entry, DC-BAR21 or DC-BAR25, shall be center positive (DC-004).

VARIANT	PIN × BARREL (mm)	TYPICAL CONTINUOUS (A)	NOTES
DC-BAR21	2.1 × 5.5	2.5	Also a PWR-DC12 outlet to a module (DC-009). Jacks for a 2.1 mm plug are rated 2.5 A to 8 A by their makers.
DC-BAR25	2.5 × 5.5	5	Higher current, from an adapter, 5 A to 7 A by the jack; never an output to a module (DC-009). A DC-BAR25 plug enters a DC-BAR21 DC entry but makes unreliable contact (ASM-004).

DC-VH2 is a 2-pin JST VH wire-to-board header, rated 10 A with 16 AWG wire and its terminals, that takes power from a PWR-DC12 outlet. Above 5 A, EIS recommends DC-M4 on row wiring, or DC-VH2, DC-DIN4, DC-MF6, or DC-MF8, rather than a barrel: a through-hole jack for a 2.1 mm plug is rated 2.5 A to 8 A by its maker (Same Sky PJ-002A 2.5 A and PJ-002AH 5 A, both with a 2.0 mm pin that a 2.1 mm plug takes; PJ-063AH 8 A) and a 2.5 mm jack 5 A to 7 A with a standard plug, and the product publishes its own figure (PWR-001).

EIS recommends that a DC entry accept at least 10.8 V to 13.2 V, ±10 % of 12 V. A 12 V adapter regulates to about ±5 %, and a reverse-polarity diode, the protection of an outlet, a lead, and a jumper cable each take a few hundred millivolts on the way to the module; a product with PWR-DC12 outlets publishes the voltage it delivers at its rated current.

DC-M4 is the row wiring entry: two M4 terminals, +V and -V, each clamping a ring terminal under a lock washer (PWR-005). It takes PWR-DC12 on row wiring from a DC entry panel's M4 outputs, from the M4 PWR-DC12 terminals of a supply or a bus board, or from an adapter lead that ends in ring terminals. Its rating follows from the row wiring rules: one conductor per pole carries at most 30 A (PWR-006), on terminals rated for the current they carry (PWR-005), so a DC-M4 entry is rated 30 A; on terminals rated lower, the entry takes

no more than their rating. A product that takes more uses a second DC-M4 pair. A DC-M4 entry sits on a power supply, a bus board, an enclosure, or a module with PWR-DC12 outlets or row wiring outputs, and is a case DC entry by that role (DC-006, DC-014); a module that only takes the rail has a DC-BAR21 or DC-VH2 entry on a protected outlet instead (DC-009, DC-012).

A product with a DC-VH2, DC-DIN4, DC-MF6, DC-MF8, or DC-M4 DC entry shall implement the pin or terminal functions tabulated for that variant (DC-005). The receptacle and plug named are reference parts; an interchangeable part rated for the published current may be used.

VARIANT	PRODUCT SIDE (REFERENCE)	CABLE SIDE (REFERENCE)	RATED CONTINUOUS (A)	RATING BASIS
DC-VH2	JST B2P-VH or B2PS-VH	JST VHR-2N	10	1 contact per pole × 10 A with 16 AWG wire (JST VH)
DC-DIN4	Kycon KPJX-4S-S	Kycon KPPX-4P	15	2 contacts per pole × 7.5 A (Kycon KPJX-4S-S)
DC-MF6	Molex 39-30-1060	Molex 39-01-2060	24	3 circuits per pole × 8 A at 18 AWG (Molex PS-5556-001, 4 to 6 circuits)
DC-MF8	Molex 39-30-1080	Molex 39-01-2080	28	4 circuits per pole × 7 A at 18 AWG (Molex PS-5556-001, 7 to 10 circuits)
DC-M4	two M4 row wiring terminals, +V and -V (PWR-005)	a crimped ring terminal on each conductor (PWR-006)	30	1 conductor per pole × 30 A, the most one row wiring conductor carries (PWR-006); each terminal rated for its current (PWR-005)

DC-VH2 pins

PIN	FUNCTION
1	+V
2	-V

DC-DIN4 pins

PIN	FUNCTION
1	+V
2	-V
3	-V
4	+V
5	shell (optional)

DC-MF6 pins

PIN	FUNCTION
1	+V
2	+V
3	+V
4	-V
5	-V
6	-V

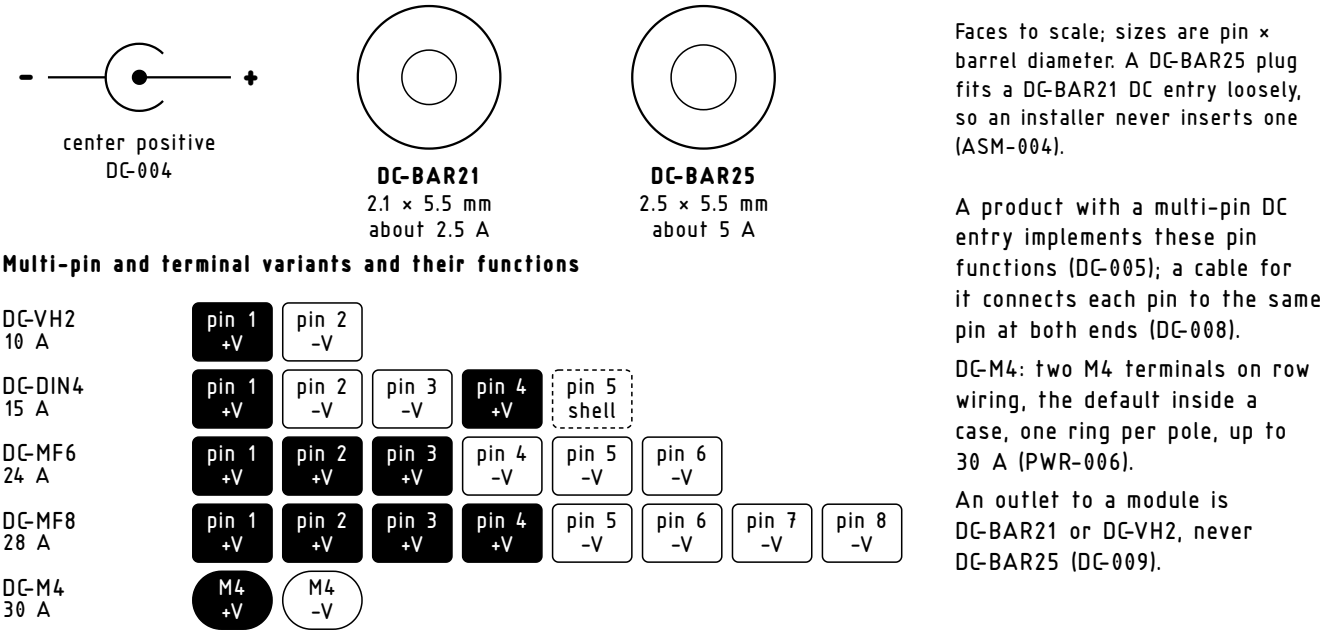
DC-MF8 pins

PIN	FUNCTION
1	+V
2	+V
3	+V
4	+V
5	-V
6	-V
7	-V
8	-V

DC-M4 terminals

TERMINAL	FUNCTION
M4, marked +V	+V
M4, marked -V	-V

EIS · PWR-DC12 DC entries: barrel polarity and sizes, multi-pin and terminal functions



Faces to scale; sizes are pin × barrel diameter. A DC-BAR25 plug fits a DC-BAR21 DC entry loosely, so an installer never inserts one (ASM-004).

A product with a multi-pin DC entry implements these pin functions (DC-005); a cable for it connects each pin to the same pin at both ends (DC-008).

DC-M4: two M4 terminals on row wiring, the default inside a case, one ring per pole, up to 30 A (PWR-006).

An outlet to a module is DC-BAR21 or DC-VH2, never DC-BAR25 (DC-009).

Figure 41. DC entries: barrel polarity and sizes, multi-pin pin functions, and the DC-M4 terminals

MODULES WITH A DC ENTRY

A barrel DC entry, and every case DC entry, shall tolerate reverse polarity without damage (DC-006). A computer supply's 8-pin EPS12V cable is a Mini-Fit Jr 2 × 4 like DC-MF8, with its +12 V on the other row: it may mate a DC-MF8 entry reversed.

A module may have both a power header and a DC entry. The rules of 6.1 and 6.3 cover it: it does not require both entries connected at once (PWR-003), and the installer connects one (ASM-003); it does not feed its DC rail onto the bus (PWR-004); and its DC rail's -V is its 0 V (GND-001). While the DC entry carries the load, its published bus currents (PWR-001) state what it draws from the bus, which may be nothing.

CABLES

A straight DC barrel cable shall connect tip to tip and sleeve to sleeve at both ends (DC-007). A cable for a DC-VH2, DC-DIN4, DC-MF6, or DC-MF8 DC entry shall connect each pin to the same pin and function at both ends (DC-008). The conductors into a DC-M4 entry

are row wiring, not a DC cable: they meet PWR-006 and PWR-007, and the installer who adds them ASM-008.

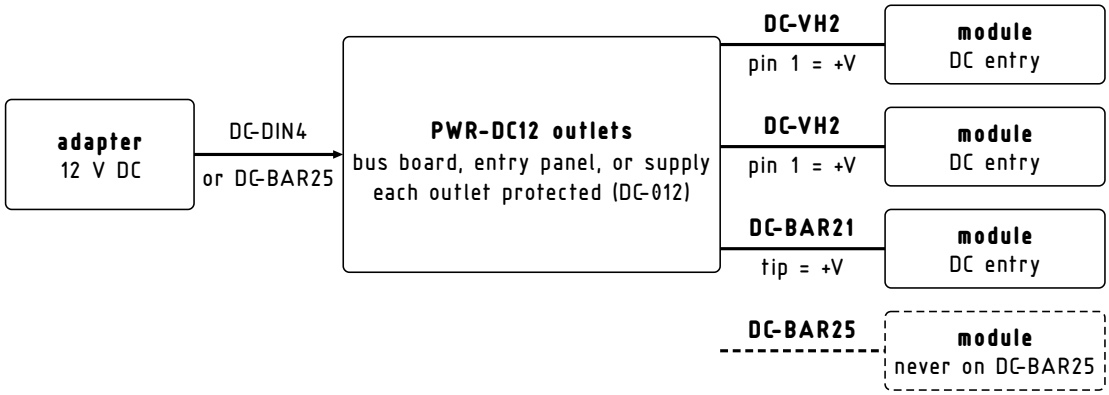
DISTRIBUTION TO MODULES

A product with PWR-DC12 outlets to modules, a bus board, a DC entry panel, or a power supply (SUP-009), shall feed them only through DC-BAR21 jacks or DC-VH2 headers, never DC-BAR25 (DC-009). A product with PWR-DC12 outlets to modules shall protect each output separately and shall publish the current at which the protection acts (DC-012), so that one shorted cable takes down one module and not the rail. Its own DC entry shall tolerate reverse polarity without damage and shall not pass the reversed voltage to its outlets (DC-013). Its outputs to a supply, a bus board, or another product with PWR-DC12 outlets are row wiring on M4 terminals (6.1), into that product's DC-M4 entry, not outlets to modules: the default way the DC rail travels inside a case, with outlets to modules the last step to each module that takes the rail.

A cable from a PWR-DC12 outlet to a module shall end in DC-BAR21 plugs or DC-VH2 housings and connect +V to +V and -V to -V, tip and pin 1 being +V (DC-010).

EIS · PWR-DC12 distribution: from the adapter to the modules

Inside a case the DC rail reaches a supply, a bus board, or a product with outlets on M4 row wiring, at a DC-M4 entry: the default (PWR-005, PWR-006). Outlets to modules are the last step, one module each.



A product with PWR-DC12 outlets feeds modules only through DC-BAR21 jacks or DC-VH2 headers, never DC-BAR25 (DC-009); its cables connect +V to +V and -V to -V (DC-010).

DC-BAR25 is for an adapter only: its plug enters a DC-BAR21 entry but makes unreliable contact, and installation never inserts it there (ASM-004).

Figure 42. From the adapter to the modules: DC-BAR21 or DC-VH2 outputs, never DC-BAR25

8.2 VIDEO ON 75 Ω COAXIAL JACKS (VID-75)

VID-75 is the 75 Ω coaxial interface of EIS: video between products on 75 Ω coaxial cable with RCA, BNC, or SMA jacks. It carries a row's video sync, black burst or bi-level or tri-level video sync of an 8.3 format, behind the panel from one source to every module that locks to it. A *video sync distributor* is a product, usually a bus board, with buffered COAX-THRU ports beside its COAX-IN, which fans the video sync out to several modules. The tables are in `data/video_75.json`.

A picture on a coaxial jack on the front, composite or component video, is not a video sync port: it is listed by its Annex C class (7.3) and follows no rule of this clause.

VIDEO SYNC PORTS

A product that generates or locks to an external video sync takes or gives it at a video sync port on its rear (SIG-018), never at a patch jack (SIG-015, 7.1).

Every video sync port shall be a COAX-IN (75 Ω ±5 % to 0 V at the jack), a COAX-OUT (a 75 Ω ±5 % series source driven at twice the line level), or a COAX-THRU, buffered or looped, never a patch jack (V75-010). The tolerance is of the impedance at the jack. EIS recommends a ±1 % resistor for each, which leaves the rest of the tolerance to the buffer and the jack. Line level is defined below.

The difference a buyer needs most: a COAX-OUT can be the row's video sync, a COAX-IN follows it, and a COAX-THRU is neither a source nor a second input. The rules of each mode apply to a product that has a port of that mode:

- *COAX-IN, video sync input.* A product with a video sync input shall take the video sync at a COAX-IN on its rear, lock any video timing of its own to it, and list the formats it accepts (V75-006): the ones it locks to, or, on a distributor, the ones it passes.
- *COAX-OUT, video sync output.* A product with a video sync output shall generate video sync of a listed format itself and give it at a COAX-OUT on its rear (V75-007). A copy of the video sync it takes at its COAX-IN is a COAX-THRU, not a COAX-OUT.
- *COAX-THRU, video sync through.* A product shall have a video sync through only if it also has a video sync input (V75-008). Each

through shall be a COAX-THRU, marked THRU, and its port list shall say which kind, buffered or looped (V75-008).

The two kinds of COAX-THRU:

- *Buffered*: a copy of the video sync at the COAX-IN, driven as a COAX-OUT into one COAX-IN load. Each THRU drives the next module's input, and a chain of about 18 keeps a tri-level edge inside its tolerance (Topology, V75-012).
- *Looped*: a jack bridged to the COAX-IN jack on one line. One cable run passes every module and only the last one terminates it, so the run takes no power and no buffer, but every module on it bridges the line. A product with a looped COAX-THRU shall give its COAX-IN a termination switch, marked TERM, that presents 75 Ω to 0 V across the line when on and no load when off, and shall lock the same with the switch on or off (V75-009). EIS recommends that a looped THRU with TERM off bridge the line at 10 kΩ or more in parallel with 20 pF or less.

Video sync ports are an optional interface (Part 3): a module, a bus board, or an enclosure may have them. The claim file lists each port with its mode and formats, and each COAX-IN, COAX-OUT, or COAX-THRU in that list brings in the rules of its mode. Distribution is a capability of whatever product has a COAX-IN and buffered COAX-THRU ports, not a product type: a distributing bus board claims `EIS draft, bus board` (6.5) (6.5).

SIGNAL AND LINE LEVEL

The video sync waveform follows the selected 8.3 format:

- black burst for the two interlaced formats;
- bi-level video sync for any standard-definition format;
- tri-level video sync for any high-definition format.

Line level, in this clause, is the level of the signal's own standard at a terminated input:

- black burst: the 1 V p-p composite scale, pulse tip −300 mV and white +700 mV (−286 mV and +714 mV for 525i59.94, per SMPTE ST 170);
- bi-level video sync alone: 300 mV p-p, pulse tip −300 mV (−286 mV for 525i59.94), blanking 0 V;
- tri-level video sync: ±300 mV about blanking (SMPTE ST 274 and ST 296).

A buffered distributor may AC-couple its buffered THRU outputs when its manual says so.

JACKS

Every jack in a VID-75 tree shall be an RCA, BNC, or SMA jack (V75-001). On every jack in a VID-75 tree, the center pin shall carry the video signal and the shell shall be 0 V (V75-002). A video sync port shall be marked beside it as an input (IN), an output (OUT), or a through (THRU), and a termination switch shall be marked TERM (V75-011). EIS recommends that each jack be insulated from the panel (7.1).

No jack inside the case is a BNC (SIG-017, 7.1). A video sync port on the rear of a module or on a bus board is therefore an RCA or an SMA, and a facility video sync arrives at a BNC on the enclosure's wall, wired inside to RCA or SMA.

The three jack types are electrically the same here. An SMA jack is a 50 Ω connector, a catalog BNC jack is as often 50 Ω as 75 Ω, and an RCA jack has no controlled impedance; but each is electrically short below 100 MHz, so the discontinuity does not matter and either BNC impedance serves. A product picks the type that suits its panel, and a cable may change type from one end to the other. A cable's SMA end is a 50 Ω assembly, and the same argument covers it.

TOPOLOGY

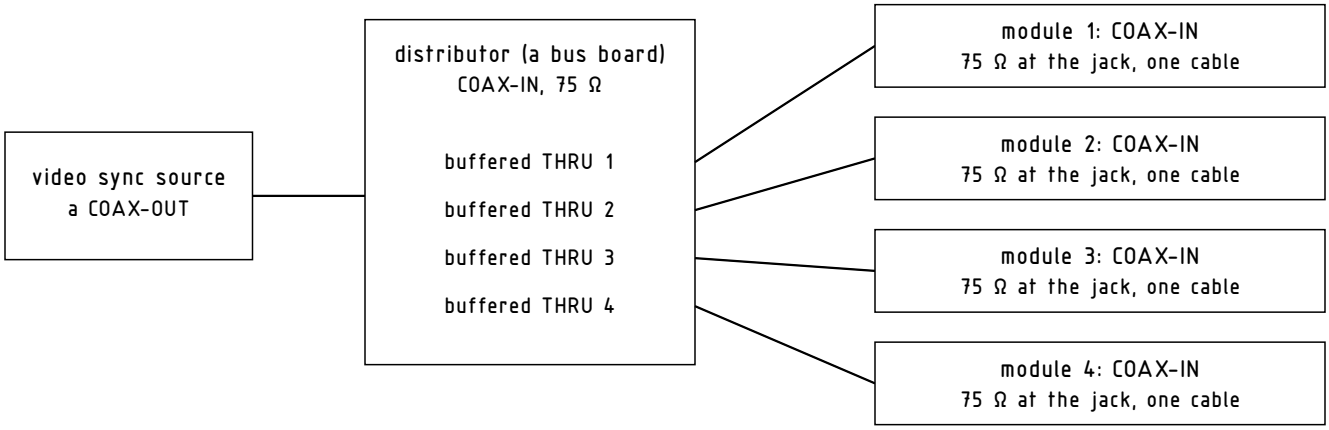
A *tree* is the star of cables from one source to the COAX-IN of every module in it. The source is a COAX-OUT, or an external video sync at one COAX-IN; the branches are buffered COAX-THRU ports, or one looped run. Each COAX-IN on the tree is named in its module's port list (V75-006) and terminated as every COAX-IN is (V75-010).

- A COAX-OUT or a buffered COAX-THRU shall drive one COAX-IN load, and an output shall not be split passively to several terminated ports (V75-003). A second termination on the same output drops the level to two thirds, and a third to half.
- A COAX-OUT port or a buffered COAX-THRU port shall pass the video sync with a -3 dB bandwidth of at least 30 MHz into a 75 Ω load (V75-012). A tri-level video sync edge is 54 ns ± 20 ns (SMPTE ST 274 and ST 296), and a 30 MHz stage adds about 12 ns of rise in

quadrature, so a 54 ns edge stays inside that tolerance through about 18 buffered THRUs. A COAX-OUT whose video sync is synthesised from samples (a generator's DAC) reconstructs them with a filter below half its sample rate; a 30 MHz path there would pass the sampling images and scatter the edge timing between samples, so such an output is held instead to the rise time tolerance of each format it lists, at the port, into 75 Ω (V75-012). Its edge is then the edge the buffered THRUs downstream carry.

- A looped run is one line: it is terminated once, at the module whose TERM is on, and every other module on it bridges it.

EIS · VID-75: one star per video sync source

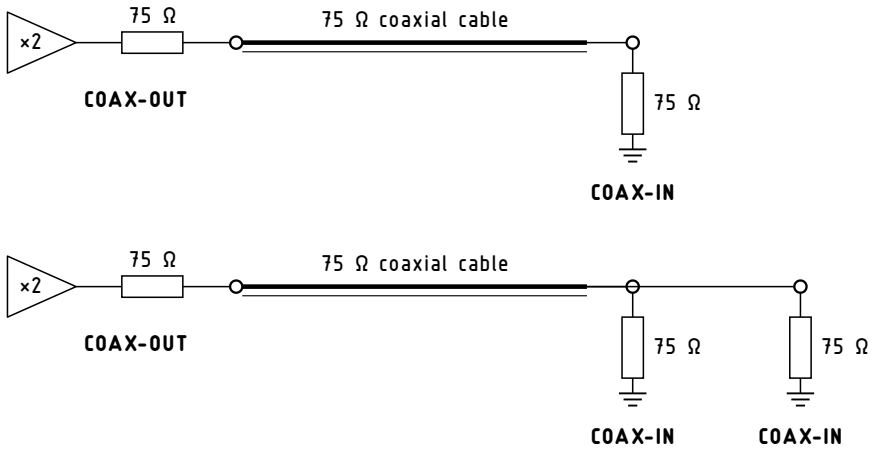


One source per tree: a COAX-OUT, or an external video sync at the distributor's COAX-IN (ASM-007). Each buffered THRU drives one COAX-IN and is never split passively (V75-003).

Every cable is 75 Ω coaxial, or 50 Ω up to 1.5 m, center to center and shell to shell (V75-004); a jack inside the case is an RCA or an SMA (SIG-017).

Figure 43. A video sync tree: a COAX-OUT feeds a distributor's COAX-IN, and each of the distributor's four outputs feeds one module's COAX-IN

EIS · VID-75 levels: one load per output



A COAX-OUT drives twice the line level through 75 Ω, so the 75 Ω COAX-IN at the far end sees the line level (V75-010). A COAX-OUT or a buffered COAX-THRU drives one COAX-IN load and is never split passively (V75-003).

Figure 44. A COAX-OUT driving one COAX-IN at line level, and split passively to two COAX-INs at two thirds of it

CABLES

A VID-75 cable shall be a 75 Ω coaxial cable, or a 50 Ω coaxial cable no longer than 1.5 m, with RCA, BNC, or SMA plugs, that connects center pin to center pin and shell to shell at both ends (V75-004).

A 50 Ω cable is allowed because the common SMA cable assemblies are 50 Ω, and over a short run the mismatch is hidden inside the edge. At each 75 Ω end it reflects a fifth of the edge: the first arrival reaches 96 % of the level, and the rest follows after each round trip. Over 1.5 m that round trip is about 15 ns, against 34 ns for the fastest tri-level edge the tolerance allows, so the steps settle inside the edge. The cable adds under 7 ns of rise, less than one buffered THRU adds (Topology), and the terminated level is unchanged, since the level is set by the 75 Ω source and termination alone. A longer 50 Ω run spreads its steps beyond the edge, so it is not a VID-75 cable. A cable claim states its impedance; with 50 Ω it also states its length.

SUMMARY

ITEM	VALUE
Jack	RCA, BNC, or SMA jack, insulated from the panel (recommended)

ITEM	VALUE
Center pin	video
Shell	0 V
Signal	The video sync: black burst, or bi-level or tri-level video sync, of the selected clause 8.3 format
Line impedance	75 Ω
COAX-IN	Terminated input: 75 Ω to 0 V at the jack; a product's video sync input.
COAX-OUT	Back-terminated output: 75 Ω series source, driven at twice the line level so that the terminated line sees the line level; a module's video sync output, generated by the product; -3 dB bandwidth at least 30 MHz into 75 Ω, or, synthesised from samples, every edge inside its format's rise time tolerance (V75-012).
COAX-THRU	Through: marked THRU, beside the product's COAX-IN; never video sync the module generates. Buffered: a COAX-OUT driven from the video sync at the COAX-IN into one COAX-IN load, -3 dB bandwidth at least 30 MHz into 75 Ω (V75-012). Looped: a jack bridged to the COAX-IN jack, the input's termination a switch marked TERM, 75 Ω to 0 V when on, no load when off.
Topology	Star. One source, a COAX-OUT or an external video sync at one COAX-IN, feeds each tree; each COAX-OUT or buffered COAX-THRU drives one COAX-IN load, and a looped line is terminated once, at the module whose TERM is on. An output is not split passively.
Cable	75 Ω coaxial, or 50 Ω coaxial no longer than 1500 mm, with RCA, BNC, or SMA plugs; center pin to center pin, shell to shell at both ends

8.3 VIDEO TIMING

EIS defines the video timing formats tabulated below: four standard-definition (SD) and fourteen high-definition (HD) rasters. The three 1080-line formats at 50, 59.94, and 60 frames per second are listed because display equipment defaults to them; on an analog component interface at 148.5 MHz they are rare, and a port lists one only when it generates or locks to it.

A product's port list shall name, for each video sync input (COAX-IN) and output (COAX-OUT), every format of clause 8.3 the port accepts or generates, by its format ID (VID-001). A port may list one format or all of them. A COAX-THRU carries the formats of its COAX-IN, and a patch jack lists none (7.1). A format that is not in the table is listed under its own name, and EIS says nothing about it.

For each format a port lists, the video timing a product generates at a COAX-OUT, and the video timing it locks to at a COAX-IN, shall match the format's publication within the tolerances that publication states (VID-002). For a progressive format, and along the line for a

high-definition interlaced format, the row below is that publication's raster, sample for sample. For the two standard-definition interlaced formats the row is the reference raster: the publication's figures in microseconds, with the digital active line placed as ITU-R BT.601 places it against the timing reference OH, 16 and 122 luminance samples for the 525-line system and 12 and 132 for the 625-line system.

Composite color encoding (NTSC or PAL) applies only to the interlaced SD formats. A component output (YPbPr, RGBS, RGSB, or RGBHV) may use any listed format. A port that locks to an external video sync takes the selected format; EIS does not require format conversion.

FORMATS

The tables are generated from `data/video_timings.json`, where each row cites its publication: SMPTE or ITU, and CTA-861 for the two progressive SD formats.

Progressive SD. 480p59.94 and 576p50 are the 720 × 480 and 720 × 576 progressive rasters CTA-861 tabulates (video format timings 2 and 3, and 17 and 18), the rasters display equipment accepts. SMPTE ST 293, with 483 active lines, and ITU-R BT.1358 are the production systems they descend from, not what the rows reproduce.

Sample clocks are exact:

- SD formats at 27.000 MHz: two samples per 13.5 MHz luma sample for the interlaced formats, so 525i59.94 has 1716 samples per line; one per luma sample for the progressive formats, so 480p59.94 has 858.
- HD formats at 74.25 MHz or 74.25/1.001 MHz.
- The three 1080p formats at 50 Hz and above at 148.5 MHz or 148.5/1.001 MHz.

Horizontal columns. H front runs from the end of active picture to the timing reference OH; H back runs from the end of horizontal video sync to the start of active picture.

- SD: OH is the leading edge of the bi-level video sync pulse, and H video sync is that pulse.
- HD: OH is the zero crossing of the tri-level pulse. The negative half of the pair lies at the end of the front porch and is counted there; H video sync is the positive half, from OH to its trailing edge.

For example, a 1080-line row at 60, 59.94, 30, or 29.97 Hz reads 88 | 44 | 148: ST 274's 44 samples from the end of active picture to the pair, 44 negative, 44 positive, and 148 of back porch. A 720p60 or 720p59.94 row reads 110 | 40 | 220, ST 296's 70, 40, 40, and 220. At the other rates only H front widens, to fill the longer line.

Vertical columns. V front and V video sync count whole lines per frame, the two fields of an interlaced format added together. For the interlaced SD formats, the front porch is the pre-equalizing lines and the video sync the broad-pulse lines of each field. A whole-line count cannot express a half line: ST 274 starts field 2's video sync of 1080i at mid-line, so its front porch is 2.5 lines after field 1's picture and 2 after field 2's, 4.5 per frame, where the row's count is 4. Active lines are the count each publication gives for the format.

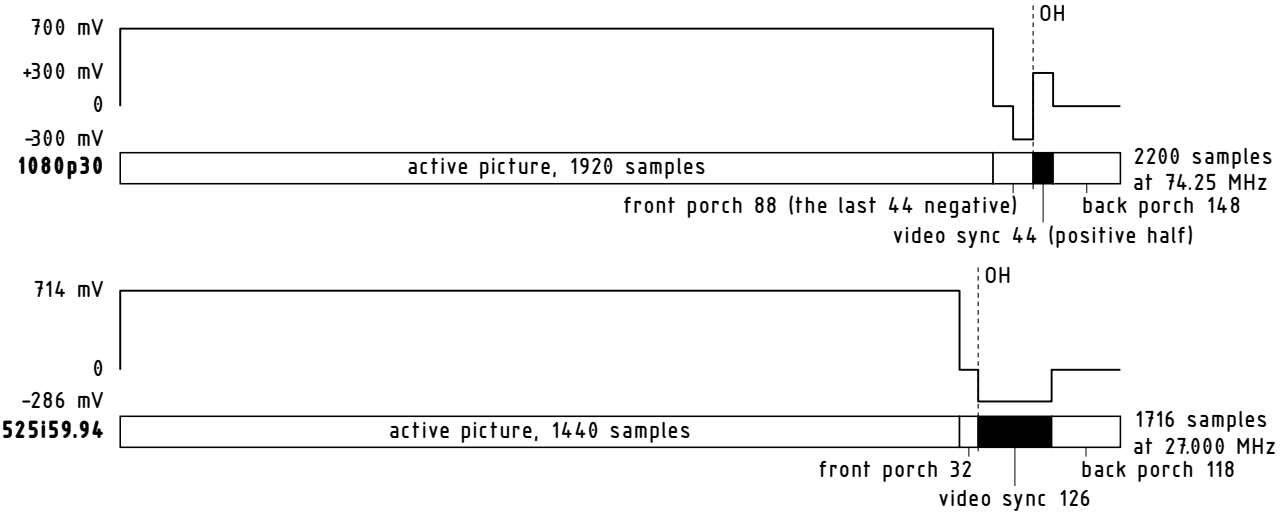
Rates. A fractional rate is exact: 59.94, 29.97, and 23.98 are the familiar names of 60/1.001, 30/1.001, and 24/1.001 Hz, the rates a 1.001 sample clock gives. The Rate column prints the exact form, `vertical_rate` in the data file; `vertical_rate_hz` beside it carries the rounded name.

Interlaced formats in the publication's terms. The analog publications state a line in microseconds, with tolerances EIS does not restate:

- 525i59.94 (SMPTE ST 170): a 63.556 µs line, a 4.7 µs video sync pulse, a 1.5 µs front porch, and about 10.9 µs of blanking;
- 625i50 (ITU-R BT.470): a 64 µs line, a 4.7 µs video sync pulse, a 1.5 µs front porch, and 12 µs of blanking.

A port meets VID-002 inside those tolerances; the row is where a sample-domain design places the active line.

EIS · One line of video, to scale: an HD and an SD format



SD: a bi-level pulse, and OH is its leading edge. HD: a tri-level pair, and OH is its zero crossing; the front porch holds the negative half and the video sync column the positive half, so 88 | 44 | 148 reads 44 blank, 44 negative, 44 positive, 148.

A port that lists a format generates or locks to that format's timing, within its publication's tolerances (VID-002).

Figure 45. One line of 1080p30 and of 525i59.94, to scale, with the timing reference OH marked

Line. Samples at the sample clock: total per line, active picture, front porch, video sync, back porch.

FORMAT ID	SAMPLE CLOCK	SAMPLES/LINE	ACTIVE	H FRONT	H VIDEO SYNC	H BACK
525i59.94	27.000 MHz	1716	1440	32	126	118
625i50	27.000 MHz	1728	1440	24	126	138
480p59.94	27.000 MHz	858	720	16	62	60
576p50	27.000 MHz	864	720	12	64	68
720p50	74.25 MHz	1980	1280	440	40	220
720p59.94	74.25/1.001 MHz	1650	1280	110	40	220
720p60	74.25 MHz	1650	1280	110	40	220
1080i50	74.25 MHz	2640	1920	528	44	148
1080i59.94	74.25/1.001 MHz	2200	1920	88	44	148
1080i60	74.25 MHz	2200	1920	88	44	148
1080p23.98	74.25/1.001 MHz	2750	1920	638	44	148
1080p24	74.25 MHz	2750	1920	638	44	148
1080p25	74.25 MHz	2640	1920	528	44	148
1080p29.97	74.25/1.001 MHz	2200	1920	88	44	148
1080p30	74.25 MHz	2200	1920	88	44	148

FORMAT ID	SAMPLE CLOCK	SAMPLES/LINE	ACTIVE	H FRONT	H VIDEO SYNC	H BACK
1080p50	148.5 MHz	2640	1920	528	44	148
1080p59.94	148.5/1.001 MHz	2200	1920	88	44	148
1080p60	148.5 MHz	2200	1920	88	44	148

Frame. Lines per frame: total, active, front porch, video sync; the rate is the field rate of an interlaced format and the frame rate of a progressive one. SD marks the four standard-definition formats.

FORMAT ID	LINES	ACTIVE LINES	V FRONT	V VIDEO SYNC	RATE (Hz)	INTERLACED	SD
525i59.94	525	486	6	6	60/1.001	yes	yes
625i50	625	576	5	5	50	yes	yes
480p59.94	525	480	9	6	60/1.001	no	yes
576p50	625	576	5	5	50	no	yes
720p50	750	720	5	5	50	no	—
720p59.94	750	720	5	5	60/1.001	no	—
720p60	750	720	5	5	60	no	—
1080i50	1125	1080	4	10	50	yes	—
1080i59.94	1125	1080	4	10	60/1.001	yes	—
1080i60	1125	1080	4	10	60	yes	—
1080p23.98	1125	1080	4	5	24/1.001	no	—
1080p24	1125	1080	4	5	24	no	—
1080p25	1125	1080	4	5	25	no	—
1080p29.97	1125	1080	4	5	30/1.001	no	—
1080p30	1125	1080	4	5	30	no	—
1080p50	1125	1080	4	5	50	no	—
1080p59.94	1125	1080	4	5	60/1.001	no	—
1080p60	1125	1080	4	5	60	no	—

PICTURE BANDWIDTH

A format's *picture bandwidth* is the luma bandwidth its publication specifies for an analog interface. For the two CTA-861 formats, whose publication is digital only, it is half the luma sample rate. The bandwidth of a VIDEO path is compared with it (7.3); the figure is a property of the format, and EIS requires no path to reach it.

FORMATS	PICTURE BANDWIDTH	FROM
525i59.94	4.2 MHz	SMPTE ST 170, luminance bandwidth
625i50	5.5 MHz	ITU-R BT.470, System I nominal video bandwidth (5.0 MHz for B/G, 6.0 MHz for D/K and L)
480p59.94, 576p50	13.5 MHz	half the 27 MHz luma sample rate; CTA-861 specifies no analog bandwidth
720p50, 720p59.94, 720p60	30 MHz	SMPTE ST 296, analog interface bandwidth
1080i50, 1080i59.94, 1080i60, 1080p23.98, 1080p24, 1080p25, 1080p29.97, 1080p30	30 MHz	SMPTE ST 274, analog interface bandwidth at 74.25 MHz
1080p50, 1080p59.94, 1080p60	60 MHz	SMPTE ST 274, analog interface bandwidth at 148.5 MHz

PHASE

A module that locks to video sync produces its output a fixed time after the video sync. EIS recommends publishing that offset, horizontal and in nanoseconds, at each listed format, and any adjustment the module offers, so that several generators locked to one video sync can be lined up on the screen.

VERIFICATION

A maker compares samples per line, lines per frame, field or frame rate, and video sync pulse width and placement with the tables and the cited publication. `tests/video_timings_contract.py` checks every row that has an entry in its test fixture, a timing contract measured on hardware, clock for clock; the three 148.5 MHz rows, 1080p50, 1080p59.94, and 1080p60, are listed from their publication and are not in the contract.

PART 4 — ASSEMBLY

The rules for the person who fits a system together (chapter 9). They bind the installer, not a product. Each protects conforming products from a system put together wrongly: a row over its power budget, two transmitters on one bus line, two sources on one DC rail, two sources on one video sync tree. Each applies where the system has what it names.

9 ASSEMBLING A SYSTEM

Rules for the person who fits modules, bus boards, supplies, DC rails, and the video sync into a row. They bind the installer, not a product: a product conforms whether or not its owner follows them. Each rule protects a conforming product from a system put together wrongly; all are Core.

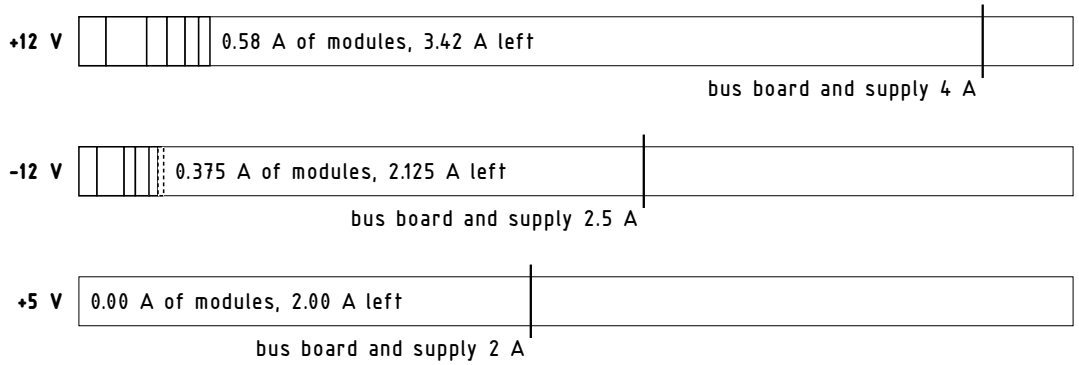
9.1 POWER

A module shall be added to a row only while, on each rail of each power interface, the sum of the published currents (PWR-001) stays within the published totals of every source and every product with outlets that feeds it, such as the bus board and the supply, and the current through each outlet, such as one bus header, stays within that outlet's limit (PWR-002) (ASM-001).

- Each rail counts on its own.
- A row with several bus boards sums each board separately.
- A supply on the bus, mounted on the product it powers, counts at its published input current; its heat counts in Annex H.

The informative row budget is a worksheet for the sum.

EIS · A row's current budget on the bus: the example row 'performance'



- ☐ Audio I/O: +12 V 0.12 A, −12 V 0.08 A
- ☐ VCO: +12 V 0.09 A, −12 V 0.05 A
- ☐ Envelope/LFO: +12 V 0.06 A, −12 V 0.04 A
- ☐ Mixer: +12 V 0.18 A, −12 V 0.12 A
- ☐ VCF/VCA: +12 V 0.08 A, −12 V 0.06 A
- ☐ MIDI utility (Type A): +12 V 0.05 A, −12 V not published

A module goes into a row only while each rail's sum stays within the bus board's totals, its per-header limit, and the supply's rating (ASM-001). The dashed segment is the module with no published −12 V figure, planned at 50 % of its +12 V draw, as EIS recommends.

Figure 46. The example row's module currents against its bus board and supply

When a module publishes its +12 V current but not its −12 V current, EIS recommends planning −12 V at 50 % of +12 V. In the eis-reference survey, +12 V usually runs out first.

A module goes in with the power off: the ribbon seated square at both ends with the marked conductor toward −12 V (6.4), the panel screwed to the rails, and any blank panel that was removed put back.

Row wiring an installer adds between a power supply, bus boards, a DC entry, or PWR-DC12 outlets shall meet PWR-006 and PWR-007, with each ring terminal clamped on the product's M4 terminal under a lock washer, and a bond an installer adds shall meet PWR-008 (ASM-008). Row wiring on M4 terminals is the default way to join them; the terminals, gauges, and recommended parts are in 6.1.

Where a system has more than one power supply, installation shall link the bus boards' 0 V so that every bus board reaches, directly or through other boards' links, a bus board fed by each other supply, each 0 V link at most 2 mΩ terminal to terminal, and each bus board shall keep its own 0 V conductor to the supply that feeds it (ASM-009). The links hold one reference across the rows; the returns stay a star (6.3). The system's one chassis tie is at its power entry (6.3).

9.2 BUS CV AND GATE

At most one module shall transmit on each CV line and at most one on each gate line, where a line runs across linked bus boards up to a region split (ASM-002). EIS recommends at most ten listeners on a line, the load 6.6 states its transmitter limits into (6.6). With no CV transmitter on a line, EIS recommends leaving the listening jumpers of oscillators off, so that a floating CV line cannot detune them.

9.3 DC POWER ENTRY

- Installation shall connect only one of a product's alternative power entries at a time (ASM-003), such as the power header or the DC entry of a dual-source module.
- Installation shall not insert a DC-BAR25 plug into a DC-BAR21 DC entry (ASM-004).
- Each DC rail shall be fed from one adapter or one case DC entry at a time (ASM-005).
- A DC-VH2, DC-DIN4, DC-MF6, or DC-MF8 DC entry shall be mated only with that variant's plug (ASM-006).

A DC-M4 entry takes row wiring, not a plug: its conductors meet ASM-008. The product rules for the DC entry are in 8.1.

9.4 VIDEO SYNC

Each video sync tree in a row shall have exactly one source, a COAX-OUT or an external video sync at one COAX-IN, and each COAX-IN shall be fed by one output (ASM-007). The product rules are in 8.2; how to distribute the video sync is in the informative Annex F.

TESTS

`python -m pytest tests` (`eis check`) runs every generator in `tools/`, every check here, and fails if a generated file in `spec/`, `figures/`, `annex/`, `data/`, or `README.md` differs from the committed one. CI runs the same (`.forgejo/workflows/checks.yml`). Each test module covers one concern and names what failed.

MODULE	WHAT IT CHECKS	WHAT IT DOES NOT DO
test_model.py	The document model (data/document.json) is consistent; every register row binds a role or an interface and names how it is verified; the identifiers match data/register.lock.json, never reused or resequenced, their text never changed silently; no tool types the identifier prefixes.	It does not write the lock: python tools/model.py --lock does, deliberately.
test_generators.py	Every generator listed in tools/eis.py validates its model and runs; the example claim files and the row budget check; the generated files are committed.	It does not set any model.
test_claims.py	Claim files: the class each port names, what brings a row in, the power block per interface, and a supply mounted on the product it powers.	It does not validate a product's claim; eis claim FILE does.
test_doepfer_compare.py	Annex J: every Doepfer statement and every register row is listed once, with no binding word in the EIS column.	It does not judge the comparison.
test_marks.py	The EIS mark and its claim line, drawn from the example claims.	
test_pages.py	Every relative link and #anchor resolves, every figure is referenced, every shall sentence carries an identifier, the prose keeps one voice (links.py); every figure card follows the house style (figures.py); every example names the edition in pyproject.toml (eis_edition.py); the site builds with no broken link.	
test_sources.py	HP, rack unit, and the 3U panel height match the published A-100 construction page (doepfer.py); the published Technical Details figures are quoted and the places EIS chose otherwise reported (doepfer_technical.py); every row of data/video_timings.json matches the hardware-verified timing contract, clock for clock (video_timings_contract.py, --yaml PATH checks a full one).	None of these sets a model: a difference is reported, not applied.

The scripts links.py, figures.py, eis_edition.py, doepfer.py, doepfer_technical.py, and video_timings_contract.py also run on their own (python tests/links.py).

Construction page: Construction Details A-100, retrieved 2026-10-09. Signal page: Technical Details A-100, retrieved 2026-10-16. The comparison is summarized in Annex J. Where each normative number comes from is in the requirements register.

INFORMATIVE ANNEXES

The annexes hold reference data, verification methods, planning aids, and worked examples. Every annex is informative: it adds no requirement, and where an annex and a clause differ, the clause governs.

ANNEX	TITLE	USE IT FOR
A	Verification measurements	How each requirement is verified, and typical bench checks for a claim
B	Patch and bus level map	The patch classes on one page
C	Port vocabulary	Names for ports that are not patch jacks
D	Designer's guide	What each product claims, and where to start reading
E	Row budget	A planning worksheet for one row
F	Video sync distribution	The video sync behind the panel: direct links or a tree, never patched
G	Expanders and inter-module links	Expander headers, I2C, and analog links behind the panel
H	Heat and mechanical load	A row's dissipation, a case's temperature rise, screw torque, and module mass
I	Worked examples	A module, a case, and a video row taken to their claims
J	EIS and the Doepfer A-100 documents	What a product built to Doepfer's figures changes to conform: the figures EIS inherits, and every difference
K	Control layout	Where the controls on a front panel sit: the row lines, the lattice, the grid of each family, and a layout check
L	Front-panel legends and artwork	What is printed on a front panel: the title and the maker's mark, legend type and position, input and output marking, and block-diagram symbols
M	The LZX Panel Stroke typeface	The LZX Panel Stroke typeface: downloads, setting a size, and its center-line font for engraving

ANNEX A (INFORMATIVE) — VERIFICATION MEASUREMENTS

Annex A gives the verification methods the register names, then bench procedures for selected measurements. A product's own documented procedure, or an equivalent analysis, serves as well.

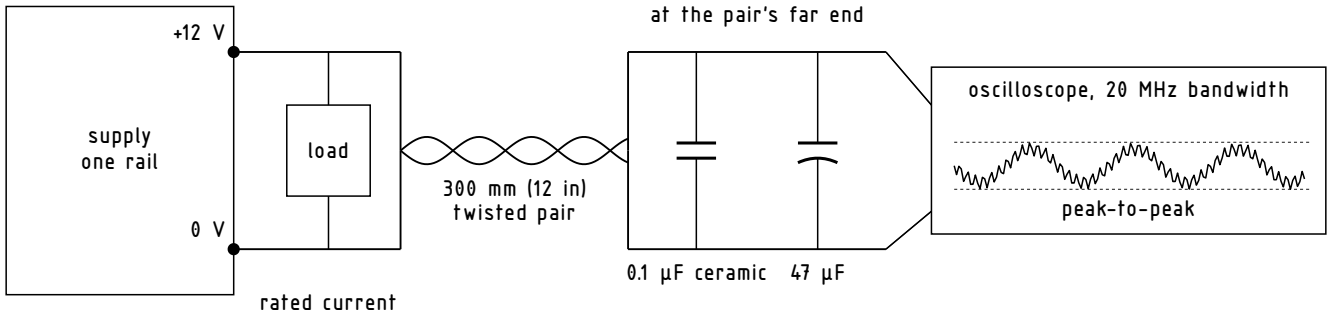
METHODS

The register (4.4) names, for every requirement, how it is verified and the figure checked, from the `verify` field of `data/requirements.json`. A may row is a permission, and what is verified is the condition it sets. The methods:

METHOD	MEANING
inspection	Inspection of the product, its drawings, or its documentation
analysis	Documented analysis or calculation from the product's design figures
measurement	A bench measurement against the figure the requirement states

SUPPLY RIPPLE AND NOISE

EIS · Measuring ripple and noise



Every rail at its rated current; the pair runs from the output terminals, or from test points the product publishes, and the probe, with a short ground spring, sits across the capacitors at its far end, as common supply datasheets measure.

The supply publishes the peak-to-peak figure for each rail (SUP-001); every rail stays below 150 mV (SUP-007). A linear or post-regulated supply, typically under 5 mV, suits a row of modules with VIDEO ports.

Figure 47. How ripple and noise are measured

1. Measure the ripple and noise of each rail, peak-to-peak, by the method of 6.2.
2. Compare it with the published figure (SUP-001) and with the limit of the rail's power interface, 150 mV on the bus (SUP-007).

MODULE HEADER CURRENT

1. Run the module under its heaviest load.
2. Measure each rail's current at the module's power header. Confirm it is within the published figure (PWR-001) and no more than 1.5 A

(BUS-008), once the decoupling has charged.

3. With the module running from a bench supply, confirm that no current flows out of any rail pin into the supply (PWR-004).

DC ENTRY

1. Confirm the polarity: center positive on a barrel (DC-004), the tabulated +V and -V pins on a multi-pin variant, or the marked +V and -V terminals of DC-M4 (DC-005).
2. Confirm that the product runs across its published input voltage range (DC-002) at its published current (PWR-001).

PATCH AUDIO AND CV

1. Check each *AUDIO* and *CV* port against its claimed range (SIG-005).
2. Hold ±12 V from a source of 1 kΩ or less on each patch input, and confirm no damage (SIG-002).
3. Short each patch output to 0 V and to another output, and confirm no damage (SIG-003).

VIDEO LEVELS

DC-couple the probe at the patch tip. Confirm that the output's full scale is 0 to +1 V and that it stays within the U1 ceiling, -0.1 V to +1.2 V (SIG-005).

VIDEO IMPEDANCES

1. For each VIDEO output, measure the series resistor from the buffer output node to the patch tip: 75 Ω ±1 % (SIG-010).
2. For each VIDEO input, with the module powered, measure the resistance from the tip to 0 V: 100 kΩ ±1 % (SIG-009).

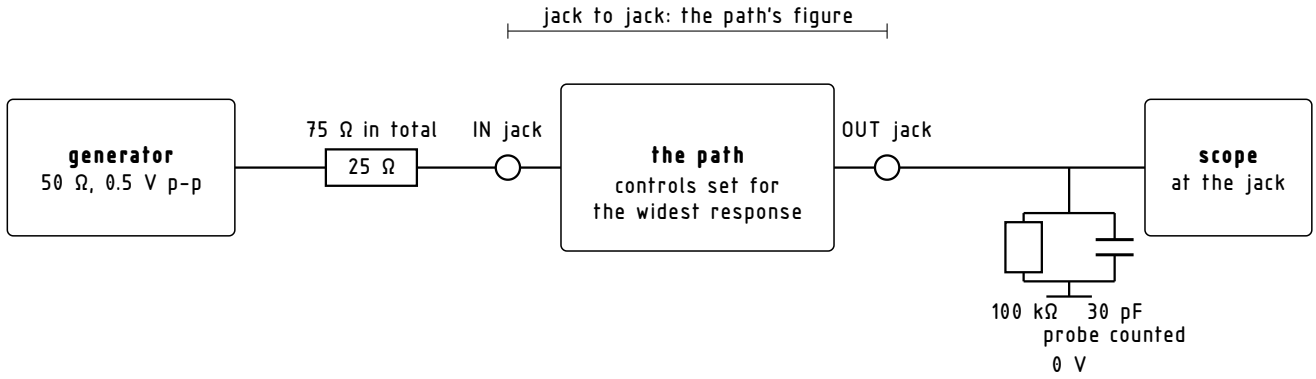
The input figure is the resistance at the tip: the resistor to 0 V and the input stage behind it read together. Where the stage's own input resistance is a few megohms, choose the resistor so that the parallel value lands inside the window.

EIS recommends checking that each patch jack barrel is insulated from the panel (7.1).

VIDEO PATHS

These procedures measure the path figures of 7.3: the bandwidth and delay of a linear or variable path (SIG-016), the rise time of a shaped path, and the input capacitance of a VIDEO input. The fixture below serves the first three; input capacitance has its own set-up. Methods A, B, and C give the same bandwidth for the smooth roll-off of a video buffer; where they disagree, Method A is the reference. A port list names the method by its letter (`measured_by`).

EIS · Measuring a VIDEO path: the fixture



A, the reference: a stepped sine from 100 kHz; bandwidth where the amplitude is 0.707 of the 100 kHz reading.

B: a step from +0.25 to +0.75 V; bandwidth in MHz = 350 / rise time in ns (10 % to 90 %, source and probe taken out in quadrature).

C: a multiburst; the bandwidth lies between the last packet at 0.707 of the bar or above and the first below it.
Delay: the B step, between the 50 % points at the two jacks.

Input capacitance: drive the input through 10 kΩ with no 75 Ω; C = 1 / (2 × 3.14 × 10 kΩ × f) at the -3 dB frequency f, less the probe's.

Figure 48. The bandwidth fixture: a 75 Ω source, the path, and a 100 kΩ load in parallel with 30 pF

Fixture.

1. Drive the input jack from a generator through 75 Ω in total: a 75 Ω generator, or a 50 Ω generator with 25 Ω in series.
2. Load the output jack with 100 kΩ ±1 % in parallel with 30 pF ±5 pF, the probe's own capacitance counted: a 10:1 passive probe of 10 to 15 pF beside a 100 kΩ resistor and a 15 to 20 pF capacitor across the jack, or an active probe with 30 pF across it.
3. Measure at the jacks with the shortest leads the probe allows. A 300 mm patch cable left in the fixture adds 30 pF and halves the figure of a wide path.

4. Set every control in the path for its widest response, unity gain where there is a gain control. Record any setting that is not the default.
5. Drive 0.5 V peak-to-peak about +0.5 V, which keeps the output inside U1 at unity gain; drive a path with gain proportionally lower.

Method A, stepped sine (the reference method).

1. Apply a 100 kHz sine and read the output amplitude.
2. Step the frequency up by a ratio of 1.4 or finer, reading the amplitude at each step.
3. The bandwidth is the frequency, interpolated between steps, at which the amplitude is 0.707 of the 100 kHz reading.

A network analyzer, or an oscilloscope with a tracking generator, does the same in one sweep. A path whose response rises before it falls is reported at its −3 dB point all the same, with the peak noted.

Method B, step.

1. Apply a 0.5 V step, from +0.25 V to +0.75 V, from a source whose own rise time is under a fifth of the path's.
2. Read the 10 % to 90 % rise time at the output jack.
3. Take out the source's and the probe's rise times in quadrature: the path's rise time is the square root of the read time squared less the source's squared and the probe's squared.
4. The bandwidth in MHz is 350 divided by the path's rise time in nanoseconds.

The result is within about 10 % of Method A for a path with a smooth roll-off, which the buffers of the trade have; measure a path that peaks or rings by Method A. The same step, read at the input and the output jack on two channels, gives the *delay* between the 50 % points. The rise time of a *shaped* path, the figure 7.3 recommends for it, is read the same way with a step through the path's threshold.

Method C, multiburst.

1. Apply a multiburst test signal through the path, from a video test generator or a module that produces one: a reference bar, then packets of sine at fixed frequencies, each at one amplitude.
2. Read each packet's amplitude at the output against the bar.
3. The bandwidth lies between the last packet at or above 0.707 and the first below it; Method A places it within that interval.

A standard-definition generator's packets run to 4.2 or 5.8 MHz and a high-definition generator's to 30 MHz, so Method C places a figure only within the generator's reach.

Input capacitance.

1. With the module powered and the input otherwise unpatched, drive the input jack from a generator through 10 kΩ, with no 75 Ω.
2. Read the −3 dB frequency f at the jack itself.
3. The capacitance is 1 / (2 × 3.14 × 10 kΩ × f), less the probe's own.

An LCR meter at 1 MHz across the jack reads it directly.

Worked figures. One pole of 75 Ω into 30 pF is 70.7 MHz, with a 10 % to 90 % rise time of 4.9 ns. 75 Ω into 130 pF, a meter of cable and the input, is 16 MHz: the 1000 mm row of the link table read the other way. A 35.7 MHz path has a rise time near 9.8 ns and is written BW35.

VID-75 TERMINATION AND DRIVE

With the product powered:

1. At each COAX-IN, measure 75 Ω ±5 % from the center pin to the shell (V75-010).
2. At each COAX-OUT and buffered COAX-THRU, measure twice the line level open-circuit and the line level into a 75 Ω load (V75-010), and a −3 dB bandwidth of at least 30 MHz into 75 Ω; at a COAX-OUT synthesised from samples, the 10 % to 90 % rise of each edge of each listed format, inside its publication's tolerance, into 75 Ω (V75-012).
3. At a looped THRU, measure 75 Ω across the line with TERM on and no load with TERM off, and confirm that the product locks either way (V75-009).

ANNEX B (INFORMATIVE) — PATCH AND BUS LEVEL MAP

Annex B sets every patch and bus signal class side by side: nominal level, full scale, and impedance. The limits are in 7.2 for the patch classes, 7.3 for VIDEO's interface, 7.3 for VIDEO, and 6.6 for the bus classes.

WHERE	CLASS	NOMINAL	FULL SCALE	IMPEDANCE
Patch jack	*AUDIO*	±5 V (10 V peak-to-peak), typical	±10 V peak (B10)	out: 1 kΩ typical; ≤ 2 kΩ; in: 100 kΩ typical; ≥ 47 kΩ
Patch jack	*CV*	By range: ±5 V or 0 to +5 V for a typical control	By range; ±5 V at B5	out: 1 kΩ typical; ≤ 2 kΩ; in: 100 kΩ typical; ≥ 47 kΩ
Patch jack	*PITCH*	1.00 V/octave pitch CV, ±0.3 % of scale over the claimed span	By range; ±10 V at B10	out: 1 kΩ typical; ≤ 2 kΩ; in: 100 kΩ typical; ≥ 47 kΩ
Patch jack	*GATE*	Output high +4 V to +12 V into 100 kΩ, low ≤ +0.5 V; a sustained level	—	out: 1 kΩ typical; ≤ 2 kΩ; in: 100 kΩ typical; ≥ 47 kΩ
Patch jack	*TRIG*	Output pulse high +4 V to +12 V into 100 kΩ, low ≤ +0.5 V, at least 1 ms high; 5 ms recommended	—	out: 1 kΩ typical; ≤ 2 kΩ; in: 100 kΩ typical; ≥ 47 kΩ
Patch jack	*CLOCK*	Output square wave high +4 V to +12 V into 100 kΩ, low ≤ +0.5 V, each state ≥ 1 ms; any duty	—	out: 1 kΩ typical; ≤ 2 kΩ; in: 100 kΩ typical; ≥ 47 kΩ
Patch jack	*VIDEO*	0 to +1 V DC; black at 0 V and full scale at +1 V recommended	+1 V (U1)	out: 75 Ω ±1 % series resistor; in: 100 kΩ ±1 %
Bus CV / gate (16-pin)	*BUS-CV*	1.00 V/octave pitch CV (bus CV), ±0.3 % of scale, from one transmitter	—	out: ≤ 100 Ω; in: ≥ 100 kΩ per listener
Bus CV / gate (16-pin)	*BUS-GATE*	0 / +5 V gate (bus gate): output high +4 V to +12 V, low ≤ +0.5 V, from one transmitter	—	out: ≤ 2 kΩ; in: ≥ 47 kΩ per listener

The table is generated from `data/signals.json`.

Every patch input withstands ±12 V whatever its class (SIG-002), and EIS recommends the same of every other 3.5 mm socket on a panel (7.1). A range (B1, U1, B5, U5, B10, U10) names a port's full-scale swing, and a port claiming one meets its limits (SIG-005). EIS recommends that an output claim the smallest range that contains its signal, and an input the largest it accepts.

EIS · Every patch class on one ±12 V axis

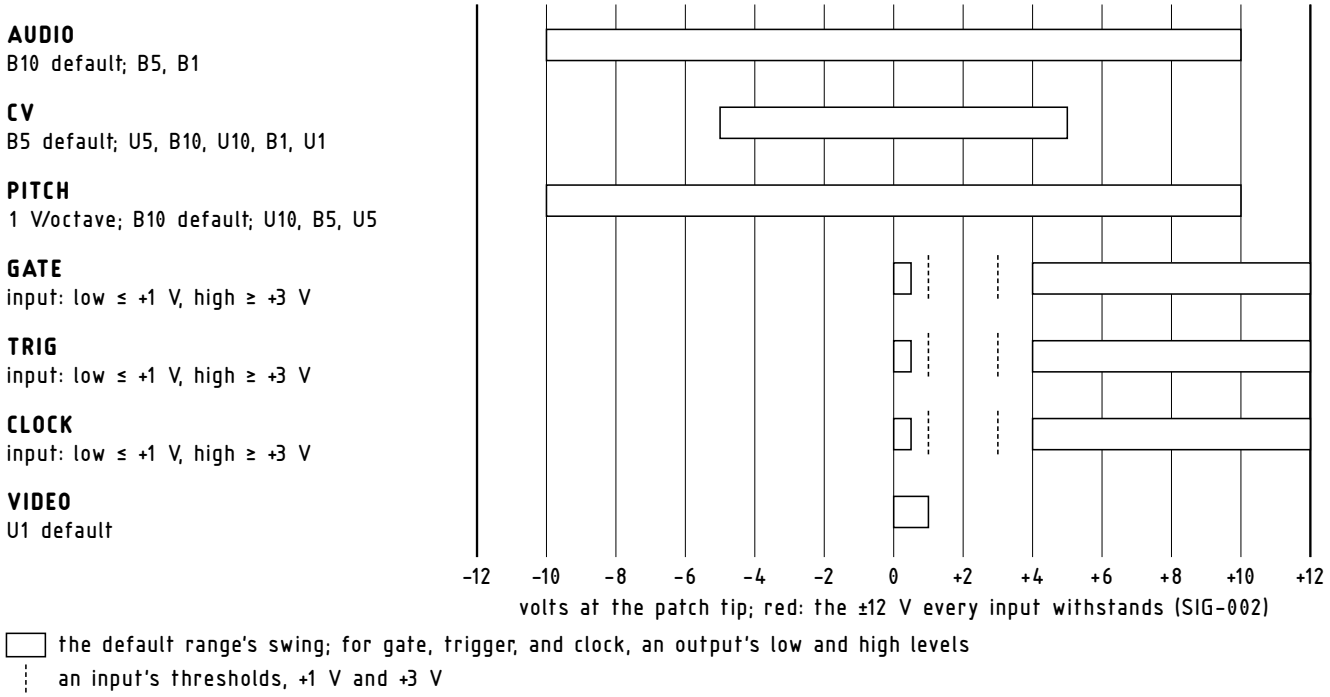


Figure 49. Every patch class on one ±12 V axis

ANNEX C (INFORMATIVE) — PORT VOCABULARY

Annex C gives class names for ports that are not patch jacks, so that manuals and port lists (SIG-001) describe them the same way: line, instrument, microphone, and headphone audio, digital audio, analog and digital video, MIDI, DMX512, the DIN clock interface, word clock, an expander link, and the ILDA laser connector. Such a port does not change whether one Eurorack product fits or works with another, so EIS places no requirement on it.

- *Port list.* A port of this annex is listed by its class name or as `unclassified`; either satisfies SIG-001.
- *Not a patch class.* A class of this annex names a port; a module lists it beside its patch jacks (7.2).
- *Patch jacks.* A port on a 3.5 mm mono patch jack is a patch jack whatever it carries, and the patch-safety rules of 7.1 apply to it. EIS recommends that a 3.5 mm TRS port survive a mono patch plug as well.
- *Figures.* Levels and impedances are the usual industry figures, for orientation; the Nominal column names the level or the governing

document, whichever defines the port. Where a published standard governs a port, the product cites that standard directly; EIS applies none of them by reference.

C.1 EXTERNAL AUDIO

Balanced ports are pin 2 or tip hot (AES14, IEC 60268-12). A microphone input that offers phantom power states it beside the port, since P48 per IEC 61938 can damage a line output patched into it. A headphone output states the load its level figure assumes; headphones run from 16 Ω to 600 Ω. The digital audio ports carry no EIS level; the classes name S/PDIF (IEC 60958-3), AES3, ADAT, and USB Audio Class so that a port list can say which.

CLASS	CONNECTOR	COUPLING	NOMINAL	CLASS CEILING	SOURCE Z	LOAD Z
LINE-BAL	6.35 mm TRS or XLR	AC	+4 dBu (1.228 V RMS); pin 2 or tip hot (AES14, IEC 60268-12)	+24 dBu	200 Ω	10 kΩ
LINE-UNBAL	6.35 mm TS, RCA, or 3.5 mm TRS stereo pair	AC	−10 dBV (316 mV RMS); tip left, ring right on a TRS pair	+8 dBV	600 Ω	10 kΩ
INST	6.35 mm TS	AC	Instrument level; passive pickup source 5 kΩ to 20 kΩ	+12 dBu	—	1 MΩ
MIC	XLR	AC	−60 to −40 dBu typical; pin 2 hot; phantom power, when offered, is P48 per IEC 61938 (48 V ± 4 V through 6.8 kΩ) and is stated beside the port	+10 dBu	200 Ω	2 kΩ
AUD-HP	3.5 mm or 6.35 mm TRS	AC	Headphone output, tip left, ring right; level into the stated load	Per the product	10 Ω	32 Ω
DIG-SPDIF	RCA 75 Ω or TOSLINK	Digital	S/PDIF per IEC 60958-3, 0.5 V p-p into 75 Ω on RCA	Per IEC 60958-3	75 Ω	75 Ω
DIG-AES3	XLR 110 Ω	Digital	AES3, 2 to 7 V p-p into 110 Ω balanced	Per AES3	110 Ω	110 Ω
DIG-ADAT	TOSLINK	Digital	ADAT Lightpipe, eight channels at 48 kHz (four at 96 kHz S/MUX)	Per the ADAT optical interface	—	—
DIG-USB-AUDIO	USB	Digital	USB Audio Class 1 or 2, as stated	Per the USB Audio Class	—	—

C.2 EXTERNAL VIDEO

Composite and component video on 75 Ω coaxial jacks on the front are external ports like the audio ports above. A port list names

each by its class (VID-CVBS, VID-YPBPR, VID-RGBS, VID-RGSB, VID-RGBHV) with the formats it carries. EIS recommends that such a port take the COAX-IN termination or the COAX-OUT back-termination of 8.2. The video sync ports behind the panel belong to 8.2 and are listed by mode.

- *Levels.* Y with video sync is 1 V p-p whether the video sync is bi-level (–300 mV tip) or tri-level (±300 mV); Pb and Pr are 700 mV p-p.
- *RGB.* Three connector contracts, of which a product names the one it has: separate composite video sync, four components (VID-RGBS); video sync on green, three components (VID-RGSB); separate horizontal and vertical video sync, five components on five coaxial jacks or a D-sub 15 (VID-RGBHV).
- *Placement.* Each is a front or wall port; no BNC jack is inside the case (SIG-017).
- *HDMI.* The HDMI specification is available to adopters only, so a product states its HDMI version in its own documentation.

CLASS	CONNECTOR	COUPLING	NOMINAL	CLASS CEILING	SOURCE Z	LOAD Z
VID-CVBS	RCA, BNC, or SMA, 75 Ω	DC	Composite video, 1 V p-p into 75 Ω: 525-line per SMPTE ST 170, 625-line per ITU-R BT.1700	Per the composite standard	75 Ω	75 Ω
VID-YPBPR	3 × RCA, BNC, or SMA, 75 Ω	DC	Component video into 75 Ω: Y 700 mV video plus video sync, 1 V p-p with bi-level video sync (EIA-770.1 and 770.2) or tri-level ±300 mV (EIA-770.3, SMPTE ST 274 and ST 296); Pb and Pr 700 mV p-p	Per the component standard	75 Ω	75 Ω
VID-SVIDEO	4-pin mini-DIN per IEC 60933-5	DC	Y 1 V p-p with video sync, C 286 mV p-p burst (525-line, ST 170) or 300 mV (625-line, BT.1700)	Per SMPTE ST 170 or ITU-R BT.1700	75 Ω	75 Ω
VID-RGBS	4 × RCA, BNC, or SMA, 75 Ω (R, G, B, composite video sync)	DC	R, G, B 700 mV p-p into 75 Ω; separate composite video sync 300 mV (video) or TTL, stated by the product	Per EIA-770 or the product's statement	75 Ω	75 Ω
VID-RGBHV	5 × RCA, BNC, or SMA, 75 Ω (R, G, B, H, V), or D-sub 15 (VGA)	DC	R, G, B 700 mV p-p into 75 Ω; H and V video sync TTL on separate conductors; timing per the format, VESA DMT for a VGA mode	Per EIA-770 or VESA	75 Ω	75 Ω
VID-RGSB	3 × RCA, BNC, or SMA, 75 Ω	DC	R, G, B 700 mV p-p into 75 Ω with video sync on green, G 1 V p-p with bi-level or tri-level video sync	Per EIA-770	75 Ω	75 Ω

CLASS	CONNECTOR	COUPLING	NOMINAL	CLASS CEILING	SOURCE Z	LOAD Z
VID-HDMI	HDMI Type A	Digital	HDMI Type A connector; version per product documentation	Per HDMI specification	—	—
VID-SDI	BNC 75 Ω	Digital	SD-SDI, HD-SDI, 3G-SDI, 6G-SDI, or 12G-SDI per SMPTE	Per SMPTE ST 259, ST 292, ST 424, ST 2081, ST 2082	75 Ω	75 Ω

C.3 CONTROL AND DATA

The table gives each connector's pinout and level. MIDI TRS Type B swaps the tip and ring of Type A, and the two do not interwork; EIS recommends that a product with Type B wiring say so next to the jack. The DIN clock interface runs at 24 pulses per quarter note (Roland) or 48 (Korg), and the product states which. A word clock input states whether it terminates or loops through. An XLR-3 lighting port is common but is not DMX512-A. LINK names an expander or chaining header between products of one maker, which EIS does not define.

CLASS	CONNECTOR	COUPLING	NOMINAL	CLASS CEILING	SOURCE Z	LOAD Z
MIDI-DIN	5-pin DIN	Digital	MIDI 1.0 current loop (5 V or the 3.3 V option of CA-033); an output and a thru are both MIDI-DIN, stated by the product	Per MIDI 1.0	—	—
MIDI-TRS-A	3.5 mm TRS Type A	Digital	MIDI Association RP-054 Type A: tip to DIN pin 5, ring to pin 4, sleeve to pin 2	Per MIDI Association RP-054	—	—
MIDI-TRS-B	3.5 mm TRS Type B	Digital	MIDI Association RP-054 Type B: tip to DIN pin 4, ring to pin 5, sleeve to pin 2	Per MIDI Association RP-054	—	—
DMX512	XLR-5 (E1.11); RJ45 per ANSI E1.27-2	Digital	ANSI E1.11 DMX512-A; an XLR-3 port is not DMX512-A and is listed as unclassified	Per ANSI E1.11	—	—
SYNC-DIN	5-pin DIN	DC	the DIN clock interface, 24 or 48 PPQN as stated: pin 1 start/stop, pin 3 clock, pin 2 0 V, 0/+5 V TTL	TTL (5 V)	—	—

CLASS	CONNECTOR	COUPLING	NOMINAL	CLASS CEILING	SOURCE Z	LOAD Z
CLK-WORD	BNC 75 Ω	DC	Word clock, as AES11 Annex B (informative) describes it: a square wave at the sample rate, TTL at the source, about 2.5 V at a 75 Ω termination; an input states whether it terminates or loops through	TTL (5 V)	75 Ω	75 Ω
LINK	A board-to-board or expander header, as the product documents	Digital or analog, as documented	An expander or chaining connection between products of one maker; outside EIS	Per the product	—	—

C.4 ILDA LASER

Laser safety and interlock behavior follow the ILDA document and the applicable laser safety regulations, not EIS.

CLASS	CONNECTOR	COUPLING	NOMINAL	CLASS CEILING
ILDA-DB25	DB-25	Analog	ILDA ISP-DB25: X and Y differential pairs ±5 V per leg (±10 V differential), color 0 to +5 V, shutter TTL, interlock	Per ILDA ISP-DB25

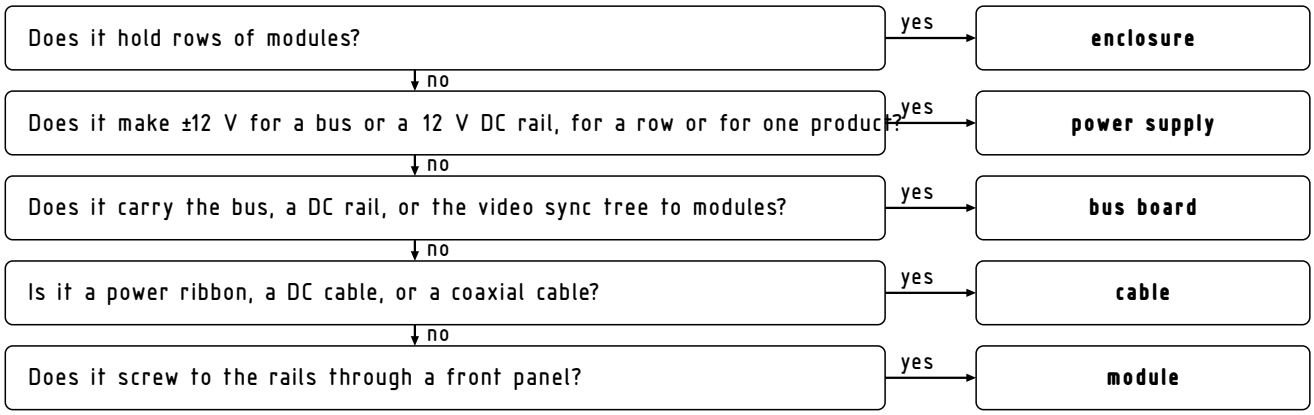
ANNEX D (INFORMATIVE) — DESIGNER'S GUIDE

The shortest path through EIS for a new product. Where this page and a normative clause differ, the clause governs.

D.1 CHOOSE THE CLAIM

Choose the product type (4.2); the table lists what each type publishes.

EIS · Which product type a product claims



Take the first yes: a case with a built-in supply is an enclosure, and a board that fans video sync or a DC rail out behind the panel is a bus board; distribution is a capability, not a type. Then list every port of a module by its class.

Figure 50. Which product type a product claims

PRODUCT	CLAIM	PUBLISHES
module	`module`	PANEL-003, PANEL-015, PWR-001, PWR-002, PWR-005, GND-004, DC-001 [PWR-DC12 entry], DC-002 [PWR-DC12 entry], DC-012 [PWR-DC12 outlet], DC-014 [PWR-DC12 entry], SIG-001, SIG-016 [VIDEO]
enclosure	`enclosure`	RAIL-011, ENC-001, PWR-001, PWR-002, PWR-005, GND-004, GND-005, BUS-012 [PWR-BUS outlet], DC-001 [PWR-DC12 entry], DC-002 [PWR-DC12 entry], DC-012 [PWR-DC12 outlet], DC-014 [PWR-DC12 entry]
bus board	`bus board`	PWR-001, PWR-002, PWR-005, GND-004, BUS-012 [PWR-BUS outlet], BUS-022 [PWR-BUS outlet], DC-001 [PWR-DC12 entry], DC-002 [PWR-DC12 entry], DC-012 [PWR-DC12 outlet], DC-014 [PWR-DC12 entry]
power supply	`power supply`	PWR-001, PWR-002, PWR-005, SUP-001, SUP-010, SUP-008, SUP-009, GND-003, GND-004, BUS-012 [PWR-BUS outlet], DC-001 [PWR-DC12 entry], DC-002 [PWR-DC12 entry], DC-012 [PWR-DC12 outlet], DC-014 [PWR-DC12 entry]
cable	`cable`; the claim file names the one interface it mates: PWR-BUS a power ribbon, PWR-DC12 a DC cable, VID-75 a coaxial cable	Nothing; it meets the wiring rules of its interface

D.2 MODULES BY ROLE

MODULE	CLAIM	PORT LIST AND CLAIM FILE
Logic, sequencer, quantizer, envelope, LFO, utility	module	A class for each patch jack; a quantizer's pitch ports as PITCH, with the tracking accuracy EIS recommends publishing
VCO, VCF, VCA, mixer, effect	module	AUDIO ports beside the control ports
Audio I/O with line or headphone jacks	module	Each line and headphone jack by its Annex C audio class
MIDI interface	module	Each MIDI jack by its Annex C control class
Video processor, keyer, mixer	module	VIDEO patch ports, each output with its path kind and bandwidth (SIG-016)
SD encoder or monitor locked to a rear video sync	module	VIDEO patch ports; the composite jack as a VID-CVBS port; the COAX-IN lists the four SD formats
HD encoder, scaler, or video I/O	module	VIDEO patch ports; each composite or component jack as a VID-CVBS, VID-YPBPR, VID-RGBS, VID-RGSB, or VID-RGBHV port; the COAX-IN lists the formats it locks to
Video sync generator	module	Each COAX-OUT lists the formats it generates, and a COAX-IN the formats it genlocks to
Any module locked to a rear video sync	module	A COAX-IN on an RCA or SMA jack, never a BNC inside the case (SIG-017); a THRU as a COAX-THRU, buffered, or looped with a termination switch; no patch jack carries the video sync (SIG-015, SIG-018)
DC entry panel, or bus board with PWR-DC12 outlets	module or bus board	The entry variant and input range (DC-001, DC-002); outputs to a supply or a bus board on M4 row wiring terminals, the default (PWR-005); outlets to modules on DC-BAR21 or DC-VH2 (DC-009), each with its current and the current at which its protection acts (DC-012); whether its 0 V is bonded to the chassis at the entry (DC-014)
Video sync distributor	bus board	A COAX-IN listing the formats it accepts; buffered COAX-THRU ports, each driving one module
Supply fed from a case DC entry	power supply	A DC-M4 entry on row wiring, the default: 30 A per pair at most, its terminals rated for their current (DC-001, PWR-005, PWR-006); its input range (DC-002); whether its 0 V is bonded to the chassis at the entry (DC-014)
Dual-source module	module	A PWR-BUS entry and a PWR-DC12 entry; runs from either alone (PWR-003); the installer connects one (ASM-003)

Every module also publishes whether its panel is connected to its 0 V and bonded to the rails (PANEL-015). The claim file lists each power entry: a power header for the bus, a DC entry for PWR-DC12. A module that needs more than one power header carries (BUS-008) uses a second power header, adds a DC entry, or takes PWR-DC12

alone. A power entry of another kind, at the maker's own rails, is outside EIS; the claim file names it as an entry EIS does not cover (6.1).

D.3 READING ORDER

1. Conformance: Core, product types, and the claim.
2. A module: front panels and boards. A case: rack, rails, enclosures, and the row budget.
3. Power: architecture, the bus, bus boards, power supplies, DC power entry, bus CV and gate, and grounding.
4. Signals: signals and patch signal classes. Video: video signals, video timing, VID-75, and, for a system, video sync distribution.
5. Worked examples of a module, a case, and a video row; Annex G for expanders, Annex H for heat.

D.4 MACHINE-READABLE NUMBERS

Read the numbers from the models rather than from the PDF tables:

TOPIC	FILE
Requirements	`requirements.json`
Document structure	`document.json`
EIS and the Doepfer A-100 documents	`doepfer_comparison.json`
A claim file	`claim.schema.json`
Panels, rails, inserts, screws	`module.json`, `rail.json`, `insert.json`, `screw.json`, `screw-fits.json`
Control layout on a front panel	`control_layout.json`
Legends and artwork on a front panel	`panel_art.json`
Rack figures	`standards.json`
Third-party sources cited	`sources.json`
Locked identifiers	`register.lock.json`
Power interfaces	`power_interfaces.json`
Power distribution examples: six cases wired, every conductor's gauge and length	`distribution_examples.json`
Power ribbons	`power_ribbon.json`
Signals, video, and DC entry	`signals.json`, `video_timings.json`, `video_75.json`, `dc_12.json`
Row budget (Annex E)	`row_budget.schema.json`

TOPIC	FILE
Examples	data/examples/

ANNEX E (INFORMATIVE) — ROW BUDGET

A planning worksheet for one row, with a schema and a validator. EIS does not require an enclosure to publish it. The rows behind it are ENC-001 (width and clear depth), PWR-001 and PWR-002 (the currents each power entry and outlet publishes, 6.1), BUS-012 (a bus board's per-header limit), SUP-001 (supply ripple), and ASM-001 (the installer's sum).

A row is budgeted per power interface (6.1): *the bus* and *PWR-DC12*, each where a source of that interface feeds modules in the row. Each interface's sources are listed with their totals (+12 V, −12 V; +5 V optional on the bus; 12 V: one +V and −V pair on PWR-DC12), and each module with its draw on each interface it uses.

THE ROW

FIELD	SOURCE
Row id or name	Maker
Width (HP)	ENC-001
Clear depth behind the panel (mm)	ENC-001
Video sync distribution	None, or VID-75 (a coaxial tree)

SOURCES, ONE LINE EACH, PER POWER INTERFACE

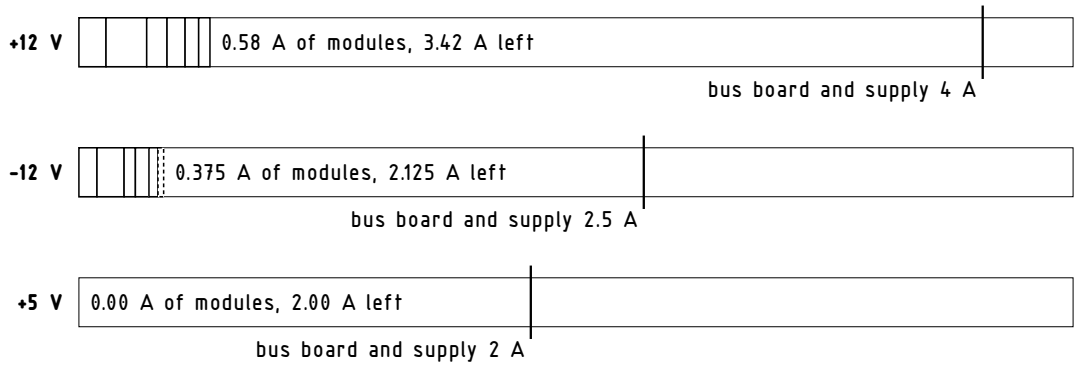
FIELD	SOURCE
Power interface	PWR-BUS or PWR-DC12 (6.1)
Source	Bus board, supply, or a product with PWR-DC12 outlets
Total on each rail of the interface (A)	PWR-002
Outlets, and the limit at each (A); a bus board header at most 1.5 A per rail	PWR-002, BUS-012
Ripple and noise, mV peak-to-peak (a supply)	SUP-001

MODULES

FIELD	SOURCE
HP and depth	PANEL-003
Draw on each power interface and rail (A)	PWR-001

On each power interface and rail, the modules' sum stays within every source on that interface, and each module's draw within the limit of its outlet (ASM-001). For a module that publishes no −12 V current, 9.1 recommends planning 50 % of its +12 V current.

EIS · A row's current budget on the bus: the example row 'performance'



- ☐ Audio I/O: +12 V 0.12 A, −12 V 0.08 A
- ☐ VCO: +12 V 0.09 A, −12 V 0.05 A
- ☐ Envelope/LFO: +12 V 0.06 A, −12 V 0.04 A
- ☐ Mixer: +12 V 0.18 A, −12 V 0.12 A
- ☐ VCF/VCA: +12 V 0.08 A, −12 V 0.06 A
- ☐ MIDI utility (Type A): +12 V 0.05 A, −12 V not published

A module goes into a row only while each rail's sum stays within the bus board's totals, its per-header limit, and the supply's rating (ASM-001). The dashed segment is the module with no published −12 V figure, planned at 50 % of its +12 V draw, as EIS recommends.

Figure 51. The example row's module currents against its bus board and supply

MACHINE-READABLE EXAMPLE

`data/examples/row_budget_two_row.yaml` describes a two-row instrument; `data/row_budget.schema.json` is its schema. Check it with:

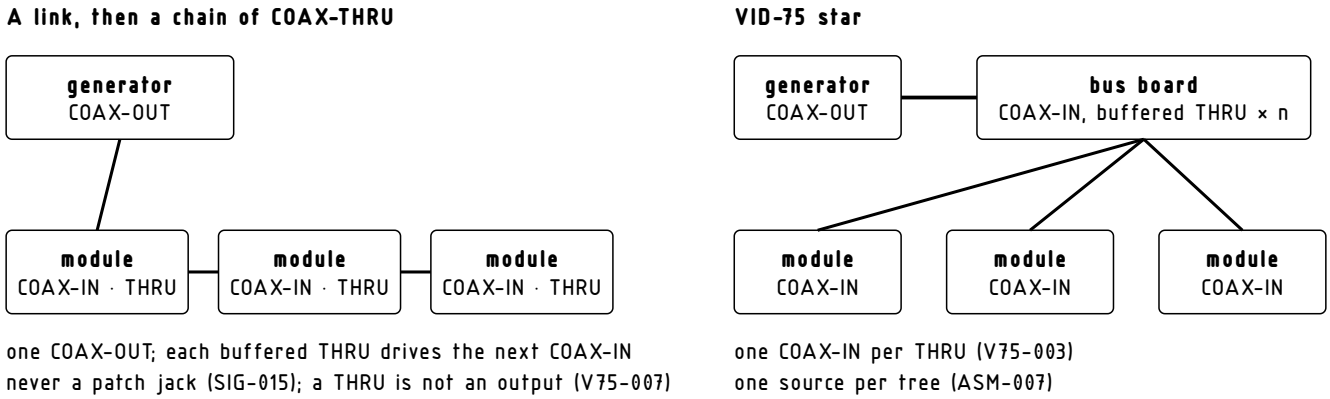
```
python tools/row_budget.py --check data/examples/row_budget_two_row.yaml
```

ANNEX F (INFORMATIVE) — VIDEO SYNC DISTRIBUTION

How to bring one video sync to every video module in a system. The video sync travels behind the panel on the 75 Ω coaxial interface of 8.2, from a COAX-OUT to each module's COAX-IN. It never travels on a patch cable: a patch jack carries patched signals only (SIG-015), and a module takes or gives the video sync at a rear port that its claim file lists by mode (SIG-018).

The video sync is black burst, or bi-level or tri-level video sync. Pictures travel between products on the same 75 Ω cabling, but the two are not interchangeable at a COAX-IN.

EIS · Video sync in a row: direct links, a THRU chain, or a star



Video sync is rear coaxial cabling, wired once. A direct link suits a few modules; a chain of buffered THRUs, or one looped run, suits a row whose modules have them; a star suits many modules on one video sync.

A facility video sync enters at a BNC on the enclosure's wall; no BNC is inside the case (SIG-017). Jack types may be mixed in a tree; an output is never split passively.

Figure 52. Video sync in a row: direct coaxial links, a chain of THRUs, or a distribution star

SITUATION	TYPICAL CHOICE
A few modules, and a generator with several COAX-OUT ports	A direct coaxial link from a COAX-OUT to each module's COAX-IN; no distributor
A row of modules with buffered COAX-THRU	A chain: the generator's COAX-OUT to the first COAX-IN, that module's COAX-THRU to the next COAX-IN, and so on; each buffered THRU drives one input
Modules with looped COAX-THRU	One cable run through each module's COAX-IN and looped THRU, with TERM on at the last module only
Many modules locked to one video sync	A star: a distributor, usually a bus board that carries the tree (BUS-020), with one COAX-THRU for each COAX-IN

SITUATION	TYPICAL CHOICE
A facility that distributes black burst or tri-level video sync between racks	The facility video sync at a BNC on the enclosure's wall, wired inside to the distributor's COAX-IN on RCA or SMA (SIG-017)
Two rows, one for performance and one for processing	A distributor in each row, or one coaxial link from the first row's tree to the second row's COAX-IN

A tree may mix jack types. Each output drives one terminated input (V75-003); see 8.2. A COAX-THRU is not a source: a tree needs one COAX-OUT, or an external video sync at a designated COAX-IN (ASM-007), and the claim files say which port is which.

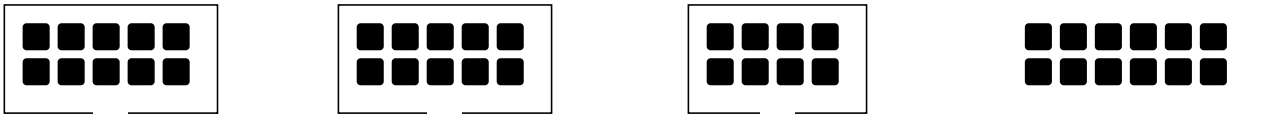
A module's front patch jacks carry its pictures, ramps, keys, and control (7.3). None of them is the video sync, so a patch never changes a module's timing.

Many video modules in use take their video sync on a rear 2 × 7 ribbon header, which is not a port of 8.2. Such a header mates a power ribbon socket, so BUS-011 applies to it (6.4), and the port list gives it as `unclassified`, named for what it connects to (Annex G). Such a module does not meet SIG-018 unless it also takes the video sync at a COAX-IN on its rear.

ANNEX G (INFORMATIVE) — EXPANDERS AND INTER-MODULE LINKS

The connections modules make with each other behind the panel: expander headers, digital links such as I2C, and analog links. EIS places one requirement on them, BUS-011 in 6.4: a header that is not the power header either does not mate a Eurorack power ribbon socket, or survives one fitted to it either way round. The rest of this annex is recommended practice.

EIS · An expander header beside the power header



power header, 2 × 5

expander, 2 × 5, same key
a ribbon fits: survive it

expander, 2 × 4
a ribbon does not fit

expander, 2 × 6, unshrouded
a ribbon fits: survive it

A header that is not the power header either does not mate a power ribbon socket or survives one fitted to it, either way round (BUS-011).

A different pitch or connector family, or a shrouded header too small for the socket, meets the first; protection on every pin meets the second.

Figure 53. An expander header next to the power header: a ribbon that fits both, and two ways to keep it out

G.1 EXPANDERS

An expander is a second module that adds jacks, controls, or memory to a main module through a short cable behind the panel. The signals on that cable are the maker's own, so EIS does not classify them.

TOPIC	PRACTICE
Port list	The expander header as a port, `unclassified`, named for what it connects to, for example `EXPANDER (to main module)`
Connector	A pin count or connector family that a power ribbon does not fit, or a shrouded header keyed against one; the board labels what the header is
Cable	Supplied with the expander, keyed, and long enough for the positions it is meant for, typically 100 mm to 150 mm
Power	From the expander's own power header or through the main module, as the manual states; its currents published either way (PWR-001)
Placement	The manual states where the expander may sit: next to the main module, in the same row, or in any row the cable reaches

G.2 I2C LINKS

Several module families share an I2C bus between modules, usually on a 3-pin header carrying SDA, SCL, and 0 V. I2C is defined by its own specification, NXP UM10204. So that modules from different makers can share one bus, EIS recommends:

TOPIC	PRACTICE
Logic level	3.3 V logic, with inputs that tolerate 5 V
Pull-ups	Fitted only by the products that say so; the manual states their value and whether they can be switched off
Bus loading	Total bus capacitance within the I2C limit of 400 pF; a bus across more than one row, or over more than about 1 m of cable, is a design to check, not a default
Addresses and roles	The manual lists each address the module answers and whether it acts as controller or target
Header	Pin order SDA, SCL, 0 V is common but not universal; the board marks each pin

A link header goes on the port list like an expander header, `unclassified`, named for its function, for example `I2C`.

G.3 ANALOG LINKS

A cable that carries analog signals between modules behind the panel, such as a normalled bus or a chained clock, joins the 0 V of the modules it links (6.3). EIS recommends listing it on the port list with the class its signals would have on a patch jack, so that its levels are known.

ANNEX H (INFORMATIVE) — HEAT AND MECHANICAL LOAD

The heat a row produces, how a case sheds it, and the forces a panel and its screws carry. EIS places no requirement here; the figures are planning aids built on the currents modules already publish (PWR-001).

H.1 HEAT FROM A ROW

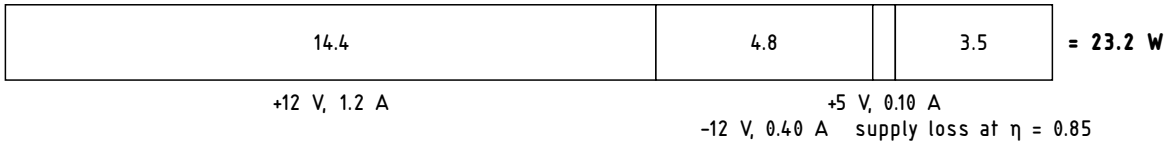
Every watt a module draws becomes heat inside the case. From its published currents, a module on the bus dissipates at most

```
P = 12 V × I(+12 V) + 12 V × I(−12 V) + 5 V × I(+5 V)
```

and a module at a DC entry adds 12 V × I(12 V). A row dissipates the sum over its modules; a published current is a maximum, so the sum is an upper bound. A supply inside the case adds its own loss, $P \times (1 / \eta - 1)$, where η is its efficiency at that load.

EIS · The heat of a row: published currents, supply loss, and the case's rise

Watts inside one 84 HP row



Temperature rise of a closed case

ΔT ≈ P / (h × A) = 23 W / (5 × 0.26) ≈ 18 °C in sheet metal, 23 W / (3 × 0.26) ≈ 30 °C in wood
h ≈ 5 W per square meter and kelvin through a sheet-metal wall, about 3 through wood or plastic;
A ≈ 0.26 square meters open to the air, a case 0.48 × 0.15 × 0.15 m on a table. An open-backed or vented case runs much cooler.

P = 12 V × I(+12) + 12 V × I(−12) + 5 V × I(+5), from the published currents (PWR-001); an upper bound.

Figure 54. The heat of a row: module dissipation from published currents, supply loss, and the case's temperature rise

For example, one 84 HP row whose modules publish 1.2 A on +12 V, 0.40 A on −12 V, and 0.10 A on +5 V:

SOURCE	CALCULATION	WATTS
+12 V	12 V × 1.2 A	14.4
−12 V	12 V × 0.40 A	4.8
+5 V	5 V × 0.10 A	0.5
Modules	sum	19.7
Supply loss at η = 0.85	19.7 × (1 / 0.85 − 1)	3.5
Inside the case		23.2

A supply mounted on the product it powers publishes its loss (SUP-008); 9.1 already counts it inside 12 V × its input current, and it is published so the installer knows where the heat sits. A linear regulator from 12 V to 5 V for a module's logic turns (12 V − 5 V) × I into heat behind the module: 2.1 W at 0.3 A. The row budget counts the mounted supply's input current on the interface it takes.

H.2 HOW WARM THE CASE GETS

A closed case sheds heat by natural convection and radiation from its outer surfaces, in about equal parts, through its walls. A rough estimate of how far the air inside rises above the room is

```
ΔT ≈ P / (h × A)
```

where h is the overall coefficient through the wall, about 5 W/(m2·K) for a sheet-metal case and about 3 for wood or plastic, and A is the outer surface open to the air: a desktop case's base on a table does not count. A 3U, 84 HP case about 0.48 m wide, 0.15 m deep, and 0.15 m tall has about 0.33 square meters of surface, 0.26 without its base, so 23 W raises a sheet-metal case by about 18 °C and a wooden one by about 30 °C. The same row in an open-backed or vented case runs much cooler.

EIS recommends that an enclosure publish, for each row, the dissipation it carries for a 10 °C rise above room temperature. EIS recommends that a module whose dissipation is much higher than its current suggests, such as one with a linear regulator dropping 12 V to 3.3 V, say so in its manual.

H.3 MECHANICAL LOAD

LOAD	PLANNING FIGURE	WHERE IT COMES FROM
Plug insertion at a jack	10 N	The force 5.2.1 uses for panel bow
Mounting-screw torque	At most 0.5 N·m	An M3 screw holds in three threads of a 1.5 mm to 2.0 mm insert (5.3); more torque strips the insert before it tightens the panel
Module mass	Published when it is more than the panel and board alone	A heavy module in a portable case loads its four screws in transport

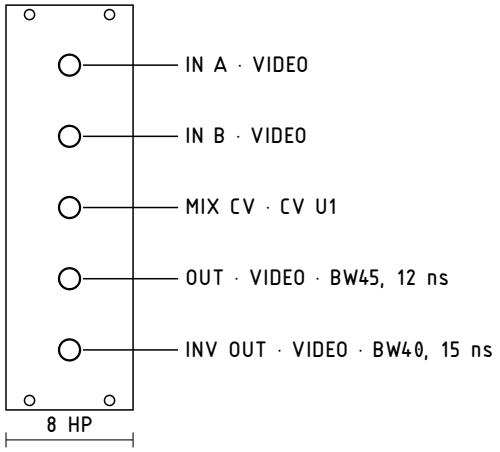
EIS recommends that a module whose mass would bend its panel in transport, such as one with a large transformer or a display, publish its mass and supply a support bracket where it needs one.

ANNEX I (INFORMATIVE) — WORKED EXAMPLES

Three products taken from first sketch to claim, to show how the clauses fit together, and six cases wired as 6.1 and 6.3 ask. The figures are illustrative. Each product example has a claim file in `data/examples/` that `eis claim` accepts.

I.1 A MODULE: A TWO-CHANNEL VIDEO MIXER

EIS · Worked example: a two-channel video mixer, from panel to claim



claim	**EIS draft, module**
size	3U, 8 HP, 28 mm deep
+12 V	0.12 A
-12 V	0.06 A
+5 V	0 A, 10-pin header
ports	5, each with a class
heat	2.2 W at most

From data/examples/claim-module-video-mixer.yaml.

Figure 55. The video mixer: its panel, its port list, and the claim it publishes

STEP	DECISION	REQUIREMENT
1. Size	3U, 8 HP: a panel 128.5 mm high and no wider than 40.64 mm, made 40.34 mm; four Ø3.2 mm holes on the hole grid	PANEL-002, PANEL-006, PANEL-010, PANEL-011
2. Board	28 mm deep behind the panel, and 9.25 mm clear of the top and bottom edges	PANEL-003, PANEL-012
3. Power	Publishes 0.12 A on +12 V, 0.06 A on -12 V, and 0 on +5 V; it uses neither +5 V nor bus CV or gate, so a 10-pin header is enough	PWR-001, BUS-007
4. Protection	Survives a reversed ribbon; every 0 V pin of the header is tied to the board's 0 V	BUS-009, GND-001
5. Ports	IN A and IN B: VIDEO inputs, 100 kΩ. OUT and INV OUT: VIDEO outputs through 75 Ω. MIX CV: CV at U1, the 0 to +1 V scale of VIDEO. All five go on the port list	SIG-001, SIG-005, SIG-009, SIG-010
6. Patch safety	Every input survives ±12 V; every output survives a short and never drives beyond ±12 V	SIG-002, SIG-003, SIG-004
7. Video paths	OUT and INV OUT are linear paths from IN A, published as BW45 and BW40. As EIS recommends, it also publishes the measuring method, Method A of Annex A, the delays, 12 ns and 15 ns, and 22 pF at each input	SIG-016, 7.3
8. Claim	A module; its power header is a PWR-BUS entry of Core: `EIS draft, module`	`claim-module-video-mixer.yaml`

It dissipates at most 12 V × 0.12 A + 12 V × 0.06 A = 2.2 W (Annex H).

I.2 A CASE: TWO ROWS WITH A BUILT-IN SUPPLY

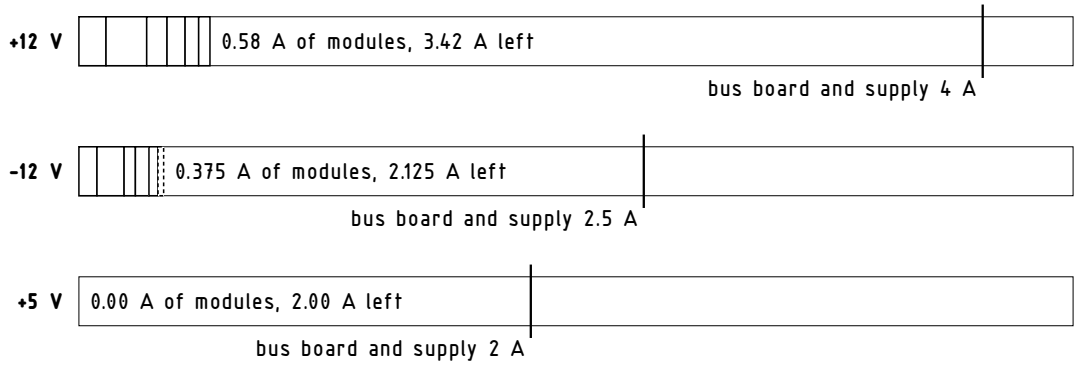
A desktop case with two 104 HP rows, each 55 mm deep behind the panel; a built-in supply rated 4.0 A on +12 V, 2.0 A on −12 V, and 2.0 A on +5 V; and a built-in bus board with 28 headers and a 1.5 A per-header limit.

STEP	DECISION	REQUIREMENT
1. Rows	Publishes 104 HP and 55 mm for each row, so a 28 mm module fits and a 60 mm one does not	ENC-001, PANEL-003
2. Rails	Rails of the recommended section with M3 inserts; ships 6 mm M3 screws and states their length	RAIL-003, RAIL-009, RAIL-011
3. Supply	Publishes each rail's rating and ripple: 10 mV, 10 mV, and 15 mV, all below 150 mV. Marks each terminal with its rail; survives a short on any rail; swings no more than a diode drop toward the opposite polarity, and overshoots by no more than 10 % at start-up	PWR-002, SUP-001 to SUP-007
4. Bus board	Publishes its totals and the 1.5 A per-header limit; every header's 0 V runs to the supply's 0 V	PWR-002, BUS-012, GND-002
5. Earth	Its 0 V is bonded to the chassis at the built-in supply's earth terminal, by a 14 AWG strap to a bare pad, and the chassis to protective earth at the IEC inlet; the documentation says so	GND-003, PWR-008
6. Row wiring	14 AWG from the supply's M4 terminals to each bus board, the 0 V carrying the larger of 4.0 + 2.0 A and 2.0 A, 6 A	PWR-005 to PWR-007
7. Claim	It plays three roles: `EIS draft, enclosure + power supply + bus board` (4.2)	`claim-enclosure.yaml`

Whoever fills a case then budgets each row (9.1). `row_budget_two_row.yaml` does so for a separate example instrument, not the case above: two 84 HP rows, each with its own bus board and supply.

ROW	+12 V	−12 V	PWR-DC12	HEAT (ANNEX H)
Performance	0.58 A	0.375 A, the MIDI utility's unpublished −12 V current planned at half its +12 V current	—	about 11.5 W
Processing	1.03 A	0.50 A	1.6 A	about 37.6 W

EIS · A row's current budget on the bus: the example row 'performance'



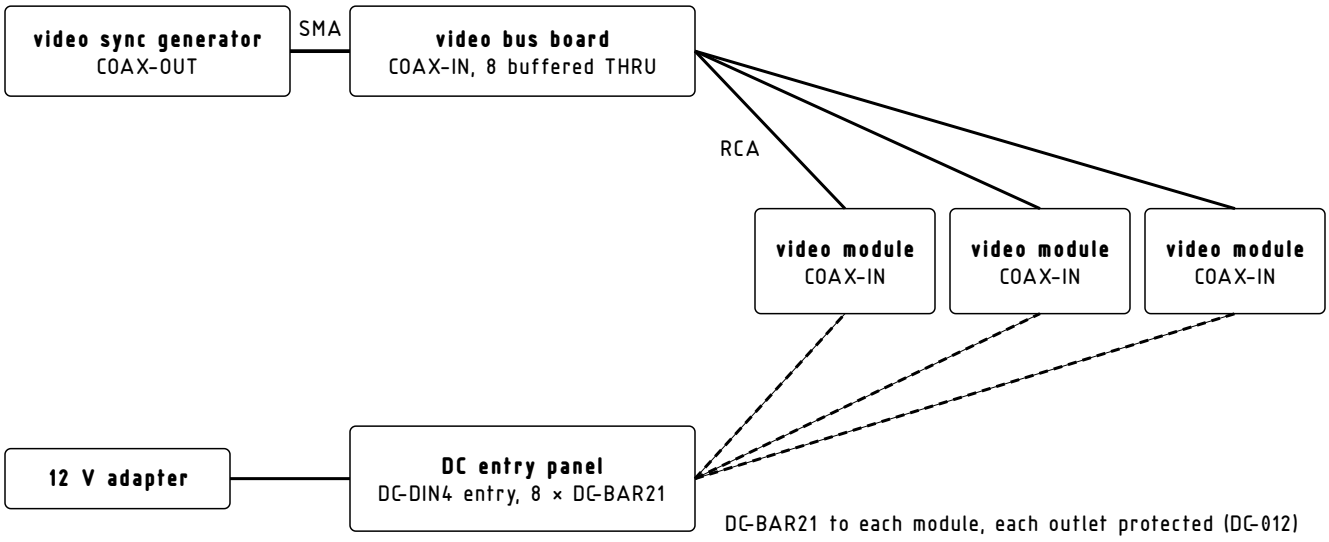
- ☐ Audio I/O: +12 V 0.12 A, −12 V 0.08 A
- ☐ VCO: +12 V 0.09 A, −12 V 0.05 A
- ☐ Envelope/LFO: +12 V 0.06 A, −12 V 0.04 A
- ☐ Mixer: +12 V 0.18 A, −12 V 0.12 A
- ☐ VCF/VCA: +12 V 0.08 A, −12 V 0.06 A
- ☐ MIDI utility (Type A): +12 V 0.05 A, −12 V not published

A module goes into a row only while each rail's sum stays within the bus board's totals, its per-header limit, and the supply's rating (ASM-001). The dashed segment is the module with no published −12 V figure, planned at 50 % of its +12 V draw, as EIS recommends.

Figure 56. The example row's module currents against its bus board and supply

I.3 A VIDEO ROW: ONE VIDEO SYNC, ONE DC RAIL

EIS · Worked example: one video sync and one DC rail across a row



One source per tree (ASM-007); each module on one of its power entries at a time (ASM-003); shells and −V are 0 V (V75-002, GND-001).

Figure 57. A video row: a video sync generator feeding a bus board's tree, and a DC entry panel feeding the same modules

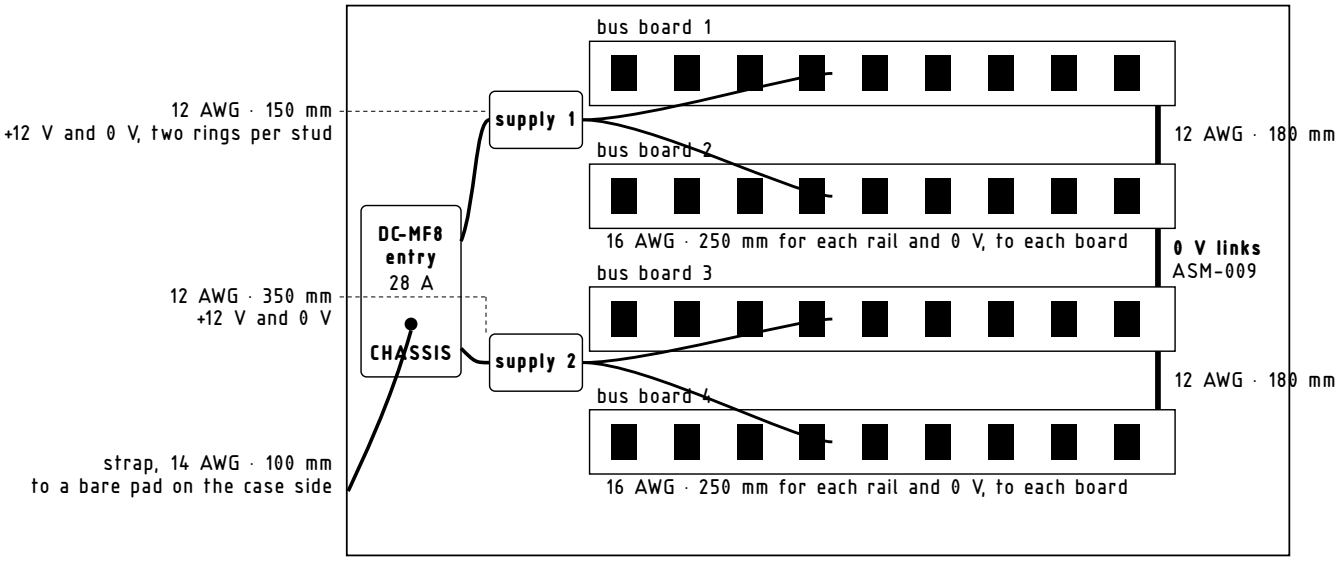
STEP	PART AND CLAIM	WHAT IT DOES IN THE ROW
1. Generate	Video sync generator, `module`, `claim-module-video-sync-generator.yaml`	Its VIDEO SYNC OUT, a COAX-OUT on SMA, drives the bus board's VIDEO SYNC IN
2. Distribute	Video bus board, `bus board`, `claim-bus-board-video-sync.yaml`	Takes the video sync at VIDEO SYNC IN, a COAX-IN, and gives each module a buffered copy at a COAX-THRU
3. Lock	Video modules, `module`	Each takes the video sync at a rear COAX-IN on RCA or SMA; no BNC is inside the case (SIG-017)
4. Power	DC entry panel, `module`, `claim-module-dc-entry.yaml`	Takes 12 V at a DC-DIN4 case entry and feeds modules at DC-BAR21 outlets, each protected
5. Cable	`cable` mating VID-75 or PWR-DC12	Coaxial cables center to center and shell to shell (V75-004); DC cables +V to +V and -V to -V (DC-010)
6. Install	The installer	One source per tree (ASM-007); each dual-source module connected to one source (ASM-003)

Every coaxial shell, and the DC rail's -V, is the modules' 0 V (V75-002, GND-001), so the video sync, the picture, and the power share one 0 V. With the DC adapter floating and one earth bond at the case supply, there is no ground loop to show as hum bars (6.3).

I.4 POWER DISTRIBUTION: SIX CASES WIRED

Every conductor of row wiring in six cases, with its gauge and length, its resistance and drop, and the rule it meets. The resistances are the row wiring table's figures (6.1): stranded copper at 1.05 times the solid figure, plus 0.25 mΩ for each crimp and its bolted joint. Every ring terminal sits on an M4 terminal under a lock washer (PWR-005), the default way power travels between products, and every supply fed from a case DC entry takes the rail at a DC-M4 entry (8.1). The tables are generated from `data/distribution_examples.json`, and the generator refuses an example that breaks a rule.

EIS · Four rows from two supplies: one entry, two stars of returns, three links, one tie



Two supplies, two stars: each board's 0 V returns to its own supply (GND-002); the links hold the four boards at one reference (ASM-009); the entry's studs take one lead per supply, two rings each. One tie, at the entry's CHASSIS stud (DC-014); both supplies publish their 0 V as floating from the case. The table in Annex I.4 gives every conductor's resistance and drop.

Figure 58. Four rows from two supplies: the DC entry feeding both, two stars of returns, three links, one tie

ONE ROW FROM A DC ADAPTER

A 3U, 84 HP desktop case in wood with anodized rails and steel M3 strips. A 12 V, 5 A desktop adapter plugs into a DC-DIN4 case DC entry panel at the left end of the row; a 48 W-class supply (2.6 A on +12 V, 1.0 A on −12 V, 1.0 A on +5 V) sits behind the row beside the entry and takes the rail at its DC-M4 entry; one bus board runs the row, its inlet terminals at mid-row.

The DC entry panel bonds 0 V to its panel through a 0 Ω link and carries the M4 CHASSIS stud; the case is wood and the rails anodized, so the chassis is the steel strips and whatever panels are bare under their screw heads, and no strap is needed (6.3). The adapter floats.

CONDUCTOR	CARRIES	GAUGE	LENGTH	RESISTANCE	DROP	MEETS	OR
entry +12 V to supply +12 V in	5 A	16 AWG or 1.5 mm²	150 mm	2.6 mΩ	13 mV	PWR-006, 16 AWG up; PWR-007, 5 mΩ	—
entry 0 V to supply 0 V in	5 A	16 AWG or 1.5 mm²	150 mm	2.6 mΩ	13 mV	PWR-006, 16 AWG up; PWR-007, 5 mΩ	—

CONDUCTOR	CARRIES	GAUGE	LENGTH	RESISTANCE	DROP	MEETS	OR
supply +12 V to bus board +12 V	2.6 A	16 AWG or 1.5 mm^2	300 mm	4.6 mΩ	12 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	18 AWG would be 7.1 mΩ: fails
supply −12 V to bus board −12 V	1 A	16 AWG or 1.5 mm^2	300 mm	4.6 mΩ	5 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	—
supply +5 V to bus board +5 V	1 A	16 AWG or 1.5 mm^2	300 mm	4.6 mΩ	5 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	—
supply 0 V to bus board 0 V	3.6 A	16 AWG or 1.5 mm^2	300 mm	4.6 mΩ	17 mV	PWR-006, 16 AWG up; PWR-007, 5 mΩ; 0 V no higher than its rails	—

- One gauge for the whole case: 16 AWG, 1.5 mm^2 silicone, with red, blue, yellow, and black insulation for +12 V, −12 V, +5 V, and 0 V, and a 22 to 16 AWG ring terminal at every end.
- The 0 V conductor to the bus board carries the three rails' return, 3.6 A at most, and is the same gauge as the rail conductors beside it (PWR-007).
- Every module hangs on a power ribbon of at most 400 mm (BUS-015); the row wiring ends at the bus board.

TWO ROWS FROM ONE SUPPLY

A 6U, 104 HP case in powder-coated aluminum with bare pads where the rails meet its sides, so the sides, rails, and strips are one chassis (GND-005). A DC-DIN4 case DC entry at the left feeds the DC-M4 entry of a 100 W-class supply (6.0 A on +12 V, 2.5 A on −12 V, 2.0 A on +5 V, 112 W out, about 11 A in at 85 % efficiency) mounted between the rows at the left end; each row has its own bus board with its inlet at mid-row, 250 mm from the supply for the upper row and 400 mm for the lower.

The tie is the DC entry panel's CHASSIS stud. A strap from it to the nearest bare pad on the case side bonds the metalwork; the supply's 0 V is not bonded to the case anywhere else, and the supply publishes that.

CONDUCTOR	CARRIES	GAUGE	LENGTH	RESISTANCE	DROP	MEETS	OR
entry +12 V to supply +12 V in	11 A	12 AWG or 4 mm^2	200 mm	1.6 mΩ	18 mV	PWR-006, 12 AWG up; PWR-007, 5 mΩ	—
entry 0 V to supply 0 V in	11 A	12 AWG or 4 mm^2	200 mm	1.6 mΩ	18 mV	PWR-006, 12 AWG up; PWR-007, 5 mΩ	—

CONDUCTOR	CARRIES	GAUGE	LENGTH	RESISTANCE	DROP	MEETS	OR
supply +12 V to upper board	3 A	16 AWG or 1.5 mm^2	250 mm	4.0 mΩ	12 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	18 AWG would be 6.0 mΩ: fails
supply −12 V to upper board	1.25 A	16 AWG or 1.5 mm^2	250 mm	4.0 mΩ	5 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	—
supply +5 V to upper board	1 A	16 AWG or 1.5 mm^2	250 mm	4.0 mΩ	4 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	—
supply 0 V to upper board	4 A	16 AWG or 1.5 mm^2	250 mm	4.0 mΩ	16 mV	PWR-006, 16 AWG up; PWR-007, 5 mΩ; 0 V no higher than its rails	—
supply +12 V to lower board	3 A	14 AWG or 2.5 mm^2	400 mm	4.0 mΩ	12 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	16 AWG would be 6.0 mΩ: fails
supply −12 V to lower board	1.25 A	14 AWG or 2.5 mm^2	400 mm	4.0 mΩ	5 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	—
supply +5 V to lower board	1 A	14 AWG or 2.5 mm^2	400 mm	4.0 mΩ	4 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	—
supply 0 V to lower board	4 A	14 AWG or 2.5 mm^2	400 mm	4.0 mΩ	16 mV	PWR-006, 16 AWG up; PWR-007, 5 mΩ; 0 V no higher than its rails	—
0 V link, upper board to lower board	no load: a reference	12 AWG or 4 mm^2	180 mm	1.5 mΩ	—	ASM-009, 2 mΩ	—
strap, CHASSIS stud to the case side	no load: a bond	14 AWG or 2.5 mm^2	100 mm	1.4 mΩ	—	PWR-008, 14 AWG up	—

- The lower board's conductors are 14 AWG because of their length: 16 AWG over 400 mm would be over the 5 mΩ limit, as the table's alternative column shows.
- Each supply output terminal carries two ring terminals, one per board (6.1 recommends at most two); the +12 V terminal carries 6.0 A, within a 15 A terminal.
- The two boards hang on one supply, so ASM-009 does not require the link, but the two returns drop differently under load; the 12 AWG link holds the rows' references together for the cost of 180 mm of wire.

FOUR ROWS FROM TWO SUPPLIES

A 12U, 104 HP case, four rows, two 100 W-class supplies, one DC-MF8 case DC entry rated 28 A at the left feeding both supplies' DC-M4 entries in parallel, about 11 A each. Supply 1 sits between rows 1 and 2 and feeds their boards; supply 2 between rows 3 and 4 and feeds theirs. Each board's inlet is at mid-row, 250 mm from its supply.

One tie, at the DC entry: its CHASSIS stud, strapped to the case side. Both supplies publish their 0 V as floating from the case. Row wiring returns run as two stars, one per supply; the links between the boards hold the four rows at one reference (ASM-009).

CONDUCTOR	CARRIES	GAUGE	LENGTH	RESISTANCE	DROP	MEETS	OR
entry +12 V to supply 1 +12 V in	11 A	12 AWG or 4 mm^2	150 mm	1.3 mΩ	15 mV	PWR-006, 12 AWG up; PWR-007, 5 mΩ	—
entry 0 V to supply 1 0 V in	11 A	12 AWG or 4 mm^2	150 mm	1.3 mΩ	15 mV	PWR-006, 12 AWG up; PWR-007, 5 mΩ	—
entry +12 V to supply 2 +12 V in	11 A	12 AWG or 4 mm^2	350 mm	2.4 mΩ	27 mV	PWR-006, 12 AWG up; PWR-007, 5 mΩ	14 AWG carries at most 8 A: fails PWR-006
entry 0 V to supply 2 0 V in	11 A	12 AWG or 4 mm^2	350 mm	2.4 mΩ	27 mV	PWR-006, 12 AWG up; PWR-007, 5 mΩ	—
supply 1 +12 V to board 1	3 A	16 AWG or 1.5 mm^2	250 mm	4.0 mΩ	12 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	—
supply 1 0 V to board 1	4 A	16 AWG or 1.5 mm^2	250 mm	4.0 mΩ	16 mV	PWR-006, 16 AWG up; PWR-007, 5 mΩ	—
supply 1 +12 V to board 2	3 A	16 AWG or 1.5 mm^2	250 mm	4.0 mΩ	12 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	—
supply 1 0 V to board 2	4 A	16 AWG or 1.5 mm^2	250 mm	4.0 mΩ	16 mV	PWR-006, 16 AWG up; PWR-007, 5 mΩ	—

CONDUCTOR	CARRIES	GAUGE	LENGTH	RESISTANCE	DROP	MEETS	OR
supply 2 +12 V to board 3	3 A	16 AWG or 1.5 mm^2	250 mm	4.0 mΩ	12 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	—
supply 2 0 V to board 3	4 A	16 AWG or 1.5 mm^2	250 mm	4.0 mΩ	16 mV	PWR-006, 16 AWG up; PWR-007, 5 mΩ	—
supply 2 +12 V to board 4	3 A	16 AWG or 1.5 mm^2	250 mm	4.0 mΩ	12 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	—
supply 2 0 V to board 4	4 A	16 AWG or 1.5 mm^2	250 mm	4.0 mΩ	16 mV	PWR-006, 16 AWG up; PWR-007, 5 mΩ	—
0 V link, board 1 to board 2	no load: a reference	12 AWG or 4 mm^2	180 mm	1.5 mΩ	—	ASM-009, 2 mΩ	—
0 V link, board 2 to board 3 (the one ASM-009 requires)	no load: a reference	12 AWG or 4 mm^2	180 mm	1.5 mΩ	—	ASM-009, 2 mΩ	—
0 V link, board 3 to board 4	no load: a reference	12 AWG or 4 mm^2	180 mm	1.5 mΩ	—	ASM-009, 2 mΩ	—
strap, CHASSIS stud to the case side	no load: a bond	14 AWG or 2.5 mm^2	100 mm	1.4 mΩ	—	PWR-008, 14 AWG up	—

- The −12 V and +5 V conductors of each board are left out of the table; they follow the +12 V ones at 16 AWG and 250 mm.
- The DC entry's +12 V and 0 V terminals each carry two ring terminals, one lead per supply, and 22 A in all, within a 30 A terminal and the entry's 28 A; a 15 A terminal would need one lead per stud, which is why a high-current entry carries two studs per pole.
- Boards 2 and 3 each take their return and two links on 0 V, three rings: a bus board's second M4 0 V position, or a 0 V strip with a bar (BUS-021), is where the third goes.
- A chain of three links satisfies ASM-009 here, since every board reaches a board of the other supply through them; a fourth link, board 1 to board 4, would make it a grid.
- Terminals with more than two ring terminals: b2.0V, b3.0V; a second M4 position or a 0 V strip takes the third (6.1, BUS-021).

TWO HEAVY ROWS FROM ONE SUPPLY AT A 28 A ENTRY

A 6U, 104 HP case of video modules, two heavy rows, one 300 W-class supply (15 A on +12 V, 6.0 A on −12 V, 4.5 A on +5 V, 275 W out, about 25 A in at 90 % efficiency) with a DC-M4 entry, fed from a DC-MF8 case DC entry panel rated 28 A at the left. The supply sits between the rows at the left end; each row's bus board has its inlet at mid-row, 250 mm from the supply.

One tie, at the DC entry panel's CHASSIS stud, strapped to the case side. The supply's 0 V floats from the case, and the supply publishes that (DC-014).

CONDUCTOR	CARRIES	GAUGE	LENGTH	RESISTANCE	DROP	MEETS	OR
entry +12 V to supply DC-M4 +V	28 A	10 AWG or 6 mm²	200 mm	1.2 mΩ	33 mV	PWR-006, 10 AWG up; PWR-007, 5 mΩ	12 AWG carries at most 15 A: fails PWR-006
entry 0 V to supply DC-M4 −V	28 A	10 AWG or 6 mm²	200 mm	1.2 mΩ	33 mV	PWR-006, 10 AWG up; PWR-007, 5 mΩ	—
supply +12 V to upper board	7.5 A	14 AWG or 2.5 mm²	250 mm	2.7 mΩ	20 mV	PWR-006, 14 AWG up; PWR-007, 5 mΩ	16 AWG carries at most 5 A: fails PWR-006
supply 0 V to upper board	9.75 A	12 AWG or 4 mm²	250 mm	1.9 mΩ	18 mV	PWR-006, 12 AWG up; PWR-007, 5 mΩ; 0 V no higher than its rails	—
supply +12 V to lower board	7.5 A	14 AWG or 2.5 mm²	250 mm	2.7 mΩ	20 mV	PWR-006, 14 AWG up; PWR-007, 5 mΩ	—
supply 0 V to lower board	9.75 A	12 AWG or 4 mm²	250 mm	1.9 mΩ	18 mV	PWR-006, 12 AWG up; PWR-007, 5 mΩ; 0 V no higher than its rails	—
strap, CHASSIS stud to the case side	no load: a bond	14 AWG or 2.5 mm²	100 mm	1.4 mΩ	—	PWR-008, 14 AWG up	—

- The entry leads are sized for the 28 A the entry can deliver, as 6.1 recommends, not for the supply's 25 A: one 10 AWG conductor per pole, within PWR-006's 30 A, at 1.2 mΩ over 200 mm.
- The supply's claim file lists its input as a DC-M4 entry at its 25 A input current (PWR-001); its M4 terminals are rated 30 A, above the 28 A they can carry (PWR-005), and take one ring each.
- Each board's 0 V carries the larger of 7.5 + 2.25 A and 3.0 A, 9.75 A, and takes 12 AWG. The −12 V and +5 V conductors follow the +12 V ones at 16 AWG and 250 mm and are left out of the table.

A RACK FRAME WITH AN AC INLET

A zinc-plated steel 19-inch rack frame, 3U, 84 HP, with an AC inlet on its rear panel and a linear bus supply (2.0 A on +12 V, 2.0 A on −12 V, 1.0 A on +5 V) on the rear panel too, 350 mm from the bus board's inlet at mid-row. The frame's plated steel bonds at every bolt.

The chassis is bonded to protective earth at the AC inlet, under the safety standard the supply is built to; 0 V meets the chassis at the supply's earth terminal, which the supply publishes (GND-003), on a strap to the frame. The DC side has no case DC entry, so there is no second tie.

CONDUCTOR	CARRIES	GAUGE	LENGTH	RESISTANCE	DROP	MEETS	OR
supply +12 V to bus board +12 V	2 A	14 AWG or 2.5 mm^2	350 mm	3.5 mΩ	7 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	16 AWG would be 5.3 mΩ: fails
supply −12 V to bus board −12 V	2 A	14 AWG or 2.5 mm^2	350 mm	3.5 mΩ	7 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	—
supply +5 V to bus board +5 V	1 A	14 AWG or 2.5 mm^2	350 mm	3.5 mΩ	4 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ	—
supply 0 V to bus board 0 V	3 A	14 AWG or 2.5 mm^2	350 mm	3.5 mΩ	11 mV	PWR-006, 18 AWG up; PWR-007, 5 mΩ; 0 V no higher than its rails	—
bond, supply earth terminal to the frame	no load: a bond	14 AWG or 2.5 mm^2	80 mm	1.2 mΩ	—	PWR-008, 14 AWG up	—

- 2 A on +12 V would allow 18 AWG by current, but 350 mm of 18 AWG is 8.2 mΩ and 16 AWG 5.3 mΩ; the length, not the current, sets 14 AWG here. Shorter leads, a supply nearer the inlet, would do the same with 16 AWG.
- The 0 V conductor carries 3.0 A at most, +12 V and +5 V returning together against −12 V's 2.0 A.

TWO CASES, EACH WITH ITS SUPPLY

Two desktop cases of the first example side by side, each with its own adapter, DC entry, supply, and bus board, patched together. Each case's bus board carries a second M4 0 V terminal for the link.

Each case has its own tie at its DC entry; the adapters float, so the two ties make no loop. Each case has its own supply, so EIS recommends a 0 V link between the two bus boards (6.3): 10 AWG or

heavier, as short as the cases allow, at most 2 mΩ where it can be. ASM-009's 2 mΩ binds inside one enclosure; three or more cases link as a grid.

CONDUCTOR	CARRIES	GAUGE	LENGTH	RESISTANCE	DROP	MEETS	OR
0 V link, case A bus board to case B bus board	no load: a reference	10 AWG or 6 mm^2	400 mm	1.9 mΩ	—	2 mΩ, recommended between cases (6.3)	12 AWG would be 2.7 mΩ: fails

- A 400 mm link on 10 AWG measures 1.9 mΩ, inside the 2 mΩ EIS recommends between cases; 12 AWG would reach only 270 mm, and past about 440 mm even 10 AWG cannot hold it, which is why the figure binds only inside a case. Hinton Instruments' ZeroVolt links between cases measure under 2 mΩ on heavy cable and high-current connectors.
- If the two cases shared one adapter through a case DC entry with two outlets, they would be one system with one tie; the supplies would still be two, so the link would still be wanted.

ANNEX J (INFORMATIVE) — EIS AND THE DOEPFER A-100 DOCUMENTS

The A-100 is the system the Eurorack format comes from. This annex answers one question: what would a product built to Doepfer's figures need to change to conform to EIS? J.1 gives the figures EIS takes from Doepfer's construction and technical pages; J.2 lists every statement of Doepfer's A-100 documents on which EIS is stricter, looser, different, or more specific. A statement EIS restates unchanged, or one EIS does not take up (a fact about a Doepfer product, or advice for Doepfer's own systems), is not listed.

EIS applies none of Doepfer's documents by reference; where they differ, EIS governs a product that claims it.

In the Provenance column of J.1, `inherited` marks a figure EIS takes from the Doepfer page and `EIS` a figure EIS sets itself.

J.1 FIGURES EIS INHERITS

J.1.1 CONSTRUCTION DETAILS

Doepfer publishes Construction Details A-100, retrieved 2026-10-09. EIS restates some of its figures as `inherited` requirements and does not apply the page by reference. The A-100 check compares selected figures with EIS.

FIGURE ON THE PAGE	VALUE	EIS REQUIREMENT	PROVENANCE
3U front panel height	128.5 mm	PANEL-006, 128.5 mm	inherited
Front panel mounting-hole inset	3.0 mm	PANEL-008	inherited
Front panel mounting-hole drill	Ø3.2 mm	PANEL-010	inherited
Front panel thickness	2 mm	PANEL-004, at most 2.0 mm, +0.1 mm sheet tolerance; EIS recommends 1.6 mm to 2.0 mm	inherited; EIS
Front panel widths	below N × 5.08 mm	PANEL-002, at most N × 5.08 mm for any positive whole N; EIS recommends 0.3 mm below	inherited; EIS
Mean front panel width gap	0.309 mm	The 0.3 mm width clearance EIS recommends	EIS

The panel figures EIS derives from these are in 5.2.1.

J.1.2 TECHNICAL DETAILS

Doepfer publishes Technical Details A-100, retrieved 2026-10-16. The signal check quotes its figures and reports where EIS differs.

The page's patch levels are typical ranges, and modules in use exceed them. Because an input has to accept what an output may send, EIS sets audio at ±10 V peak (AUDIO, B10), and sets control CV by the range a port claims, ±5 V (B5) when none is named.

FIGURE ON THE PAGE	VALUE	EIS CLASS	PROVENANCE
Audio	typically 10 Vpp (-5 to +5 V)	*AUDIO* ±10 V peak	EIS
LFO	-2.5 to +2.5 V	*CV* at range B5 (±5 V)	EIS
ADSR	0 to +8 V	*CV* at range U10 (0 to +10 V)	EIS
Gate, trigger, clock	typically 0/+5 V; above about +3 V is high, below 1 V is low; withstands up to +12 V	*GATE* high ≥ +3 V, low ≤ +1 V; *BUS-GATE* 0/+5 V	inherited
Pitch CV	1 V per octave; no CV value is assigned an absolute pitch	*PITCH* 1.00 V/octave, 0 V = C0 recommended (the reference is EIS's); *BUS-CV* 1 V/octave	EIS; inherited

FIGURE ON THE PAGE	VALUE	EIS CLASS	PROVENANCE
Input and output impedance	not stated	1 kΩ source, 100 kΩ load, typical	EIS

J.2 WHERE EIS DIFFERS

Each statement keeps its number from the full inventory (D-001 to D-171, in the repository's history), is paraphrased with every figure as Doepfer gives it, and links the page or document it comes from. The Kind column keeps Doepfer's own distinction between a rule, a typical value, and a recommendation. Each is classified by one difference:

- *tightened*: EIS keeps Doepfer's rule and makes it stricter, gives it a tolerance, or makes Doepfer's typical value a binding figure.
- *relaxed*: EIS allows more than Doepfer does.
- *changed*: EIS sets a different value or rule.
- *added*: EIS sets a figure or a rule for something Doepfer describes but leaves open.

`tools/doepfer_compare.py` generates the tables below from `data/doepfer_comparison.json`.

DIFFERENCE	STATEMENTS
tightened	27
relaxed	5
changed	8
added	12
total	52

J.2.1 RACK AND FRAME

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-001	The A-100 is built on the international 19" rack system: DIN 41494 / IEC 297-3 / IEEE 1001.1.	rule	EIS requires a rack-mount frame to meet IEC 60297-3-101:2004 and IEC 60297-3-100:2008 for the 482.6 mm flange width, the flange holes and slot, the 132.55 mm 3U height H1, and the 84 HP row; a desktop case needs no flanges.	RACK-001, RACK-002, RACK-003	*tightened*	Construction
D-003	Because the 19" standard is used, A-100 front panels "may fit" frames from other makers.	typical	EIS makes cross-maker fit binding through the panel width ceiling, the 122.5 mm hole span, the hole grid and the 5.08 mm insert pitch.	RACK-003, PANEL-002, PANEL-009, PANEL-011, RAIL-001	*tightened*	Accessories
D-005	Usable width per row is 84 HP (= 426.4 mm). Elsewhere 84 HP is given as 426.7 mm (back panel remark).	rule	EIS keeps the 84 HP row and requires a rail of at least N × 5.08 mm, 426.72 mm for 84 HP, which Doepfer's 426.4 mm figure falls 0.32 mm short of.	RACK-003, RAIL-002	*tightened*	Construction, Accessories
D-023	Self-build: cover and rear panel length must equal the rail length. Side height is found by test-mounting a module on two rails and measuring from the top of the upper rail to the bottom of the lower rail.	recommendation	EIS fixes the span between the two rails' inserts at 122.5 mm, so a row's height is set by figure rather than by test-mounting.	PANEL-009	*added*	Kit #1

J.2.2 RAILS AND INSERTS

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-009	A tapped-hole strip with M3 threads goes into each of the four front lipped rails, and modules fix to it. Each lipped back rail gets 3 sliding nuts (middle and both ends) for the back plate. Two unlipped rails get 8 sliding nuts for the bus board; the third has no insert and only reinforces the top cover. Nuts in rail 2 face the rear; nuts in rail 3 and the strip in rail 1 face the front. Using the wrong rail type in a position causes problems.	rule	EIS requires a threaded M3 insert at least 1.5 mm thick with holes 5.08 mm apart; the rear and bus board rail arrangement is not covered.	RAIL-001, RAIL-003, RAIL-004	*tightened*	G6 frame
D-020	DIY Kit #1 rails: four 84 HP aluminum extruded rails, ~427 mm long, with 8 mounting screws. About 160 M3 nuts (kit PDF: ~168 = 4 × 42, ~42 per rail) slide into the rail groove. Modules can then sit anywhere, including other makers' modules with different hole positions, without gaps.	typical	EIS requires insert holes on a fixed 5.08 mm pitch and every panel hole on that grid; slide nuts appear only informatively, in the recommended rail section of 5.3.	RAIL-001, RAIL-002, PANEL-011	*changed*	DIY kits, Kit #1

J.2.3 MODULE DEPTH

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-013	Doepfer sets no maximum module depth. Depth appears only as the usable depth of each case. Modules with increased depth (e.g. A-113, A-126) must not go in the PSU area of the low-cost cases.	not specified	A module publishes how far it extends behind the panel and an enclosure publishes each row's clear depth; EIS recommends at most 50 mm module depth and at least 50 mm row depth, with no maximum.	PANEL-003, ENC-001	*added*	Cases

J.2.4 PANEL HEIGHT

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-029	1U = 1.75 inch = 44.45 mm; 3U = 133.4 mm. All front panels are 3U high.	rule	One rack unit is 44.45 mm, three are 133.35 mm, and a module may be 1U or 3U high.	RACK-002, PANEL-001	*relaxed*	Construction

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-030	Final panel height is less than 133.4 mm because of the mounting-rail rim: 128.5 mm for all A-100 front panels.	rule	EIS requires a 3U front panel 128.5 mm high, within ±0.2 mm.	PANEL-006	*tightened*	Construction

J.2.5 MOUNTING HOLES

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-031	The panel drawing gives hole centers 3.0 mm above the bottom edge (0) and at 125.5 mm, which is 3.0 mm below the 128.5 mm top. The figures are only in image A100FP.gif (no alt text); I read them from the image.	rule	Mounting holes are 3.0 mm in from top and bottom within ±0.1 mm, a 122.5 mm span within ±0.1 mm on the panel and between the rail inserts.	PANEL-008, PANEL-009	*tightened*	Construction
D-040	Horizontal distance between holes must be a multiple of the HP grid, N × 5.08 mm.	rule	Each hole is a whole number of HP plus 2.54 mm from the nominal left edge, within ±0.1 mm, so hole spacing stays a multiple of 5.08 mm.	PANEL-011, RAIL-001	*tightened*	Construction
D-041	Drawing: hole diameter d = 3.2 mm; first hole column 7.5 mm from the left panel edge. Image only (A100FP.gif).	rule	Holes are Ø3.2 mm +0.1/−0 mm or a 3.2 mm slot up to 5.5 mm long, and the first column of a wide panel is 7.62 mm from the nominal left edge, 0.12 mm further in than Doepfer's 7.5 mm.	PANEL-010, PANEL-011	*changed*	Construction
D-042	Table 1 is titled as giving hole positions relative to the panel edges, but the positions appear only in the drawing. No per-width hole table is published.	not specified	EIS fixes every hole position for every width and draws the patterns from 1 to 8 HP.	PANEL-011	*added*	Construction

J.2.6 PANEL WIDTH AND HP

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-033	Actual panel width is "a few tenth of a mm" less than N × 5.08 mm, to give assembly tolerance.	rule	EIS requires an N HP panel no wider than N × 5.08 mm, and recommends 0.3 mm narrower.	PANEL-002	*tightened*	Construction
D-034	Table 1, HP: calculated / actual mm: 1: 5.08/5.00; 1.5: 7.62/7.50; 2: 10.16/9.80; 4: 20.32/20.00; 6: 30.48/30.00; 8: 40.64/40.30; 10: 50.80/50.50; 12: 60.96/60.60; 14: 71.12/70.80; 16: 81.28/80.90; 18: 91.44/91.30; 20: 101.60/101.30; 21: 106.68/106.30; 22: 111.76/111.40; 28: 142.24/141.90; 42: 213.36/213.00.	rule	Widths are whole HP only, at most N × 5.08 mm, with N × 5.08 mm minus 0.3 mm recommended; EIS's own width table replaces Table 1.	PANEL-002	*tightened*	Construction
D-035	Blank panels: B1 1 HP / 5 mm (only to combine odd-HP modules, e.g. Harvestman). B1.5 1.5 HP / 7.5 mm (gap filler for modules with different hole positions, e.g. Analogue Systems). B2 2 HP / 10 mm; B4 4 HP / 20 mm; B8 8 HP / 41 mm; B42 42 HP / 213 mm. The 8 HP blank at 41 mm differs from Table 1's 40.30 mm.	rule	A blank meets the module panel rules: whole HP and at most N × 5.08 mm, so a 1.5 HP blank is not an EIS width and an 8 HP blank at 41 mm would exceed 40.64 mm by 0.36 mm.	PANEL-002, PANEL-004	*tightened*	Accessories
D-036	Order notes say every A-100 panel is a multiple of 2 HP, with no odd HP, and the frame sketch uses a 2 HP grid. This conflicts with the 1, 1.5 and 21 HP entries in Table 1.	rule	A panel may be any positive whole number of HP, odd or even.	PANEL-002	*relaxed*	Ordering

J.2.7 PANEL THICKNESS AND MATERIAL

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-038	Front panels are 2 mm anodized aluminum. Standard blanks are 2 mm silver-grey anodized; Vintage Edition blanks (B2V/B4V/B8V/B42V) are 2 mm black anodized; B1V and B1.5V are not available.	rule	EIS limits a front panel to 2.0 mm thick; it recommends 1.6 to 2.0 mm 5052 aluminum or FR-4 and sets no finish or color.	PANEL-004, PANEL-014	*relaxed*	Construction, Accessories

J.2.8 MOUNTING SCREWS

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-043	Modules mount with M3x6 oval-head cross-recess screws (DIN 7985). The short-form manual also says "M3x6".	rule	EIS requires an M3 screw of 0.5 mm pitch with a head at most 7.0 mm across, its length inside a window each rail sets and the enclosure publishes.	RAIL-005, RAIL-006, RAIL-007, RAIL-008, RAIL-009, RAIL-010, RAIL-011	*changed*	Construction, Short manual

J.2.9 BOARDS

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-046	Modules built since about 2015 carry a rectangle and the text "RED STRIPE" on the PCB beside the bus connector.	rule	EIS requires a module, a bus board, or a power supply to mark the −12 V end of each power header on the board, in any form.	BUS-019, BUS-004	*tightened*	FAQ

J.2.10 BUS CONNECTOR AND PINOUT

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-055	Bus headers are 16-pin, 2-row, 2.54 mm pitch. Cables use 10- or 16-wire flat cable with press-on 16-pin IDC sockets.	rule	A header on a module or a bus board is a 2 × 5 or 2 × 8 header on a 2.54 mm grid mated by IDC ribbon sockets, so a bus board header may also be 10-pin, not only 16-pin as on Doepfer's boards.	BUS-002, BUS-015	*relaxed*	FAQ
D-057	Module side: with a vertical header the colored wire goes at the bottom. With a horizontal header it goes left (rear view), except on the A-111-5, which has its own drawing.	rule	EIS fixes no orientation of the header on a module; it requires the −12 V end of every power header to be marked on the board and the marked conductor to point to it.	BUS-004, BUS-019	*changed*	FAQ, Bus orientation
D-058	Applying other voltages than described, or reversing polarity, destroys a module instantly.	rule	EIS requires a module to survive a reversed ribbon at its power header; any other voltage on the pins is outside EIS.	BUS-009, DC-006	*added*	Technical

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-059	Supplies above ±12 V, a missing GND or swapped rails destroy modules, and the warranty is void.	rule	EIS requires modules to survive a reversed ribbon, holds each supply rail within ±5 % of nominal, and bounds the supply's start-up overshoot to 10 % and its reverse swing to 0.7 V; rails beyond that or a missing 0 V are outside EIS.	BUS-009, GND-001, SUP-005, SUP-006, SUP-010	*added*	Ordering

J.2.11 RIBBON CABLE

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-063	Cable length ~20 cm: A-100BM10 (10-to-16) and A-100BM16 (16-to-16). Special cables with 2 or 4 ten-pin module connectors have them ~6.5 cm apart.	typical	EIS limits a power ribbon from a bus header to a module to 400 mm, with conductors of at least 28 AWG; it sets no connector spacing for multi-socket cables.	BUS-015	*added*	Accessories, Bus cables

J.2.12 BUS BOARD

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-071	PSU-to-bus cables: until end of 2015, 3 wires (GND, -12, +12); since then 4 wires (+5 V added). Flat connectors both ends, ~30 cm, 0.75 mm^2.	typical	Row wiring is stranded copper rated 105 C with a crimped ring terminal on an M4 terminal at each end, at least 18 AWG and heavier as the current rises, and at most 5 mΩ end to end with 0 V no higher than the rails; Doepfer's 0.75 mm2 lead on flat connectors is outside EIS, and +5 V stays optional.	PWR-005, PWR-006, PWR-007, ASM-008	*tightened*	Accessories

J.2.13 CURRENT LIMITS

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-086	The total current of all modules must not exceed the PSU maximum (1200 mA; 650 mA on old units). Otherwise fit a second PSU at position (4).	rule	Each rail's summed module current must stay within the published total of every source and bus board feeding it and within each outlet's limit, counted per rail and per board.	ASM-001, PWR-001, PWR-002, BUS-008, BUS-012	*tightened*	Construction, Manual

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-087	Historically only the +12 V current was quoted, as the worst case. No A-100 module draws more at −12 V than at +12 V. Since the PSU3 (2016) both are given separately.	rule	Every module publishes its maximum current on each rail, stating 0 for a rail it does not draw; where −12 V is missing EIS recommends planning it at 50 % of +12 V.	PWR-001	*tightened*	FAQ
D-089	The Excel planner total must be under 1200 mA; otherwise a second PSU is needed.	rule	The per-rail sum stays within every published source and outlet total; the Annex E row budget is an informative worksheet for it.	ASM-001	*tightened*	Ordering

J.2.14 POWER SUPPLY

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-097	Each PSU3 rail has its own switcher, so the rails do not rise together: delay 1–1.5 s after power-on, rise time 20–30 ms. This may upset the reset of third-party digital modules.	typical	EIS sets no rail delay, rise time or order, but at start-up no rail may overshoot by more than 10 % or swing more than one diode drop toward the opposite polarity.	SUP-005, SUP-006	*added*	Accessories
D-108	A high-quality linear supply is recommended. Switching supplies Doepfer tested showed up to 200 mV load-dependent change on ±12 V, against 5 mV for the PSU2. For frames with VCOs use the PSU2 or a linear supply with load regulation of 10 mV or better.	recommendation	EIS requires no linear topology; bus ripple and noise must be below 150 mV peak-to-peak and published, and it only recommends load regulation within 1 % (about 120 mV at 12 V), looser than Doepfer's 10 mV for VCO frames.	SUP-001, SUP-007	*relaxed*	DIY

J.2.15 RIPPLE AND PROTECTION

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-115	No ripple, noise, regulation-tolerance or output-voltage tolerance figure is published for any A-100 PSU. The only related figures are the load-change ones in D-108.	not specified	EIS requires a supply to publish its ripple and noise on each rail by a stated method (20 MHz, 0.1 µF with 47 µF, 300 mm twisted pair), and bus ripple below 150 mV peak-to-peak.	SUP-001, SUP-007	*added*	Technical, Accessories, FAQ
D-124	Most A-100 outputs have a 1k series protection resistor against shorts to GND or to another output. It causes a small drop that can affect 1 V/oct accuracy; use a buffer (A-185-1/-2) or bridge the resistor.	typical	EIS requires every patch output to survive an indefinite short to 0 V or to another output; its source impedance is 1 kΩ typical and at most 2 kΩ.	SIG-003, SIG-005	*tightened*	DIY
D-125	Inserting a plug into a standard A-100 jack momentarily shorts it, so non-protected outputs need another socket type. The DIY manual-gate circuit uses a 470 Ω resistor against shorting +12 V.	recommendation	EIS requires every patch output on the 3.5 mm TS jack to survive an indefinite short to 0 V or to another output, so an unprotected output does not conform.	SIG-003, PANEL-005	*tightened*	DIY

J.2.16 GROUNDING

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-128	Protective earth: the yellow/green lead goes to an eyelet screwed to the metal case and must never be another color. The 16-pin bus has three GND pin pairs (10-pin likewise). No other grounding scheme (star point, audio vs power ground) is specified.	rule	Every 0 V pin of a header is connected, a bus board joins all headers to one 0 V at the supply terminal, a supply publishes where 0 V meets protective earth, and a 0 V bond is 14 AWG, or board copper of that section, on a ring, bracket, or standoff on an M4 or larger stud under a toothed washer.	GND-001, GND-002, GND-003, PWR-008	*added*	PSU3 wiring, Manual

J.2.17 BUS CV AND GATE

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-137	More than three VCO CV inputs on one bus (FAQ: more than 2–3 VCOs) need a buffered writer (A-185-1/-2, A-180-3). Otherwise losses cause scaling or octave-purity problems. A-190-2/-3/-4 have buffered outputs.	recommendation	Every bus CV transmitter drives from an op-amp through at most 100 Ω and holds 1.00 V/octave within 0.3 % at the header into 10 kΩ, ten listeners of 100 kΩ, whatever they are; EIS recommends at most ten listeners on a line.	BUS-017	*tightened*	DIY, FAQ
D-140	A 10-pin module can still use bus CV/Gate with a 16-wire cable that has a 10-pin module connector, tapping wire #13/14 (CV) or #15/16 (Gate).	rule	A module may use the 10-pin header only if it uses neither +5 V nor bus CV or gate, so a module on bus CV or gate has a 16-pin header.	BUS-007	*changed*	DIY

J.2.18 AUDIO SIGNAL LEVELS

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-142	Audio is typically 10 Vpp (-5 V to +5 V); the module description usually gives the exact level. The manual instead says audio "lie[s] in the range" -5 to +5 V (10 Vss).	typical	EIS keeps ±5 V (10 Vpp) as the typical nominal level but sets AUDIO full scale at ±10 V peak at the default range B10.	SIG-005	*changed*	Technical, Manual
D-143	Audio-processing inputs need about 1 Vpp minimum for a usable S/N. Higher levels are fine because nearly every audio input has an attenuator. Mics and guitars need an external preamp.	typical	EIS sets no minimum input level; an AUDIO input must accept its range's full swing without clipping, ±10 V at B10 within 0.5 dB, and mic and instrument levels appear only in informative Annex C.	SIG-005	*tightened*	FAQ
D-145	Audio inputs are normally AC-coupled and all filters are AC-coupled. CV generators and processors are DC-coupled. VCAs, dividers and waveshapers vary.	typical	AUDIO may be AC or DC coupled, with an AC-coupled input passing 20 Hz within 1 dB; CV, pitch, gate, trigger and clock classes are DC-coupled.	SIG-005	*tightened*	DIY

J.2.19 CV SIGNAL LEVELS

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-146	CVs are typically -2.5 to +2.5 V (5 Vpp) for LFOs and 0 to +8 V for ADSRs; module descriptions usually give exact levels.	typical	EIS places an LFO at ±2.5 V in CV range B5 (±5 V, the default) and an ADSR at 0 to +8 V in range U10 (0 to +10 V).	SIG-005	*added*	Technical
D-147	CVs are relative: no fixed relation between a CV value and the controlled parameter. 0 V on a VCO does not mean C0 or 65.4 Hz. Panel scale labels do not matter.	rule	EIS leaves CV unscaled but recommends that 0 V on a PITCH port mean C0 (16.35 Hz), as a recommendation only.	SIG-005	*changed*	FAQ

J.2.20 GATE AND TRIGGER

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-150	Gate, trigger and clock are rectangle signals, typically 0/+5 V. The trigger acts on the rising edge.	typical	GATE, TRIG and CLOCK outputs must be high at +4 V to +12 V into 100 kΩ and low at +0.5 V or less, and a TRIG input reads the rising edge through +3 V.	SIG-005	*tightened*	Technical
D-151	Within the A-100, anything above about +3 V is "high" (+5, +8, +10, +12 V all work). Anything below 1 V is "low". Deviations are stated in the module description.	rule	A gate, trigger or clock input must read +3 V or more as high and +1 V or less as low, with at least 0.5 V of hysteresis recommended.	SIG-005	*tightened*	Technical
D-152	All A-100 modules withstand gate/trigger/clock signals up to +12 V.	rule	Every patch input, whatever its class, must withstand ±12 V indefinitely from a source of 1 kΩ or less, and ±15 V is recommended.	SIG-002	*tightened*	Technical
D-154	The manual says gates are typically 0 to +5 V or 0 to +12 V, and A-100 modules usually output +12 V. Gate, clock and reset inputs also work at lower levels (typically +5 V). This differs from D-150.	typical	EIS accepts gate outputs anywhere from +4 V to +12 V high and requires inputs to read +3 V as high, so 0/+5 V and 0/+12 V gates both conform.	SIG-005	*tightened*	Manual

J.2.21 PITCH CV AT 1 V/OCTAVE

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-157	A 1 V increase raises VCO pitch by one octave.	rule	PITCH is 1.00 V per octave within ±0.3 % of scale (3.6 cents per octave) over the claimed span, B10 by default.	SIG-005	*tightened*	Technical
D-158	CV is relative: no CV value (e.g. +1.0 V) is tied to an absolute pitch. Pitch is the sum of tune (coarse/fine), octave switch, CV inputs, attenuated inputs, bus CV, trims and linear FM. Attenuated and linear-FM inputs are not 1 V/oct. Some VCOs have 2+ 1 V/oct inputs, one possibly from the bus.	rule	EIS recommends that 0 V on a pitch port mean C0 (16.35 Hz), calling it a calibration figure, and lists a control input scaled other than 1 V/oct as CV with its scaling named.	SIG-005	*changed*	Technical, FAQ

J.2.22 IMPEDANCES

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-159	Doepfer publishes no input or output impedance figures.	not specified	EIS sets source impedance at 1 kΩ typical and at most 2 kΩ and load at 100 kΩ typical and at least 47 kΩ for every class but VIDEO, which is 75 Ω ±1 % out and 100 kΩ ±1 % in.	SIG-005, SIG-009, SIG-010	*added*	Technical
D-160	Typical summing-input circuit: 47k is a common value, giving sensitivity 1. Factory input and feedback resistors are normally in the 100k range (~47k…220k). Mixers use 100k.	typical	EIS makes the input load binding at 100 kΩ typical and at least 47 kΩ on every class but VIDEO.	SIG-005	*tightened*	DIY

J.2.23 USE, HANDLING, AND DOCUMENTS

	DOEPFER	KIND	EIS	REQUIREMENTS	DIFFERENCE	SOURCE
D-169	Fitting procedure: total the currents, unplug mains, fit the cable at the module (colored wire down), then at the nearest bus position (colored wire down), screw in, close gaps, power up and test. If anything is wrong, disconnect immediately.	rule	EIS requires the installer to keep each rail's published currents within every source, bus board, and outlet limit; the fitting steps of clause 9, with the marked conductor on −12 V, are informative.	ASM-001, BUS-004	*tightened*	Construction, Short manual
D-171	No Doepfer technical page exists for a "flying bus board", "1U" format or the "Vintage Edition". Vintage Edition differences are cosmetic only (black panel, KV knob).	not specified	EIS defines a 1U panel 39.65 mm high from the Intellijel format; flying bus boards appear only in the eis-reference survey, and the Vintage Edition is not mentioned.	PANEL-001, PANEL-007, PANEL-009	*added*	Accessories

J.3 SOURCES

Doepfer's pages and documents as read on 2026-10-22; EIS restates none of them by reference.

	DOCUMENT	ADDRESS
Construction	Construction Details A-100	https://www.doepfer.de/a100_man/a100m_e.htm
Accessories	A-100 accessories	https://www.doepfer.de/a100z_e.htm
Ordering	A-100 ordering notes	https://www.doepfer.de/a100_man/a100o_e.htm
DIY	A-100 DIY page	https://www.doepfer.de/DIY/a100_diy.htm
G6 frame	A-100G6 frame assembly instructions	https://www.doepfer.de/a100_man/A100G6_e.pdf
Cases	A-100 cases	https://www.doepfer.de/a100_cases_e.htm
DIY kits	A-100 DIY kits	https://www.doepfer.de/a100_DIY_kits.htm
Kit #1	A-100 DIY Kit #1 instructions	https://www.doepfer.de/a100_man/A100_DIY_Kit_1.pdf
Short manual	A-100 short-form manual, 2025	https://www.doepfer.de/a100_man/A100_short_form_manual_2025.pdf

	DOCUMENT	ADDRESS
Technical	Technical Details A-100	https://www.doepfer.de/a100_man/a100t_e.htm
Bus orientation	A-100 bus cable orientation	https://www.doepfer.de/a100_man/A100_bus_orientation.pdf
FAQ	A-100 FAQ	https://www.doepfer.de/faq/a100_faq.htm
Bus cables	A-100 bus cables	https://www.doepfer.de/a100_man/A100_bus_cables.pdf
Manual	A-100 manual, complete	https://www.doepfer.de/a100_man/A100_Manual_complete.pdf
PSU3 wiring	A-100PSU3 wiring	https://www.doepfer.de/a100_man/A100PSU3_wiring.pdf

ANNEX K (INFORMATIVE) — CONTROL LAYOUT

Where the controls and every other part on a 3U or 1U front panel sit: jacks, knobs, switches, buttons, faders, indicators, ports, windows, and hardware, and the board parts behind them that pass through it. EIS places no requirement on where a control sits; the rules here are a design guide. A module laid out to them lines up with its neighbors across a row, takes knobs and plugs at a familiar pitch, and has a panel and a board drawn from one list of positions that a tool can check.

The rules are in inches, the unit the parts are drawn in; millimeters are derived at 25.4 mm per inch. The numbers are in `data/control_layout.json`, and `tools/control_layout.py` checks a layout against them and draws the cards of this annex.

K.1 THE FRAME

Every position is measured from the *panel center*: the middle of the panel's nominal width, halfway between its top and bottom mounting holes (5.2.1). x runs to the right and y up, looking at the front of the panel.

The controls of a 3U panel sit in a band between two row lines (K.8 gives the 1U rows):

- the *top row* of controls is 1.75 in (44.45 mm) above the panel center;
- the *bottom row* of controls is 1.75 in (44.45 mm) below the panel center.

No control's center is above the top row line or below the bottom one. EIS recommends that a layout use the full band: its highest controls on the top row line and its lowest on the bottom one, so that the rows of neighboring modules meet. The band is 3.5 in (88.9 mm) tall and leaves 19.80 mm from each row line to the panel edge, room for the mounting screw heads, the panel legend over the top row, and a knob's skirt or a jack's nut clear of the rail. On a 110 mm board (5.2.2) a row line is 10.55 mm inside the board's edge.

THE 1.875 IN VARIANT

A 3U panel may instead put its row lines *1.875 in (47.625 mm)* above and below the panel center, one lattice step further out: the variant standard, a band 3.75 in (95.25 mm) tall. It leaves 16.63 mm from each row line to the panel edge and 13.63 mm to the line of the mounting holes, and on a 110 mm board a row line is 7.38 mm inside the board's edge. Everything else in this annex is unchanged; the vertical pitches of K.3 still count from the row line in use. A small control's cell on a 1.875 in row line stays clear of the mounting screws, but a rotary control's does not where it lines up with a screw (K.4): EIS recommends the variant's outer rows for jacks and switches, and rotary controls there only clear of the screws. A layout names the variant with `row_line: 1.875`; one that names no row line is checked against the narrower band that holds all its controls.

EIS · Control layout: the band and the lattice

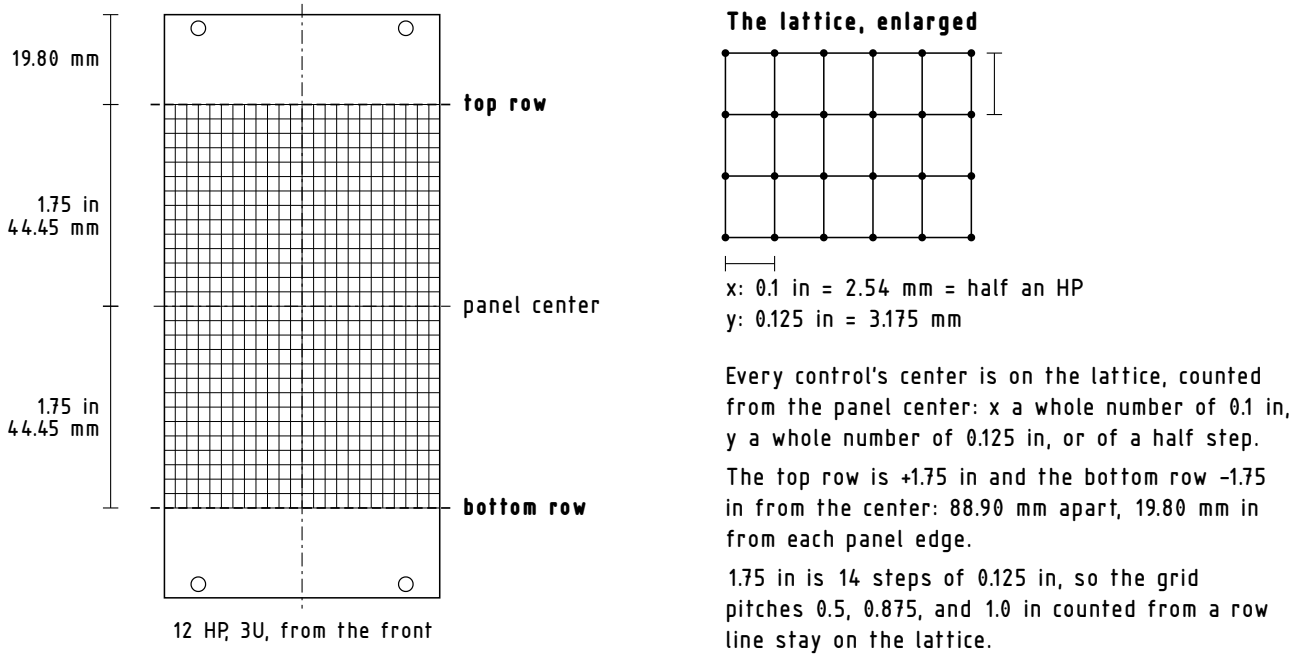


Figure 59. A 12 HP panel from the front: the panel center, the top and bottom row lines 1.75 in from it, and the lattice every control sits on

K.2 THE LATTICE

Every control's center is on a lattice counted from the panel center:

- *horizontally*, x is a whole number of *0.1 in* (2.54 mm), half an HP;
- *vertically*, y is a whole number of *0.125 in* (3.175 mm).

A center may also sit on a *half* lattice step: x a whole number of 0.05 in (1.27 mm), y a whole number of 0.0625 in (1.5875 mm). Finer subdivisions are not part of the lattice. The half step is for a part that a full step would push too far, a switch between two jack columns or a legend-led nudge; EIS recommends the whole lattice wherever it serves, so that rows and columns line up across a row of modules.

Both are counted from the center, and both reach the edges evenly: a panel's nominal edges are N × 0.1 in from its center at any width N HP, so the lattice runs on unbroken from one panel to the next across a row, and a control's position from the panel's nominal left edge is on the lattice too. Vertically, the row lines are 14 steps of 0.125 in from the center, and every vertical pitch in K.3 (0.25, 0.375, 0.5, 0.625, 0.75, 0.875, and 1.0 in) is a whole number of steps, so a column counted down from the top row line stays on the lattice.

K.3 THE FAMILIES AND THEIR GRIDS

Every part on the panel belongs to a family. A family with a grid sets the *least* pitch between neighboring parts of the family, across (x) and up and down (y): the clearance a part needs, not the only distance it may stand at. Parts may stand further apart, with blank space between them, as long as every center stays on the lattice of K.2. Ports, windows, and hardware have no grid and are sized by their openings (K.5).

RULE	INCHES	MILLIMETERS
3U: top row of controls, above the panel center	+1.75	+44.45
3U: bottom row of controls, below the panel center	−1.75	−44.45
3U variant: row lines, above and below the panel center	±1.875	±47.625
1U: row lines, above and below the panel center	±0.25	±6.35
1U: rotary controls, on the center line, at y =	0	0
Horizontal lattice: every x a whole number of	0.1	2.54
Vertical lattice: every y a whole number of	0.125	3.175
Lattice subdivided by 2: x and y a whole number of	0.05 × 0.0625	1.27 × 1.5875
Margin around an opening, each side, before rounding up to the lattice	0.1	2.54
Reach of a fader, port, window, or hardware cell past a row line, at most	0.25	6.35

FAMILY	PARTS	LEAST GRID, ACROSS × UP AND DOWN (IN)	(mm)
Small controls	3.5 mm jack; subminiature toggle switch; slide switch; SMA jack; push button with a round cap up to 6 mm or a 5 mm square cap	0.4 × 0.5; 0.5 × 0.5; 0.6 × 0.5	10.16 × 12.70; 12.70 × 12.70; 15.24 × 12.70
Rotary controls	potentiometer, 9 mm to 16 mm; rotary switch; rotary encoder	1.0 × 0.875; 0.8 × 1.0; potentiometers 0.75 up and down	25.40 × 22.225; 20.32 × 25.40; 19.05
Large rotary controls	potentiometer, 24 mm	1.0 × 1.0	25.40 × 25.40
Large controls	RCA jack; push button with a 9 mm to 12 mm cap, or a lit push button	0.6 × 0.625	15.24 × 15.875
BNC jacks	BNC jack	0.8 × 0.75	20.32 × 19.05
Indicators and miniature buttons	3 mm LED or light pipe; access hole for a recessed tact switch; push button with a 4 mm square cap	0.2 × 0.25; 0.3 × 0.375	5.08 × 6.35; 7.62 × 9.525

FAMILY	PARTS	LEAST GRID, ACROSS × UP AND DOWN (IN)	(mm)
Faders	15 mm fader; 30 mm fader; 45 mm fader; 60 mm fader	0.5 across; 0.6 across; up and down, the slot plus the margin	12.70 across; 15.24 across
Ports	USB-C receptacle; USB-A receptacle; HDMI receptacle; microSD slot; 25-way D-sub with its jackscrews; DC barrel jack; 4-pin DIN power jack; wire-to-board power header (Micro-Fit and similar); IEC mains inlet, with its fuse drawer or switch	none: the opening plus 0.1 in each side, rounded up to the lattice	
Windows	display or indicator window	none: the opening plus 0.1 in each side, rounded up to the lattice	
Hardware	terminal stud with its washer; fixing screw through the face	none: the opening plus 0.1 in each side, rounded up to the lattice	

- *Small controls* (3.5 mm jacks, subminiature toggle switches, slide switches) stand at least 0.4 in apart across and 0.5 in up and down. 0.5 in and 0.6 in across (2.5 and 3 HP) suit larger nuts and longer legends, and 0.625 in or 0.75 in up and down leaves room for a legend between rows; all are simply more than the least pitch. Any of the parts may share any of these pitches; a jack and a toggle in one row at 0.4 in are as good as two jacks. An SMA jack, whose 8 mm nut is a 3.5 mm jack's, and a push button with a cap up to 6 mm round or 5 mm square join them.
- *Rotary controls* (potentiometers, rotary switches, rotary encoders) keep one of two least grids: *1.0 × 0.875 in*, five HP across by seven steps down, or *0.8 × 1.0 in*, four HP across by eight steps down. A module keeps one rotary grid throughout, and two rotary controls are at least its pitch apart one way or the other. Potentiometers may stand closer up and down: at least *0.75 in* (six lattice steps) on either grid, room for two 9 mm pots' knobs of up to about 18 mm, where rotary switches and encoders keep the grid's full pitch. A single column of pots on a narrow panel fits either grid; the 0.8 in grid's narrower cell is the one that keeps it inside a 4 HP panel's edge. From the top row line the 0.875 in grid gives rows at +1.75, +0.875, 0, −0.875, and −1.75 in, five rows that fill the band exactly; the 1.0 in grid gives rows at +1.75, +0.75, −0.25, and −1.25 in, and leaves the bottom row line to the small controls.
- *A rotary switch's positions.* A rotary switch's *position 1 stands exactly to the left of it, at nine o'clock*: its stop is set so that the pointer stands there at position 1, and the other positions follow

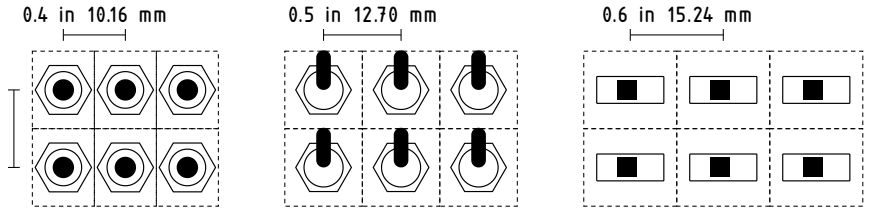
clockwise at the switch's detent pitch (30° for a twelve-position switch such as the Alpha SR1712F, 360° / 12). Its positions are marked as Annex L.9 sets out.

- *Large rotary controls*, 24 mm potentiometers, are wider than 0.875 in and keep at least a 1.0 × 1.0 in grid.
- *Large controls* (RCA jacks, push buttons with 9 mm to 12 mm caps, lit push buttons) stand at least 0.6 in apart across or 0.625 in up and down: three HP, five steps. A 13.4 mm button opening at the least pitch leaves 1.8 mm of panel between neighbors across and 2.5 mm up and down.
- *BNC jacks* stand at least 0.8 in apart across or 0.75 in up and down, room for fingers to turn a bayonet beside its neighbor.
- *Indicators and miniature buttons*: a 3 mm LED, a light pipe, or the access hole of a recessed tact switch keeps at least a 0.2 × 0.25 in grid; a push button with a 4 mm cap at least 0.3 × 0.375 in.
- *Faders* stand at least 0.5 in apart across, 0.6 in where the caps are wide; up and down, a fader owns its slot plus the margin. A fader's center is on the lattice like any part's, and its slot may run to a row line and up to 0.25 in past it.

Within those least pitches a layout is free: neighbors may be any distance apart on the lattice that keeps their cells clear (K.4), and a row or a column may leave gaps.

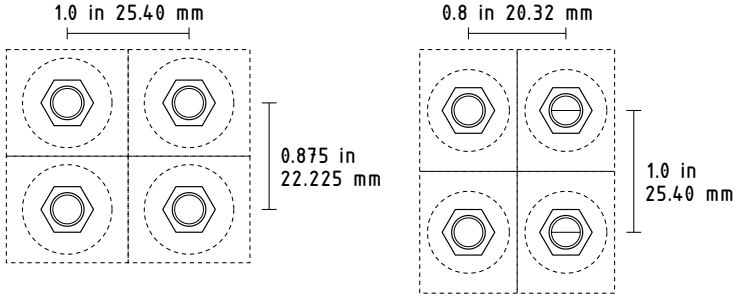
EIS · Control layout: the grid of each family

Small controls: 3.5 mm jacks, toggles, slide switches, SMA jacks, small buttons



At least 0.5 in 12.70 mm up and down; any of the parts on any of the grids, and further apart wherever the panel wants

Rotary controls: potentiometers, rotary switches, encoders



A dashed cell is the least room a control owns: its grid, centered on it. No two cells overlap, and blank space between cells is fine; a module uses one rotary grid throughout.

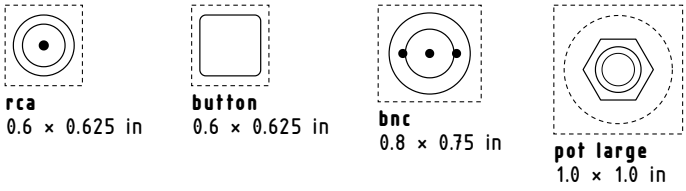
Across families, a small control's 0.4 by 0.5 in cell and a rotary control's cell do not overlap either.

The dashed circle is a knob that stays within its cell; a larger knob takes a larger grid.

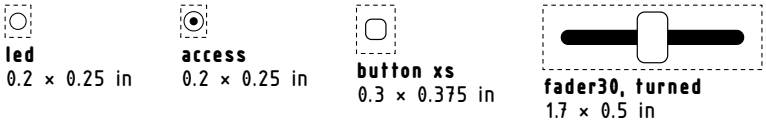
Figure 60. The small-control grids, at least 0.4 in across (0.5 and 0.6 in shown too) by 0.5 in, and the two rotary grids, 1.0 × 0.875 in and 0.8 × 1.0 in, each control in its cell

EIS · Control layout: every other part on the panel, in its cell

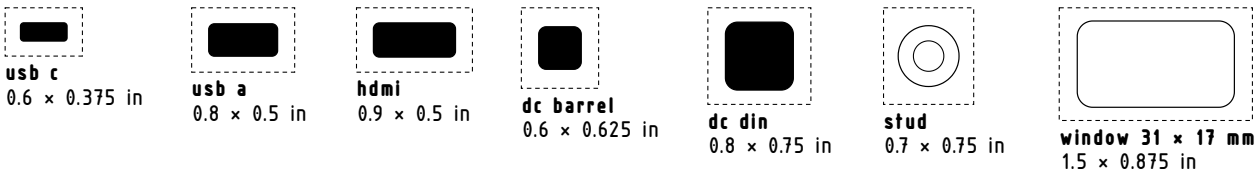
Large controls, BNC, large rotary



Indicators, miniature buttons, faders



Ports, windows, hardware



A part with a grid owns the cell of its family's grid; a port, a window, or hardware owns its opening plus 0.1 in each side, rounded up to the 0.1 by 0.125 in lattice.

Faders are 0.5 or 0.6 in across; up and down, the slot plus the margin.

Green: a family with a grid. Grey: rotary. Pink: sized by the opening.

Figure 61. Large controls, BNC jacks, and a large potentiometer; indicators, miniature buttons, and a fader; ports, a terminal stud, and a display window, each in its cell

K.4 CELLS, FAMILIES TOGETHER, AND THE PANEL

A least grid is easiest to apply as a *cell*: the rectangle of the grid, centered on the part, the clearance the part needs around it. A part's cell is its family's smallest grid (a rotary control's is the rotary grid the module uses; a fader's is 0.5 in across by its slot plus the margin); a port's, a window's, or hardware's is its opening plus 0.1 in each side, rounded up to the lattice. Then:

- within a family, no two cells overlap: two small controls are at least 0.4 in apart across or 0.5 in apart up and down, two rotary controls at least the rotary grid's pitch apart one way or the other, and so on for each family;
- across the families, no two cells overlap either: a jack's cell does not reach into a pot's, nor an LED's into a button's. A knob may overhang a part that sits flat in the panel, an LED, a light pipe, the access hole of a recessed switch, or a display window, as long as the part stays clear of the knob's 12 mm bushing and nut;
- blank space between cells is allowed anywhere: the cells set the least distance, and the layout chooses the rest;
- every cell stays within the panel's nominal width. A control is then at least half its pitch from the nominal edge, and the pitch holds across the joint to the next module: a 4 HP panel takes one column of rotary controls on the 0.8 in grid on its center, and two columns of jacks at ±0.2 in;
- no cell reaches over a mounting screw: the 7.0 mm disc under each screw head of 5.2.1 stays clear. A knob is the exception: it stands above the panel, so its skirt may overhang a screw head, and only its bushing and nut, 12 mm across, keep clear of the disc;
- a fader, indicator, port, or window cell reaches no more than 0.25 in past a row line, half a small control's row, so that it stays clear of the legend over the top row and of the screws. An indicator, a port, or a window may sit outside the band on that condition, a power LED over the top row for one; hardware, which fixes the panel to what is behind it, answers to neither the band nor the reach, only to the mounting screws and its neighbors' cells.

EIS recommends that a knob stay within its cell. A knob too large for the cell is a reason to choose the larger grid, not to break the cell. A display, a fader, or a port that spans a row line fills that row for K.1.

Finger room. Cells keep parts from colliding; they do not keep room for the hand that turns a knob. A toggle, a slide switch, or a button

whose cell clears a knob's can still stand where the thumb goes to turn the knob: a toggle 0.5 in beside a pot leaves about 3 mm between the lever cap and the skirt. EIS recommends that a toggle, a slide switch, or a button in a knob's row (within 0.4375 in of it up or down) stand at least *0.75 in* across from the knob's center; one that cannot goes above or below the knob instead, or into a row of its own.

Where cables fall. A patch cable leaves its jack and hangs down across whatever is below it, and its plug takes the room beside the jack. EIS recommends jack columns at the bottom of the band, or at the panel's sides, and never *between* two groups of knobs or faders: not with knobs or faders on both sides of a jack in its row, nor with knobs above and below it in its column. A jack field across the bottom keeps every cable clear of the controls; a column of jacks down the middle of a panel hangs a cable over a control in every row.

K.5 PORTS, WINDOWS, AND HARDWARE

A port (USB, HDMI, a card slot, a D-sub, a DC power jack or header, a mains inlet), a window over a display or an indicator, and hardware through the face (a terminal stud, a fixing screw) have no grid. Each sits with its center on the lattice and owns its opening plus 0.1 in each side, rounded up to the lattice. EIS recommends that a window or a port opening be drawn to the part's drawing and placed by its center, and that a row of ports keep their cells side by side, which puts their openings at least 0.2 in apart.

The kinds a layout names, with the opening each takes when the layout gives none:

KIND	PART	OPENING (mm)	LEAST CELL, ACROSS × UP AND DOWN (IN)
`jack`	3.5 mm jack		0.4 × 0.5
`toggle`	subminiature toggle switch		0.4 × 0.5
`slide`	slide switch		0.4 × 0.5
`sma`	SMA jack		0.4 × 0.5
`button_s`	push button with a round cap up to 6 mm or a 5 mm square cap		0.4 × 0.5
`pot`	potentiometer, 9 mm to 16 mm		the module's rotary grid, at least 0.75 up and down
`rotary`	rotary switch		the module's rotary grid
`encoder`	rotary encoder		the module's rotary grid

KIND	PART	OPENING (mm)	LEAST CELL, ACROSS × UP AND DOWN (IN)
`pot_large`	potentiometer, 24 mm		1.0 × 1.0
`rca`	RCA jack		0.6 × 0.625
`button`	push button with a 9 mm to 12 mm cap, or a lit push button		0.6 × 0.625
`bnc`	BNC jack		0.8 × 0.75
`led`	3 mm LED or light pipe	3.2 × 3.2	0.2 × 0.25
`access`	access hole for a recessed tact switch	3.8 × 3.8	0.2 × 0.25
`button_xs`	push button with a 4 mm square cap		0.3 × 0.375
`fader15`	15 mm fader	3 × 21.2	0.5 × 1.125
`fader30`	30 mm fader	3 × 36.2	0.5 × 1.75
`fader45`	45 mm fader	3 × 51.2	0.5 × 2.25
`fader60`	60 mm fader	3 × 66.2	0.5 × 2.875
`usb_c`	USB-C receptacle	9.2 × 3.6	0.6 × 0.375
`usb_a`	USB-A receptacle	13.6 × 6.4	0.8 × 0.5
`hdmi`	HDMI receptacle	16.2 × 6.75	0.9 × 0.5
`microsd`	microSD slot	12 × 2	0.7 × 0.375
`dsub25`	25-way D-sub with its jackscrews	50.2 × 9.1	2.2 × 0.625
`dc_barrel`	DC barrel jack	8.4 × 8.4	0.6 × 0.625
`dc_din`	4-pin DIN power jack	13.4 × 13.4	0.8 × 0.75
`dc_header`	wire-to-board power header (Micro-Fit and similar)	given in the layout	from the opening the layout gives
`ac_inlet`	IEC mains inlet, with its fuse drawer or switch	given in the layout	from the opening the layout gives
`window`	display or indicator window	given in the layout	from the opening the layout gives
`stud`	terminal stud with its washer	12 × 12	0.7 × 0.75
`screw`	fixing screw through the face	5.5 × 5.5	0.5 × 0.5

A window, a wire-to-board power header, and a mains inlet vary from part to part; a layout gives their openings as `w` and `h`. Any part may be turned a quarter turn with `rot: 90`, which swaps its opening's width and height.

K.6 THE BOARD BEHIND THE PANEL

Controls mounted on a board pass through the panel, so the board and the panel are drawn from one list of positions. EIS recommends:

- *One list.* Keep one list of controls, each with its kind and its position from the panel center, and draw both the panel's holes and the board's footprints from it. A hole and the part behind it then cannot drift apart.
- *The board's origin at the panel center.* Set the board's grid origin to the point behind the panel center. On a parallel board (5.2.2) whose controls are on the side facing the panel, the board's x is the panel's x; with the controls on the far side, x is mirrored.
- *A 0.025 in grid.* A grid of 0.025 in (0.635 mm) divides both 0.1 in and 0.125 in, so a single square grid in a CAD tool lands on every lattice point and on every half step across. A position on the lattice prints exactly in inches and to the third decimal in millimeters. The vertical half step, 0.0625 in, needs a 0.0125 in grid.
- *The footprint's origin on the bushing axis.* Place each control by the axis of the bushing or shaft that passes through the panel, not by a pin or the body's corner, so that the position in the list is the center of the panel hole.
- *Hole size from the part, position from the lattice.* The panel hole's diameter is the part's drawing plus clearance; its center is the lattice point. A part whose bushing is not on its footprint's grid gets its offset in the footprint, not in the layout.

K.7 CHECKING A LAYOUT

A layout is a short file: the panel's width in HP, its format (`3U`, the default, or `1U`), the units, optionally the rotary grid and, on 3U, the row line (`row_line: 1.75` or `1.875`), and one line per part with its reference, kind, x, and y from the panel center, and for a port or a window its opening. `data/examples/control-layout-8hp.yaml` is one:

```
name: 8 HP, six pots and eight jacks
hp: 8
units: in
rotary_grid: [0.8, 1.0]
controls:
  - [VR1, pot, -0.4, 1.75]
  - [J1, jack, -0.6, -1.25]
```

The kinds are those of K.5's table: `jack`, `toggle`, `slide`, `sma`, and `button_s` for the small controls; `pot`, `rotary`, and `encoder` for the rotary ones; `pot_large`, `rca`, `button`, `bnc`, `led`, `access`, `button_xs`, the faders `fader15` to `fader60`, the ports, `window`, `stud`, and `screw`. A part of any other kind is listed and not checked.

A port takes its opening from its kind; a window takes `w` and `h` beside its position, `{ref: DS1, kind: window, x: 0, y: 1.375, w: 1.22, h: 0.67}`. A CSV file with the columns `ref`, `kind`, `x`, and `y`, and optionally `w`, `h`, and `rot`, works too, with the width and units given on the command line:

```
python tools/control_layout.py --check data/examples/control-layout-8hp.yaml
python tools/control_layout.py --check panel.csv --hp 12 --units mm --strict
```

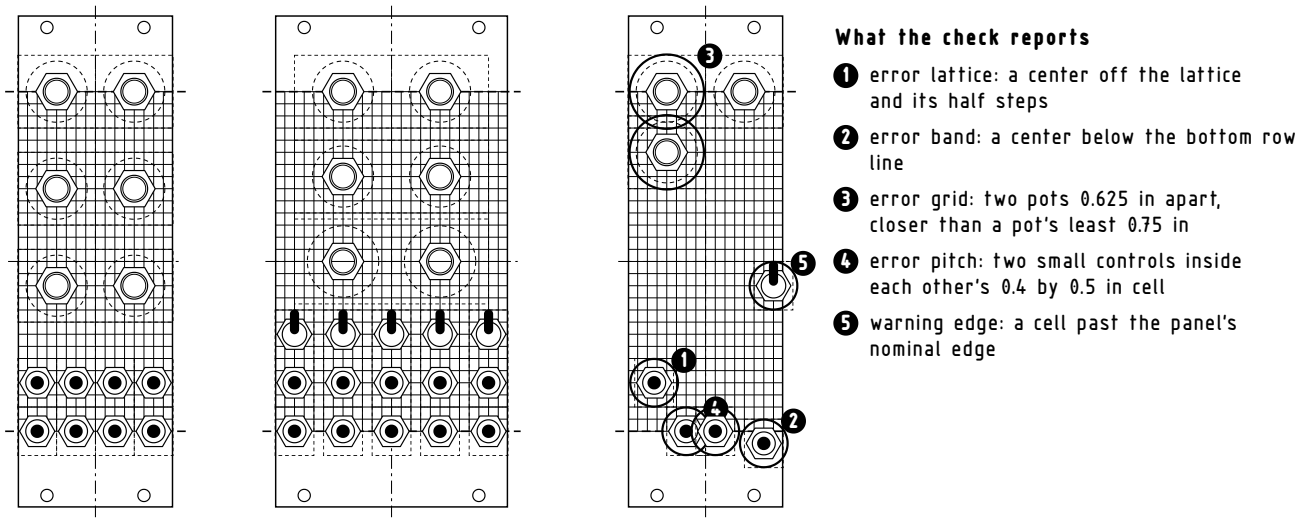
The check exits 1 on any error, and with `--strict` on any warning; `--json` prints the findings for another tool. Errors break the rules of K.1 to K.3 and K.5; warnings flag what K.1 and K.4 recommend, finger room and cables included. Distances larger than a least pitch are never reported:

LEVEL	CODE	WHAT IT REPORTS
error	`lattice`	A center off the 0.1 × 0.125 in lattice and its half steps (0.05 × 0.0625 in)
error	`band`	A control's center above the top row line or below the bottom one, or on a 1U panel a rotary control off the center line
error	`pitch`	Two parts of one family inside each other's cells: two small controls closer than 0.4 in across and 0.5 in up and down, and so on
error	`grid`	Rotary controls that fit neither rotary grid, or not the one the layout names
error	`size`	A window, a power header, or a mains inlet given no opening
warning	`rows`	No control on the top row line, or none on the bottom one (a fader, indicator, port, or window cell that spans the line counts)
warning	`edge`	A cell past the panel's nominal edge
warning	`mount`	A cell over the 7.0 mm disc of a mounting screw; for a knob, its 12 mm bushing and nut
warning	`reach`	A fader, indicator, port, or window cell more than 0.25 in past a row line
warning	`mixed`	Two parts of different families, or two ports, windows, or pieces of hardware, inside each other's cells; a flat part under a knob only where it reaches the knob's bushing and nut
warning	`finger`	A toggle, slide switch, or button in a knob's row less than 0.75 in across from the knob's center (K.4, finger room)
warning	`cables`	A jack, SMA, RCA, or BNC jack with knobs or faders on both sides of it in its row, or above and below it in its column (K.4, where cables fall)

Where a layout names no rotary grid, the check uses the grid its rotary controls fit; where they fit both, as a single column of pots does, it takes the grid whose cells stay within the panel's nominal edge and clear of the mounting screws, which on a 4 HP or 12 HP panel is usually 0.8 × 1.0 in. Where a layout fails the lattice as a whole, as one drawn on the right grids from the wrong origin does,

the check also tries moving it by its controls' offset from the lattice, plus up to four lattice steps each way, and reports the move that leaves the fewest errors.

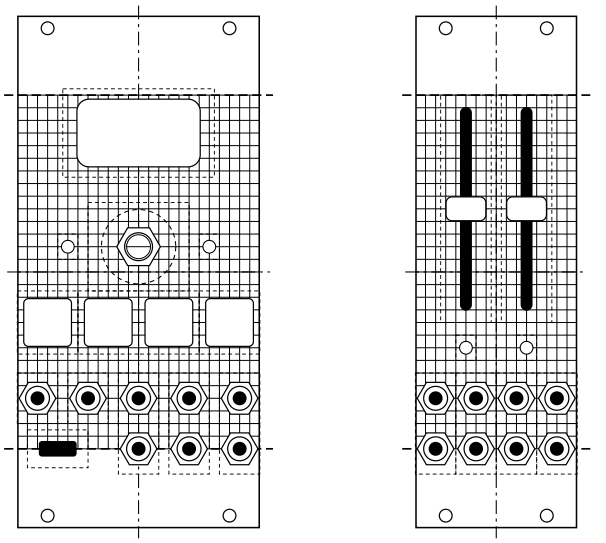
EIS · Control layout: two layouts that conform, and one that does not



Pink dashed: the row lines. Green dashed: a small control's 0.4 by 0.5 in cell. Grey dashed: the rotary grid's cell, and the knob within it. Fine blue: the 0.1 by 0.125 in lattice.

Figure 62. Two layouts that conform, an 8 HP module on the 0.8 × 1.0 in rotary grid and a 12 HP module on the 1.0 × 0.875 in grid, and an 8 HP layout with one fault of each kind and what the check reports

EIS · Control layout: displays, buttons, ports, and faders on the lattice



12 HP: a 31 × 17 mm display window spans the top row line; an encoder on the 1.0 × 0.875 in grid with an LED each side; four 12 mm buttons on the 0.6 in large-control pitch; jacks at 0.5 in; a USB-C port on the bottom row line.

8 HP: two 45 mm faders 0.6 in apart whose slots run to the top row line, an LED under each, and eight jacks at 0.4 in.

Both check with no errors and no warnings.

Pink dashed: the row lines. Green dashed: a small control's 0.4 by 0.5 in cell. Grey dashed: the rotary grid's cell, and the knob within it. Fine blue: the 0.1 by 0.125 in lattice. Pink dashed box: a window's or port's cell.

Figure 63. Two more layouts that conform: a 12 HP module with a display window, an encoder, buttons, LEDs, a USB-C port, and jacks, and an 8 HP module with two faders, LEDs, and jacks

K.8 1U PANELS

A 1U panel (5.2.1) is 39.65 mm tall, its mounting holes 16.825 mm above and below its center. It keeps the lattice of K.2, the grids of K.3, and the cells of K.4 and K.5; only its rows differ:

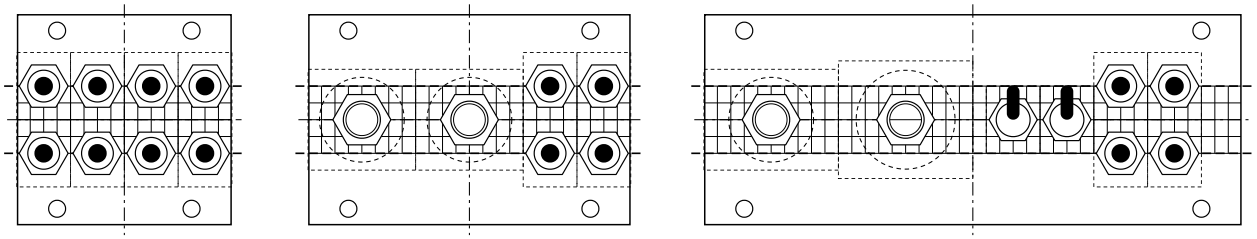
- the *row lines* are 0.25 in (6.35 mm) above and below the panel center, 0.5 in apart: two rows of small controls at the small controls' vertical pitch;
- a layout with a single row puts it on the *center line*, y = 0;
- *rotary controls*, large ones included, sit on the center line, in one row; their grids across, 1.0 in or 0.8 in, are those of K.3, and their cells reach above and below the row lines;
- small controls beside a rotary control keep out of its cell (K.4): a jack on a row line is at least 0.6 in across from a pot on the 0.8 in grid, 0.7 in on the 1.0 in grid.

The usual 1U board is 21.10 mm tall (5.2.2), 10.55 mm above and below the center, so a row line is 4.20 mm inside the board's edge. EIS recommends checking a part's body on a 1U row line against that

edge: a body that reaches more than 4.20 mm beyond its bushing toward the edge overhangs the board, and the rail, behind it.

A 1U layout file says `format: 1U`; the check applies these rows in place of K.1's.

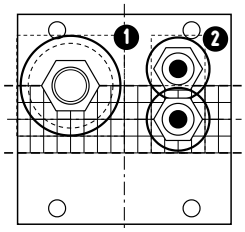
EIS · Control layout: 1U panels



1U, 8 HP
0 errors, 0 warnings

1U, 12 HP, rotary 0.8 x 1.0 in
0 errors, 0 warnings

1U, 20 HP, rotary 1.0 x 0.875 in
0 errors, 0 warnings



1U, 8 HP, rotary 0.8 x 1.0 in
3 errors, 2 warnings

What the check reports

1. error band: a pot off the center line, where a 1U panel's rotary controls sit
2. error band: a center above the top row line
3. error pitch: two small controls inside each other's 0.4 by 0.5 in cell
4. warning rows: no control on the bottom row line, −0.25 in
5. warning mount: J1's cell reaches over a mounting screw's 7 mm head

Row lines at +0.25 and −0.25 in (6.35 mm) from the panel center, 12.70 mm apart: two rows of small controls at the 0.5 in pitch, or one row on the center line.

Rotary controls sit on the center line, one row; their grids across are the 3U grids.

On the usual 21.10 mm board a row line is 4.20 mm inside the board's edge.

Figure 64. 1U panels: eight jacks in two rows at 8 HP; two pots on the center line and four jacks at 12 HP; a pot, an encoder, two toggles, and four jacks at 20 HP; and an 8 HP layout with faults and what the check reports

K.9 OTHER CONTROL SURFACES

A control surface that is not a Eurorack panel, a desktop controller or a wide front plate, takes the same lattice, grids, and cells from its own center, with its rows set by its height. A layout file for one says `format: surface`; the check then applies the lattice, the grids, and the cells, and no band, row lines, or rail screws.

ANNEX L (INFORMATIVE) — FRONT-PANEL LEGENDS AND ARTWORK

What is printed on a 3U or 1U front panel and where:
- the module's title and the maker's mark;
- the type a legend is set in, and where a legend sits on its part;
- how inputs and outputs are told apart;
- knob and fader scales, frames, rules, and heads;
- block-diagram symbols, pictograms, and illustrations.

EIS places no requirement on panel artwork; the rules here are a design guide. They are drawn from about 76 released front panels in six product families (L.10), and they keep what those panels share. Where the families differ, the rules name each choice and ask a panel to keep to one. A panel drawn to them reads like its neighbors across a row: titles on one line, legends at one distance from each kind of part, and one way of showing which jacks take a signal and which give one.

Some rules go further than the surveyed panels agree, where a panel drawn to the shared conventions alone reads poorly at patching distance or prints poorly: the label tier and knocked-out type (L.3), the seam between a knob row and the jacks under it and row figures beside plates (L.4), normals with a chevron and dashed ties (L.5), the bipolar index and end figures (L.7), section rules (L.8), and finger room and cables in Annex K. L.10 records only what the survey found.

The frame is Annex K's: lengths in millimeters, measured from the *panel center* with y up, looking at the front of the panel. Legend offsets are in inches, on the half lattice of K.2. One *tick* (tk) is 1/16 HP, 0.3175 mm. The numbers are in `data/panel_art.json`, and `tools/panel_art.py` draws the cards, writes the symbol files, and checks the numbers against each other. The typeface and its downloads are in Annex M.

L.1 INK

Every mark on a panel is ink of one stroke weight from a short list:
- 1 tk (0.3175 mm) for lines, frames, rings, and symbols;
- 2/3 tk, 4/5 tk (0.254 mm), 1 tk, and 2 tk for the type tiers (L.3), a quarter heavier where type is knocked out of a fill;
- 1/2 tk (0.15875 mm), the finest line a silkscreen holds, for a hairline.

Lines end and join round, and bend at 45° or 90°. A dimension is to the outer edge of the ink: a ring 0.45 in across is 0.45 in across its outside. The panels surveyed draw their lines between 0.30 mm and 0.53 mm; 1 tk sits in that range.

One ink carries every legend: white on a dark panel, black on a light one. A second ink is for meaning, never decoration:
- a channel's color on its jacks (L.5);
- or one accent for states and heads, such as a switch's positions or a frame's function line.

EIS recommends these clearances:

- no ink within *0.7 mm* of a panel edge;
- no legend within *0.5 mm* of a part's hardware (a nut, a bushing, a knob's skirt) or a screw head;
- no ink within *0.5 mm* of a tab or anti-rotation slot in the panel: a slot is a hole for every clearance here, though no part's hardware covers it;
- no gap between two marks under *0.3175 mm* (1 tk), so that neither fills in (inside a legend, the letter gaps of L.3);
- every knockout (a jack's hole in a filled plate) *0.2 mm* larger than the hole, the registration of print to drilling.

L.2 THE TITLE AND THE MAKER'S MARK

The module's title goes at the top of the panel and the maker's mark at the bottom, both centered on the panel.

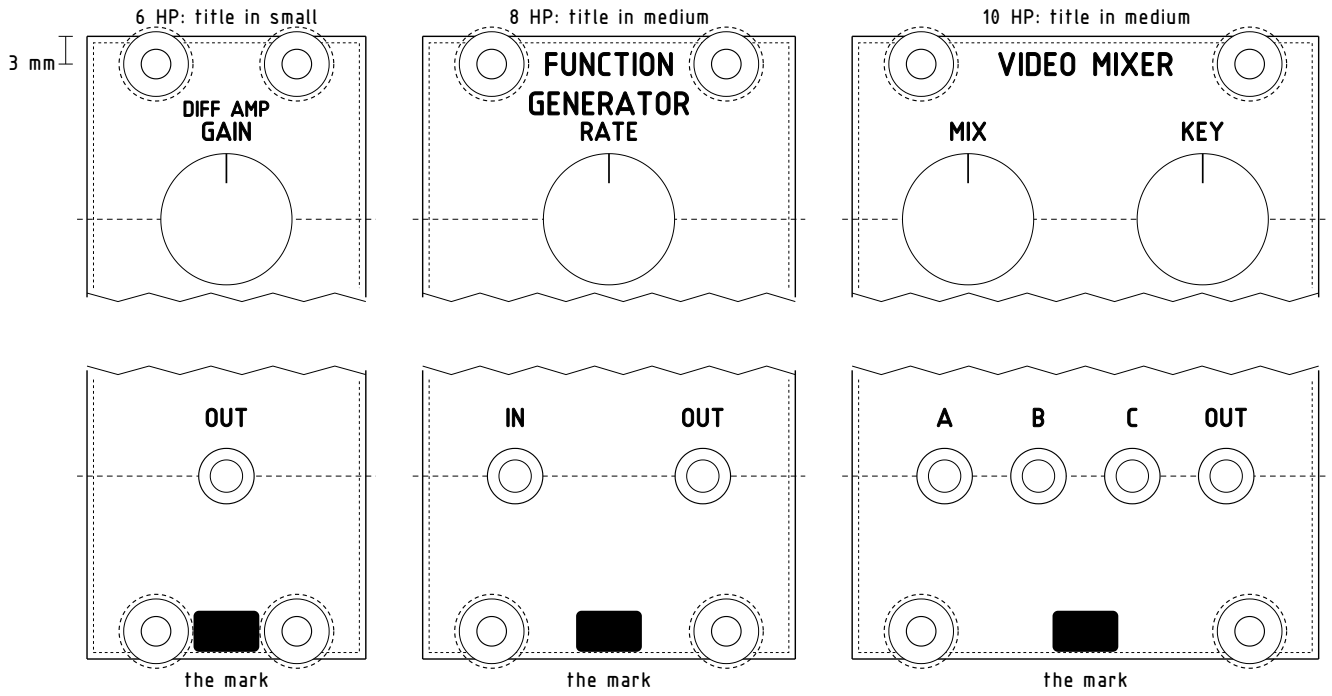
- *The title* is set in the medium tier (L.3), centered across the panel, its first line's capitals centered on the *top mounting-hole line*: 61.25 mm above the panel center on 3U, 16.825 mm on 1U. A title too long for the room between the screws breaks into a second line, 1.7 capitals (4.25 mm) lower. Every line keeps the 0.5 mm hardware margin from the screw heads (at most 7.0 mm across, RAIL-010) and the 0.7 mm edge margin.
- *Narrow panels.* Where the screws stand too close together for the title (4 HP and narrower, or a long title at 6 HP), the title moves down below the screw heads. If that brings it near the legends of the top row, it drops to the small tier, and it keeps a 1 tk gap over those legends. A narrow panel with one screw at each edge may instead set its title beside the screw, in two short lines.
- *Title forms.* A title is either:
- plain capitals;

- knocked out of a *title plate*, a filled rounded rectangle 3.81 mm (12 tk) tall, centered on the hole line, with corners of 1 tk;
- a short *code* knocked out of a plate, with the name beside it in the same tier, the two centered together.

A title may be set larger than medium, up to 4 mm capitals, where it fits between the screw heads, and it is never smaller than the panel's legends.
- *One treatment.* EIS recommends one title treatment across a family of panels: one line, in the medium tier, on the mounting-hole line. A title too long for that room is shortened first, to a code or the function's name, and only then broken into a second line or dropped to the small tier. A panel of two or more functions that work apart may carry section heads (L.8) in place of a title that lists them.
- *The function line.* One line in the small tier may say what the module does, under the title or set into the top edge of a frame (L.8).
- *The maker's mark* is a filled shape *4.45 mm tall*, centered on the *bottom mounting-hole line*. Where the room between the screws is narrower than the mark, the mark shrinks to fit, down to 4.45 mm across. Narrower still, it stands at full size just above the screw heads.
- *The series name.* Where a family prints a series or generation name, it goes in the small tier on the bottom mounting-hole line beside the mark, or one line over it, centered.
- *Nothing else* goes in the title's or the mark's band. A panel number or code, where a panel carries one, goes in a number plate (L.6) on the mounting-hole line beside a screw or between the screws.

The two bands leave the controls' band of Annex K free. A top-row knob's legend above its knob (L.4) tops out at 54.98 mm, under a second title line at 55.75 mm. On the 1.875 in variant rows (K.1) the top-row legends take the second line's place, and the title keeps to one line.

The band layout. A panel whose parts carry no legends over the top row may instead close off each screw band with a *band rule*, 1 tk, 2.25 in (57.15 mm) from the panel center and the panel's nominal width less 2.54 mm long:
- the title goes under the top rule, its capitals' tops 1.5875 mm below it, in one medium line or two small ones;
- a line pair or the function line may sit over the bottom rule;
- a code plate and the mark take the hole lines.



The title is centered on the panel, its first line's capitals centered on the top mounting-hole line, in the medium tier (2.5 mm capitals); a second line stands 1.7 capitals lower. Pink dashed circles: each screw head (7 mm) and the 0.5 mm hardware margin; green dashed: the 0.7 mm edge margin. No ink inside either.

Where the screws stand too close for the title (6 HP here), it moves down below their keepouts and may drop to the small tier to clear the legends of the top row. The maker's mark (black) is centered on the bottom mounting-hole line, or just above the screws where they leave too little room.

Figure 65. The top and bottom of 6, 8, and 10 HP panels: the title on the top mounting-hole line or below the screws, the screw heads and their margin, the edge margin, the top row's legends, and the maker's mark

The room on each line, by panel width, at the medium tier (the letter count is of capitals as wide as E):

WIDTH (HP)	PANEL WIDTH (mm)	FIRST LINE, ON THE MOUNTING-HOLE LINE (mm)	SECOND LINE (mm)	ONE LINE JUST BELOW THE SCREWS (mm)	MAKER'S MARK ON THE MOUNTING-HOLE LINE, UP TO (mm)
2	9.86	none	none	8.5 (about 4 letters)	none: above the screws
4	20.02	none	none	18.6 (about 10 letters)	none: above the screws
6	30.18	7.2 (about 4 letters)	9.9 (about 5 letters)	28.8 (about 16 letters)	7.2
8	40.34	17.4 (about 9 letters)	20.1 (about 11 letters)	38.9 (about 22 letters)	17.4
10	50.50	27.6 (about 15 letters)	30.3 (about 17 letters)	49.1 (about 28 letters)	27.6

WIDTH (HP)	PANEL WIDTH (mm)	FIRST LINE, ON THE MOUNTING-HOLE LINE (mm)	SECOND LINE (mm)	ONE LINE JUST BELOW THE SCREWS (mm)	MAKER'S MARK ON THE MOUNTING-HOLE LINE, UP TO (mm)
12	60.66	37.7 (about 21 letters)	40.4 (about 23 letters)	59.3 (about 33 letters)	37.7
14	70.82	47.9 (about 27 letters)	50.6 (about 28 letters)	69.4 (about 39 letters)	47.9
16	80.98	58.0 (about 33 letters)	60.7 (about 34 letters)	79.6 (about 45 letters)	58.0
18	91.14	68.2 (about 39 letters)	70.9 (about 40 letters)	89.7 (about 51 letters)	68.2
20	101.30	78.4 (about 44 letters)	81.1 (about 46 letters)	99.9 (about 57 letters)	78.4
24	121.62	98.7 (about 56 letters)	101.4 (about 58 letters)	120.2 (about 68 letters)	98.7
28	141.94	119.0 (about 68 letters)	121.7 (about 69 letters)	140.5 (about 80 letters)	119.0
32	162.26	139.3 (about 79 letters)	142.0 (about 81 letters)	160.9 (about 92 letters)	139.3
36	182.58	159.6 (about 91 letters)	162.3 (about 92 letters)	181.2 (about 103 letters)	159.6
42	213.06	190.1 (about 108 letters)	192.8 (about 110 letters)	211.7 (about 121 letters)	190.1

L.3 TYPE

Legends are set in one face, *LZX Panel Stroke* Regular (Annex M), in capitals. Another single-weight face drawn to the same capital height and stroke serves where a maker has its own; the sizes below are of the ink, not of the font.

A legend's size is a *tier*: a capital height and the stroke of a stem, the same drawing at four sizes. The board tiers are for the silkscreen of a board behind the panel, where references and pin names stand smaller than any panel legend. A panel uses at most *three* sizes, and no capital under *1.5 mm*. The panels surveyed set their legends with capitals 1.6 mm to 2.3 mm tall, most near 2.0 mm: the label tier. The small tier is at the light end of that range.

TIER	CAPITAL HEIGHT (mm)	STROKE (mm)	STROKE (TK)	FONT SIZE (mm)	FONT SIZE (PT)	TEXT STROKE (mm)	KNOCKED OUT: STROKE (mm)	KNOCKED OUT: FONT SIZE (mm)	KNOCKED OUT: TEXT STROKE (mm)	USE
small	1.6667	0.211667	2/3	2.0786	5.89	0.0038	0.264584	2.003	0.0643	scale figures, switch positions, the function line, a series name
label	2	0.254	4/5	2.4943	7.07	0.0046	0.3175	2.4036	0.0771	control names, jack names, plate and section heads, row figures
medium	2.5	0.3175	1	3.1179	8.84	0.0057	0.396875	3.0045	0.0964	the module title
large	5	0.635	2	6.2357	17.68	0.0114	0.79375	6.0089	0.1929	a figure or a word standing alone, such as a number plate
board, small	1	0.15875	1/2	1.2018	3.41	0.0386	not used			references, pin and rail names on the board's silkscreen
board, large	1.27	0.15875	1/2	1.5875	4.5	0	not used			the board's title and part number, connector titles

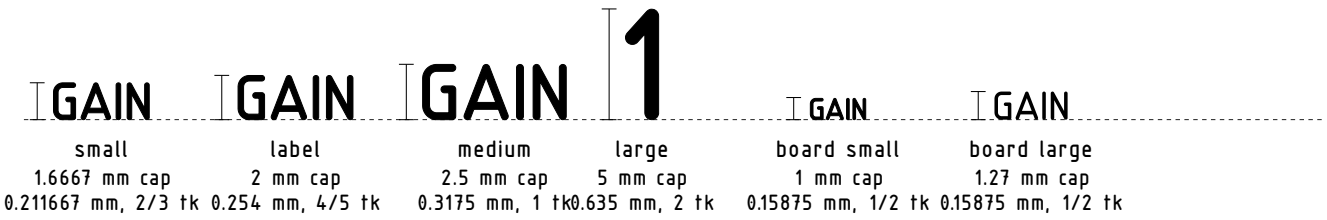
The font size and the text stroke land a capital on the tier's height and a stem on its stroke. LZX Panel Stroke's capital stands 0.8 em and its stem 0.1 em, so the font size is (capital height − stroke) / 0.7, and a text stroke in the ink makes up the rest (M.2).

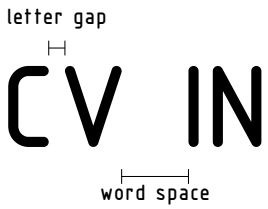
Spacing. The face's own spacing is used, with no tracking: two straight stems stand 0.16 em apart, about 1.6 strokes, and the word space is 0.5 em, five strokes. A legend too long for its place may be tracked tighter, never under one stroke between letters or three strokes between words. Lines of a legend stand 1.7 capitals apart. Board legends are set untracked: at the 1.0 mm tier the face's own gap is already about one stroke.

TIER	LETTER GAP BETWEEN STEMS (mm)	LEAST LETTER GAP (mm)	WORD SPACE (mm)	LINE PITCH (mm)
small	0.329	0.212	1.039	2.833
label	0.395	0.254	1.247	3.4

TIER	LETTER GAP BETWEEN STEMS (mm)	LEAST LETTER GAP (mm)	WORD SPACE (mm)	LINE PITCH (mm)
medium	0.493	0.318	1.559	4.25
large	0.986	0.635	3.118	8.5
board, small	0.154	set untracked	0.601	1.7
board, large	0.254	set untracked	0.794	2.159

EIS · Annex L · Legend type: tiers, stroke, and spacing





One face, LZX Panel Stroke Regular, in capitals. A tier fixes the capital height and the stroke of a stem; the font size and a text stroke in the ink solve both (Annex M). At most 3 sizes on a panel; no capital under 1.5 mm.

The face's own spacing: a letter gap of about 1.6 strokes between straight stems (never under 1), a word space of 5 strokes. The board tiers are the silkscreen of a board behind the panel.

Figure 66. The tiers at one scale with their capital heights and strokes, and the letter gap and word space

What goes in which tier. The title is medium. The *label* tier names things: a control's name, a jack's name, a plate's or a section's head, and the row figures of a jack field (L.4). The *small* tier is for what sits beside a named part: the figures of a scale, a switch's positions, the function line, and a series name. Large is for a figure or a word standing alone, such as a big number. A panel with a title, labels, and figures uses its three sizes; one that adds the large tier sets its figures in the label tier too. Values and units go on a control's scale; the function goes in its legend.

Knocked-out type. Type knocked out of a fill (a name inside an output plate or disc, a code in a title plate) is a gap in the ink, and a silkscreen spreads into it. EIS recommends setting it at its tier's capital height with a stroke a *quarter heavier* than printed type (the "knocked out" columns above): the label tier's 0.254 mm becomes 1 tk. Knocked-out type that carries a name is set in the

label tier or larger; the small tier knocked out is for a single figure. Fine marks inside knocked-out small type, a degree sign or the counters of 6, 8, 0, and Q, are the first to fill: write the unit out (720 DEG) or set the label tier.

Words. A legend names a function, not a part: GAIN, not POT. Short forms are fine where the panel's manual spells them out (CV, FREQ, THRESH, A+B); a jack that sets a control's value is named after it with VC or CV (RATE CV). A range may be named at its ends, left and right of the legend (- DEPTH +, BLUR | SHARP).
- *One sign, one meaning.* A slash does not stand for both division and NOT on one panel: a divider is ÷2, and a logical NOT is an overbar, a line in the legend's stroke a least ink gap over the capitals (Q with a bar, not /Q).
- *A switch's noun once.* A toggle's name is its legend; its positions carry only what differs between them (+ and -, not + EDGE and - EDGE).
- *Every part named.* Every control, switch, jack, and lamp carries a name, by its own legend, a plate's head, or a section head, so that the panel can be used without its manual.

L.4 WHERE A LEGEND SITS

A legend is set in the label tier, centered on its part, the middle of its capitals a fixed *offset* from the part's center. Most of the panels surveyed set a knob's legend 0.375 in from its center, either way. Four of the six families put their legends *below* the parts and two *above*. Either is fine, and *every legend on a panel takes the same side*. The offset depends on the part's family (K.3) and is a whole number of half lattice steps (0.0625 in), so the legends of a row line up across a row of modules, whatever the panel.

FAMILY	OFFSET FROM THE PART, ABOVE OR BELOW (IN)	(mm)	LEGEND CLEAR OF THE PART'S MARGIN BY (mm)	LEAST PITCH UP AND DOWN WITH A LEGEND BETWEEN (IN)	FAMILY'S LEAST PITCH (IN)	PART ALLOWED FOR
Small controls	0.25	6.35	0.85	0.5	0.5	a 3.5 mm jack's knurled nut (8 mm), a toggle's hex nut
Small controls, a jack with a 0.45 in ring (L.5)	0.3125	7.9375	0.905	0.625	0.5	the ring, a least ink gap
Rotary controls	0.375	9.525	0.087	0.8125	0.75	a knob up to 14.2 mm across, or its scale arc at 7.9375 mm

FAMILY	OFFSET FROM THE PART, ABOVE OR BELOW (IN)	(mm)	LEGEND CLEAR OF THE PART'S MARGIN BY (mm)	LEAST PITCH UP AND DOWN WITH A LEGEND BETWEEN (IN)	FAMILY'S LEAST PITCH (IN)	PART ALLOWED FOR
Large rotary controls	0.5	12.70	1.2	1.0	1.0	a knob up to 20 mm across
Large controls	0.3125	7.9375	0.438	0.625	0.625	an RCA jack's nut, a 12 mm button cap
BNC jacks	0.375	9.525	1.025	0.75	0.75	a BNC jack's nut and bayonet
Indicators and miniature buttons	0.1875	4.7625	0.762	0.375	0.25	a 5 mm LED or a 4 mm button cap
Faders	0.25	6.35	5.35	not applicable	none	measured from the end of the slot, past the end of travel

Pitch and clearance.
- The offsets hold the hardware margin to the part (the fourth column).
- A legend between two parts of a column needs the pitch in the fifth column. Where a family's least pitch (K.3) is closer than that, the column's parts take the wider pitch, or the column carries one head legend instead of one per part.
- A jack with a 0.45 in ring (L.5) takes its legend 0.3125 in away. Ringed jacks with a legend each stand 0.625 in apart; ringed jacks 0.5 in apart carry one *column head*, at the column's foot or top, 0.3125 in past its end jack.
- A legend that cannot take the panel's side, where a part stands right next to it, goes beside its part, its near edge a 1 tk gap outside the part's hardware margin.

A centered knob over a slot. A centered (bipolar) knob whose index (L.7) shares twelve o'clock with an anti-rotation slot or tab takes its legend *one half lattice step further out*: 0.4375 in for a rotary control. The slot and its margin take the inner part of the scale's band, and the step gives the index its full tick under the legend. The other legends of the row keep the family's offset.

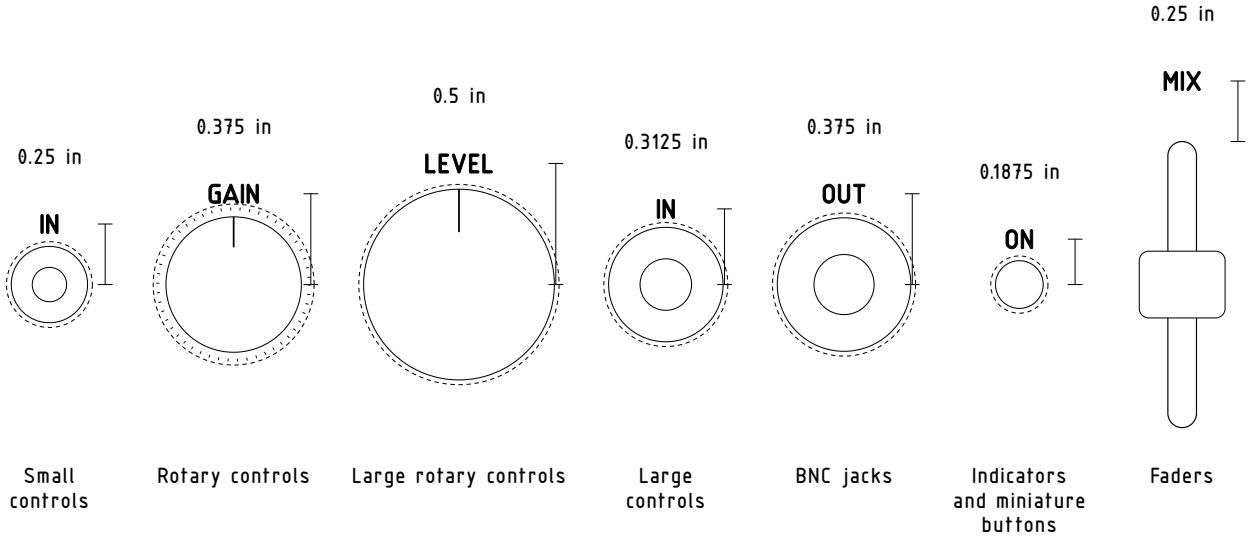
A rotary switch's name. Where a rotary switch's positions (L.9) stand within 30° of its legend's side (twelve o'clock for a legend above), its legend takes the same half step out: 0.4375 in. The positions take the place the legend would have.

Small marks beside a part.
- *Switch positions* go at the throws, in the small tier: the words or pictograms of a toggle's or a slide switch's positions above and below it, *0.25 in* from its center for a bare lever or a slide, or at its ends for a sideways slide. Where a *lever cap* is fitted, the cap stands over the thrown side's legend at 0.25 in from any angle but straight on, and the positions go *0.3125 in* from the center. That needs 0.625 in or more to the next part up or down the column; a toggle with less sets its positions beside it, level with each throw. A three-position toggle marks all three positions, its center too.
- *Jack numbers* (1, 2, 3, or a channel letter) beside a bare jack go 0.225 in to its side, level with its center, the same side down a column. A jack in a plate or a ring takes row figures instead.
- *Row figures.* Where jacks stand in plates, the rows of the field are numbered on both sides a user patches from: one figure per row in the label tier, level with the row's jacks, in the *gutter left of the field's first plate* and again in the *gutter at the boundary between the input plates and the output plates*, centered between the plates' ink (on the left, 2 tk outside the first plate's outline). A gutter narrower than the figure and 2 tk each side passes it to the next gutter out. Sister modules keep the same two places.
- *An LED* needs no legend where the jack or control it shows is named and the lamp stands next to it. A lamp that stands apart from what it shows, or under a knob, carries a word for it (Q, GATE), at the indicator family's offset.

The seam. Where a row of rotary controls stands over jacks, three kinds of small ink can meet in one band: the knobs' scale figures and ties, the legends of the row, and the heads of the plates or the legends of the ringed jacks under it. Each may clear the next by the least ink gap, and the band still reads as one line of text. EIS recommends a *seam*: every mark that belongs to the knob row keeps at least *1.5875 mm* (half a lattice step, five least ink gaps) from every mark that belongs to the jacks under it. A scale over a plate carries no end figures in its bottom gap (L.7); where a row cannot keep the seam, its figures go first, then its ties.

A group of parts that work together (a channel, the jacks of one input) shares a head legend rather than repeating a word over each part (L.8). Jacks are named one way on a panel: a column of like jacks takes a head in its plate's edge; a column of unlike jacks takes a name over each jack inside its plate and no head; a single jack takes a ring and a legend. A column never carries both a head and a name over its first jack.

EIS · Annex L · Where a legend sits



A legend is centered on its part, the middle of its capitals the family's offset (dimension, in inches) above or below the part's center: a whole number of half lattice steps, so the legends of a row line up across a row of modules. Shown above; below is the same distance down. A fader's legend stands the offset past the end of its slot.

Pink dashed: the part's hardware or knob and the 0.5 mm hardware margin. A legend never reaches inside it. Every legend on a panel takes the same side of its part.

Figure 67. Each family's part with its legend at the offset, and the part's hardware margin

L.5 MARKING INPUTS AND OUTPUTS

A panel tells inputs from outputs one way, on every jack. Five of the six families surveyed draw style A; the sixth, style B. EIS recommends one of the two.

Style A, outline and fill. An input is *outlined*; an output is *filled*.
- *Rings.* A ring around a single jack is *0.45 in* (11.43 mm) across, a 1 tk line for an input and a filled disc for an output. The output disc's hole is knocked out 0.2 mm wide, or left under the jack's nut. Rings need the jacks 0.5 in apart; on jacks 0.4 in apart, a ring 0.375 in across leaves the same 2 tk gap.
- *Plates.* A group of jacks in one column may share a *plate* instead:
- 0.45 in wide, reaching 0.35 in past the end jacks, with corners 0.1 in (2.54 mm) round;
- outlined in a 1 tk line for inputs, or filled with the jacks' holes knocked out for outputs;
- the group's head legend is set into the plate's top edge: the outline breaks round it, or a tab is knocked out of the fill;
- jacks 0.4 in apart share one plate;

- a plate on columns 0.4 in apart is *0.375 in* (9.525 mm) wide, as the narrow ring is, so that the 2 tk gap between neighboring plates holds.
- *Normals.* Inside style A, a normal, the signal an unpatched input receives, is a *solid* 1 tk line from the jack it comes from to the jack it reaches, with a *chevron* in it pointing along the signal: two strokes of the line's weight, 1.27 mm across and 0.635 mm deep, the tip on the line. Inside a plate the line runs between the nuts; between plates it leaves and enters through their outlines. A normal drawn *down a column*, through its jacks with a chevron between each, says that the column's unpatched jacks receive the signal of its top jack. Whether that is a chain of switched jacks or a buffered bus is the manual's to say, not the panel's: both are drawn this way. The chevron is stroked and open, never a filled or closed head, so that it never reads as style B.
- *Ties.* A control tied to the jack that sets it (a CV input and its attenuverter) is joined by a *dashed* 1 tk line with no head: dashes of 1.27 mm of ink, 0.635 mm apart, none under 0.635 mm. Rows of isolated dots are not used: a 1 tk dot is at the edge of what a silkscreen holds, and a row of them reads faintest on the panel.
- *Reaching the target.* A normal or a tie runs all the way: each end stops a least ink gap short of the ink of what it joins (a ring, a plate's outline, a scale) or of a bare nut's hardware margin, never in open panel short of it.
- *Names.* An input and an output never share a name on a panel, even where outline and fill tell them apart: a manual, a patch note, or a spoken instruction cannot. Name them KEY IN and KEY OUT, or THRU.
- *Column heads.* A column of inputs or outputs may also be headed with an outlined or filled block arrow (L.6), the same distinction again.

Channel colors. A jack that carries one channel of a color signal may take the channel's color for its ring, disc, or plate, with every other mark in the legend ink. This is the second ink of L.1:

CHANNEL	COLOR	PANTONE (AS SURVEYED)
Red; Pr; R − Y	red	1797 C
Green; Y (luma)	green	348 C
Blue; Pb; B − Y	blue	7462 C
Composite video	yellow	none recorded

Red, green, and blue jacks stand in that order, top to bottom or left to right.

Style B, arrows. The jacks are left plain and the signal is drawn.
- A line *leaves each input* toward what it feeds; where it enters a block symbol or a normalled jack, it ends in an *open head*.
- A line *ends at each output* in a *filled head* pointing at the jack.
- The jacks of a passive multiple are joined by a line with no head.
- Lines are 1 tk, bend at 45° or 90°, and stop 0.2 in from a jack's center, clear of its nut.
- A head is 5 tk (1.5875 mm) long and 4 tk (1.27 mm) across, drawn in the 1 tk line, and filled for an output.

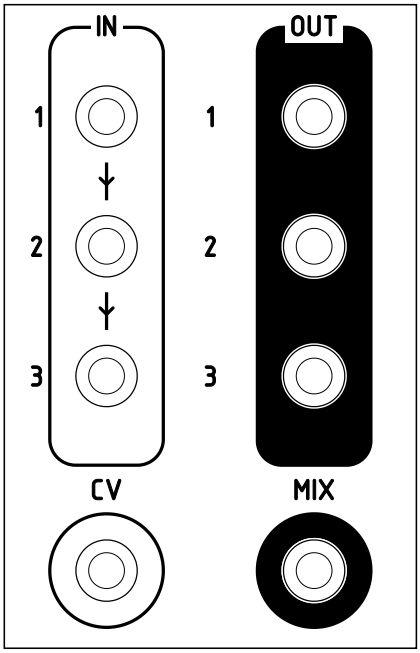
Style B panels in use carry few legends: the title and the blocks say what the panel does.

Fill. A filled plate is the largest mark on a panel and the first the eye finds. EIS recommends that filled ink cover no more than *a fifth* of the panel's face. Where tall output columns would pass that, a column of five jacks or more may be marked with a *heavy outline*, 2 tk, in place of a fill, as some surveyed panels mark an output with a heavy ring. A heavy outline is a full output mark: it is as valid as a fill, its names and head print in the ink (nothing is knocked out of it), and only filled ink counts toward the fifth.

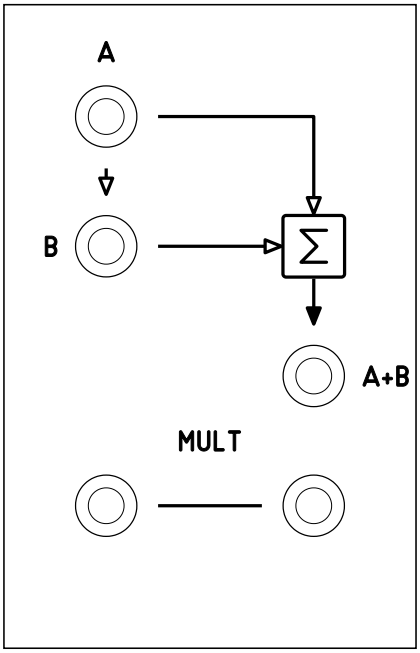
Style A suits a panel whose jacks stand in groups; style B, a panel whose function is a short signal path, where the block symbols of L.6 say what happens between the jacks. A panel uses one style; style A's normals carry a stroked chevron, never a head, so the two never read alike.

EIS · Annex L · Marking inputs and outputs

A outline and fill



B arrows



A: an input is outlined, a ring or a plate in a 1 tk line; an output is filled, a disc or a plate of ink. A ring is 0.45 in across; a plate 0.45 in wide, reaching 0.35 in past its end jacks, corners 2.54 mm round, its head set into the top edge. Normalled inputs are linked with a solid line and a chevron along the signal. Row figures stand in the gutter left of the first plate and at the input / output boundary.

B: a line leaves each input toward what it feeds and ends in an open head where it enters a block or a normalled jack; a line ends at each output in a filled head pointing at it. Jacks of a passive multiple are joined with no

Figure 68. Style A, an outlined input plate with its normals and their chevrons, a filled output plate, row figures left of the field and at the input / output boundary, an input ring and an output disc; style B, an input normalled down to a second input, both into a sum, the sum to an output, and a passive multiple

L.6 BLOCK-DIAGRAM SYMBOLS AND PICTOGRAMS

A set of symbols for the block diagram of style B, or anywhere a panel says what a stage does.

- *Blocks and lines* are drawn in a 1 tk line with round ends and joins. A block is a 0.25 in (6.35 mm) square with 1 tk corners, the size of a jack's hole circle, and stands on the jacks' grid.
- *Pictograms* (L.9) are drawn in the legend's stroke, 1.5 small capitals tall.
- A signal enters a symbol at its top and leaves at its bottom; turn a symbol in steps of 90° to follow the panel, keeping waveforms and responses upright.

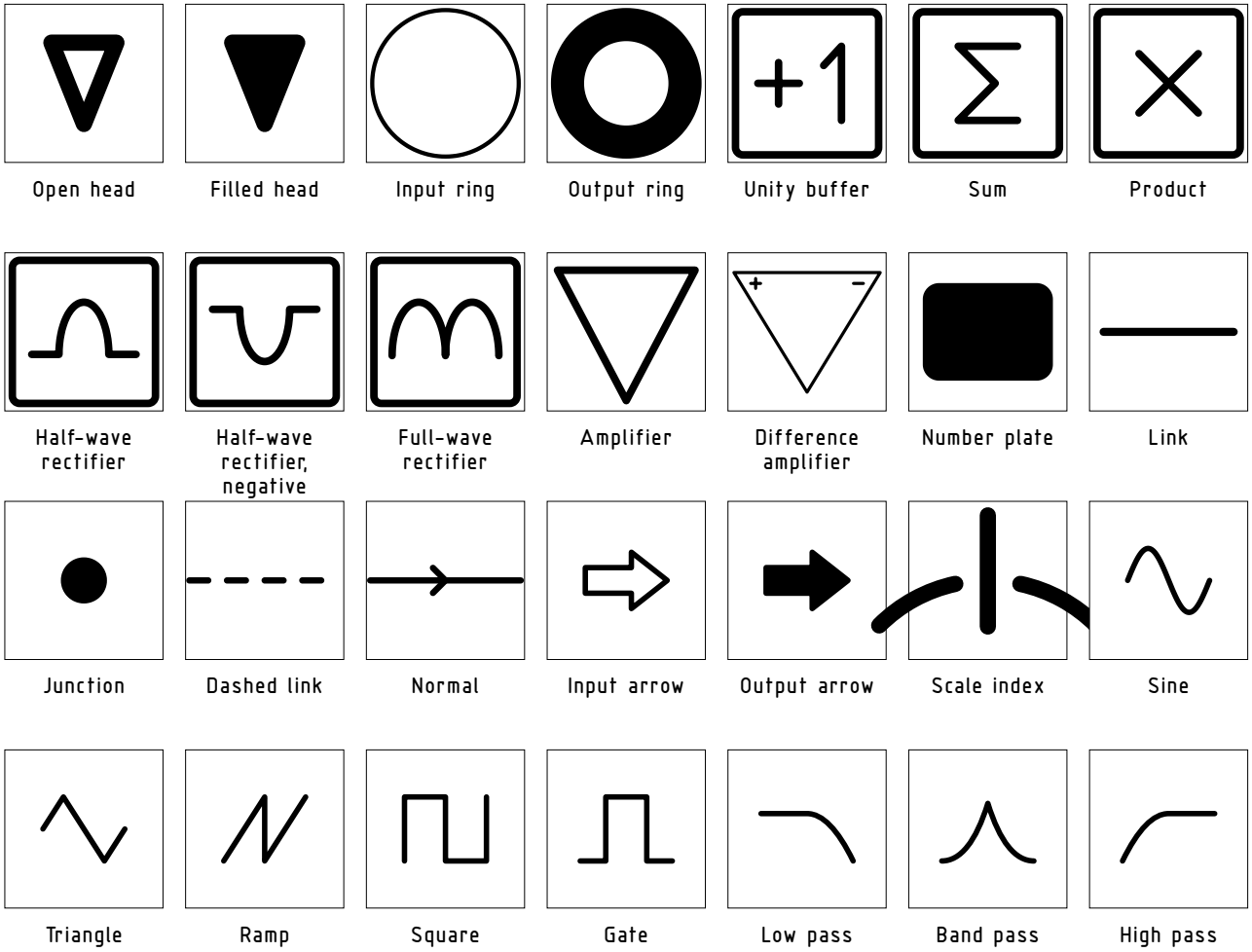
- An amplifier's gain is a small legend beside it or inside its top edge (0.5X, 2X), and its inputs' + and − are drawn in.

Each symbol is a file in millimeters, at the size it prints:

SYMBOL	FILE	MEANING
Open head	`head-open.svg`	a signal entering a block, or normalled to the next jack
Filled head	`head-filled.svg`	a signal arriving at an output jack
Input ring	`ring-input.svg`	an input jack (style A)
Output ring	`ring-output.svg`	an output jack (style A)
Unity buffer	`unity.svg`	a buffer of gain 1 (+1)
Sum	`sum.svg`	the inputs added
Product	`product.svg`	the inputs multiplied
Half-wave rectifier	`half-wave.svg`	the positive half of the signal
Half-wave rectifier, negative	`half-wave-negative.svg`	the negative half of the signal
Full-wave rectifier	`full-wave.svg`	the magnitude of the signal
Amplifier	`amplifier.svg`	a buffer or amplifier; its gain is a legend beside it
Difference amplifier	`difference.svg`	the + input less the − input; its gain is a legend beside it
Number plate	`plate.svg`	a filled plate carrying a short number or code, knocked out
Link	`link.svg`	jacks of a passive multiple, joined with no head; with a chevron, a normal
Junction	`dot.svg`	lines joined: one signal feeding several
Dashed link	`link-dashed.svg`	a control tied to the jack that sets it
Normal	`chevron.svg`	a normal inside style A: a line with a stroked chevron pointing along the signal
Input arrow	`arrow-input.svg`	a column of inputs (style A head)
Output arrow	`arrow-output.svg`	a column of outputs (style A head)
Scale index	`index.svg`	the center of a bipolar control's travel: a break in the scale and an outward tick
Sine	`sine.svg`	a sine wave
Triangle	`triangle.svg`	a triangle wave
Ramp	`saw.svg`	a ramp or sawtooth
Square	`square.svg`	a square wave
Gate	`gate.svg`	a gate, trigger, or pulse
Low pass	`lowpass.svg`	a low-pass response
Band pass	`bandpass.svg`	a band-pass response

SYMBOL	FILE	MEANING
High pass	highpass.svg	a high-pass response

EIS · Annex L · Block-diagram symbols and pictograms



Blocks and lines in a 0.3175 mm (1 tk) line with round ends and joins; a block is a 6.35 mm (0.25 in) square, the size of a jack's hole circle. A signal enters at the top and leaves at the bottom; turn a symbol in steps of 90 degrees to follow the panel. Pictograms (last two rows) are drawn in the legend's stroke, 1.5 small capitals tall, and stay upright. Heads, the junction, and the index are shown at twice the scale. Each is a file in figures/symbols/, in millimeters, at the size it prints.

Figure 69. The block-diagram symbols and pictograms: heads, rings, blocks, amplifiers, the number plate, links, the junction, block arrows, the scale index, waveforms, and filter responses

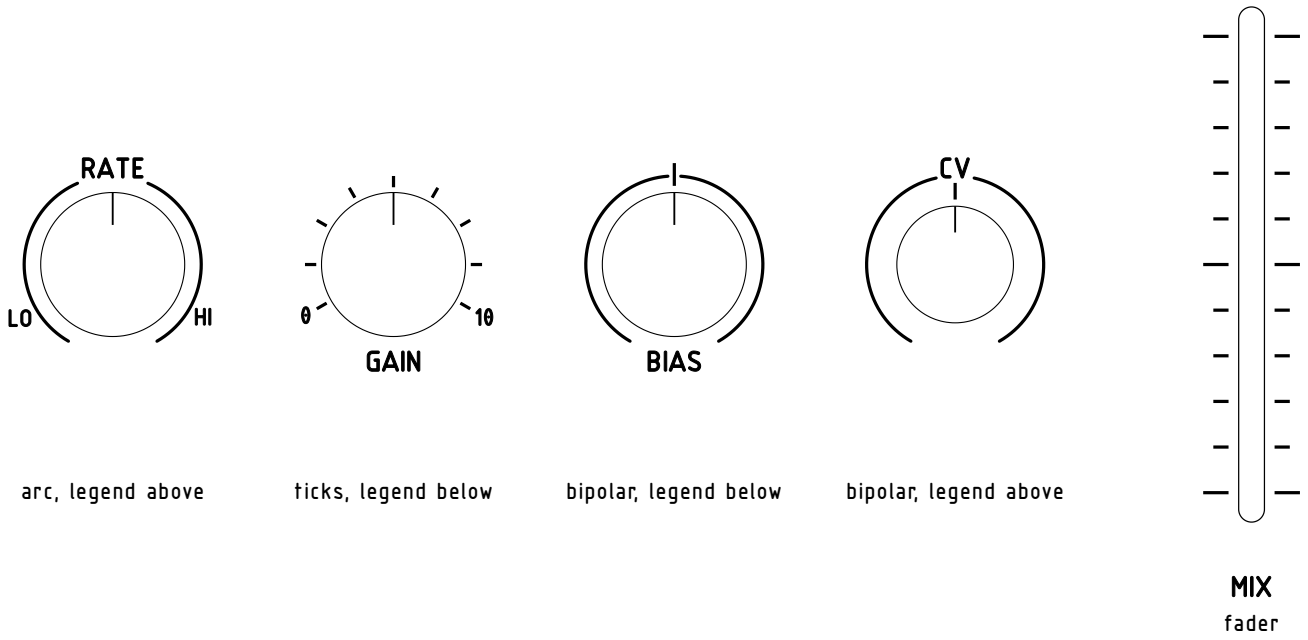
L.7 KNOB AND FADER SCALES

A knob needs no scale where its legend says enough; most panels surveyed draw scales only where a setting is read back.

- *Where it goes.* A scale lies between the knob's skirt, plus the 0.5 mm hardware margin, and 0.35 in (8.89 mm) from the knob's center. It

is drawn in 1 tk over the pot's travel, 300°: ±150° from twelve o'clock.
- *Its form.* A scale is an arc, or *ticks* every 30° (1.27 mm long, to the outer edge).
- *The legend's side.* A scale is open on the legend's side. A legend below a knob sits in the gap at the bottom of the travel; a legend above breaks the arc round it.
- *Figures.* Figures go on a scale only where they name something a user reads back or sets by eye: a value (0 to 10), a unit, or the ends' names (A and B, LO and HI). A plain unipolar knob carries none; the knob says that much. A designer's shorthand (−N and N for inverting and non-inverting gain) does not reach a panel; a bipolar knob's ends, where they need a sign at all, are − and +. Figures are in the small tier, *outside* the scale, centered on 120° either side of twelve o'clock (eight and four o'clock), a least ink gap past its outer edge, with a midpoint figure at twelve o'clock where the legend is below. A scale over a plate (the seam, L.4) carries no figures in its bottom gap.
- *Index.* A bipolar or centered control marks its center with a *break* in the scale at twelve o'clock and a 1 tk *tick* across it, from the skirt's hardware margin to 1.27 mm proud of the scale, the arc stopping a least ink gap off the tick. Where the legend stands above, the legend's own break is the break, and the tick stands in it from the skirt's margin to a least ink gap under the legend, at least 0.9525 mm (3 tk) of ink. A knob too large to leave that under its legend takes a smaller cap (an attenuverter's) or its legend below; a knob whose anti-rotation slot or tab stands at twelve o'clock takes its legend a half lattice step further out (L.4). One mark, on every bipolar knob, legend or none.
- *Faders.* A fader carries *11 ticks* either side of its slot, its travel in tenths, the middle and the ends a little longer, and its legend 0.25 in past the end of the slot.

EIS · Annex L · Knob and fader scales



arc, legend above ticks, legend below bipolar, legend below bipolar, legend above fader

A scale lies between the knob's skirt (plus the 0.5 mm margin) and 0.35 in from its center, in a 1 tk line, over the pot's 300 degrees of travel, open on the legend's side. Figures only where they name something read back (LO and HI, 0 to 10), in the small tier outside the scale at 120 degrees either side of twelve o'clock, clear of the row below; a plain unipolar knob carries none.

A bipolar control marks its center with a break in the scale and a tick across it, 1.27 mm proud of it. With the

Figure 70. Four knobs: an arc with the legend above and its ends named outside the arc, ticks read back from 0 to 10 with the legend below, a bipolar scale's break and tick with the legend below, and the tick under a legend above on a smaller cap; and a fader with eleven ticks

L.8 FRAMES, RULES, AND HEADS

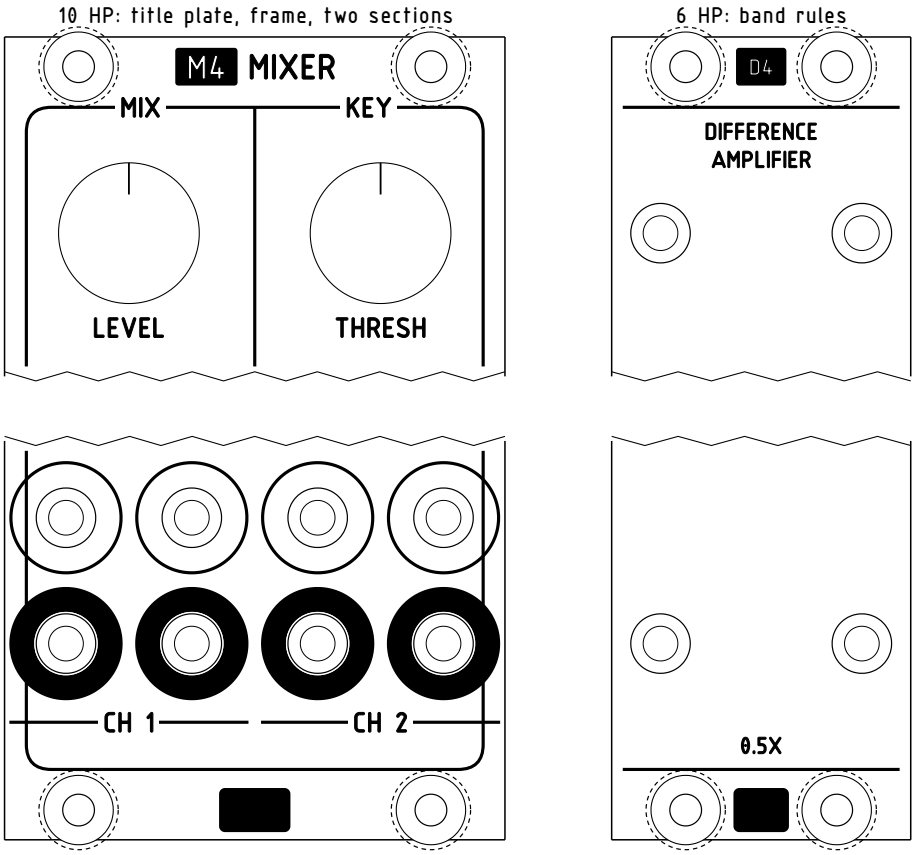
Panels group parts graphically only where they work together. Three elements do it.

- *The frame.*
- One rounded frame may enclose a panel's whole control area: 1 tk, 2.2 mm inside the panel's sides, its top and bottom edges 2.25 in from the center, corners 0.1 in round.
- The function line is set into its top edge.
- A framed panel's legends sit below their parts, clear of the frame's top edge.
- *The rule.*
- A 1 tk rule parts two sections of a panel that work apart, the full width of the frame or panel, keeping 1.5 mm from every legend.
- Sections side by side are parted by a *vertical* rule, from the

frame's top edge to its bottom one, or between the band rules, or the height of the controls' band, keeping the same 1.5 mm.
- The band rules of L.2 are rules too.
- *The section head.* Each section of a panel of two or more functions carries a head in the label tier, set into the frame's top edge or the rule over it, or at the top of the section where there is neither. A compound panel's title may then be shortened to what the sections share (L.2).
- *The inset head.*
- A head legend set into a line: a plate's edge, a frame's top edge, or a rule under or over the columns it names (— CH 1 —).
- The line stops 0.635 mm (2 tk) short of the legend's ink on each side.

Frames and plates do not nest: a plate may stand inside a frame, but no frame inside a plate and no second frame inside the first. EIS recommends no more structure than the panel's function needs.

EIS · Annex L · Frames, rules, and heads



Left: the title as a code knocked out of a plate (3.81 mm tall) with the name beside it, on the mounting-hole line; one frame round the control area, 2.2 mm inside the panel's sides, its top and bottom edges 2.25 in from the center. Two functions that work apart: a section head each set into the frame's top edge (where a single function's line would go) and a vertical rule between them, 1.5 mm clear of every legend. Channel heads are set into a rule under their columns: with rings on jacks 0.5 in apart, one head per column or group, not one per jack.

Right: band rules 2.25 in from the center close off the screw bands; the title goes under the top rule, a code plate on the mounting-hole line, the maker's mark on the bottom one. For a panel whose parts carry no legends over the top row.

Figure 71. A 10 HP panel with a code-and-name title plate, a frame with two section heads and a vertical rule between them, and channel heads set into rules under ringed jacks; a 6 HP panel in the band layout

L.9 PICTOGRAMS AND ILLUSTRATIONS

Pictograms. A pictogram stands where a word would, at the word's offset, as tall as 1.5 small capitals and drawn in the small tier's stroke; one that is a head, set into a plate's edge or over an output, may stand *2 small capitals* tall (3.33 mm), drawn in the label tier's stroke. Four of the six families surveyed use them. They are best for:

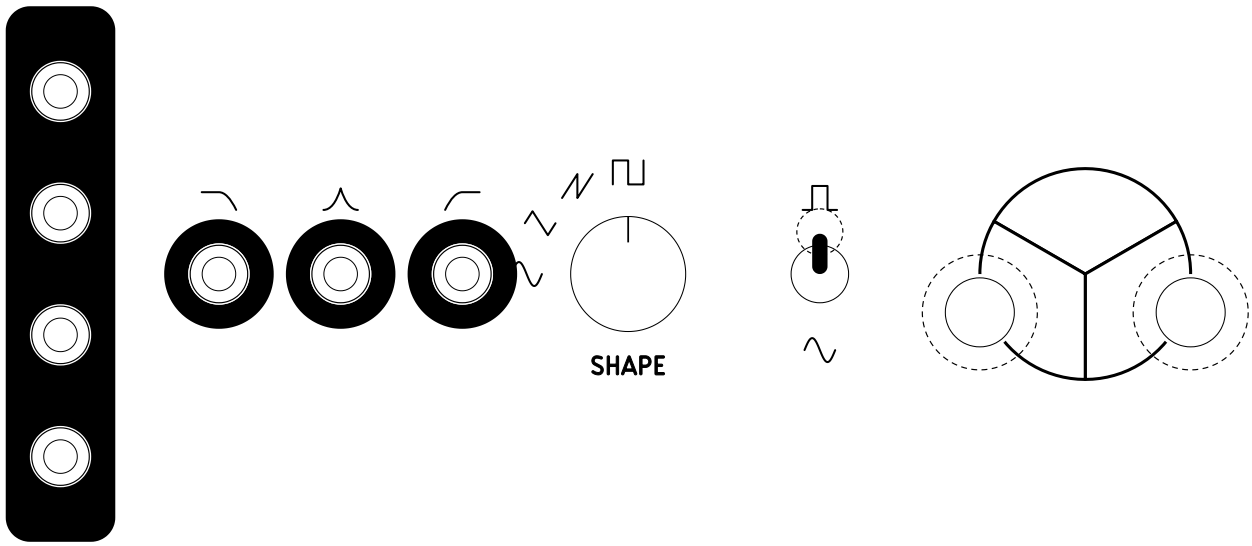
- waveforms over the outputs that give them;
- a filter's responses over its outputs;

- the positions of a rotary switch, round it: *position 1 exactly to its left, at nine o'clock, and the rest clockwise at its detent pitch* (Annex K.3), each on its detent's ray as near the knob as the hardware margin and the least gap allow, and no farther out than 10.6 mm from its center;
- the throws of a toggle, above and below it;
- a gate input or output.

Knocked out of a filled plate, a pictogram is an output's head. A panel uses pictograms or words for the same kind of thing, not both. The pictograms of L.6 are the common set; a panel may draw others in the same weight and size. Pictograms of one set differ in their *outline*, as a sine differs from a square: a set whose members differ only in a detail under 1 mm (the curve of one stroke, the length of a foot) cannot be told apart at patching distance, and reads better as words or figures.

Illustrations. An illustration is flat ink that shows what the module does, such as a color wheel between a chroma control's knobs. It is rare: one family surveyed carries one. Knobs may stand over it. It stops the hardware margin short of every hole and nut, and it keeps clear of jacks, legends, and the title and mark bands. A panel carries one illustration or none.

EIS · Annex L · Pictograms and illustrations



waveform outputs filter outputs switch positions toggle positions an illustration

A pictogram stands where a word would, as tall as 1.5 small capitals and drawn in the legend's stroke: a waveform over an output, a filter's response, a switch's positions round it or above and below it (here 0.3125 in, clear of the lever cap, dashed). Knocked out of a filled plate, it reads as an output's head; on the panel, as a legend. Pictograms of one set differ in outline; where they would differ only in a detail, use words.

Figure 72. Waveform pictograms knocked out of an output plate, filter responses over output discs, a rotary switch's positions round it, a toggle's positions above and below it clear of its lever cap, and a color-wheel illustration between two knobs

L.10 CONVENTIONS IN USE

The rules above were taken from the released front panels of six product families: about 76 panels, measured from their print artwork. The table gives, for each convention, how many families follow it. A family counts where nearly all its panels do.

CONVENTION	FAMILIES (OF 6)
Inputs outlined, outputs filled (rings, plates, or frames)	5; the sixth draws arrows (style B)
Rings 0.45 in across, a thin ring for an input and a filled disc or heavy ring for an output	3
Title centered on, or within 1.75 mm below, the top mounting-hole line	5
Title knocked out of a plate, or a code plate beside the name	3
Maker's mark centered at the bottom, on or just above the bottom mounting-hole line	6 (in each family's latest panels)
Knob legend 0.35 in to 0.4 in from the knob's center	4

CONVENTION	FAMILIES (OF 6)
Knob legends below the knobs (the rest above)	4
Switch positions above and below the switch, 0.2 in to 0.28 in away	4
LEDs without legends	6
Normals drawn: a line, plain, dotted, or with a head	6
Knob scales: an arc or ticks round the knob (the rest none)	4
Fader scales of 11 ticks	2 (of the 2 families with faders)
Plates or frames round groups of jacks	3
A frame round the whole control area, or band rules closing off the screw bands	3
Channel colors on red, green, and blue jacks	3
Pictograms in place of words	4
Legend capitals 1.6 mm to 2.3 mm, one weight, capitals only	6
Jack rows 0.5 in apart, knob rows 0.875 in or 1.0 in apart (Annex K)	6

ANNEX M (INFORMATIVE) — THE LZX PANEL STROKE TYPEFACE

The typeface the legends of Annex L and the figures of this document are set in, and how to set it at a legend's size. LZX Panel Stroke is drawn as if by a round pen: every stem is one weight and every end is round, the way a silkscreen or an engraving cutter lays ink. It is free to use, copy, and change for any purpose.

M.1 DOWNLOADS

FILE	FORMAT	FOR	SIZE	SHA-256
LZXPanelStroke-Regular.ttf	TrueType outlines	CAD and drawing programs, KiCad, Inkscape, Illustrator; the face the panel legends are set in	617 kB	e32258aa02c85b4f
LZXPanelStroke-Regular.woff2	WOFF2 outlines	web pages; the same outlines	62 kB	c53b313bc36febd9
LZXPanelStroke-Centerline.svg	SVG font of open center lines	engraving, pen plotting, Inkscape's Hershey Text; drawn with a round pen of the stroke's width	165 kB	9bf7861019f0f805

The outline fonts (TrueType and WOFF2) draw each letter as a filled shape: the ink of the pen. A drawing program, a PCB tool, or a printer sets them like any font. The *center-line font* draws each letter as open paths through the middle of the pen's stroke, for a tool that drags a cutter or a pen along a line: an engraving machine, a pen plotter, a laser in vector mode, or Inkscape's Hershey Text extension (copy the file into the extension's folder of SVG fonts). Both have the same advances, so a legend set in one stands where the other would.

The fonts are released under *CC0 1.0 Universal*: LZX Industries has waived all copyright and related rights to them (creativecommons.org/publicdomain/zero/1.0). They are drawn from *Norm Stroke* by octycs (github.com/octycs/norm-stroke, CC0 1.0), a lettering in the manner of ISO 3098 type B.

M.2 SETTING A SIZE

A legend's size is its *capital height* and its *stroke*, the width of a stem (Annex L's tiers). In LZX Panel Stroke Regular a capital stands *0.8 em* and a stem is *0.1 em*. Setting the font at a size and adding a text stroke in the ink (an outline the same color as the fill) makes both come out right:

- *font size* = (capital height − stroke) / 0.7;
- *text stroke* = stroke − 0.1 × font size.

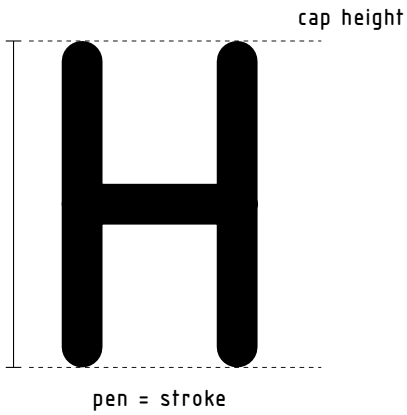
The center-line font's lines run half a stroke inside the capital: 0.7 em of line from the foot of a stem to its top. Drawn at the same font size with a round pen as wide as the stroke, it lays the same capital as the outline font.

TIER	CAPITAL HEIGHT (mm)	STROKE (mm)	OUTLINE FACE: FONT SIZE (mm)	OUTLINE FACE: TEXT STROKE (mm)	CENTER-LINE FACE: FONT SIZE (mm)	CENTER-LINE FACE: PEN (mm)
small	1.6667	0.211667	2.0786	0.0038	2.0786	0.211667
label	2	0.254	2.4943	0.0046	2.4943	0.254
medium	2.5	0.3175	3.1179	0.0057	3.1179	0.3175
large	5	0.635	6.2357	0.0114	6.2357	0.635
board, small	1	0.15875	1.2018	0.0386	1.2018	0.15875
board, large	1.27	0.15875	1.5875	0	1.5875	0.15875

A program that gives a font's size in points takes the font size in millimeters × 72 / 25.4. A program with no text stroke sets the font

size alone: the stem then stands 0.1 em, slightly under the tier's stroke, and the capital slightly under its height, by the text stroke in each.

EIS · Annex M · LZX Panel Stroke and its center lines



ABCDEFGHIJKLM
NOPQRSTUVWXYZ
0123456789
+−.,:/()%&#

Pink: the center lines of the center-line font, half a stroke inside the capital. Light blue: a round pen of the stroke's width drawn along them, the ink of LZX Panel Stroke Regular at the same size. A capital stands 0.7 em of center line plus one pen, so either face is set at a size of (cap height − stroke) / 0.7.

Right: the center-line font, as an engraver or a pen plotter draws it.

Figure 73. A capital H: its center lines, the pen drawn along them, the capital height, and the center-line alphabet

M.3 THE CHARACTER SET

The face sets the Basic Latin letters, figures, and punctuation, the Latin-1 accented capitals, and the signs a panel uses: ± × ÷ − ° µ Ω. It has no arrows: a panel draws its arrows (L.5). Its zero has a center dot, to tell it from the letter O. Panel legends are set in capitals; the face has lowercase letters for other text.

BIBLIOGRAPHY (INFORMATIVE)

These sources explain or justify EIS; none is normative. This repository stores no third-party document: `data/sources.json` records the URL, the retrieval date, and, where one was taken, the SHA-256 of each source it cites. The reference repository does the same for the survey and the catalog sections.

SOURCE	USE IN EIS
nVent Schroff EuropacPRO catalog, December 2025, threaded inserts p. 6.37, front rails pp. 6.26 to 6.32, collar screws p. 6.74	Evidence for the 5.0 mm × 2.0 mm M3 insert section and tap drill; the L-KD, L-OD, and H-KD sections in the catalog rail sections and H-LD in the rejected catalog rails
IEC 60297-3-100:2008 and IEC 60297-3-101:2004 public preview pages (IEC samples)	The front panel, flange and slot figures of 5.1, read from the publications' own Figure 2, Table 1, Figure 3 and Figure 5
nVent Schroff standards summary	Transcription of the IEC 60297-3-100 rack mounting grid (465.1 mm centers, 12.7 mm and 31.75 mm steps) in 5.1, beyond the public preview
TraceParts solid of Schroff 34560-184	Measured L-KD section, insert seat, and end machining (the catalog rail sections)
Vector Electronics drawing 5280006, T-strut	Collected rail section; T-slot dimensions; the lower rail limits
Gie-Tec Trägerprofil sheet 2.5 and accessory sheet 2.18	Collected rail section and the M3 insert 138049 in the Doepfer A-100 frame
HEITEC horizontal rail page (3684.562, 9908.721); Verotec KM6-RF front extrusions; Tiptop Audio Z-rail data sheet	The catalog rail sections in eis-reference
Doepfer pages restating A-100 conventions; Intellijel 1U technical specifications; Hinton Instruments, Power Distribution	Listed with retrieval dates under inherited conventions
Doepfer, A-100 short-form manual 2026, retrieved 2026-10-14	The keying of shrouded bus headers (6.4)
LZX Industries, Eurorack module depth survey and flight-case sample, 2026-09	Module depths in `survey/module-depths.json`; the eis-reference survey
LZX Industries, Eurorack module power survey, 2026-09-30	Module widths and current draws in `survey/module-power.json`
LZX Industries, Eurorack power supply and bus board survey, 2026-09-30	Bus boards and supplies in `survey/`
LZX Industries, Eurorack case catalog, maker pages checked 2026-09-26	Commercial case depths in `survey/cases.json`
Mean Well RT-65B and GST series datasheets, retrieved 2026-10-16	Ripple ratings of common Eurorack and desktop supplies, behind the 150 mV ripple limit (6.2)
JST VH, Kycon KPJX/KPPX, and Molex Mini-Fit Jr PS-5556 product specifications	Reference parts for the multi-pin DC entries (8.1)
Hinton Instruments, Power Cables, retrieved 2026-10-24	The 30 mΩ contact resistance of a 0.1 in Eurorack header contact, behind the 0 V of a power ribbon (6.5)
Keystone 7795, 7794, and 7769 M4 screw terminals; Würth Elektronik REDCUBE terminals, distributor listings, retrieved 2026-10-24	Example M4 row wiring terminals and their 15 A ratings (6.1)

SOURCE	USE IN EIS
ASTM B258, standard nominal diameters and cross-sectional areas of AWG sizes	The copper resistance per meter behind the row wiring table (6.1)
3M 3365 series ribbon cable, distributor listings, retrieved 2026-10-19	The 28 AWG conductor of standard 1.27 mm pitch ribbon behind BUS-015 (6.5)
Same Sky PJ-002A and PJ-002AH data sheets, retrieved 2026-10-19 and 2026-10-25	The 2.5 A and 5 A ratings of through-hole jacks for a 2.1 mm plug, whose pin is 2.0 mm (8.1)
DIN 562 square thin nuts	M2.5 slide nut inside the recommended section; M3 nut too wide (the insert catalog)
apra 19-inch catalog, rail 241-022; Vector groove nut NT4-7PA; No. 43 twist drill	M2.5 and #4-40 subrack hardware in the eis-reference insert catalog
SMPTE ST 293:2003; ITU-R BT.1358-1 (2007)	The production systems 480p59.94 and 576p50 descend from; the rows of 8.3 are CTA-861's rasters
ITU-R BT.1700; EIA/CEA-770.1, 770.2, and 770.3, analog component video interfaces; IEC 60933-5, the 4-pin mini-DIN Y/C interface; VESA DMT; SMPTE ST 259, ST 292, ST 424, ST 2081, and ST 2082	External video ports named in the informative port vocabulary, Annex C
MIDI 1.0; MIDI Association CA-033 (RP-054), TRS adapter specification; ANSI E1.11 and E1.27-2; AES11	Control, data, and clock ports named in Annex C
IEC 60958-3 (S/PDIF); AES3; IEC 61938 (phantom power)	Digital audio and phantom power named in Annex C
ILDA ISP-DB25	The laser port named in Annex C
IEC 62368-1, protective bonding resistance; IEC 61000-4-2, contact discharge	The 100 mΩ pass mark of GND-004 and the static case behind it (6.3)
MIL-DTL-5541 (chromate conversion coatings, class 3); MIL-A-8625 (anodic coatings); IPC-4552 (ENIG)	The finish classes of the chassis-continuity table (6.3)
LZX Industries, chassis bonding model, 2026-10-24	Which surfaces conduct under a fastener, and six case types solved for the resistance from the tie to every part

INDEX

Page numbers are the footer's. Under a requirement, the italic number is its register row and the others are the pages that cite it. A term found on more pages than an entry can list gives the pages where it heads a section, then *passim*.

REQUIREMENTS

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