ETE Pacific Northwest Chapter Module SIG

MODULE ELECTRICAL SPECIFICATION

Version 0.4 (Draft), 9/8/2023

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1 Version history

Version	Date	Released by	Changes
0.1	5/26/23	Jan Schiefer	Initial draft
0.2	6/17/23	Jan Schiefer	Swapped pairs 3/4 and 5/6 on the Wago connectors Added cable, Wago connector details and links for ordering.
0.3	7/27/23	Jan Schiefer	Incorporated excellent feedback from Magnus. Reworded Req. 6.2 for clarity Added terminal block specification. Made terminal blocks required, rather than optional. Deleted the concept of an “option”. Multiple clarifications/reordering of section 5. Various clarifications in sections 6 and 7. Open issues are marked with highlighter.
0.4	9/8/2023	Jan Schiefer	Changed Terminal Block Colors back to the pre-0.3 convention, for compatibility with modules already built. Clarified some wording in section 6, added a requirement for strain relief.

2 Introduction

This specification defines the electrical characteristics for modules used by the Special Interest Group (SIG) of the Pacific Northwest chapter of the ETE (European Train Enthusiast). The purpose of this document is to provide a clear and unambiguous standard that all module builders shall follow, so that we have uniformity and compatibility between modules. All modules must use the same components, same gauge wire, same terminal strips, same connectors, etc.

This will be accomplished through a complete set of testable requirements for module builders, so they can be sure that their module will be electrically compatible with the rest of the layout.

3 Definitions and terminology

Requirements stated in this document are in **bold**. There may also be explanations and commentary, which will be in *italics*. If there is any inconsistency between requirements and explanations, the requirements shall have priority.

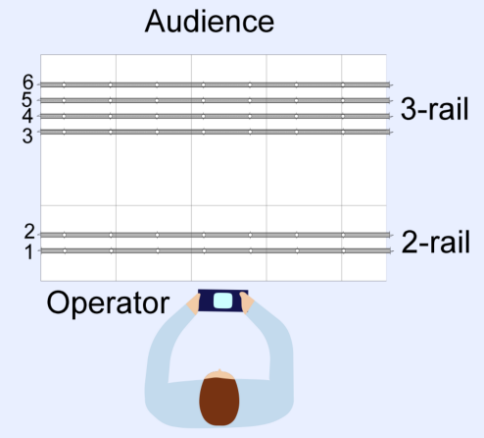
Some very specific words are used to distinguish between requirements that are necessary for compliance with this standard, and others that are not:

- In **requirements**, “shall” means that the requirement is necessary for compliance with the standard.
- In **recommendations**, “should” is an option that is advised, but not required. Often, following the recommendation will help compatibility with future versions of the standard or define a best practice.

4 Track and rail numbering

For unambiguous definitions, it is important to be able to refer to specific tracks or rails. This document uses the following nomenclature:

- Tracks are identified with numbers, counting from track 1, which is the closest to the operator side of the module. The highest numbered track will be at the audience’s side.
  Modules are expected to have 6 tracks.
- The individual rails of a track are identified by letters, with A being the one closest to the operator side, B being the Marklin “third rail”, C being the rail closest to the audience side. A 2-rail track, which have only A and C rails. *The purpose of this nomenclature is to ensure consistency and avoid confusion.*



5 Bus definitions

There are 6 electrical buses defined in the system. The following sections will explain the function of each one of them. The reason for calling some of them a “loop” is that there is an assumption that there is a loop module at each end of the layout. This places constraints on which power bus should be connected to which rail(s).

5.1 2L: 2-rail Loop

The 2L loop consists of tracks 1 and 2. Track is assumed to be 2-rail. This bus may be run analog DC or digital.

5.2 3OL: 3-rail Outer Loop

The 3OL bus consists of tracks 3 and 6. Track is assumed to be 3-rail. This bus may be run analog AC or digital. DC is possible, but unlikely to be useful.

5.3 3IL: 3-rail Inner Loop

The 3IL bus consists of tracks 4 and 5. Track is assumed to be 3-rail. This bus may be run analog AC or digital. Analog DC is possible, but unlikely to be useful.

Should there be a requirement that modules never electrically connect 3IL and 3OL?

5.4 ACA: AC Accessory Power

AC accessory power is the traditional way to connect powered accessories, such as lights, stationary motors, etc. The voltage is approximately 16 V AC, 60 Hz. There is a limited amount of power available on this bus, so it should only be used when absolutely necessary.

Requirement 5.4.1: Modules shall be able to tolerate up to 20 V if they connect to the ACA bus.

Recommendation 5.4.3: Modules shall fuse their connection to the ACA bus at 0.5 A or less.

5.5 DCA: DC Accessory Power

DC accessory power is nominally 19 V DC. This is a voltage used in many laptop power supplies, which makes safe and inexpensive power supplies easy to find.

Requirement 5.5.1: Modules shall be able to tolerate voltages between 14 and 26 V, if they connect to the DCA bus.

Requirement 5.5.2: Modules shall fuse their connection to the DCA bus at 1 A or less.

Recommendation 5.5.3: Accessories should use DC power from the DCA bus whenever possible.

DC power is easier and cheaper to scale up.

Recommendation 5.5.4: Modules should use an efficient DC/DC converter local to the module, to bring the voltage down to what the module requires.

Many accessories designed for traditional AC operation can also be operated on 12 V DC.

5.6 DIG: Digital Control Bus

As the 2L, 3OL and 3IL buses could be operated in analog mode, there needs to be a separate digital control bus, that can be relied on to always be digital.

Requirement 5.6.1: Modules shall not use the DIG bus to power accessories.

This is a bus intended only for control.

Requirement 5.6.2: Modules shall be able to tolerate both DCC and Märklin MM/mfx messages on the DIG bus.

Recommendation 5.6.3: Modules should use accessory decoders that separate the control bus from accessory power.

Examples of this include the Viessmann 5211 or the tams WD-34.

Requirement 5.6.4: There shall be a list of the device addresses of all accessory control device that connect to the DIG. This list shall be near the terminal blocks and not visible from the audience's side.

There is the potential for address collisions, which are hard to debug if the addresses are not easily accessible.

6 Module Interconnect

Modules are electrically connected to their neighbors on either side with an Interconnect Cable. The Interconnect Cable has 12 color-coded conductor and is terminated on with a 12 pin connector.

Requirement 6.1: Modules shall present an Interconnect Cable "pigtail" of approximately 12" length, with a 12 pin Wago MCS MIDI Classic connector on either side.

The male connector is a Wago 231-642 (data sheet, order). The female is of type Wago 231-312 (data sheet, order).

Requirement 6.2: When seen from the operator side, the female connector shall be on the left side, and the male connector on the right side of the module.

Requirement 6.3: All 12 connector pins on the left side shall be connected to the corresponding pins on the right side, using 18 AWG cable.
Since the electrical integrity of the entire layout is dependent on a good solid bus, great attention should be paid to the makeup of these electrical connectors.

Requirement 6.4: Interconnect Cables shall be provided with appropriate strain relief.

Requirement 6.5: Modules shall provide easy access to all wiring from the operator's side.

Recommendation 6.5: Modules should provide a secure way to store the connector and pigtail during transport.

Requirement 6.7: Modules shall not connect any of the wires to any other wire.
Should such interconnections be desired or necessary, they will the connected on the operator podium.

Recommendation 6.8: Modules should use cable of type Belden 8466 (data sheet, order).

7 Connections internal to the module

Requirement 7.1: Modules shall supply power to each of the tracks 1-6.
Because to the SIG wants to have the option to cut track and not rely on electrical connections through the rails, each module is required to provide power to each of the tracks.

Requirement 7.2: The pinout and recommended color of the cables and connectors shall be as follows:

Pin	Cable color	Terminal block color	Bus	Connect to Rail	Notes
1	Black	Black	3OL/neutral	3A, 6A,	A and C rails are connected through track
2	Red	Red	3OL/hot	3B, 6B	
3	White	Grey	2L/- (neutral)	1A, 2C	Is this the polarity we want?
4	Blue	Blue	2L/+ (hot)	1C, 2A	
5	Orange	Yellow	3IL/neutral	4A, 4C, 5A, 5C	
6	Green	Green	3IL/hot	4B, 5B	
7	Black/White	Black	ACA/neutral	None	
8	Red/Black	Red	ACA/hot	None	
9	White/Black	Grey	DCA/-	None	
10	Blue/Black	Blue	DCA/+	None	
11	Orange/Black	Yellow	DIG/neutral	None	
12	Green/Black	Green	DIG/hot	None	

Requirement 7.3: Modules shall use DIN-rail mounted terminal blocks for any connections of the bus.

Recommendation 7.4: Module builders should consider mounting other hardware (accessory decoders etc.) on DIN rail also.

Recommendation 7.5: 20 AWG or better stranded copper wire should be used for intra-module wiring.

Recommendation 7.6: Module builders should strive to label all the connections clearly.
This should allow other people to troubleshoot if the builder/owner is not present.

8 Test specification

To be done. The intent is to have an easy way to verify compliance with each of the requirements.

End of document