# General

## Introduction and Intended Use (Informative)

This standard defines a uniform multi-pole interface for vehicles for safe and quick installation or exchange of electronic modules (vehicle and function decoder or SUSI module, herein after referred to as decoder) for the purpose of control via Digital Command Control systems.

## References

This standard should be interpreted in the context of the following NMRA Standards, Technical Notes, and Technical Information.

### Normative

* S-9.1.1 DCC Interfaces, which specifies general DCC interface requirements
* S-9.2.3 DCC Service Mode, which specifies service mode programming requirements

### Informative

* TN-9.1.1 DCC Interfaces, which provides commentary on general DCC interface  
  requirements
* TN-9.1.1.3 21MTC Decoder Interface, which provides commentary on the
* 21MTC decoder interface
* TI-9.1.1 Sources for Connectors for DCC, which provides a list of manufacturer part
* numbers for DCC interface connectors
* TI-9.2.3 Serial User Standard Interface for DCC, which provides information on SUSI
* RCN-121 Decoder Interface 21MTC, with which this standard is intended to be in harmony
* NEM 660 Electrical Interface 21MTC, with which this standard is intended to be in harmony

### 1.2.3 Description of the Interface

The interface supports the connection of a motor, a maximum of 8 function outputs and 2 sensor inputs. The installation space and the size of the decoder are part of the interface. Vehicles with a factory-installed interface and decoder with the interface according to this RCN must be clearly marked with the Logo 21MTC on the packaging.



The interface is defined for plugging the decoder directly into the vehicle. A connection via cable is not provided and such a design does not correspond to this standard.

## Terminology

|  |  |
| --- | --- |
| **Term** | **Definition** |
| Vehicle | Mobile model railroad device. This includes locomotives and other rolling stock. |
| Decoder | DCC receiver for controlling vehicle animation. |
| System Board | Electronic circuit board that is considered part of the vehicle which a decoder is intended to be plugged into. |
| Train Bus | Serial User Standard Interface (SUSI) |

## Requirements

To meet this standard all mechanical and electrical values mentioned must be met and respected, unless otherwise noted. It is not necessary to implement all connections of the interface. The connections belonging to unimplemented features must remain unconnected. This applies to vehicles as well as for other devices that use this interface.

## Mechanical Properties

The interface on the system main PCB (printed circuit board) consists of a 22-pin header male connector arranged in two rows with pitch <p>. Dimensions of the area reserved for the decoder are at the minimum Lr x Wr x Hr (please refer to table <1> for actual values). The system PCB must provide sufficient room for a decoder to be plugged in with no mechanical stress.

Male and female connectors form a ridge consisting of 11 contacts in two rows. Soldering connector pins directly to the PCB is preferred. Pin 11 is an index pin and shall be blocked to ensure the correct orientation of the decoder on the main board.

### Decoder

The decoder is provided with a 22 position socket connector arranged in 2 rows of 11 pins. The pins are oriented along the short edge of the decoder PCB as shown in Figure 5.

The connector shall be located as shown in Figure 5, vertically centered along the short edge of the PCB. The decoder may be shorter than the specified Ld. Decoder width should be <Wd> as specified in order to accommodate the connector. The horizontal distance of the pin centerline in reference to the short edge shall be <c> and must be accurately implemented to avoid misalignment.

### System PCB

The system PCB provides the housing for the Decoder according to its maximum dimensions. A suitable male pin arrangement is shown in Fig. 8. The male connector pins length is <Tm>. The profile can be either a square measuring <m> x <m>, or round with diameter <rm>. The surface is gold plated and allows a maximum current of at least 1A.



Figure 8: Male plug arrangement for system PCB

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameter | Description | Min. | Nominal | Max | Unit | Comments |
| p | **Connector pitch** |  | **1.27** |  | **mm** |  |
| r | **Connector row spacing** |  | **1.27** |  | **mm** |  |
| Ld | **Overall Decoder Length** |  |  | **30.0** | **mm** |  |
| Lr | **Reserved length in main board** | **30.0** |  |  | **mm** |  |
| Wd | **Overall Decoder Width** |  |  | **15.5** | **mm** |  |
| Wr | **Reserved width in main board** | **15.5** |  |  | **mm** |  |
| Hd | **Decoder height** |  |  | **6.5** | **mm** |  |
| Hr | **Reserved area height** | **6.5** |  |  | **mm** |  |
| C | **Distance of connector center line from decoder edge/ reserved area short edge** |  | **2.8** |  | **mm** |  |
| Ta | **Connector & Component area height** |  |  | **2.2** | **mm** |  |
| Tb | **Decoder PCB thickness** |  | **1.0** |  | **mm** |  |
| Tc | **Backside component area height** |  |  | **3.3** | **mm** |  |
| tp | **Socket pin width/ diameter** |  |  | **0.5** | **mm** | **Squared** |
| Tf | **Decoder (socket) Connector Height** |  | **2.25** |  | **mm** |  |
| Wf | **Decoder (socket) overall connector Width** |  | **4.95** |  | **mm** |  |
| m | **Main board (header) connector pin width** |  | **0.4** |  | **mm** | **Squared** |
| rm | **Main board (male) connector pin diameter** |  | **0.43** |  | **mm** | **Round** |
| Wb | **Main board (male) connector base width** |  | **3.40** |  | **mm** |  |
| Wm | **Main board (male) overall connector width** |  | **5.1** |  | **mm** |  |
| Tm | **Main board (male) pin length** |  | **3.00** |  | **mm** |  |
| Td | **Main board (male) base height** |  | **3.00** |  | **mm** |  |

Table 5 21MTC Physical Dimensions

### Decoder-Mounting

It is permissible to mount the decoder in two different positions: Compact mounting and upside-down mounting.

### Compact Mounting

Compact mounting results in the lowest space requirements. In this case the decoder is plugged in with the female socket on top. The male pins make contact through the PCB of the decoder. The decoder can be supported on the system PCB.



Figure 9: Compact Mounting

### Up-side-down Mounting

In case there is enough room above the system PCB, but no free area on the system PCB, the decoder may be mounted in the up-side-down position. The Decoder shall be plugged in with the female socket oriented down onto the system PCB. The pin orientation of system PCB must be mirrored at the axis of pin 6/17.



Figure 10: Up-side-down mounting

## Electrical Characteristics

Manufacturer of this decoder must specify the maximum current allowed to be drawn for each output and input. In case the decoder utilizes a flat ribbon cable with a connector at the remote end, following the wire color specification is optional. For standalone extension cables and interface cables, with connectors at both ends, wire color coding is mandatory.

### Pin Assignments

The pin assignments for 21MTC are defined in Table 6:

**Table 6: Interface Connections**

|  |  |  |  |
| --- | --- | --- | --- |
| **Pin** | **Name** | **Description** | **Group** |
| **1** | Input1 | Sensor-Input 1, alternate AUX7 | 4 |
| **2** | Input2 | Sensor-Input 2, alternate AUX8 | 4 |
| **3** | AUX6 | Output 6 | 8 |
| **4** | AUX4 | Output 4 | 8 |
| **5** | ZBCLK | Train Bus Clock, alternate AUX9 | 7 |
| **6** | ZBDTA | Train Bus Data (TxD, RxD), alternate AUX 10 | 7 |
| **7** | F0r | Light direction rear | 5 |
| **8** | F0f | Light direction forward | 5 |
| **9** | LS/A | Speaker Connection A | 6 |
| **10** | LS/B | Speaker Connection B | 6 |
| **11** | Index | Not used, Orientation |  |
| **12** | Vcc | Internal Decoder-Voltage 1.8 – 5.7 Volt | 2 |
| **13** | AUX3 | Output 3 | 8 |
| **14** | AUX2 | Output 2 | 5 |
| **15** | AUX1 | Output 1 | 5 |
| **16** | V+ | Decoder Plus, referenced at rectifier, port storage capacitors | 2 |
| **17** | AUX5 | Output 5 | 8 |
| **18** | Motor2 | Motor-connection #2 minus / direction rear | 3 |
| **19** | Motor1 | Motor-connection #1 plus / direction forward | 3 |
| **20** | GND | Decoder GND, Referenced at rectifier | 2 |
| **21** | Track left | Track left in direction forward | 1 |
| **22** | Track right | Track right in direction forward | 1 |

### Descriptions of Signals

**Group 1:** When supplied with AC-Motors Pin 21 is connected to the outer rails und Pin 22 to the middle rail.

**Group 2:** Pin 12 is not mandatory. It is recommended to supply this pin in order to connect additional processors.

**Group 3:** Pin 19 is field coil A; Pin 18 is field coil B for AC-Motors.

**Group 4:** Pin 1 and 2 are Open-Collector-Inputs and will switch on against GND. The input resistance should be approximately 100K Ohms. Sensor-Input 1 shall be used to synchronize wheel movement and sound when steam engines are used.

**Group 5:** In case the rear lights are connected to the decoder separately, the rear lights of locomotive in forward direction 1 are switched from Pin 15 and those in rear direction 2 to Pin 14.

**Group 6:** The speaker impedance is determined by the manufacturer of the decoder and must be documented.

**Group 7:** The microcontroller-pins of the train bus are connected through a serial resistor with a maximum of 470 Ohm.

**Group 8:** Outputs are defined as TTL/LVTTL logic-level according to Table 7.

**Table 7: Logic Level Values**

|  |  |  |
| --- | --- | --- |
|  | Voltage Level Decoder Output | Voltage Level for switching element on the system PCB. |
| Function switched off | <= 0.4 Volt | <= 0.8 Volt |
| Function switched on | >= 2.4 Volt | >= 2.0 Volt |

### Use of Interface with SUSI

This interface can also be used as a SUSI interface according to TI-9.2.3. In this case, only four signals may be used:

1. GND (pin 21)

2. V+ (pin 16)

3. Train Bus Clock (pin 5)

4. Train Bus Data (pin 6)

In particular, the track connections are not to be used when wired as a SUSI interface. All other connections can be used for functions of the SUSI module.

### Operation without Decoder

By operation without Decoder it is required to use a female plug. At least the pins track right must be bridged with motor 1 and track left must be bridged with motor 2. If lights exist, the appropriate pins must be bridged to the appropriate pins.



Figure 11: Typical female bridge plug

Depending of the connections of the various outputs, the manufacturer may generate a specific female bridge plug.

# Document History

|  |  |
| --- | --- |
| **Date** | **Description** |
| 09/10/2020 | First Revision of S.9.1.1.3, created with new template. |
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