Recommendation **Edition 2019**

(First English Edition)

1. Purpose of the Standard

This standard describes the protocols necessary for the operation of control modules over their serial interface. In connection with standard NEM 693, these protocols are applicable in a LAN[1)] environment that includes connecting to a central controller. The standard needs updating.

2. Basics

The protocol data record consists of a minimum of 19 comma separated fields. Each entry, with the exception of the fields 2-17, can contain a sequence of UTF8 character codes. The data record is ended with the control characters CR (Carriage Return, 013, x0D) and LF (Line Feed, 010, x0A). These characters, the comma (044, x2C), as well as the characters listed in Table 1 may not be used within a field.
The protocol requires the implementation of an identifier (ID) in the control module in accordance with NEM 690, and the use of a driver for control modules according to NEM 693.

3. Prerequisites

3.1 Dataflow

The data flow is bidirectional to and from the control modules to and from the central controller.
The symbol after the IP address and the ID determines the type and direction between the control module and the central controller.

Table 1:

Symbol	Description	Priority	Direction
#	Action to connected control module		from central controller
$	Message from control module		to central controller
!	Diagnostic	high	from control module
&	Configuration of connected control module	high	from central controller

3.2. General Record Description

After the IP address and the 16 byte ID according to NEM 690, a record consists of a symbol from Table 1, as well as a variable number of fields which is terminated with the CR, LF sequence. If a field is empty it is immediately ended with a comma. If no further fields need be specified, the record is terminated after the last used field with CR, LF. The fields 1 and 2 are not populated by the control module, but by the driver for control modules.

3.3 Identifier Administration

The identifier (ID) is administered by the central controller. The user should be able to link an ID with a unique meaningful name, or alias, and use this alias for control in place of the ID. The central controller associates the IDs with their respective IP address.

1) "Local Area Network"

4. Record Definition

4.1 General Data Record Definitions

Field 1 of the record contains the assigned IP address (IP) and fields 2 – 17 contain the ID of the control module. Neither are shown here. A control symbol from Table 1 follows in field 18. The symbol X represents the number of control module connections on the driver for control modules.

Table 2:

Field 18	Field 19	Field 20	Field 21	Comment
&	reset			Driver for control modules and connected control modules restart. Every field with ID value 0
&	reset	X		Driver for control modules and control module connected on X restart
!	on	X		There is communication between the control module on connection X and the driver for control modules
!	off	X		There is no communication between the control module on connection X and the driver for control modules
!	new	X		New / different control module on connection X
!		X	IP address	Control module on connection X not under this IP address
!	bitrate in bit/s	X		Last determined bitrate of control module on connection
$	IP address	X		Control module is reached on connection X on the driver for control modules with this IP address
$		X	sent record	Action not applicable on control module on connection X

4.2 Data Record Definition Control Module for Turnout

Table 3:

Field 18	Field 19	Field 20	Comment
#	L R		Turnout left Turnout right
$		L R B	Feedback L active Feedback R active State of both Feedback active/inactive
#	E A		Illumination ON Illumination OFF
$		E A	Illumination turned on Illumination turned off
!		F	Illumination defective or not installed

Example:

Adjust Command: IP,ID,#,L,CR,LF
Message Feedback: IP,ID,$,,L,CR,LF
Message Lighting: IP,ID,!,,F,CR,LF

4.3 Data Record Definition Control Module for Signal

The following descriptions apply for the respective positions in the signal data record:

Table 4:

Pos 19	Speed 1, in km/h with omission of the singles digit
Pos 20	Illumination, Day-/Nightlight, Blanking
Pos 21	Emergency red, Replacement-signal
Pos 22	Speed 2, in km/h with omission of the singles digit
Pos 23	Shunting signal
Pos 24	Support Signal / Additional Signal
Pos 25	Directional Indicator

4.3.1 Data Record Definition Control Module for Mechanical Signal

Table 5:

Pos 18	Pos 19	Pos 20	Pos 21[1)]	Pos 22[1)]	Pos 23[2)]	Pos 24[2)]	Pos 25[2)]	Comment
#	0 1 - 15 16							Stop Reduced Speed Top Speed
#		E A						Lighting ON Lighting OFF
$		E A						Lighting engaged Lighting disengaged
!		F						Lighting defective or not installed

Notes:

1) These position remain unused.

2) Insofar as this signal is equipped with the, the values of Table 6 apply.

4.3.2 Data Record Definition Control Module for Light Signal

Table 6:

Pos 18	Pos 19	Pos 20	Pos 21	Pos 22	Pos 23	Pos 24	Pos 25	Comment
#	0 1 - 15 16							Stop Reduced Speed Top Speed
#		T N						Daytime light, max. brightness Nighttime light, dimmed brightness
#		0 1						Signal display blanked. Signal display present.
#	0 1 - 16		1 0					Stop, Emergency red ON Emergency red OFF
#				0 1 - 16				Expect Stop Follow on speed
#	0				1 0			Stop, Shunting signal ON Shunting signal OFF
#	 0 1 - 16 1 - 16 1 - 16 1 - 16			 1 - 16		0 1 2 3 3 6 7 8 11 13 99	 A - Z	Additional / supporting signal OFF Replacement signal for limited time Generate direction indication Display speed Display Follow on speed Display track change Drive on left order signal Drive on wrong track Proceed under visual driving Entry into siding Signal repetition or reduced braking zone

Note:

Additional signals of Pos 24 or 25 can be displayed without connection to Pos 19 or 22, if no values for speed are required.

Examples:

Three aspect light signal limited speed:	IP,ID,#,4,CR,LF
Light signal stop with replacement signal:	IP,ID,#,0,,,,,1,CR,LF
Mechanical signal unrestricted speed and direction indicator:	IP,ID,#,16,,,,,2,S,CR,LF
Light signal initial and follow on speed:	IP,ID,#,5,,,16,CR,LF
Light signal initial and follow on speed with display:	IP;ID,#,8,,,4,,3,CR,LF

4.4 Data Record Definition Control Module for Track Sections

The following descriptions apply for the positions in the data records to / from the module track sections:

Table 7:

Pos 19	Operation with address or programming / configuration
Pos 20	Address for programming
Pos 21	Track section number
Pos 22	Action or parameter in track section
Pos 23	Parameter
Pos 24	unused
Pos 25	Acknowledgement

The definitions are partitioned between those for the usage of a traditional hand controller and those for prototypically similar operations mode. Tables 7a, 7b and 7c describe the data records for both methods. In conjunction, the symbol G represents the track segment assigned to respective module.

Table 7a: Configuration

Pos 18	Pos 19	Pos 20	Pos 21	Pos 22	Pos 23	Pos 24	Pos 25	Comment
&	 DC AC PWM MF DCC SL MFX MP							Type of track segment supply: Direct Current Alternating Current Pulse Width Modulation Motorola-Format DCC Selectrix Märklin / ESU Multi-protocol
!	DC AC PWM MF DCC SL MFX MP						OK	Supply has been configured with the indicated type. Without OK, the type of supply is not configurable.
&	HR VB							Operation by hand controller Operations by prototypical means
$	HR VB						OK	Operations configured as by hand controller or prototypical means Without OK the operations type is not configurable.

Examples:

Configure module for DCC: IP,ID,&,DCC,CR,LF
Module acknowledges DCC configuration: IP,ID,!,DCC,,,,,,OK,CR,LF
Hand controller operations: IP,ID,&,HR,CR,LF
Hand controller acknowledgement: IP,ID,$,HR,,,,,,OK,CR,LF

Table 7b: Operations

Pos 18	Pos 19	Pos 20	Pos 21	Pos 22	Pos 23	Pos 24	Pos 25	Comment
!	value mA		G					Current usage in mA in track section G
!	Si		G					Short circuit in track section G
$			G	B				Track section G occupied
$	ADR		G	B				Track section G occupied with address
#			G	F				Mark track section G as unoccupied
#			G	S				Stop in track section G
$			G	S			OK	Stop completed in track section G
#	ADR		G					Assign address to track section G
$	ADR		G				OK	Address assigned to track section G
#	ADR		G	V R				Assign address of track section G for direction of travel forwards (V) or backwards (R)
$	ADR		G	V R			OK	Address assigned in track section G for direction of travel forwards (V) or backwards (R)
#	ADR		G	0 - 68	E A T			Enable (E), Disable (A), Toggle (T) specified function number of specified decoder address in track section G
$	ADR		G	0 - 68	E A		OK	Specified function of specified decoder address in track section G has been enabled (E) or disabled (A)

Examples:

Assign loco address 4711 to track section 1: IP,ID,#,4711,,1,CR,LF
Loco address 4711 to track section 1 forwards: IP,ID,#,4711,,1,V,CR,LF
Loco address 4711 to track section 1 light on: IP,ID,#,4711,,1,0,E,CR,LF
Loco(s) in track section 1 stop: IP,ID,# ,,,1,S,CR,LF

Table 7c: Programming

Pos 18	Pos 19	Pos 20	Pos 21	Pos 22	Pos 23	Pos 24	Pos 25	Comment
&	PROG		G					Set track section G into programming mode
$	PROG		G				OK	Track section G is in programming mode
&	PROG		G	1 – 1024	0 – 511			Set CV to decimal value
$	PROG		G	1 – 1024	0 – 511		OK	Decimal value (after setting) read out
&	PROG		G	E				End programming mode on track section G
$	PROG		G	E			OK	Track section G has ended programming mode

4.4.1 Data Record Definition Hand Controller

Table 8:

Pos 18	Pos 19	Pos 20	Pos 21	Pos 22	Pos 23	Pos 24	Pos 25	Comment
#	ADR	0 - 128	G					Select specified throttle position for address ADR in track section G
$	ADR	0 - 128	G				OK	Address ADR in track section G has achieved throttle position

Examples:

Loco Address 4711, Track Section 1, Throttle to 14: IP,ID,#,4711,14,1,CR,LF
Loco Address 4711, Track Section 1, Throttle 14 achieved: IP,ID,#,4711,14,1,,,,OK,CR,LF

4.4.2 Data Record Prototypical Control

Table 9:

Pos 18	Pos 19	Pos 20	Pos 21	Pos 22	Pos 23	Pos 24	Pos 25	Comment
#	ADR	0 - 250	G	MM				Address ADR, in track section G, with model gauge (MM), to target speed in km/h
$	ADR	0 - 250	G	MM			OK	Address ADR, in track section G, with model gauge (MM), target speed in km/h achieved
#	ADR	?	G	MM				Request present speed (km/h) from address ADR in track section G
$	ADR	0 - 250	G	MM				Present speed (km/h) of address ADR in track section G
#	ADR	B	G	MM	0 - 2			Set acceleration factor (cm/s) for address ADR in track section G
$	ADR	V	G	MM	0 - 2			Set delay factor (cm/s) for address ADR in track section G

Examples:

Loco address 4711 to speed 40 km/h:
Track section 1, Scale 1:87: IP,ID,#,4711,40,1,87,CR,LF
Track section 1, Scale 1:160: IP,ID,#,4711,40,1,160,CR,LF
Track section 1, Scale 1:45, Speed query: IP,ID,#,4711,?,1,45,CR,LF
Answer: IP,ID,$,4711,37,1,45,CR,LF