Carl Marchand

NMRA Standard	
Configuration Variables for Digital Command Control, All Scales	
Feb 11, 2026	S-9.2.2 Draft

1 General

1.1 Introduction and Intended Use (Informative)

This Standard provides a map and descriptions for Digital Decoder Configuration Variables. Configuration Variables allow the decoder to be customized for each locomotive, or other mobile or stationary devices. Unless otherwise specified, configuration Variables shall be stored in non-volatile memory and must not change when power is removed from the decoder over long extended periods of time.

1.2 References

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

1.2.1 Normative

- S-9.2 DCC Communication Standard, which covers the format of the information sent via Digital Command Stations to Digital Decoders
- S-9.2.1 DCC Extended Packet Formats, which provides a minimal, basic packet format required for interoperability
- S-9.2.1.1 DCC Advanced Extender Packet Formats, which contains methods for reading and writing CV's.
- S-9.2.3 Service Mode Programming, which covers the programming mode to allow customization and test of Digital Decoders

1.2.2 Informative

- RCN-225 Configuration Variable Standards, with which this standard is intended to be in harmony
- ~~TN-X.X.X~~

1.3 Requirements and Definitions

Tables 1 and 2 identify each of the Configuration Variables (CVs), along with additional information about each one. Following Table 1 is a written description of each of the CVs. In Tables 1 and 2 each Configuration Variable (CV) is identified by name and number, along with the following information:

- **Required:** Mandatory (M), Recommended (R) or Optional (O). CVs identified as Mandatory (M) must be implemented in order to conform to this Standard, while those

marked as Recommended (R) are strongly encouraged but not mandatory, and those marked Optional (O) are at the manufacturer's discretion.

- **Default Value:** the required factory default value when the CV is provided in an implementation.
- **Read-Only:** indicates a CV whose value should be set by the manufacturer and which the user cannot modify.
- **Uniform Spec**: Many CVs are implementation specific, and no uniform specification is required. Others must be implemented in a uniform fashion in order to achieve compatibility. A "Y" in the Uniform Spec column indicates a CV which requires implementation by manufacturers according to a common specification. A ~~blank~~ "-" in the Uniform Specification means that the CV must be used for its designated purpose, but the action taken by the decoder for a specific value can vary from manufacturer to manufacturer.
- ~~**Dynamic**: CVs in this range are dynamic and are used for Unsolicited Decoder Initiated Transmission. Manufacturers who utilize these CVs are requested to contact the NMRA DCC WG for current uniform specifications.~~

Table 1 - Multifunction Decoder Configuration Variables

CV Name	CV #	Required	Default Value	Read Only	Uniform Spec	Additional Comments
Multifunction Decoders:						
Primary Address	1	M	3	-	Y	
Vstart	2	M	-	-	-	
Acceleration Rate	3	M	-	-	-	
Deceleration Rate	4	M	-	-	-	
Vhigh	5	M	-	-	-	
Vmid	6	M	-	-	-	
Manufacturer Version No.	7	M	-	Y	-	Manufacturer defined version info
Manufactured ID	8	M	-	Y	Y	Values assigned by NMRA
Total PWM Period	9	O	-	-	-	
EMF Feedback Cutout	10	O	-	-	-	
Packet Time-Out Value	11	R	-	-	-	
Power Source Conversion	12	O	-	-	Y	Values assigned by NMRA
Alternate Mode Function Status F1-F8	13	O	-	-	Y	
Alternate Mode Function. Status F_L,F9-F12	14	O	-	-	Y	
Decoder Lock	15-16	O	0	-	Y	
Extended Address	17+18	M	-	-	Y	
Consist Address	19	R	0	-	Y	
Extended Consist Address	20	O	-	-	Y	Extended Consist Address format initially proposed by Zimo and adopted by RailCommunity
Consist Addr Active for F1-F8	21	O	-	-	Y	
Consist Addr Active for FL-F9-F12	22	O	-	-	Y	
Acceleration Adjustment	23	O	-	-	Y	
Deceleration Adjustment	24	O	-	-	Y	
Speed Table/Mid-range Cab Speed Step	25	O	-	-	Y	
Configuration Variable 26	26	O	-	-	Y	Reserved by NMRA for future use
Decoder Automatic Stopping Configuration~~Decoder Automatic Stopping Configuration~~	27~~27~~	O~~O~~	-	-	Y ~~Y~~	Under re-evaluation – see details~~Under re-evaluation – see~~
Bi-Directional Communication Configuration (RailCom)	28	O	-	-	Y	Under re-evaluation – see details
Configuration Data [1]~~Bi-Directional Communication Configuration~~	29~~2~~	M[1]	-	-	Y ~~Y~~	~~Under re-evaluation – see details~~
Error Information~~Configuration Data~~	30~~2~~	O	-	-	Y	
Index High Byte	31	O	-	-	Y	Primary index for CV257-512

CV Name	CV #	Required	Default Value	Read Only	Uniform Spec	Additional Comments
Index Low Byte ~~Index High Byte~~	32 ~~31~~	O ~~O~~	-	-	Y ~~Y~~	Secondary index for CV257-512 ~~Primary index for CV257-512 00000000 - 00001111 reserved by~~
Output Loc. FL(f), FL(r), F1-F12 ~~Index Low Byte~~	33-46 ~~33-4632~~	O ~~O~~	-	-	Y ~~Y~~	~~Secondary index for CV257-512~~
Manufacturer Unique ~~Output Loc.~~	47-64 ~~33-~~	~~OO~~	-	-	-	Reserved for manufacturer use
			-	-	-	
Kick Start ~~Manufacturer Unique~~	65 ~~47-64~~	O	-	-	-	~~Reserved for manufacturer use~~
Forward Trim ~~Kick Start~~	66	~~OO~~	-	-	-	
Speed Table ~~Forward Trim~~	67-94 ~~66~~	~~OO~~	-	-	-	
Reverse Trim ~~Speed Table~~	95 ~~67-94~~	O	-	-	-	
Function Mapping Method ~~Reverse~~	96 ~~-~~	O	-	-	Y	
	97-104 ~~96~~	~~-~~	-	-	-	Reserved for manufacturer
User Identifier #1	105 ~~97-104~~	O	-	-	-	Reserved for customer
User Identifier #2 ~~User Identifier #1~~	106	O	-	-	-	Reserved for customer
~~User Identifier #2~~	107	~~O~~	-	-	-	Reserved by NMRA for future use
Manufacturer Unique	112-256 ~~107-111~~	O ~~-~~	-	-	-	Reserved for manufacturer use ~~Reserved by NMRA for future use CV107,108: expanded Mfg. ID~~
Indexed area ~~Manufacturer Unique~~	257-512 ~~112-~~	-	-	-	-	Indexed area - see CV 31,32
~~Indexed area~~						~~Indexed area - see CV# 31,32~~
Manufacturer Unique	513-879 ~~-768~~	-	-	-	-	~~Reserved by NMRA for future use~~
	769 -896	-	-	-	-	Reserved by NMRA for future
SUSI CVs	897-1024	-	-	-	-	Reserved for SUSI See TI-9.2.3
~~Decoder Load~~	~~892~~ 880-895	~~O~~			~~Y~~	~~Reserved by NMRA for future use~~
~~Dynamic Flags Decoder Load~~	~~893~~	~~O~~			~~Y~~	
~~Fuel/Coal Dynamic Flags~~	~~894~~	~~OO~~			~~Y~~	
~~Water Fuel/Coal~~	~~895~~	~~OO~~			~~Y~~	
~~Water~~	~~895~~	~~O~~				
~~SUSI Sound and Function Modules~~	~~896~~	~~O~~			~~Y~~	~~See TN-9.2.3~~

1 If any of these features are provided, then this CV is Mandatory

Note ~~**Note**~~: While all *Digital Decoders* need not implement all variables, it is required that if a function is ~~provided, that~~provided, all the relevant CV information must be adhered to.

Additional Comments: CVs identified as ""Reserved by NMRA for future use"" are allocated for future needs and must not be used by an implementer without prior written approval from the NMRA Technical Department. CVs identified as ""Values assigned by NMRA"" indicate that the allowable values are defined by the NMRA and any requests for additional values should be directed to the NMRA Technical Department. CVs identified as ""Reserved for manufacturer use"" are allocated for use by implementers, for which no prior NMRA authorization is needed, and for which no common usage across decoders from different implementers can be assured by the NMRA

1.3.1 General Definitions

Binary numerical quantities are stored such that the rightmost bit is the least significant, and the leftmost is the most significant:

Configuration Variable MSB |d07|d06|d05|d04|d03|d02|d01|d00| LSB

1.3.2 Descriptions of Configuration Variables for Multifunction Decoders

Configuration Variable 1: -Primary Address

Bits 0-6 contain an address with a value between "1" and "127". Bit seven must have a value of "0". Any values are allowed for using protocols other than DCC. If the value of CV 1 = "0" or > "127" and CV 29 bit 5 = "0", then the DCC protocol is disabled. ~~If the value of Configuration Variable #1 is "00000000" then DCC protocol is disabled. the decoder will go out of NMRA digital mode and convert to the alternate power source as defined by Configuration Variable #12.~~ This setting will not affect the Digital Decoder's ability to respond to service mode packets (see S 9.2.3). The default value for this Configuration Variable is "3", if the decoder is not installed in a locomotive or other unit when shipped from the manufacturer.

Configuration Variable 2: -Vstart

Vstart is used to define the voltage drive level used as the start voltage on the motor. The voltage drive levels shall correspond linearly to the voltage applied to the motor at speed step one, as a fraction of available rectified supply voltage. When the voltage drive level is equal to zero, there shall be zero voltage applied to the motor. When it is at maximum "11111111", the full available rectified voltage shall be applied.

Configuration Variable 3: -Acceleration Rate

Determines the decoder's acceleration rate. The formula for the acceleration rate shall be equal to (the contents of CV 3*.896)/(number of speed steps in use). For example, if the contents of CV #3 = "2", then the acceleration is 0.064 sec/step for a decoder currently using 28 speed steps. If the content of this parameter equals "0" then there is no programmed momentum during acceleration.

Configuration Variable 4: -Deceleration Rate

Determines a decoder's braking rate, in the same fashion as acceleration above (CV #3).

Configuration Variable 5: -Vhigh

Vhigh is used to specify the motor voltage drive levels at the maximum speed step. This value shall be specified as a fraction of the available rectified supply voltage. When the contents of CV 5 equal "11111111", the full available rectified voltage shall be applied. Values of "00000000" or "00000001" shall indicate that Vhigh is not used in the calculation of the speed table.

Configuration Variable 6: Vmid

Vmid specifies the voltage drive level at the middle speed step. Vmid is used to generate a performance curve in the decoder that translates speed step values into motor voltage drive

levels and is specified as a fraction of available rectified supply voltage. Values of ""00000000"" or ""00000001"" shall indicate that Vmid is not used in the calculation of the speed table.

Configuration Variable 7: -Manufacturer Version Number

~~This is reserved for the manufacturer to store information regarding the version of the decoder.~~This CV shows the version of the decoder specified by the manufacturer and its value cannot be changed. Write commands to CV 7 can also be used specifically to configure address-less devices as described in RailCommunity document [RCN-226].

Configuration Variable 8: -Manufacturer ID

~~CV8 shall contain the NMRA assigned id number of the manufacturer of this decoder. The currently assigned manufacturer ID codes are listed in Appendix A of this Standard. The use of a value not assigned by the NMRA shall immediately cause the decoder to not be in conformance to this Standard. The CV shall be implemented as a read-only value, which cannot be modified.~~This CV ~~m~~ust contain the manufacturer identifier assigned by the NMRA to the manufacturer of the decoder. The currently assigned manufacturer identifiers are listed in S-9.2.2 Appendix A. The value in CV 8 cannot be changed. Since the value range of this variable is limited and new manufacturers are added every year, an extension is planned. If CV 8 has the value 238 = 0xEE, CVs 107 and 108 contain an extended 12-bit manufacturer ID. Write commands to CV 8 can also be used specifically to reset the decoder.

Configuration Variable 9: -Total PWM Period

The value of CV# 9 sets the nominal PWM period at the decoder output and therefore the frequency is proportional to the reciprocal of the value. ~~The recommend formula for PWM period should be: PWM period (uS) = (131 + MANTISSA x 4)x 2 EXP ,Where MANTISSA is in bits 0-4 bits of CV 9 (low order) and EXP is bits 5-7 for CV 9.~~ If the value programmed into CV-9 falls outside a decoder's capability, it is suggested (but not required) that the decoder ""adjust"" the value to the appropriate highest or lowest setting supported by the decoder.

Configuration Variable 10: EMF Feedback Cutout

Contains a value between ""1"" and ~~128~~ ""126"" that indicates the speed step above which the back EMF motor control cuts off. When 14 or 28 speed steps are used the LSB's of the value are truncated appropriately.

Configuration Variable 11: Packet time-out Value

Contains the maximum time period that the decoder will maintain its speed without receiving a valid packet. See S 9.2.4 Section C for further information.

Configuration Variable 12: Power Source Conversion[2]

Contains the identity of the alternate power source to which the decoder will be converted should CV 1 contain all zeros. This is also the primary alternative power source selected should the decoder perform power source conversion. The currently assigned Power Source Conversion codes are listed in Appendix B of this Standard. The decoder may only switch to analogue operation if this is enabled and none of the supported digital operating modes are recognized. It is irrelevant whether the digital operating mode is enabled. Bit 2 in CV 29 must also be set for analog operation. If none of the recognized digital operating modes are enabled or if no digital operating mode is recognized and the corresponding analogue operating mode is blocked, the decoder has to switch off all outputs.

Configuration Variable 13: Alternate Mode Function Status

Indicates the status of each function (F1 through F8) when the unit is operating in alternate power mode, which cannot control the functions. If a function can be controlled, then the corresponding bit is ignored. A value of "0" indicates the function is off, while ~~a value~~a value of "1" indicates the function is on. Bit 0 corresponds to F1, while Bit 7 corresponds to F8.

Configuration Variable 14: Alternate Mode Function 2 Status

Indicates the status of each function (F9 through F12, & FL) when the unit is operating in alternate power mode, which cannot control the functions. If a function can be controlled, then the corresponding bit is ignored. A value of "0" indicates the function is off, while a value of "1" indicates the function is on. FL in the forward direction is controlled by bit 0, FL in the reverse direction is controlled by bit 1. Bit 2 corresponds to F9, while Bit 5 corresponds to F12.

Configuration Variables 15, 16: —Decoder Lock

The Decoder Lock ~~is used to change CVs in only one of several decoders with~~ feature is used to allow or conditionally forbid write access to CVs. A typical application is when more than one decoder is installed in a locomotive, and each decoder is assigned the same short address (CV 1) or long address (CV 17 and CV 18) ~~that are installed in the same locomotive~~. Assign a number to CV 16 in each decoder (i.e., 1 to motor decoder, 2 to sound decoder, 3 or higher to other decoders) before the decoders are installed in the locomotive. To change a value in another CV of one of the installed decoders, first write the number 1 (motor), 2 (sound), or 3 or higher (other) into CV 15, then send the new value to the CV to be changed. ~~The decoders will~~ A decoder shall compare CV 15 to CV 16 and, if the values are equal, the CV to be changed will be changed. If the values in CV 15 and CV 16 are different, the update will be ignored. A value of 0 in CV 16 disables decoder lock and allows write access to CV values in the unlocked decoder. The decoder lock is not applicable to writes to CV 15 and CV 16, and change of values of CV 15 or CV 16 shall always be allowed.

Configuration Variables 17, 18: —Extended Address

The Extended Address is the locomotives address when the decoder is set up for extended addressing (indicated by a value of "1" in bit location 5 of CV 29). CV 17 contains the most significant bits of the two-byte address and must have a value between 11000000 and 11100111, inclusive, in order for this two-byte address to be valid. CV 18 contains the least significant bits of the address and may contain any value.

Configuration Variables 19, 20: —Consist Address

7-bit consist address – CV 19 contains a 7-bit address in bit positions 0-6. Bit 7 indicates the relative direction of this unit within a consist, with a value of "0" indicating normal direction, and a value of "1" indicating a direction opposite the unit's normal direction. If the seven-bit address in bits 0-6 is "0000000" the unit is not in a consist. CV 20 for 7-bit consist addressing is set to "0".

14-bit consist address – in this configuration CV 19 contains the two lower-significant digits of the address in decimal notation in bits 0 to 6 and CV 20 contains the two higher-significant digits of the address in decimal notation. Values above 99 in bits 0-6 of CV 19 are not intended in this ~~case, but~~case but should be tolerated by the decoder. The address is calculated by the decoder by multiplying the value in CV 20 by 100 and adding it to the address part in CV 19. If the address is above 10239, then the decoder is not part of a consist. CV 19 Bit 7 indicates the relative direction of this unit within a consist, with a value of "0" indicating normal direction, and a value of "1" indicating a direction opposite the unit's normal direction. If the value of CV 19 in bits 0-6 is "0000000" and the value of CV 20 is "00000000" the unit is not in a consist.

Commented [CM1]: Should 7-bit consist address and 14-bit consist address be formatted as bold or italicized?

Configuration Variable 21: Consist Address Active for F1-F8

Defines for functions F1-F8 whether the function is controlled by the consist address. For each Bit a value of "1" indicates that the function will respond to instructions addressed to the consist address and instructions addressed to the locomotive address (CV 1 or CV 17/CV 18). A value of "0" indicates that the function will only respond to instructions addressed to the locomotive address. F1 is indicated by bit 0. F8 by bit 7.

Configuration Variable 22: Consist Address Active for FL and F9-F12

Defines for function FL whether the function is controlled by the consist address. For each Bit a value of "1" indicates that the function will respond to instructions addressed to the consist address and instructions addressed to the locomotive address (CV 1 or CV 17/CV 18). A value of "0" indicates that the function will only respond to instructions addressed to the locomotive address. FL in the forward direction is indicated by bit 0, FL in the reverse direction is controlled by bit 1. Bit 2 corresponds to F9, while Bit 5 corresponds to F12.

Configuration Variable 23: Acceleration Adjustment

This Configuration Variable contains additional acceleration rate information that is to be added to or subtracted from the base value contained in Configuration Variable #3 using the

formula (the contents of CV 23*.896)/(number of speed steps in use). This is a 7-bit value (bits 0-6) with bit 7 being reserved for a sign bit (0-add, 1-subtract). In case of overflow, the maximum acceleration rate shall be used. In case of underflow no acceleration shall be used. The expected use is for changing momentum to simulate differing train lengths/loads, most often when operating in a consist.

Configuration Variable 24: Deceleration Adjustment

This Configuration Variable contains additional braking rate information that is to be added to or subtracted from the base value contained in Configuration Variable #4 using the formula (the contents of CV 24*.896) / (number of speed steps in use). This is a 7-bit value (bits 0-6) with bit 7 being reserved for a sign bit (0-add,1-subtract). In case of overflow, the maximum deceleration rate shall be used. In case of underflow no deceleration shall be used. The expected use is for changing momentum to simulate differing train lengths/loads, most often when operating in a consist.

Configuration Variable 25: Speed Table/Mid-Range Cab Speed Step

A value between 2 and 127 shall be used to indicate 1 of 126 factory preset speed tables. A value of ~~"~~"00000010"~~"~~ indicates that the curve shall be linear. A value between 128 and 154 defines the 28-speed step position (1~~-26-~~27) which will define where the mid-range decoder speed value will be applied (CV 6). In 14-speed mode the decoder will utilize this value divided by two If the value in this variable is outside the range, the default mid cab speed of 14 (for 28 speed mode or 7 for 14 speed mode) shall be used as the mid speed value. Values of ~~"00000000" or "00000001"~~ 0, 1, or > 154 shall indicate that this CV is not used in the calculation of the speed table.

Configuration Variable 27: Decoder Automatic Stopping Configuration

Used to configure which actions will cause the decoder to automatically stop.

Table 2 – CV 27 Parameters

Bit #	Description	Setting
Bit 0	Enable/Disable Auto Stop in the presence of an asymmetrical DCC signal which is more positive on the right rail	“0” = Disabled “1” = Enabled
Bit 1	Enable/Disable Auto Stop in the presence of an asymmetrical DCC signal which is more positive on the left rail	“0” = Disabled “1” = Enabled
Bit 2	Enable/Disable Auto Stop in the presence of ~~ana~~ Signal Controlled Influence cutout signal	“0” = Disabled “1” = Enabled
Bit 3	Reserved for Future Use	-
Bit 4	Enable/Disable Auto Stop in the presence of ~~reverse polarity~~ opposite direction DC	“0” = Disabled “1” = Enabled
Bit 5	Enable/Disable Auto Stop in the presence ~~forward polarity~~ same direction DC	“0” = Disabled “1” = Enabled
Bit 6	Reserved for Future Use	-
Bit 7	Reserved for Future Use	-

Note: If the decoder does not support a feature contained in this table, it shall not allow the corresponding bit to be set improperly (i.e., the bit should always contain it’s default value)

265

Configuration Variable 28: ~~———~~Bi-Directional Communication Configuration (RailCom)

This CV is used to configure decoder's Bi-Directional communication characteristics when CV29-Bit 3 is set.

Table 3 - CV 28 Parameters

Bit #	Description	Setting
Bit 0	~~Enable/Disable Unsolicited Decoder Initiated Transmission~~ Enable Channel 1 Address Broadcast	~~"~~"0"~~"~~ = Disabled ~~"~~"1"~~"~~ = Enabled ~~"0" = Locked~~ ~~"1" = Released~~
Bit 1	~~Enable/Disable Initiated Broadcast Transmission using Asymmetrical DCC Signal~~ Enable Channel 2 Data and Acknowledge	~~"~~"0"~~"~~ = Disabled ~~"~~"1"~~"~~ = Enabled ~~"0" = Locked~~ ~~"1" = Released~~
Bit 2	~~Enable/Disable Initiated Broadcast Transmission using Signal Controlled Influence Signal~~ Switch Off Channel 1 Enable Automatically	~~"~~"0"~~"~~ = Disabled ~~"~~"1"~~"~~ = Enabled ~~"0" = Locked~~ ~~"1" = Released~~
Bit 3	Reserved for future use	-
Bit 4	~~Reserved for future use~~ Enable Programming Address 0003 (Long Address 3)	"0" = Disabled ~~"~~"1"~~"~~ = Enabled
Bit 5	Reserved for future use	-
Bit 6	~~Flag Bits, Reserved for Future Use~~ Enable High-current RailCom	"0" = Disabled ~~"~~"1"~~"~~ = Enabled
Bit 7	~~Flag Bits, Reserved for Future Use~~ Enable Automatic Registration (RCN-218 or RailComPlus®)	"0" = Disabled ~~"~~"1"~~"~~ = Enabled

Note: If the decoder does not support a feature contained in this table, it shall not allow the corresponding bit to be set improperly (i.e., the bit should always contain its default value).

Configuration Variable 29: ~~———~~Configurations Supported

Table 4 – CV 29 Parameters

Bit #	Description	Setting
Bit 0	Locomotive Direction	~~"~~"0"~~"~~ = normal, ~~"~~"1"~~"~~ = reversed. This bit controls the locomotive's forward and backward direction in digital mode only. Directional sensitive functions, such as headlights (FL and FR), will also be reversed so that they line up with the locomotive's new forward direction. See S-9.1.1 for more information.
Bit 1	FL location	"0" = bit 4 in Speed and Direction instructions control FL, ~~"~~"1"~~"~~ = bit 4 in function group one instruction controls FL. See S-9.2.1 for more information.
Bit 2	Power Source Conversion	~~"~~"0"~~"~~ = NMRA Digital Only, ~~"~~"1"~~"~~ = Power Source Conversion Enabled, See CV12 for more information.

Bit #	Description	Setting
Bit 3	Bi-Directional Communications	"0" = Bi-Directional Communications disabled, "1" = Bi-Directional Communications enabled. See S-9.3.2 for more information.
Bit 4	Speed Table	"0" = speed table set by CVs 2, 5, and 6, "1" = Speed Table set by CVs 66-95
Bit 5	DCC Addressing	"0" = one byte or basic address from CV1, "1" = two byte addressing (also known as extended addressing from CV17 and CV18), See S 9.2.1 for more information.
Bit 6	Reserved for future use	-
Bit 7	~~Accessory Decoder~~ Control Type	"0" = Multifunction Decoder, "1" = Accessory Decoder (see Table 11, CV 541 for a description of assignments for bits 0-6)

Note: If the decoder does not support a feature contained in this table, it shall not allow the corresponding bit to be set improperly (i.e., the bit should always contain its default value).

Configuration Variable 30: ERROR Information

In the case where the decoder has an error condition this Configuration Variable shall contain the error condition as specified by the manufacturer. A value of "0" indicates that no error has occurred.

Commented [CM(2]: We should create a table to display the following CVs 30-32 in a future release

Commented [CM3R2]: Done

Configuration Variable 31: Index High Byte Configuration ~~Variable 32 Index Low Byte~~

The Indexed Address is the address of the indexed CV page when the decoder is set up for indexed CV operation. CV 31 contains the most significant bits of the two-byte address and may have any value between 00010000 and 11111111 inclusive. Values of 00000000 ~~thru~~through 00001111 are reserved by the NMRA for future use. (4096 indexed pages) CV 32 contains the least significant bits of the index address and may contain any value. This gives a total of 61,440 indexed pages, each with 256 bytes of CV data available to manufacturers.

Note: If the decoder does not support a feature contained in this table, it shall not allow the corresponding bit to be set improperly (i.e., the bit should always contain its default value).

Configuration Variable 32: Index Low Byte

The Indexed Address is the address of the indexed CV page when the decoder is set up for indexed CV operation. CV 31 contains the most significant bits of the two-byte address and may have any value between 00010000 and 11111111 inclusive. Values of 00000000 ~~thru~~through 00001111 are reserved by the NMRA for future use. (4096 indexed pages) CV 32 contains the least significant bits of the index address and may contain any value. This gives a total of 61,440 indexed pages, each with 256 bytes of CV data available to manufacturers. If only a block with 256 bytes is required, the CV values must be set fixed and made read-only.

The page selected with CV 31 = 0 and CV 32 = 0 corresponds to CVs 1 to 256.

The page selected with CV 31 = 0 and CV 32 = 1 corresponds to a memory area that cannot be accessed in any other way. For decoders without indexed access via CVs 31 and 32, this area corresponds to the area CVs 257 to 512.

The page selected with CV 31 = 0 and CV 32 = 2 corresponds to CVs 513 to 768.

The page selected with CV 31 = 0 and CV 32 = 3 corresponds to CVs 769 to 1024, with connected SUSI modules being accessed from CV 897 onwards. In this way, all SUSI CVs can be accessed even with central units that only allow 3-digit CV numbers.

The pages addressed via CV31 = 0 and CV32 = 40 to 43 are used for function assignments according to **S-9.2.1**.

The page addressed via CV 31 = 0 and CV 32 = 254 is intended for describing the functionalities of decoders. A bit = 1 means that the corresponding functionality is supported by the decoder. The page can only be read.

The page addressed via CV31 = 0 and CV32 = 255 is reserved for RailCom applications according to **S-9.3.2** [RCN-217].

The pages addressed via CV31 = 1 and CV32 = 0 or 1 are used by RailComPlus®

The 256 pages addressed via CV31 = 2 are used for data spaces according to **S-9.3.2** [RCN-218].

Note: If the decoder does not support a feature contained in this table, it shall not allow the corresponding bit to be set improperly (i.e., the bit should always contain its default value).

Table 5 – Overview of CV31 and CV 32

CV 31	CV 32	Page
0	0	CVs 1 to 256
0	1	CVs 257 to 512
0	2	CVs 513 to 768
0	3	CVs 769 to 1024
0	4-39	Reserved
0	40-43	Function assignment according to [RCN-227]
0	44-253	Reserved
0	254	Functionalities of decoders
0	255	RailCom page according to [RCN-217]
1	0-1	Loco Info RailComPlus®
1	2-255	Reserved
2	0	Data space 0 according to [RCN-218]
2	1	Data room 1 according to [RCN-218]
2	2	Data room 2 according to [RCN-218]
2	3	Reserved for systematic reasonss
2	4	Data room 4 according to [RCN-218]
22	54	Data room 5 according to [RCN-218]Data room 4 according to [RCN-218]
22	65	Data room 6 according to [RCN-218]Data room 5 according to [RCN-218]
22	76	Data room 7 according to [RCN-218]Data room 6 according to [RCN-218]
22	8-2557	Reserved for additional data roomsData room 7 according to [RCN-218]
3-152	0-2558-255	ReservedReserved for additional data rooms
16-2553-15	0-255	Manufacturer-specific CVsReserved
16-255		Manufacturer-specific CVs

Configuration Variables 33-46: —Output Locations 1-14 for Functions FL(f), FL(r), and F1-F12

Commented [CM(4]: RailCommunity has devised a scheme to use CV96 as a means to specify more flexible mapping techniques. The NMRA should consider adopting this scheme in a future revision.

Contains a matrix indication of which function inputs control which Digital Decoder outputs. This allows the user to customize which outputs are controlled by which input commands. The outputs that Function FL(f) controls are indicated in CV 33, FL (r) in CV 34, F1 in CV 35, to F12 in CV 46. A value of "1" in each bit location indicates that the function controls that output. This allows a single function to control multiple outputs, or the same output to be controlled by multiple functions. CVs 33-37 control outputs 1-8. CVs 38-42 control outputs 4-11 CVs 43-46 control outputs 7-14. The defaults are FL (f) controls output 1, FL (r) controls output 2, F1 controls output 3 to F12 controls output 14. The lowest numbered output is in the LSB of the CV, as shown in the table below.

Table 6 - Output Position vs. CV (a 'd' indicates the default position)

CV	Description	MSB						Output							LSB
		14	13	12	11	10	9	8	7	6	5	4	3	2	1
33	Forward Headlight FL(f)														d
34	Reverse Headlight FL(r)													d	
35	Function 1												d		
36	Function 2											d			
37	Function 3										d				
38	Function 4									d					
39	Function 5								d						
40	Function 6							d							
41	Function 7						d								
42	Function 8					d									
43	Function 9				d										
44	Function 10			d											
45	Function 11		d												
46	Function 12	d													

Configuration Variable 47-64: —Manufacturer unique

Configuration Variable 65: —Kick Start

Specifies the amount of extra Kick that will supplied to the motor when transitioning between stop and the first speed step.

Configuration Variable 66: —Forward Trim

Specifies a scale factor by which a voltage drive level should be multiplied, when the controller is driving the unit in the forward direction. It is interpreted as n/128. If the Forward Trim configuration variable contains a value of "0" then forward trim is not implemented.

Configuration Variables 67-94: —Speed Table

The speed table is defined to be 28 bytes wide, consisting of 28 values for forward speeds. A digital controller that uses this table shall have at least 64 voltage drive levels and can have as many as 256 so that a smooth power curve can be constructed. Note that voltage drive levels are specified in integer values, in the same way as most other parameters. This means that a drive level of 1/4 maximum voltage corresponds to 0100000, not 0010000, as you would expect if the number specified a fraction with a fixed denominator, i.e., value 32 out of a fixed 128 levels ~~(see Definitions section).~~.

Configuration Variable 95: ———Reverse Trim

Specifies a scale factor by which a voltage drive level should be multiplied, when the controller is driving the unit in reverse. It is interpreted as n/128. If the Reverse Trim configuration variable contains a value of "0" then reverse trim is not implemented.

Configuration Variable 96: Select Function Assignment Method

This CV is used to select the method for function assignment. If several function assignment methods are implemented in a decoder, the user can select the desired method using the configuration variable CV 96. If only one method is implemented, CV 96 must have the corresponding value. When writing CV 96, the decoder may only accept values that correspond to the implemented function assignments. Otherwise, the old value must be retained.

Within CV 96, only bits 0 to 2 are used to select the function assignment. The other bits are still reserved and must contain a 0.

Table 7 – CV 96 Function Assignment Methods

Value	Meaning
0	Invalid (a non-implemented CV 96 may return a 0)
1	Function assignment via CVs 33 to 46 according to this ~~RCN or [S-9.2.2]~~ document or [RCN-225]
2	Function assignment via CVs 257 to 512 in the bank selected by CV 31 = 0 and CV 32 = 40 with CVs per function according to [RCN-227] Section 2
3	Function assignment via CVs 257 to 512 in the bank selected by CV 31 = 0 and CV 32 = 41 with CVs per output according to [RCN-227] section 3.1
4	Function assignment via CVs 257 to 512 in the bank selected by CV 31 = 0 and CV 32 = 42 with CVs per output according to [RCN-227] section 3.2
5	Function assignment via CVs 257 to 512 in the bank selected by CV 31 = 0 and CV 32 = 43 with CVs per output according to [RCN-227] section **3.3**
6	manufacturer-specific function assignment

Value	Meaning
7	reserved

~~Configuration Variable 96-104: NMRA Reserved~~

Configuration Variables 97-104: ~~Manufacturer unique~~Manufacturer Specific CVs

This CV range can be freely assigned by the manufacturer.

Configuration Variables 105, 106: User Identification #1 and #2

These CVs are reserved for use by the owner of the decoder to store identification information, e.g., NMRA membership number. CV 105 is ID #1 and CV 106 is ID #2

~~Configuration Variable 107-111: NMRA Reserved~~

~~CVs 107, 108: with CV8=0xEE, a 16-bit manufacturer ID is stored in these two CVs~~

~~CVs 109-111: with CV7= _, these three CVs expand the version number feature~~

Configuration Variables 107, 108: Extended manufacturer ID / manufacturer specific CVs

~~If the value CV8=0xEE, a 12-bit manufacturer ID is stored in these two CVs. The 8 least significant bits go into CV108 with the 4 most significant bits going into CV107 bits 0-3; CV107 bits 4-7 must be 0000 and ignored by programming tools.~~If the value 238 = 0xEE is in CV 8 "Manufacturer ID", these two CVs are reserved for the extended 12-bit manufacturer ID. The 8 lower-order bits are in CV 108, and the 4 higher-order bits are in CV 107 bits 0 to 3. Bits 4 to 7 in CV 107 are always 0. For all other values in CV 8, these CVs can be freely assigned by the decoder manufacturer.

Configuration Variables 109 – 111: Extended Manufacturer Version Number

These three CVs are intended for an extension of the manufacturer's version number in CV7. The values used in CV 7 and CVs 109-111 are assigned at the manufacturer's discretion without restriction.

~~Configuration Variable 112-128: Manufacturer unique~~

Configuration Variables 112~~129~~-256: Manufacturer unique

CVs in this range are already being used by many manufacturers. Opening up this area officially is an attempt to legitimize what is already being done.

Configuration Variable 257-512: ~~I~~Indexed access area. (see also CV 31, 32)

This is the indexed area. It contains a total of 65536 pages, each 256 bytes in length. The first 4096 pages are reserved for NMRA use. The remaining 61440 pages are available to manufacturers for their own purposes. ~~For the manufacturer that needs only 256 additional bytes of CVs, he can simply specify a base address in CV 31-32 and not respond if that address is not enabled without actually paging data.~~ The pages are addressed via CV 31 (high address bits) and CV 32 (lower address bits).

~~Configuration Variable 880-895: Dynamic CVs~~

~~CVs in this range are dynamic and are used for Unsolicited Decoder Initiated Transmission. Manufacturers who utilize these CVs are requested to contact the NMRA DCC WG for current uniform specifications.~~

~~-~~Configuration Variables 880-896: ~~———~~Reserved NMRA / RailCommunity

These CVs are reserved. CVs 892 to 896 were reserved for dynamic values to be read via RailCom but are not required at this point in time. Therefore, these CVs are also marked as reserved.

~~Configuration Variable 892: Decoder Load~~

~~Specifies the current load of the decoder. The load is volatile and is not stored across power interruptions.~~

~~Bits 0-6 indicate the value of the load with 0 indicating no load~~

~~Bit 7 indicates a positive or negative load.~~

~~Configuration Variable 893: Flags~~

~~Up to 8 dynamic flags can be transmitted Bits 0-7 Reserved for future use.~~

~~Configuration Variable 894: Fuel/Coal~~

~~Specifies the amount of Fuel/Coal left before the decoder will stop the locomotive. A value of 0 indicates that the Fuel/Coal is totally consumed, a value of 254 indicates totally full and a value of 255 indicates that this CV is not currently supported, and its contents should not be transmitted~~

~~Configuration Variable 895: Water~~

~~Specifies the amount of water left before the decoder will stop the locomotive. A value of 0 indicates that the water is totally consumed, a value of 254 indicates totally full and a value of 255 indicates that this CV is not currently supported, and its contents should not be transmitted.~~

Configuration Variable~~s~~ ~~896~~ 897-1024: ~~—~~SUSI (Serial User Standard Interface)

Reserved ~~until March 2005~~ for use by SUSI to define CVs for Sound and Function auxiliary modules. See Technical Note TI-9.2.3 for details.

1.3.3 Descriptions of Configuration Variables for Accessory Decoders

Previous version of this Standard established CVs 513-1024 to be used by accessory decoders. CVs 1-512 were reserved for NMRA use. However, many accessory decoders were sold that used CVs 1-512. This was done for various reasons, including ~~in~~ inability of some command stations to access CVs above 512. In recognition of many accessory decoders using the lower CVs and the desire to create more space for manufacturers, the CV definitions as previously defined have been moved from 513-1024 down to 1-512. Using the CVs 513-1024, as defined in Table 2, are optional. The manufacturer may use these upper CVs in any manner they see appropriate. These changes will allow existing accessory decoders to use CVs 513-1024 as previously defined.

1.3.3.1 Accessory Decoders – CV Support

Any accessory decoder using CVs for configuration must follow the NMRA CV standard as outlined in this document. Accessory decoders that do not support CVs for configuration must have detailed documentation that is readily available, i.e., instruction sheet(s) supplied with the decoder or downloadable instructions from the manufacturer's website.

1.3.3.2 Accessory Decoders – Service Mode Programming

If an accessory decoder does not support programming mode it should be clearly noted in the decoder's documentation. Also, since identification is not possible by reading CVs, the decoder shall be clearly marked with the make and model number of the device.

Table ~~7~~8 - Accessory Decoder Configuration Variables

Accessory Decoders CV Name	CV #	CV # (optional)	Required	Default Value	Read Only	Uniform Spec	Additional Comments
Decoder Address LSB	1	513	M	1	-	Y	6-bit or 8-bit LSB
Auxiliary Activation	2	514	O	-	-	-	Auxiliary activation of outputs
Time On F1	3	515	O	-	-	-	
Time On F2	4	516	O	-	-	-	
Time On F3	5	517	O	-	-	-	
Time On F4	6	518	O	-	-	-	
Manufacturer Version Info	7	519	M	-	Y	-	Manufacturer defined version info~~.~~
Manufacturer ID	8	520	M	-	Y	Y	Values assigned by NMRA~~.~~
Decoder Address MSB	9	521	M	0	-	Y	3-bit MSB
	10-14	-	-	-	-	-	Reserved by NMRA for future use
Decoder Lock	15,16	-	O	-	-	-	
Mirrored Address	17,18	-	-	-	-	-	CVs 1 and 9 mirrored
	19-27	-	-	-	-	-	Reserved by NMRA for future use
Bi-Directional Communication	28	540	O	-	-	Y	
Accessory Decoder Configuration	29	541	M	-	-	Y	Similar to CV 29 for accessory decoders
	30	-	-	-	-	-	Reserved by NMRA for future use
Indexed Area Pointers	31, 32	-	O	-	-	-	Index High and Low Address
Manufacturer Unique	33-81	-	O	-	-	-	Reserved for manufacturer use
	82-106	-	-	-	-	-	Reserved by NMRA for future use
12 Bit Extended Manufacturer Identification	107-108	-	M	-	-	-	Only with CV8 = 238, otherwise reserved

Accessory Decoders CV Name	CV #	CV # (optional)	Required	Default Value	Read Only	Uniform Spec	Additional Comments
	109-111	-	-	-	-	-	Reserved by NMRA for future use
Manufacturer Unique	112-128	-	O	-	-	-	Reserved for manufacturer use
Manufacturer Unique	129-256	-	-	-	-	-	Reserved for manufacturer use
Extended CV Area	257-512	-	-	-	-	-	Indexed area - see CV 31,32 Index
Manufacturer Unique	513-895	-	O	-	-	-	Reserved for manufacturer use
	896-1024	-	-	-	-	-	Reserved by NMRA for future use

[1] The CV is normally read-only. Write commands to this CV trigger special functions according to RailCommunity [RCN-226].

~~**Configuration Variable 1 [513]: Decoder Address (LSB)**~~

~~Contains the low-order address bits for Accessory Decoders. The high-order address bits are stored in CV9 [521]. Two types of Accessory Decoder addressing are supported: Decoder-Address and Output-Address. An accessory decoder must support one type, and optionally the other type. The type of decoder is specified in CV29 [541], bit 6. Decoders using either type of addressing will respond to the same Accessory Decoder Control Packet when CV1 [513] = 1 and CV9 [521] = 0. The factory default value is 1. The type(s) of addressing supported must be clearly documented in the manual and on the packaging.~~

~~(1) Decoder-Address: Contains the six least significant bits of the accessory decoder's address in bits 0-5. These bits are transmitted as bits 0-5 in the first byte of the accessory decoder packet. See S-9.2.1 for more information.~~

~~(2) Output-Address: The user places the output address Contains the address value results from the following formula: Output Address modulus 256. (ex. Output Address mod 256, or Output Address % 256).~~

~~The values contained in CV1 [513] and CV9 [521] correspond to the bits in the Accessory Decoder packets as follows:~~

~~**Accessory Output = (CV1 [513] + (CV9 [521] *256)) - 1**~~

~~Bits 0 & 1 of the Accessory Output are transmitted as bits 1 & 2 of byte 2 of both Accessory Decoder Control Packets. Bits 2-7 of the Accessory Output are transmitted as bits 0-5 of byte 1 of both Accessory Decoder Control Packets. The three least significant bits of CV9 [521] contain the ones-complement of bits 4-6 of both Accessory Decoder Control Packets (See S-9.2.1 for more information on the Accessory Decoder Control Packets).~~

~~If an accessory decoder supports more than one sequential output the value in CV1 [513] will be the first output in the series~~**Configuration Variable 1 [513]: Decoder Address (LSB)**

Two different formats are supported to store the Accessory Decoder address in CV 1 and 9. An accessory decoder must support one format, and optionally the other format. The storage format is specified in CV29 [541], bit 6. The storage format(s) supported should be clearly documented in the manual and on the packaging.

Decoders using either storage format will respond to the same Accessory Decoder Control Packet when CV1 [513] = "1" and CV9 [521] = "0". The factory default value is CV1 = "1" and CV9 = "0".

(1) Decoder Address: If CV 29 bit 6 = "0" = Decoder Address method

CV1 contains the six least significant bits of the accessory decoder's address, that is the bits $A_7A_6A_5A_4A_3A_2$ of an Accessory Decoder Packet. See S-9.2.1, Chapters 2.4.1 and 2.4.2 for more information.

Therefore, the valid number range is "0" ≤ CV1 value ≤ "63".

The values in the range "64" ≤ CV1 value ≤ "255" are invalid.

CV9 contains the three most significant bits of the accessory decoder's address, that is the bits $A_{10}A_9A_8$ (in their native, i.e. non-inverted, bit value). See S-9.2.1, Chapters 2.4.1 and 2.4.2 for more information.

Therefore, the valid number range is "0" ≤ CV9 value ≤ "7".

The values in the range "8" ≤ CV9 value ≤ "255" are invalid.

(2) Output Address: If CV 29 bit 6 = "1" = Output Address method

Note: Traditionally, accessory decoders are quadruple turnout decoders and have a block of nine dip switches to configure the decoder address. CV1 and CV9 are equivalent to 9-bit dip switches, CV1 contains the six least significant bits, and CV9 contains the three most significant bits.

DCC Packet 11-bit Address is the (unsigned, decimal) value of the address bits $A_{10}A_9A_8A_7A_6A_5A_4A_3A_2A_1A_0$ as transmitted in an Accessory Decoder Packet, refer to S-9.2.1 Chapters 2.4.1 and 2.4.2. The DCC Packet 11-bit Address is hereafter shortly called Packet Address.

The valid number range for DCC Packet 11-bit Address is: "0" ≤ Packet Address ≤ "2047".

Output Address is the value that is stored in CV1 and 9.

The valid number range for Output Address is: "0" ≤ Output Address ≤ "2047".

The correspondence between Packet Address and Output Address is:

If "3" ≤ Packet Address ≤ "2047" then Output Address = Packet Address – "3".

If 0 ≤ Packet Address ≤ 2 then Output Address = Packet Address − 3 + 2048.

The Output Address is an 11-bit number.

CV1 contains the eight least significant bits of the Output Address, i. e. Output Address modulo 256.

Therefore, the valid number range is 0 ≤ CV1 value ≤ 255.

CV9 contains the three most significant bits of the Output Address, i. e. Output Address integer divided by 256.

Therefore, the valid number range is 0 ≤ CV9 value ≤ 7.

The values in the range 8 ≤ CV9 value ≤ 255 are invalid.

Note: In the case of Linear addressing convention (refer to S-9.2.1 chapter. 2.4.1) the Output Address is equal to the User Address, except for User Address 2048. In the case of Non-Linear addressing convention, an offset of 256 (modulo 2048) occurs for those addresses that differ between Linear and Non-Linear addressing convention.

If an accessory decoder supports more than one sequential output, the Output Address stored in CV1 and 9 is the first output in the series.

Table ~~8~~ 9 – CV1 [513] and CV9 [521] Address and Packet Definitions

User Address		DCC Packet			Addressing			
					Decoder		Output Pair	
Linear	Non-Linear	Byte 1 ($10A_7A_6A_5A_4A_3A_2$)	Byte 2 ($1\bar{A}_{10}\bar{A}_9\bar{A}_8DA_1A_0R$)	$A_{10}..A_0$	CV1 [513]	CV9 [521]	CV1 [513]	CV9 [521]
1	1	10000001	1111D00R	4	1	0	1	0
2	2	10000001	1111D01R	5	1	0	2	0
3	3	10000001	1111D10R	6	1	0	3	0
4	4	10000001	1111D11R	7	1	0	4	0
5	5	10000010	1111D00R	8	2	0	5	0
6	6	10000010	1111D01R	9	2	0	6	0
…	…	…	…	…	…	…	…	…
252	252	10111111	1111D11R	255	63	0	252	0
253	509	10000000	1110D00R	256	0	1	253	0
254	510	10000000	1110D01R	257	0	1	254	0
255	511	10000000	1110D10R	258	0	1	255	0
256	512	10000000	1110D11R	259	0	1	0	1
257	257	10000001	1110D00R	260	1	1	1	1
…	…	…	…	…	…	…	…	…
508	508	10111111	1110D11R	511	63	1	252	1
509	765	10000000	1101D00R	512	0	2	253	1
510	766	10000000	1101D01R	513	0	2	254	1
511	767	10000000	1101D10R	514	0	2	255	1
512	768	10000000	1101D11R	515	0	2	0	2
513	513	10000001	1101D00R	516	1	2	1	2
…	…	…	…	…	…	…	…	…
2044	2044	10111111	1000D11R	2047	63	7	252	7
2045	253	10000000	1111D00R	0	0	0	253	7

User Address		DCC Packet			Addressing			
					Decoder		Output Pair	
Linear	Non-Linear	Byte 1 (10$A_7A_6A_5A_4A_3A_2$)	Byte 2 (1$\bar{A}_{10}\bar{A}_9\bar{A}_8DA_1A_0R$)	$A_{10}..A_0$	CV1 [513]	CV9 [521]	CV1 [513]	CV9 [521]
2046	254	10000000	1111D01R	1	0	0	254	7
2047	255	10000000	1111D10R	2	0	0	255	7
2048	256	10000000	1111D11R	3	0	0	0	0

Configuration Variable 2 [514]: —Auxiliary Activation

Bits 1-8 = Auxiliary activation: = "0" output is not activated by an auxiliary input, "1" output can be activated by an auxiliary input.

Configuration Variables 3-6 [515-518]: —Time On for Functions F1-F4

Functions F1-F4 can have the time the outputs are active set by Configuration Variables 3 [515] – 6 [518]. Configuration Variable 3 [515] controls Function F1 and Configuration Variable 6 [518] Controls Function F4. Contains a time that the output is on each time the state of the function is activated. A value of all "0"s indicates continuous on.

Configuration Variable 7 [519]: —Manufacturer Version Number

(See CV 7 for the description).

Configuration Variable 8 [520]: —Manufacturer ID

(See Appendix A for a list of Manufacturer IDs; See CV 8 for the description).

Configuration Variable 9 [521]: —Decoder Address (MSB)

see description of Configuration Variable 1

~~Contains the high-order address bits for Accessory Decoders. The low-order address bits are stored in CV1 [513]. Two types of Accessory Decoder addressing are supported: Decoder-Address and Output-Address. An accessory decoder must support one type, and optionally the other type. The type of decoder is specified in CV29 [541], bit 6. Decoders using either type of addressing will respond to the same Accessory Decoder Control Packet when CV1 [513] = 1 and CV9 [521] = 0. The type(s) of addressing supported must be clearly documented in the manual and on the packaging. The bits transmitted are the ones complement of the value in this CV. See S-9.2.1 for more information on the Accessory Decoder Control Packets.~~

~~(1) Decoder Address: Contains the three most significant bits of the accessory decoder's address in bits 0-2. These bits are transmitted as bits 4-6 in the second byte of the accessory decoder packet.~~

~~(2) Output Address: Contains the address value results from the quotient of the following formula: Output Address divided by 256 (Output Address div 256, Output Address / 256).~~

~~See CV513 [1] for an explanation of how to determine the contents of CV1 [513] and CV9 [521].~~

Configuration Variables 15 – 16: Decoder Lock

Corresponds to CVs 15 and 16 for mobile decoders.

Configuration Variables 17 and 18: Mirrored Address

Mirror of CVs 1 and 9 for accessory decoders based on the CVs for mobile decoders, whereby one output pair is always addressed. Bits 6 and 7 in CV 17 are only set if bit 7 in CV 29[541] = 0, i.e. if the accessory decoder is addressed via a mobile decoder address. Since accessory decoders only have 11 address bits, if bit 7 in CV 29[541] is set, bits 3 to 7 in CV 17 must be 0.

Configuration Variable 28 [540]: ~~-~~Bi-Directional Communication Configuration

This CV is used to configure decoder's Bi-Directional communication characteristics when CV29 [541]-Bit 3 is set.

Table ~~8~~ 10 – CV 28 [540] Parameters

Bit #	Description	Setting
Bit 0	Enable/Disable Unsolicited Decoder Initiated Transmission	"0" = Disabled "1" = Enabled
Bit 1	Enable channel 2 data and acknowledge	"0" = Disabled "1" = Enabled
Bit 2	Reserved for future use.	-
Bit 3	Reserved for future use.	-
Bit 4	Reserved for future use.	-
Bit 5	Reserved for future use.	-
Bit 6	Enable high-current RailCom	"0" = Disabled "1" = Enabled
Bit 7	Enable automatic registration (RCN-218 or RailComPlus®)	"0" = Disabled "1" = Enabled

Note: If the decoder does not support a feature contained in this table, it shall not allow the corresponding bit to be set improperly (i.e., the bit should always contain its default value).

Configuration Variable 29 [541]: Accessory Decoder Configurations Supported

Table 11 – CV 29 [541] Parameters

Bit #	Description	Setting
Bit 0	Reserved for future use.	
Bit 1	Reserved for future use.	
Bit 2	Reserved for future use.	
Bit 3	Bi-Directional Communications	"0" = Bi-Directional Communications disabled "1" = Bi-Directional Communications enabled. See S-9.3.2 for more information.
Bit 4	Reserved for future use.	
Bit 5	Decoder Type	"0" = Basic Accessory Decoder "1" = Extended Accessory Decoder
Bit 6	Addressing Method	"0" = Decoder Address method "1" = Output Address method
Bit 7	~~Accessory Decoder~~ Control Type	"0" = Multifunction Decoder (See Table 4, CV-29 for description of bit Assignments for bits 0-6) "1" = Accessory Decoder If bit 7 = 1, then the decoder may ignore the two most-significant bits of the CV number in Service Mode programming only. Using this feature CV513 becomes CV1, etc. Decoders that use this conversion must clearly document this in the manual.

~~Decoders which perform the translation must clearly document the feature in their manual.~~

Note: If the decoder does not support a feature contained in this table, it must not allow the corresponding bit to be set improperly (i.e., the bit should always contain its default value).

Configuration Variable 31: Index Address High Byte

Configuration Variable 32: Index Address Low Byte

The Indexed Address is the address of the indexed CV page when the decoder is set up for indexed CV operation. ~~CV 31 contains the most significant bits of the two-byte address and may have any value between 00010000 and 11111111 inclusive. Values of 00000000 through 00001111 are reserved by the NMRA for future use. (4096 indexed pages) CV 32 contains the least significant bits of the index address and may contain any value. This gives a total of 61,440 indexed pages, each with 256 bytes of CV data available to manufacturers.~~

Refer to previous section *1.3.2, Descriptions of Configuration Variables for Multifunction Decoders* for CV31 and CV32 definitions.

Configuration Variable 33: Decoder Output Status

This CV contains the status of all four output pairs of simple (basic) accessory decoders. It can be used to query the status via RailCom. The assignment of the outputs to the bits in CV 33 is as follows:

Table ~~11~~ 12: Status of the Decoder Outputs

Output Pair	**4**		**3**		**2**		**1**	
R-bit in the -Basic Accessory Decoder Packet [S-9.2.1]	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**
Key Color [1]	R	G	R	G	R	G	R	G
Bit in CV 33								

1 In the command for simple accessory decoders R = 0 means switch on branch or direction of travel left or signal on stop (classic red button) and R = 1 means switch straight or direction of travel right or signal on go (classic green button).

Configuration Variables 107, 108: Extended Manufacturer ID / Manufacturer Specific CVs

These CVs correspond to CVs 107 and 108 for mobile decoders.

2 CV Table for SUSI Modules

The CVs for the SUSI range CV 897 to CV 1024 are documented in TI-9.2.3.

3 Appendix A: Manufacturer ID codes as assigned by the NMRA

[This appendix is published separately since it is under constant revision]

4 Appendix B: Power Source Conversion codes as assigned by the NMRA

The following Power Source Conversion codes (via values placed in CV12) ~~have been~~have been assigned by the NMRA Technical Department in harmony with RailCommunity. Manufacturers wishing to use conversions not on this list shall apply to the NMRA Technical Department for the assignment for a conversion ID.

00000001 = ~~Analog Power Conversion~~ ~~Conversion~~ DC (Analog Mode Direct Current)
00000010 = Radio Control
00000100 = ~~Zero-1~~ DCC (digital operation)
00001000 = ~~TRIX~~ Selectrix
00010000 = ~~CTC 16 / Railcommand~~ ~~Railcommand~~ AC (Analog Mode Alternating Current)
00100000 = ~~FMZ (Fleischmann)~~ Motorola (digital operation)
01000000 = mfx (digital operation)
10000000 = Reserved for Future Protocols or Modes of Operation

5 Appendix C: Process for changing Manufacturer Specific CVs to Optional or Uniform.

[An official process whereby CVs incorporated initially as Manufacturer Specific options may be incorporated into the Standard for optional and/or uniform usage by all manufacturers needs to be defined and inserted here.]

6 Document History

~~6~~

Date	Description
July 1995~~11/11/2022~~	First Release~~First Revision~~
March 1997	Revisions approved by NMRA BOD
July 2003	Revisions approved by NMRA BOD
July 2006	Revisions approved by NMRA BOD
July 2007	Revisions approved by NMRA BOD
July 2012	Revisions approved by NMRA BOD
11-Nov-2022	Moved to new template format. Table 1 - Multifunction Decoder Configuration Variables – Requirement for CV2 thru CV5, CV17, and CV18 changed from Optional to Mandatory
~~11 Dec 2022~~	~~Table 1 – Multi-function Decoder Configuration Variables – Requirement for CV2 thru CV5, CV17, and CV18 changed from Optional to Mandatory~~
~~01~~20-Jan-2023~~/20/2023~~	Added Sections 1.3.3.1, Accessory Decoders – CV Support; 1.3.3.2, Accessory Decoders – Programming Track Mode

Date	Description
8-Jun-2023	Added information to sections 1.2.1 Normative and 1.2.2 Informative. Changed CV 19 from Optional to Recommended. Removed references to Dynamic CVs. Reverted CVs 880-895 to reserved. Changes and corrections to Table 1 and to definitions for CVs 9, 10, 12, 16, 21, 22, 25, 27, 28 (including Table 2 and Table 3) to harmonize with RCN-225. CVs 97-104 changed to Manufacturer unique. CVs 107-111 changed to harmonize with RCN-225. Typos and miscellaneous corrections made. Definitions for Accessory Decoder CV31 and CV32 changed to refer to Mobile Decoder definitions for CVs 31-32. Appendix B changed to harmonize with RCN-225.
9-Jun-2023	Minor corrections to CV1 text were made. Quote marks added to CV values where missing.
14-Feb-2024	Updated Table 6, Accessory Decoder CVs; fixed various grammatical errors
10-May-2024	Changes to Table 7 – CV 28 [540] Parameters for Accessory Decoders. Updated Table 1 - Multifunction Decoder Configuration Variables. Added reference to SUSI CV Table in TI-9.2.3. Cleaned up margin errors and standardized table formatting.
11-Nov-2024	Removed blank page 5; removed blank line on page 6
12-Feb-2025	Added Table 5 – Overview of CV31 and CV 32, amended section on CV31 and CV32. Added Table 8 CV1 [513] and CV9 [521] Address and Packet Definitions
12-Mar-2025	Updates to Section 1.3.3.2: Modified decryption for CVs 1[513] and 9[521]. Added descriptions for CVs 15, 16, 17, 18, 33,107 and 108. Added Table 11: Status Of the Decoder Outputs
08-May 2025	Update to CV 7 to harmonize with RailCommunity RCN-225. Modifications to text for Configuration Variable 1 [513]: Decoder Address (LSB)
08-Aug 2025	Corrections to CV 7, CV 107 and CV 108 to harmonize with RailCommunity RCN-225
11-Sept 2025	Changed text formatted with Calibri font to Times Roman Font; corrected typos and formatting
28-Nov 2025	Created new tables; Table 5 - **Overview of CV31 and CV 32,** and Table 7 - **CV 96 Function Assignment Methods**
16-Dec 2025	Corrected CV9 values in Table 9 - **CV1 [513] and CV9 [521] Address and Packet Definitions;** updated blank cells to "-" in Table 1 - **Multifunction Decoder Configuration Variables,** and Table 6 **- Accessory Decoder Configuration Variables**
11-Feb 2026	Correction made to Tables 10, 11, 12.

Important Notices and Disclaimers Concerning NMRA Standards Documents

The Standards (S), Recommended Practices (RP), Technical Note (TN), and Technical Information (TI) documents of the National Model Railroad Association ("NMRA Standards documents") are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page, appear in all standards and may be found under the heading "Important Notices and Disclaimers Concerning NMRA Standards Documents."

Notice and Disclaimer of Liability Concerning the Use of NMRA Standards Documents

NMRA Standards documents are developed within the Standards and Conformance Department of the NMRA in association with certain Working Groups, members, and representatives of manufacturers and sellers. NMRA develops its standards through a consensus development process, which brings together volunteers representing varied viewpoints and interests to achieve the final product. NMRA Standards documents are developed by volunteers with modeling, railroading, engineering, and industry-based expertise. Volunteers are not necessarily members of NMRA, and participate without compensation from NMRA.

NMRA does not warrant or represent the accuracy or completeness of the material contained in NMRA Standards documents, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard or recommended practice, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, NMRA disclaims any and all conditions relating to results and workmanlike effort. In addition, NMRA does not warrant or represent that the use of the material contained in NMRA Standards documents is free from patent infringement. NMRA Standards documents are supplied "AS IS" and "WITH ALL FAULTS."

Use of NMRA Standards documents is wholly voluntary. The existence of an NMRA Standard or Recommended Practice does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the NMRA Standards documents. Furthermore, the viewpoint expressed at the time that NMRA approves or issues a Standard or Recommended Practice is subject to change brought about through developments in the state of the art and comments received from users of NMRA Standards documents.

In publishing and making its standards available, NMRA is not suggesting or rendering professional or other services for, or on behalf of, any person or entity, nor is NMRA undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any NMRA Standards document, should rely upon their own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given NMRA Standards document.

IN NO EVENT SHALL NMRA BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: THE NEED TO PROCURE SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD OR RECOMMENDED PRACTICE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

Translations

NMRA's development of NMRA Standards documents involves the review of documents in English only. In the event that an NMRA Standards document is translated, only the English version published by NMRA is the approved NMRA Standards document.

Official Statements

A statement, written or oral, that is not processed in accordance with NMRA policies for distribution of NMRA communications, or approved by the Board of Directors, an officer or committee chairperson, shall not be considered or inferred to be the official position of NMRA or any of its committees and shall not be considered to be, nor be relied upon as, a formal position of NMRA.

Comments on Standards

Comments for revision of NMRA Standards documents are welcome from any interested party, regardless of membership. However, **NMRA does not provide interpretations, consulting information, or advice pertaining to NMRA Standards documents.**

Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since NMRA standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive the concurrence of a balance of interests. For this reason, NMRA, its departments, Working Groups or committees cannot provide an instant response to comments, or questions except in those cases where the matter has previously been addressed. For the same reason, NMRA does not respond to interpretation requests. Any person who would like to participate in evaluating comments or in revisions to NMRA Standards documents may request participation in the relevant NMRA working group.

Laws & Regulations

Users of NMRA Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any NMRA Standards document does not constitute compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. NMRA does not, by the publication of NMRA Standards documents, intend to urge action that is not in compliance with applicable laws, and NMRA Standards documents may not be construed as doing so.

Copyrights

NMRA Standards documents are copyrighted by NMRA under US and international copyright laws. They are made available by NMRA and are adopted for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of modeling, structural and engineering practices and methods. By making NMRA Standards documents available for use and adoption by public authorities and private users, NMRA does not waive any rights in copyright to the NMRA Standards documents.

IMPORTANT NOTICE

NMRA Standards documents do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other systems, devices or networks. NMRA Standards documents development activities consider research and information presented to the standards development group in developing any safety recommendations. Other information about safety practices, changes in technology or technology implementation, or impact by peripheral systems also may be pertinent to safety considerations during implementation of the standard. Implementers and users of NMRA Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices and all applicable laws and regulations.