NMRA STANDARDS	
Configuration Variables	
For Digital Command Control,	
All Scales	
July 2012	S-9.2.2

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.

5 **General 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:

10 • 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
15   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
20   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.
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Note. While all *Digital Decoders* need not implement all variables, it is required that if a function is provided, that the all of the relevant CV information be adhered to.

   • Additional Comments: CVs identified as "Reserved by NMRA for future use" are allocated for future needs
30   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
35   different implementers can be assured by the NMRA.

Table 1 Multi-function Decoder Configuration Variables

CV Name	CV #	Required	Default Value	Read Only	Uniform Spec	Dynamic (Volatile)	Additional Comments
Multi-function Decoders:							
Primary Address	1	M	3		Y		
Vstart	2	R					
Acceleration Rate	3	R					
Deceleration Rate	4	R					
Vhigh	5	O					
Vmid	6	O					
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			Y		
Extended Address	17+18	O			Y		
Consist Address	19	O			Y		
	20	-					Reserved by NMRA for future use
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		
	26						Reserved by NMRA for future use
Decoder Automatic Stopping Configuration	27	O			Y		Under re-evaluation – see details
Bi-Directional Communication Configuration	28	O			Y		Under re-evaluation – see details
Configuration Data #1	29	M[1]			Y		
Error Information	30	O			Y		
Index High Byte	31	O			Y		Primary index for CV257-512 00000000 - 00001111 reserved by NMRA for future use.
Index Low Byte	32	O			Y		Secondary index for CV257-512
Output Loc. FL(f), FL(r), F1-F12	33-46	O			Y		
Manufacturer Unique	47-64	O					Reserved for manufacturer use
Kick Start	65	O					
Forward Trim	66	O					
Speed Table	67-94	O					
Reverse Trim	95	O					
	96-104	-					Reserved by NMRA for future use
User Identifier #1	105	O					Reserved for customer use
User Identifier #2	106	O					Reserved for customer use
	107-111	-					Reserved by NMRA for future use CV107,108: expanded Mfg. ID CV109-111: expanded CV7
Manufacturer Unique	112-256	O					Reserved for manufacturer use
Indexed area	257-512						Indexed area - see CV# 31,32 Index values of 0-4095 reserved by NMRA
	513-879	-					Reserved by NMRA for future use
	880-891					Y	Reserved by NMRA for future use
Decoder Load	892	O			Y	Y	
Dynamic Flags	893	O			Y	Y	
Fuel/Coal	894	O			Y	Y	
Water	895	O			Y	Y	
SUSI Sound and Function Modules	896-1024	O			Y		See TN-9.2.3

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

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

Descriptions of Configuration Variables for Multi-Function 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".   If the value of Configuration Variable #1 is "00000000" then 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 decoders 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 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 translate 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.

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.

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 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.

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 <u>can</u> 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. 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, & F_L) when the unit is operating in alternate power mode, which cannot control the functions. If a function <u>can</u> 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. F_L in the forward direction is controlled by bit 0, F_L 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 the same short address (CV1) or long address (CV17 and CV18) that are installed in the same locomotive. Assign a number to CV16 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 CV15, then send the new value to the CV to be changed. The decoders will compare CV15 to CV16 and, if the values are equal, the CV to be changed will be changed. If the values in CV15 and CV16 are different, the update will be ignored.

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 Variable 19   Consist Address

Contains a seven 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.

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. 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. 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

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[2]   Allocation of these bits is done by the NMRA on an as needed basis.

F9, while Bit 5 corresponds to F12.

155   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
160   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
165   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.
170
         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) which will define where the mid range decoder speed value will be applied. In 14-speed mode
175   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" shall indicate that this CV is not used in the calculation of the speed table.

180   Configuration Variable 27   Decoder Automatic Stopping Configuration
         Used to configure which actions will cause the decoder to automatically stop.
         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.
185   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 an Signal Controlled Influence cutout signal
         .   "0" = Disabled "1" = Enabled
190   Bit 3 = Reserved for Future Use
         Bit 4 = Enable/Disable Auto Stop in the presence of reverse polarity DC
                "0" = Disabled "1" = Enabled
         Bit 5 = Enable/Disable Auto Stop in the presence forward polarity DC
         .   "0" = Disabled "1" = Enabled
195   Bits 6-7 = 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).

200   Configuration Variable 28   Bi-Directional Communication Configuration
         Used to configure decoder's Bi-Directional communication characteristics when CV29-Bit 3 is set
         Bit 0 = Enable/Disable Unsolicited Decoder Initiated Transmission
                "0" = Disabled "1" = Enabled
         Bit 1 = Enable/Disable Initiated Broadcast Transmission using Asymmetrical DCC Signal
205   "0" = Disabled "1" = Enabled
         Bit 2 = Enable/Disable Initiated Broadcast Transmission using Signal Controlled Influence Signal
                      "0" = Disabled "1" = Enabled
         Bits 3-5 = Reserved for future use.
         Bits 6-7 = Flag Bits, Reserved for future use
210
         *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

215   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
220   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
         CV#12 for more information,

      Bit 3 = Bi-Directional Communications: "0" = Bi-Directional Communications disabled, "1" = Bi-Directional
         Communications enabled. See S-9.3.2 for more information.

225   Bit 4 = Speed Table: "0" = speed table set by configuration variables #2,#5, and #6, "1" = Speed Table set by
         configuration variables #66-#95

      Bit 5 = "0" = one byte addressing, "1" = two byte addressing (also known as extended addressing), See S 9.2.1
         for more information.

      Bit 6 = Reserved for future use.

230   Bit 7 = Accessory Decoder: "0" = Multifunction Decoder, "1" = Accessory Decoder (see 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).

235   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.

      Configuration Variable 31   Index High Byte
240
      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
245   00010000 and 11111111 inclusive. Values of 00000000 thru 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
250   set improperly (i.e. the bit should always contain its default value).

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

260 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 is that 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.

CV	Description	Output MSB 14	13	12	11	10	9	8	7	6	5	4	3	2	LSB 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													

265 **Table 2: Output Position vs. CV (a 'd' indicates the default position)**

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
270 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
275 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
280 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).

285 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.

290 Configuration Variable 96-104: NMRA Reserved

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

295

Configuration Variable 107-111: NMRA Reserved
CVs107, 108: with CV8=0xEE, a 16-bit manufacturer ID is stored in these two CVs
CVx109-111: with CV7=_____, these three CVs expand the version number feature

300

Configuration Variable 112-128: Manufacturer unique

Configuration Variable 129-256: Manufacturer unique
CVs in this range are already being used by many manufacturers. Opening up this area officially is an attempt
305   to legitimize what is already being done.

Configuration Variable 257-512: 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.
310   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.

Configuration Variable 880-895   Dynamic CVs
CVs in this range are dynamic and are used for Unsolicited Decoder Initiated Transmission. Manufacturers
315   who utilize these CVs are requested to contact the NMRA DCC WG for current uniform specifications.

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
320   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.
325
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
330
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.
335
Configuration Variable 896-1024   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.

Table 3 Accessory Decoder Configuration Variables

CV Name	CV #	CV # (optional)	Required	Default Value	Read Only	Uniform Spec	Additional Comments
Accessory Decoders:							
Decoder Address LSB	1	513	M	1		Y	6 LSB of accessory decoder address
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				Manufacturer defined version info
Manufacturer ID	8	520	M		Y	Y	Values assigned by NMRA
Decoder Address MSB	9	521	M	0		Y	3 MSB of accessory decoder address
	10-27		-				Reserved by NMRA for future use
Bi-Directional Communication Configuration	28	540	O			Y	
Accessory Decoder Configuration	29	541	M[1]			Y	similar to CV#29; for acc. decoders
	30		-				Reserved by NMRA for future use
Indexed Area Pointers	31, 32						Index High and Low Address
Manufacturer Unique	33-81		O				Reserved for manufacturer use
	82-111						Reserved by NMRA for future use
Manufacturer Unique	112-128		O				Reserved for manufacturer use
Manufacturer Unique	129-256						
Indexed Area	257-512						Indexed area - see CV# 31,32 Index address values of 0-4095 reserved by NMRA
Manufacturer Unique	513-895		O				Reserved for manufacturer use
	896-1024						Reserved by NMRA for future use

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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
345   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.

350   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
355   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
360   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).

365   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

370   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).

375   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 2 [514]   Auxiliary Activation
    Bits 1-8 = Auxiliary activation: = "0" output is not activated by an auxiliary input, "1" output can be activated
380   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.
385   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.
390
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)
395   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
400   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.
405
    (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].
410
Configuration Variable 28 [540]   Bi-Directional Communication Configuration
    Used to configure decoder's Bi-Directional communication characteristics. when CV29 [541]-Bit 3 is set
    Bit 0 = Enable/Disable Unsolicited Decoder Initiated Transmission
        "0" = Disabled; "1" = Enabled
415   Bit 1 = Not Used
    Bits 2-5 = Reserved for future use.
    Bits 6-7 = Flag Bits, 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
420   set improperly (i.e. the bit should always contain its default value).

Configuration Variable 29 [541]   Accessory Decoder Configurations Supported
    Bits 0-2 = Reserved for future use.
    Bit 3 = Bi-Directional Communications: "0" = Bi-Directional Communications disabled, "1" = Bi-Directional
425   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

430 Bit 7 = Accessory Decoder: = "0" Multifunction Decoder (See 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 only**. Using this feature CV513 becomes CV1, etc. Decoders which perform the translation must clearly document the feature in their manual.

435 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

440

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 445 contain any value. This gives a total of 61,440 indexed pages, each with 256 bytes of CV data available to manufacturers.

450 ## Appendix A: Manufacturer ID codes as assigned by the NMRA

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

455

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

The following Power Source Conversion codes have been assigned by the NMRA Technical Department.
460 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
00000010 = Radio
465 00000100 = Zero-1
00001000 = TRIX
00010000 = CTC 16 / Railcommand
00100000 = FMZ (Fleischmann)

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

475 [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.]