Configuration Variables For Digital Command Control, All Scales

Approved, July 2003 | RP 9.2.2

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This Recommended Practice 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 very extended periods of time. While all *Digital Decoders* need not implement all of these variables, it is required that if the applicable function is provided, that these variable assignments are adhered to.

General Definitions

Table 1 identifies 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. CVs 1-512 are for Multi-Function Digital Decoders, while CVs starting at 513 are for Accessory Decoders. In Table 1 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 Recommended Practice, 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 it's designated purpose, but the action taken by the decoder for a specific value can vary from manufacturer to manufacturer.

- 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.

Table 1a 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					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 Fnc. Status F_L,F9-F12	14	O			Y		
	15-16						Reserved by NMRA for future use
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		
Decoder Sub-Address	31	O			Y		Under re-evaluation – see details
Decoder Sub-Address Flags	32	O			Y		Under re-evaluation – see details
Output Loc. FL(f), FL(r), F1-F12	33-46	O			Y		
	47-48						Reserved by NMRA for future use
Manufacturer Unique	49-64	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
Manufacturer Unique	112-128	O					Reserved for manufacturer use
	129-879	-					Reserved by NMRA for future use
	880-891					Y	Reserved by NMRA for future use
Decoder Load	892	0			Y	Y	
Dynamic Flags	893	0			Y	Y	
Fuel/Coal	894	0			Y	Y	
Water	895	0			Y	Y	
SUSI Sound and Function Modules	896-1024	0			Y		See TN-9.2.3

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

Table 1b Configuration Variables

CV Name	CV #	Required	Default Value	Read Only	Uniform Spec	Additional Comments
Accessory Decoders:						
	1-512					Reserved by NMRA for future use
Decoder Address LSB	513	M	1		Y	6 LSB of accessory decoder address
Auxiliary Activation	514	O				Auxiliary activation of outputs
Time On F1	515	O				
Time On F2	516	O				
Time On F3	517	O				
Time On F4	518	O				
Manufacturer Version Info	519	M				Manufacturer defined version info
Manufacturer ID	520	M		Y	Y	Values assigned by NMRA
Decoder Address MSB	521	M	0		Y	3 MSB of accessory decoder address
	522-539	-				Reserved by NMRA for future use
Bi-Directional Communication Configuration	540	O			Y	
Accessory Decoder Configuration	541	M[1]			Y	similar to CV#29; for acc. decoders
	542-544	-				Reserved by NMRA for future use
Manufacturer Unique	545-593	O				Reserved for manufacturer use
	594-623					Reserved by NMRA for future use
Manufacturer Unique	624-640	O				Reserved for manufacturer use
	641-1024	-				Reserved by NMRA for future use

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 effect the Digital Decoder's ability to respond to service mode packets (see RP 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 contents 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 Recommended Practice. The use of a value not assigned by the NMRA shall immediately cause the decoder to not be in conformance to this RP. 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 addressed to it. See RP 9.2.4 Section C for further information.

Configuration Variable 12 Power Source Conversion[2]

Contains the identity of the alternate power source to be converted to 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 Recommended Practice.

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 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 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. 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 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 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

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

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) which will define where the mid range decoder speed value will be applied. 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" shall indicate that this CV is not used in the calculation of the speed table.

CVs 27-28 are under re-evaluation by the NMRA DCC Working Group. Manufacturers should contact the NMRA DCC Coordinator before implementing these CVs.

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.

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

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

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).

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
"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

*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).

Configuration Variable 29 Configurations Supported

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 RP-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 RP-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 RP-9.3.2 for more information.

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 RP 9.2.1 for more information.

Bit 6 = Reserved for future use

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 it's 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.

> CVs 31-32 are under re-evaluation by the NMRA DCC Working Group. Manufacturers should contact the NMRA DCC Coordinator before implementing these CVs.

Configuration Variable 31 Decoder Sub-Address

Used to differentiate multiple decoders in the same locomotive. If multiple decoders are installed in the same device each should be assigned a unique sub address.

Bits-0-3 Contain the Decoder's sub address. If CV31 = 0 then the decoder has no sub-address

Configuration Variable 32 Decoder Sub-Address Flags

Bit 0 = Designated decoder which responds with Bi-Directional information in accordance to RP-9.3.2
"0" = Disabled "1" = Enabled

Bit 1 = Designated decoder for which Configuration Variable Access Instruction - Long Form are acted upon.
"0" = Disabled "1" = Enabled

Bits 2-7 = 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).

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 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													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													

Table 1: Output Position vs. CV (a 'd' indicates the default position)

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 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 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 Variable 892 Decoder Load

Specifies the current load that the decoder is operating under. 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 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.

Descriptions of Configuration Variables for Accessory Decoders

Configuration Variable 513 Decoder Address (LSB)

Contains the low-order address bits for Accessory Decoders. The high-order address bits are stored in CV521. 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 CV541, bit 6. Decoders using either type of addressing will respond to the same Accessory Decoder Control Packet when CV513 = 1 and CV521 = 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 RP-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 CV513 and CV521 correspond to the bits in the Accessory Decoder packets as follows:

Accessory-Output = (CV513+(CV521*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 CV521 contain the ones-complement of bits 4-6 of both Accessory Decoder Control Packets (See RP-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 CV513 will be the first output in the series

Configuration Variable 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 515-518 Time On for Functions F1-F4

Functions F1-F4 can have the time the outputs are active set by configuration variables #515-#518. Configuration Variable #515 controls Function F1, and Configuration Variable #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 519 Manufacturer Version Number

See CV #7 for the description.

Configuration Variable 520 Manufacturer ID (See Appendix A for a list of Manufacturer IDs)

See CV #8 for the description.

Configuration Variable 521 Decoder Address (MSB)

Contains the high-order address bits for Accessory Decoders. The low-order address bits are stored in CV513. 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 CV541, bit 6. Decoders using either type of addressing will respond to the same Accessory Decoder Control Packet when CV513 = 1 and CV521 = 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 RP-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 for an explanation of how to determine the contents of CV513 and CV521.

Configuration Variable 540 Bi-Directional Communication Configuration
Used to Configure decoder's Bi-Directional communication characteristics. when CV541-Bit 3 is set
Bit 0 = Enable/Disable Unsolicited Decoder Initiated Transmission
"0" = Disabled "1" = Enabled
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 set improperly (i.e. the bit should always contain it's default value).

Configuration Variable 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 Communications enabled. See RP-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: = "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.
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 it's default value).

Appendix A: Manufacturer ID codes as assigned by the NMRA

The following Manufacturer ID codes have been assigned by the NMRA Technical Department. Manufacturers not on this list shall apply to the NMRA Technical Department for the assignment of a unique manufacturer ID. Inactive ID codes have been removed from this list as of 1-Dec-2001, pending reassignment. A column with the ISO 2-Letter Country Code for each manufacturer has been added..

Manufacturer	Binary	Hex	Decimal	Country
Arnold – Rivarossi	10101101	0xAD	173	DE
Atlas Model Railroad Products	01111111	0x7F	127	US
AuroTrains	10101010	0xAA	170	US/IT
CML Electronics Limited	00000001	0x01	1	UK
Computer Dialysis France	01101001	0x69	105	FR
cT Elektronik	01110101	0x75	117	AT
CVP Products	10000111	0x87	135	US
Dietz Modellbahntechnik	01110011	0x73	115	DE
Digitrax	10000001	0x81	129	US
Doehler & Haas	01100001	0x61	97	DE
Electronic Solutions Ulm GmbH	10010111	0x97	151	DE
Gebr. Fleischmann GmbH & Co.	10011011	0x9B	155	DE
Haber & Koenig Electronics GmbH (HKE)	01101111	0x6F	111	AT
Intelligent Command Control	10000101	0x85	133	US
Kuehn Ing.	10011101	0x9D	157	DE
Lenz Elektronik GmbH	01100011	0x63	99	DE
LGB (Ernst Paul Lehmann Patentwerk)	10011111	0x9F	159	DE
Manufacturer To be Named Jun-2003	01100101	0x65	101	US
Massoth Elektronik, GmbH	01111011	0x7B	123	DE
Model Rectifier Corp.	10001111	0x8F	143	US
Nagasue System Design Office	01100111	0x67	103	JP
NCE Corporation (formerly North Coast Engineering)	00001011	0x0B	11	US
ProfiLok Modellbahntechnik GmbH	01111101	0x7D	125	DE
PSI –Dynatrol	00001110	0x0E	14	US
Public Domain & Do-It-Yourself Decoders	00001101	0x0D	13	-
QS Industries (QSI)	01110001	0x71	113	US
Ramfixx Technologies (Wangrow)	00001111	0x0F	15	CA/US
RealRail Effects	10001011	0x8B	139	US
Rock Junction Controls	10010101	0x95	149	US
Roco Modellspielwaren	10100001	0xA1	161	AT
Throttle-Up (Soundtraxx)	10001101	0x8D	141	US
Train Control Systems	10011001	0x99	153	US
Trix Modelleisenbahn	10000011	0x83	131	DE
Uhlenbrock GmbH	01010101	0x55	85	DE
Umelec Ing. Buero	10010011	0x93	147	CH
Viessmann Modellspielwaren GmbH	01101101	0x6D	109	DE
W. S. Ataras Engineering	01110111	0x77	119	US
Wangrow Electronics	00001100	0x0C	12	US
WP Railshops	10100011	0xA3	163	CA
Zimo Elektronik	10010001	0x91	145	AT
ZTC	10000100	0x84	132	UK

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. 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
00000100 = Zero-1
00001000 = TRIX
00010000 = CTC 16 / Railcommand
00100000 = FMZ (Fleischmann)