Technical Reference

for the

POWER PRO™
Digital Command Control

D408SR Decoder

Dimensions:
1.2 x 2.30 x ..375 inches
31 x 59 x 9.5 mm

Decoder version 3.2

$89.95

This is decoder is rated at 4 Amps

This is an EPF (extended packet format) decoder supporting:

- Silent Running ™ High frequency motor drive eliminates motor hum or buzz
- Programmable Start, Mid and Maximum speed works for all speed modes
- Motor rating 4 Amp continuous, 10 Amp peak (stall)
- All seven function outputs have effects generators
- Preprogrammed for 14 different lighting effects (Mars, strobes, beacons, etc)
- Function outputs can be mapped to different functions (highly compatible with Soundtraxx™ DSX decoders)
- Two or Four digit addressing
- Uploadable speed table interpolated to 128 speed steps
- 28 and 128 Speed mode operation (always works internally at 256 steps)
- Decoder assisted consisting
- All forms of operations mode programming (programming on the mainline)
- All forms of service mode programming (programming track)

This decoder is not warranted for use in USA Trains or Charles Ro
G Gauge locomotives

Every attempt has been made to ensure this decoder complies with all applicable NMRA Standards and Recommended Practices. NMRA Conformance test results on this decoder are available on our website at www.ncedcc.com

Configuration Variables used by D408-SR Decoders

CV1 short decoder address; 1-127 valid
CV2 Start Voltage (useful range 0-100)
CV3 acceleration rate (each unit = 7mS between speed steps) 255 max.
CV4 deceleration rate (each unit = 7mS between speed steps) 255 max.
CV5 Vmax, speed at highest speed step. 0=use factory default of 255
CV6 Vmid, speed (on a scale of 1-255) at speed step 7,14,or 63. 0=use default of 128
CV7 Manufactuer ID. NCE = 11 (0B hex)
CV8 Decoder version number. This decoder is 32 which means version 3.2
CV9 Motor drive frequency
- 1-255 = PWM drive frequency period in 128uS increments,
- 0 = PWM frequency is 15,625 Hz

CV17 High byte of long (4 digit) address
- bit 6,7 always= 1
- bits 0-5 are upper 6 bits of address

CV18 low byte of long (4 digit) address
CV19 Consist address. (0 or 128 = no consist active)
- bits 0-6 short consist address (1-127 valid)
- bit 7 0= direction is normal, 1= direction is reversed

CV21 Functions active in consist mode. Bits 0-7 control F1-F8 respectively
- each bit 1=function can be controlled at consist address, 0 = no consist control

CV22 Functions active in consist mode. Bits 0,1 control FLF and FLR respectively
- each bit 1=function can be controlled at consist address, 0 = no consist control

CV23 acceleration rate adjust (in 7mS increments) this value is added to CV3
CV24 deceleration rate adjust (in 7mS increments) this value is added to CV4
CV29 - bit 0 1= direction of operation is reversed, 0= direction is normal
- bit 2 1= analog operation mode enabled, 0 = disabled
- bit 4 1= alternate speed table active, 0= use table defined by CV2,5,6
- bit 5 1= use long address in CV17/18, 0= use short address CV1
- bits 1,3,6,7 are ignored by the decoder

CV33-CV42 function mapping CVs for F0-F8
CV65 Kick start - number of 1/1000s of a second to 'kick' motor when starting
CV67-CV94 Uploadable speed table steps 1-28 (128 speed mode calculates intermediate steps)
CV118 Ditch light hold time (in ¼ second increments) after F2 goes off.
CV119 Lighting effects page. Must be set to 255 for access to CVs120-127
CV120-CV123 Effects configuration registers for outputs 1-8

CV NOTES: All CV numbers not listed above are ignored.

14 Speed mode is scheduled to be dropped as a requirement by the NMRA. This decoder does not support headlight control in 14 speed mode. It *will* operate the motor and F1-F8 correctly with all systems however the headlight may not operate correctly with older systems.

Kick Start
This CV is used to overcome 'stiction' in the motor by providing a starting kick. The values in the CV range from 0 (off) to 255 (0.61 seconds). Before adjusting this CV make sure you have CV2 (start voltage) set for reliable operation at speed step 1.

PROGRAMMING TRACK INFORMATION: This decoder complies with NMRA RP-9.2.3 for all forms of paged, direct (bit and byte) and register mode programming.

Tip for using consists and long (4 digit) addresses: leave CV1 set to 3, or some other conveniently remembered address and only use the extended address (CV17, CV18) set to your desired value. This avoids mixing up normal 'short' addresses with consist addresses.

Warranty
This decoder is fully factory tested and warranted against manufacturing defects for a period of 1 year. As the circumstances under which this decoder is installed can not be controlled, failure of the decoder due to installation problems can not be warranted. This includes misuse, miswiring, operation under loads beyond the design range of the decoder or short ciruits in the locomotive manufacturer's factory wiring. If the decoder fails for non-warranted reasons NCE will replace this decoder, no questions asked, for $25 U.S. plus $2 shipping. For warranty or non-warranty replacement send the decoder (an any payment, if required) to:

NCE Warranty Center **899 Ridge Road** **Webster, New York 14580**

Factory default values for decoder Configuration Variables (Cvs)

CV	Default value		Description
	decimal	hex	
1	**3**	03	short address
2	**0**	00	start voltage
3	**0**	00	acceleration
4	**0**	00	deceleration
5	**0**	00	Maximum speed
6	**0**	00	Mid speed
9	**0**	00	PWM frequency
17	**192**	C0	long address high byte
18	**0**	00	long address low byte
19	**0**	00	consist address
21	**255**	FF	consist functions F1-F8
22	**63**	3F	consist function FLF,FLR
23	**0**	00	consist accel trim
24	**0**	00	consist decel trim
29	**2**	02	decoder configuration
30	**0**	00	reset/error register
33	**1**	01	Outputs controlled by F0F
34	**64**	40	Outputs controlled by F0R
35	**2**	02	Outputs controlled by F1
36	**4**	04	Outputs controlled by F2
37	**8**	08	Outputs controlled by F3
38	**2**	02	Outputs controlled by F4
39	**4**	04	Outputs controlled by F5
40	**0**	00	Outputs controlled by F6
41	**0**	00	Outputs controlled by F7
42	**0**	00	Outputs controlled by F8
43	**0**	00	Outputs controlled by F9
44	**0**	00	Outputs controlled by F10
45	**0**	00	Outputs controlled by F11
46	**0**	00	Outputs controlled by F12
65	**0**	00	Kick start
67	**2**	02	alt spd table step 1
68	**5**	05	alt spd table step 2
69	**7**	07	alt spd table step 3

CV	Default value		Description
	decimal	hex	
70	**12**	0C	alt spd table step 4
71	**16**	10	alt spd table step 5
72	**21**	15	alt spd table step 6
73	**26**	1A	alt spd table step 7
74	**30**	1E	alt spd table step 8
75	**35**	23	alt spd table step 9
76	**40**	28	alt spd table step 10
77	**47**	2F	alt spd table step 11
78	**51**	33	alt spd table step 12
79	**58**	3B	alt spd table step 13
80	**65**	41	alt spd table step 14
81	**72**	48	alt spd table step 15
82	**79**	1F	alt spd table step 16
83	**84**	54	alt spd table step 17
84	**93**	5D	alt spd table step 18
85	**100**	64	alt spd table step 19
86	**112**	70	alt spd table step 20
87	**121**	79	alt spd table step 21
88	**135**	87	alt spd table step 22
89	**147**	93	alt spd table step 23
90	**161**	A1	alt spd table step 24
91	**177**	B1	alt spd table step 25
92	**196**	C4	alt spd table step 26
93	**219**	DB	alt spd table step 27
94	**255**	FF	alt spd table step 28
118	**1**	01	Ditch light hold time
119	**255**	FF	EFX page access
120	**1**	01	Output 1 EFX generator
121	**0**	00	Output 2 EFX generator
122	**0**	00	Output 3 EFX generator
123	**0**	00	Output 4 EFX generator
124	**0**	00	Output 5 EFX generator
125	**0**	00	Output 6 EFX generator
126	**2**	02	Output 7 EFX generator

About the function outputs:

The rsting of each function output on this decoder is 80mA continuous (500mA peak if less than 20mS). The <u>total</u> allowable current that can be drawn by all functions is 600mA.
We recommend Miniatronics part number 18-014-10 (2.4mm diameter 14 volt/30mA) or number 18-016-10 (2.4mm diameter 16 volt/30mA) bulbs for good results. If you wish to use 50-80mA rated lamps we suggest using a 22 ohm 1 Watt resistor in series with each bulb to greatly extend bulb life, especially if any lighting effects are used.

Recommend dropping resistors if using 1.5 volt bulbs

	Track Voltage								
Bulb Current	14.5	15	15.5	16	16.5	17	17.5	18	Wattage
15ma	680	750	750	820	820	910	910	910	¼ watt
30ma	360	390	390	390	430	430	470	470	½ watt
40ma	270	270	300	300	330	330	360	360	1 watt
50ma	220	220	240	240	240	270	270	270	1 watt
60ma	180	180	200	200	220	220	220	240	1 watt
80ma	130	150	150	150	160	160	180	180	2 watt

Description of EFX configuration Cvs

CV120 - Lighting effect configuration for output 1 (white wire).
CV121 - Lighting effect configuration for output 2 (green wire).
CV122 - Lighting effect configuration for output 3 (violet wire).
CV123 - Lighting effect configuration for output 4 (brown wire).
CV124 - Lighting effect configuration for output 5 (white/yellow wire).
CV125 - Lighting effect configuration for output 6 (white/green wire).
CV126 - Lighting effect configuration for output 7 (yellow wire).

Each output wire can select from 15 different lighting effects by using its associated EFX configuration CV. Pick the value for the CV from the table below, add 1 or 2 if you want the effect to be directional (footnotes 2 and 3), then add 128 if you are using a white LED for the effect. Ditch lights should not be made directional, they're not dierectional in real life.

bit weight	128	64	32	16	8	4	2	1
bit name	LED[1]	---	Effect configuration				REV[2]	FWD[3]

Value for CV	Description of lighting effect	Hex for Digitrax
0	Standard on/off function output	0
4	reserved	4
8	Mars light	8
12	Rotary Beacon	0C
16	Gyralight	10
20	Strobe A	14
24	Strobe B (alternates with Strobe A)	18
28	Double Strobe	1C
32	Dim when F0 and F4 on, otherwise bright	20
36	Dim when F0 and F8 on, otherwise bright	24
40	Dim in forward, bright in reverse	28
44	Dim in reverse, bright in forward	2C
48	Type 2 Right Ditch light, effect on if F2 on, output off otherwise	30
52	Type 2 Left Ditch light, effect on if F2 on, output off otherwise	34
56	Type 1 Right Ditch light, effect on if F0 *and* F2 on, bright if F0 on *and* F2 off, off if F0 off	38
60	Type 1 Left Ditch light, effect if F2 *and* F0 on, bright if F0 on *and* F2 off, off if F0 off	3C

1 - Functions are designed to use 12-16 volt 30-40ma incandescent lamps. If you are using a white LED (with 1K limiting resistor) add 128 to the CV value.
2 - If you want the function to be active only in the reverse direction add 2 to the CV value
3 - If you want the function to be active only in the forward direction add 1 to the CV value

Description of function mapping CVs:

Function mapping can change which output wire(s) are controlled by a function command from your handheld cab. It is possible to have one command control several outputs. In the tables below each row corresponds to a function mapping CV and each column indicates an output number. A '1' under an output number means that output will be controlled by the function corrsponding to the row. In the table below the factory value of CV33 is 1 which means F0 will control Output #1.

Example: Say you have output 4 set to be a Mars Light (CV123=8) and you want it to come on when the headlight (F0) is on. In the CV33 row place a '1' in Output 4 column, there is already a '1' in the Output 1 column. Now F0 will control both Output 1 and Output 4. To calculate the value that goes in to CV33 just add up the 'bit weights' for each column that has a '1' in it. In the case of our example the value will be 9. F3 has been set at the factory to control Output 4 so you may want to put 00 in to CV37 to make sure Output 4 (Mars light) doesn't come on by accident if F3 is activated.
There are more examples of function mapping on page 7.

The tables below show the original factory settings for each mapping CV. The NMRA recommended practices do not provide for mapping all functions to all outputs. The tables below are the prescribed function mapping dictated by NMRA RP-9.2.2. Note: In this decoder CV33 and CV34 operate identically. They are not directional...directionality is provided in the EFX configuration CV for each output.

Factory default function mapping values

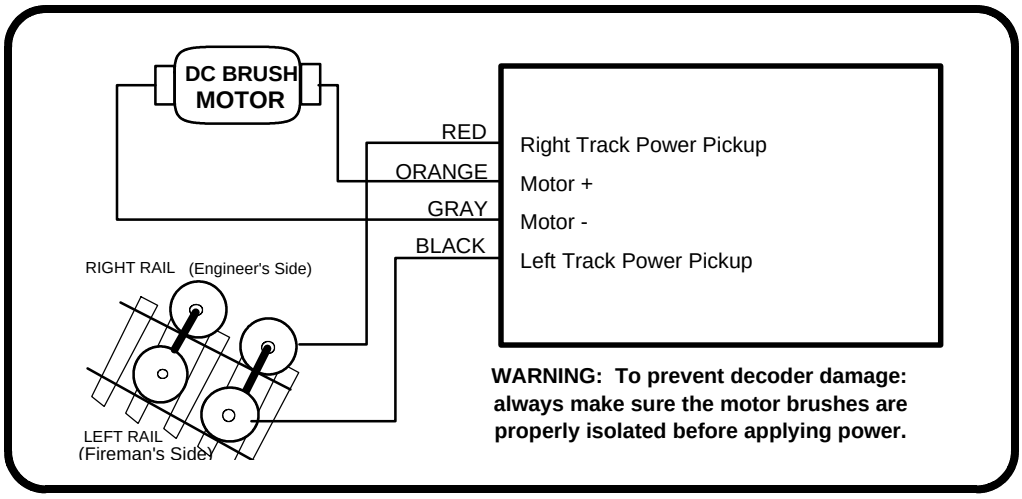
	OUTPUT NUMBER							
	--	**7**	**6**	**5**	**4**	**3**	**2**	**1**
Bit weight CV33-CV38	128	64	32	16	8	4	2	1
CV33 F0 Fwd	0	0	0	0	0	0	0	**1**
CV34 F0 Rev	0	**1**	0	0	0	0	0	0
CV35 F1	0	0	0	0	0	0	**1**	0
CV36 F2	0	0	0	0	0	**1**	0	0
CV37 F3	0	0	0	0	**1**	0	0	0

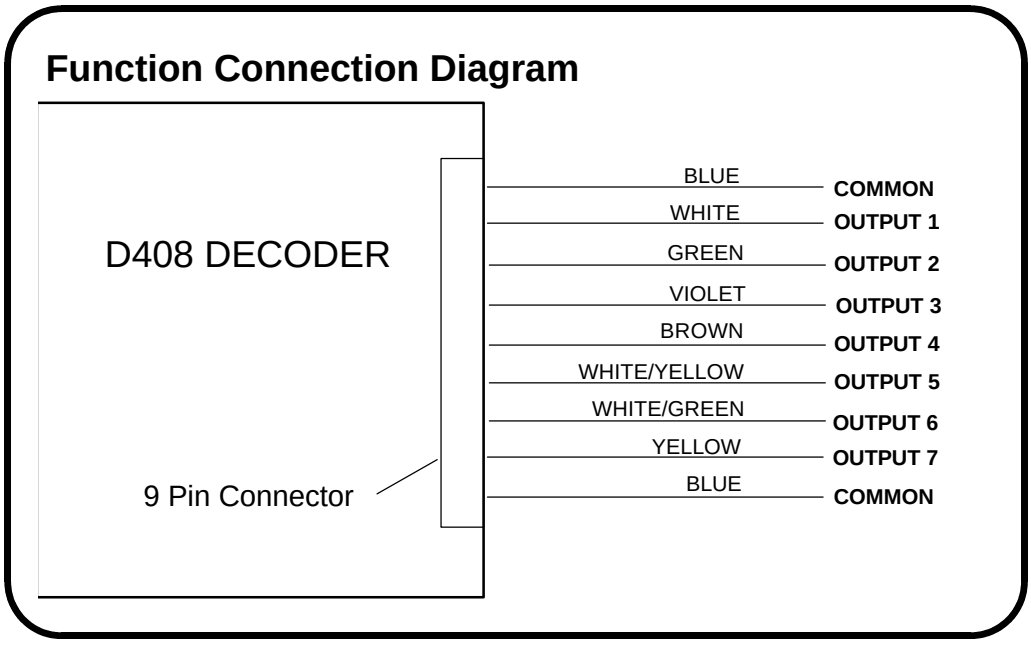
Bit weight CV39-CV41	16	8	4	2	1	These outputs not available to CV38-40		
CV38 F4	0	0	0	**1**	0			
CV39 F5	0	0	**1**	0	0			
CV40 F6	0	0	0	0	0			

Bit weight CV42-CV46	2	1	These outputs not available to CV41-CV46					
CV41 F7	0	0						
CV42 F8	0	0						
CV43 F9	0	0						
CV44 F10	0	0						
CV45 F11	0	0						
CV46 F12	0	0						

Factory function-to-output assignments

Function	Assigned to	Output #	Wire Color	Mapping CV#	Value in CV
Headlight	------	1	White	33	1
F1	------	2	Green	35	2
F2	------	3	Violet	36	4
F3	------	4	Brown	37	8
F4	------	5	Wht/Yel	38	2
F5	------	6	Wht/Grn	39	4
Rearlight	------	7	Yellow	34	64





Function mapping and effects programming examples

Ditch lights:
What we want to do:
- Use outputs 3 and 4 (violet and brown wires) for the left and right ditch lights
- They will be controlled by F2 which is the HORN button on most DCC systems
- They should continue flashing for 5 seconds after the HORN button is released

How to do it:
- ➞ Program outputs 3 and 4 to both be activated by F2. Set the F2 mapping CV (CV36) to 12 (0C hex). We get the value of 12 by adding the 'bit weights' for output 3 and output 4 on the F2 line of the **CV mapping table** on page 5.
- ➞ Program outputs 3 and 4 for ditch light operation. Set CV123 to 56 and CV122 to 60. Using these values the lights will be 'qualified' by the headlight AND function 2. The headlight must be on for the ditch lights to be activated by F2. Type 1 ditch lights are on constantly on when the headlight is on and alternately flash when the horn is blown. Type 2 ditch lights are normally off until the horn is blown. This example is for the more common Type 1. If you prefer Type 2 use EFX values 52 and 48 instead of 60 and 56.
- ➞ CV118 sets the amount of time the ditch lights stay flashing after the horn (F2) is deactivated. The time is measured in 1/4 second intervals, for a hold time of 5 seconds put a value of 20 in the CV118.
- ➞ One last thing: Set CV35 to 0 so output 4 is not also controlled by F3.

Mars Light:
What we want to do:
- Use output 2 (green wire) for the Mars light.
- It is to be on in the forward direction only

How to do it:
- ➞ Output 2 is already activated by F1 (factory default setting of CV35=2).
- ➞ Configure output 2 as a forward only Mars light. Set CV121 to 9. We get the value of 9 by using 8 (Mars Light) plus 1 (output operates only in forward direction)

Rule 17 lighting:
What we want to do:
- Use output 1 (white wire) for the Headlight
- Headlight is to be on bright in both directions of travel
- We also want to dim the headlight

How to do it:
- ➞ Output 1 is already activated by F0 (factory default setting of CV33 =1).
- ➞ Configure output 1 as a standard output, on in both directions, yet dimmable when F4 is activated. Set CV120 to 32 (20 hex). You can optionally set CV120 to 36 is you want F8 to control the dimming instead of F4.

Switcher:
What we want:
- Headlights that dim in the opposite direction that the locomotive is travelling
- Use output 1 (white wire) as Headlight and 7 (yellow wire) as Rearlight

How to do it:
- ➞ Output 1 and 7 are already activated by F0 due to the factory default settings.
- ➞ Configure output 1 as bright in forward dim in reverse . Set CV120 to 40 (28 hex)
- ➞ Configure output 1 as bright in reverse dim in forward . Set CV126 to 44 (2C hex)

Fine tuning locomotive operation

The factory settings of the D408SR normally provide good performance for most locomotives in O-Scale or G Gauge. You may want to improve or fine tune performance by adjust the starting characteristics or top speed .

There are four CVs that define:

- The voltage at which the motor starts
- How much 'kick' the motor gets to start it turning
- The maximum speed
- The response characteristics or 'speed curve'.

Start Voltage - CV2 (Vstart):

Before programming the start voltage we recommend programming CV65 (Kick Start) to zero. Kick start is used to overcome the 'stiction' of the motor by giving it a voltage 'kick' when starting from a stop. We don't want it getting in the way of setting Vstart.

We prefer using Operations Mode Programming (Program on the Main) to set CV2 so the locomotive is **just able to maintain movement** at speed step 1. You can also use the programming track... it just takes a bit longer to find the right setting for CV2.

Kick Start - CV65

After the start voltage is set . Program CV65 to provide a smooth and reliable start when you advance the throttle from stop. The high frequency drive pulses of the D408SR act more like smooth DC voltage than the low frequency pulses of a standard decoder making it harder for the decoder to overcome that starting 'stiction' of the motor. This is why the Kick start CV is needed. If the value is too low the motor will not start moving reliably, too high and the locomotive will lurch or leap as it starts.

Vmax - CV5:

If your locomotive runs too fast you can use CV5 to lower its maximum speed. Setting CV5 to 255 uses the maximum possible voltage to run the motor when full speed is requested. If you set CV5 to a smaller value you can reduce the top speed. A value of 128 will yield approximately ½ full voltage to the motor at top speed. 192 will provide about ¾ full voltage. All speeds from the middle speed step to the maximum will be proportionally reduced (see diagram below). If CV5 is set to 0 the decoder will use 255 for maximum speed.

Vmid - CV6:

CV6 determines how the motor responds through its middle speed ranges to advancement of the throttle. If you set CV6 lower than half the maximum speed you'll have smaller increases in motor speed through the lower speed ranges. Then, as you hit the upper speed ranges there will be larger increases between speed steps. In the diagram below you can see this best illustrated by the factory default line. If you set Vstart larger than 0 you'll will most likely want to raise Vmid so a reasonable slope is maintained in the 'speed curve'. If CV6 is set to 0 the decoder will use 70 as the value.

Motor Drive Frequency - CV9:

When CV9 is set to 0 the Silent Running™ motor drive frequency of 15,625 Hz is used. If a value of 1-255 is programmed into CV9 the motor drive frequency will be calculated by the formula: Frequency = 1/(CV9 * .000128).