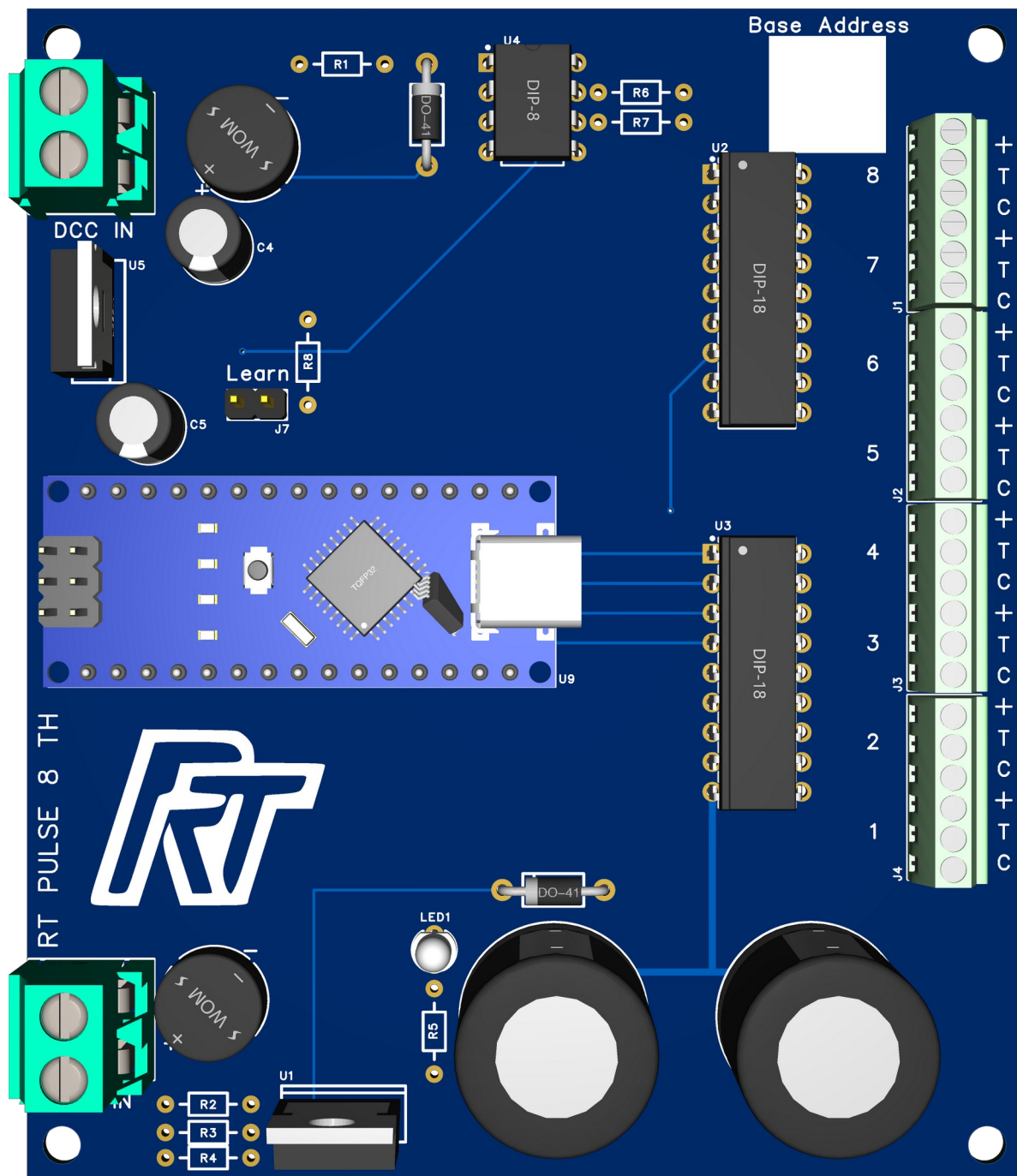# Model Railroad DCC coloured light signal decoder.



This is board is a DCC accessory decoder.

This document describes the operation of this board with the RT Signal Decoder software.

## In use.

Using this firmware on github:

https://github.com/Rosscoetrain/RT-Signal-Decoder-Direct

The board will control 2, 3 or 4 aspect coloured light signals.

This decoder incorporates a capacitor discharge unit (CDU).  When used with incandescent globes the CDU needs to be disabled.  This will be described later and depends on the version of the PCB.

The firmware currently needs to be uploaded twice to the Arduino Nano to ensure the eeprom on the board is setup correctly.

Please read the instructions in the defines.h file.

Open the firmware in the Arduino IDE.

Un-comment the line in the defines.h file as described there. (Line 5 – 7)

Upload the firmware to the Arduino Nano.

On the serial monitor you should see: 11:48:31.374 -> Resetting CVs to Factory Defaults

Comment out the line in the defines.h file as described there. (Line 5-7)

Upload the firmware again to the Arduino Nano.

Using the serial monitor enter the following command.

<>

You will then see a response like this:

17:40:32.025 -> CVs are:
17:40:32.025 -> CV1 = 1
17:40:32.025 -> CV8 = 13
17:40:32.025 -> CV9 = 0
17:40:32.025 -> CV33 = 0
...

All is now ready.

All instructions are to do with 2 aspect signals initially for simplicity.

3 and 4 aspect signals will be discussed later in this document.

## Connection to the layout.

How you connect to your layout is really dependent on your setup.

This is a how to connect to a DCC-EX command station with separate power supply for the CDU.

The DCC track is connected to the DCC Input connector on the decoder.

The power supply can be 12 - 24V DC or 12 - 20V AC and is connected to the PWR IN connector on the decoder.

## Connecting Signals.

Either led signals or incandescent globe signals can be used. The leds will need limiting resistors.

Incandescent globes can be connected in either way.  Although most have a common wire and two or more control wires.  The common wire is always connected to +.

**2 aspect coloured light signals.**

These will be green/red signals.

When using LEDs the anodes are common and connected to the + terminal for the output address.

The green cathode is connected to the C terminal and the red cathode is connected to the T terminal.

The DCC addresses for these will be the base address and the next 8 addresses.

**3 aspect coloured light signals.**

These will be green/red/amber signals.

The connection for these is the same as 2 aspect for green and red.  Amber cathode is connected to the next C terminal and the anode is connected to the + terminal.

So if you have 1C connected to green and 1T connected to red then amber is connected to 2C.  You then need to program the applicable CV for three aspect operation (see below).

The DCC addresses for these will be the base address and the next 4 addresses.

**4 aspect coloured light signals.**

These again will connect as for 2 aspect for green and red.  Aspect 3 and aspect 4 are connected to the next two C and T terminals respectively.

So if 1C is connected to green and 1T connected to red then aspect 3 is connected to 2C and aspect 4 is connected to 2T.  You then need to program the applicable CV for four aspect operation (see below).

The DCC addresses for these will be the base address and the next 4 addresses.

## CV setup

| Function | Output address | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Output Pin 1 | 34 | 44 | 54 | 64 | 74 | 84 | 94 | 104 |
| Output Pin 2 | 35 | 45 | 55 | 65 | 75 | 85 | 95 | 105 |
| Output Pin 3 | 36 | 46 | 56 | 66 | 76 | 86 | 96 | 106 |
| Output Pin 4 | 37 | 47 | 57 | 67 | 77 | 87 | 97 | 107 |
| On Time | 38 | 48 | 58 | 68 | 78 | 88 | 98 | 108 |
| On Time Multiplier | 39 | 49 | 59 | 69 | 79 | 89 | 99 | 109 |
| Off Time | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 |
| Off Time Multiplier | 41 | 51 | 61 | 71 | 81 | 91 | 101 | 111 |
| Fade In | 42 | 52 | 62 | 72 | 82 | 92 | 102 | 112 |
| Fade Out | 43 | 53 | 63 | 73 | 83 | 93 | 103 | 113 |

**Output Pin 1 - 4:** These are the output pins controlled by the DCC address. For a 2 aspect signal 1 and 2 are used. Three aspect signal 1, 2 and 3 are used. Four aspect signal 1, 2, 3 and 4 are used.

**On Time/Off Time:** Are the on and off times respectively for flashing aspects in milliseconds / 10.

**On Time Multiplier/Off Time Multiplier:** Are multipliers for the On Time/Off Time respectively. This allows on/off times up to 650250 milliseconds (650 seconds).

**Fade In/Fade Out:** The time it takes for fade in/out on fading aspects in milliseconds.

## CV Defaults

| CV | Value | CV | Value | CV | Value | CV | Value | CV | Value | CV | Value | CV | Value | CV | Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | 4 | 44 | 6 | 54 | 8 | 64 | 10 | 74 | 12 | 84 | 13 | 94 | 16 | 104 | 19 |
| 35 | 3 | 45 | 5 | 55 | 7 | 65 | 9 | 75 | 11 | 85 | 14 | 95 | 17 | 105 | 18 |
| 36 | 0 | 46 | 0 | 56 | 0 | 66 | 0 | 76 | 0 | 86 | 0 | 96 | 0 | 106 | 0 |
| 37 | 0 | 47 | 0 | 57 | 0 | 67 | 0 | 77 | 0 | 87 | 0 | 97 | 0 | 107 | 0 |
| 38 | 10 | 48 | 10 | 58 | 10 | 68 | 10 | 78 | 10 | 88 | 10 | 98 | 10 | 108 | 10 |
| 39 | 100 | 49 | 100 | 59 | 100 | 69 | 100 | 79 | 100 | 89 | 100 | 99 | 100 | 109 | 100 |
| 40 | 10 | 50 | 10 | 60 | 10 | 70 | 10 | 80 | 10 | 90 | 10 | 100 | 10 | 110 | 10 |
| 41 | 100 | 51 | 100 | 61 | 100 | 71 | 100 | 81 | 100 | 91 | 100 | 101 | 100 | 111 | 100 |
| 42 | 10 | 52 | 10 | 62 | 10 | 72 | 10 | 82 | 10 | 92 | 10 | 102 | 10 | 112 | 10 |
| 43 | 10 | 53 | 10 | 63 | 10 | 73 | 10 | 83 | 10 | 93 | 10 | 103 | 10 | 113 | 10 |

The default settings give eight 2 apsect signals with 100 millisecond on/off times (10 x 10), 100x multipliers and 10 millisecond fadein/fadeout.

## Output Pins

The output pin numbers for the CVs are based on the Arduino Nano pins.

They are:

PCB Connection

| 1T | 1C | 2T | 2C | 3T | 3C | 4T | 4C | 5T | 5C | 6T | 6C | 7T | 7C | 8T | 8C |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 4 | 3 | 6 | 5 | 8 | 7 | 10 | 9 | 12 | 11 | 13 | 14 | 16 | 17 | 19 | 18 |

Output Pin number

# Adding a signal

To add a signal it only needs to program the Output pin CVs.

This assumes that the base address is 1 and you are using DCC-EX with EX-Rail.  Other DCC command stations will have similar commands.

### 3 aspect signal

With the following connections.

Green   -       1C
Red       -       1T
Amber   -       2C

Program the CVs as below.

CV 34 =       3
CV 35 =       4
CV 36 =       5

This signal is then controlled by GREEN(1), RED(1) or AMBER(1).

The next signal will have address 3 and could be 2, 3 or 4 aspect.

### 4 aspect signal

With the following connections.

Green   -       1C
Red       -       1T
Amber   -       2C
White   -       2T

Program the CVs as below.

CV 34 =       3
CV 35 =       4
CV 36 =       5
CV 37 =       6

This signal is then controlled by GREEN(1), RED(1), AMBER(1) or ASPECT(id, 4).

The next signal will have address 3 and could be 2, 3 or 4 aspect.

## Serial Commands

Several commands are available via the Arduino serial monitor for configuring or displaying information on the decoder.

| | |
|---|---|
| <?> | Show available commands |
| <> | Show current Control Variables |
| <A address> | Change decoder base linear address |
| <W CV value> | Write a value to the CV |
| <Z> | Soft Reset |

The address is the decoder linear address to use within the DCC command station. When you set an address it will display the correct base address to use for the decoder at the serial monitor. Eg will give a base address of 1 and the signals will be assigned addresses 1 – 8.

The default address is 1, you need to change this if using more than one stationary decoder on your layout. Once the address is set, this address and the next 8 are the addresses you use to control your signals. Eg, 1-8, 5-12.

Some examples using the serial monitor are:

How you add them to your DCC Command Station will depend on the command station.

Base addresses are multiples of 4 + 1 eg, 1, 5, 9, 13, 17, …

The address can be between 1 and 2037

In all cases the 8 signals will be addressed from the base address for the next 8 address eg, base address 1, addresses are 1, 2, 3, 4, 5, 6, 7, 8. base address 5 addresses are 5, 6, 7, 8, 9, 10, 11, 12.

## Learning Mode.

To set the address on the decoder in learning mode.

Connect the decoder to your DCC track via the DCC input connector. It's best not to have any signals connected at this point.

With the power off.

Put a jumper on the Learn header next to the Arduino nano.

Turn on the power to the Arduino nano.

The LED on the nano will flash three times to show it is in learning mode.

Send a throw or close command to the base address you want for the decoder.

Base addresses are multiples of 4 + 1. eg, 1, 5, 9, 13, 17, …

The address can be between 1 and 2037.

Once the address is learnt remove the jumper from the Learn header and power off/on the decoder.

## Programming Track Setup.

The CV's can be set with the decoder connected to a programming track.

Connect the decoder DCC IN to the programming track of your command station.

How you send a write command to the decoder CV will depend on your command station.

Eg Using a DCC-EX command station connected to an Arduino IDE serial monitor send the following command to change the address:

<W 1 address>

Use the table on the following pages to determine the correct value to use for address. The value in the column CV1 is the value to use in the above command. The value in the column base address will then be the base address for the decoder.

**Address Table (CV9 = 0)**

| CV1 | Base Address | CV1 | Base Address | CV1 | Base Address | CV1 | Base Address |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 31 | 121 | 61 | 241 | 91 | 361 |
| 2 | 5 | 32 | 125 | 62 | 245 | 92 | 365 |
| 3 | 9 | 33 | 129 | 63 | 249 | 93 | 369 |
| 4 | 13 | 34 | 133 | 64 | 253 | 94 | 373 |
| 5 | 17 | 35 | 137 | 65 | 257 | 95 | 377 |
| 6 | 21 | 36 | 141 | 66 | 261 | 96 | 381 |
| 7 | 25 | 37 | 145 | 67 | 265 | 97 | 385 |
| 8 | 29 | 38 | 149 | 68 | 269 | 98 | 389 |
| 9 | 33 | 39 | 153 | 69 | 273 | 99 | 393 |
| 10 | 37 | 40 | 157 | 70 | 277 | 100 | 397 |
| 11 | 41 | 41 | 161 | 71 | 281 | 101 | 401 |
| 12 | 45 | 42 | 165 | 72 | 285 | 102 | 405 |
| 13 | 49 | 43 | 169 | 73 | 289 | 103 | 409 |
| 14 | 53 | 44 | 173 | 74 | 293 | 104 | 413 |
| 15 | 57 | 45 | 177 | 75 | 297 | 105 | 417 |
| 16 | 61 | 46 | 181 | 76 | 301 | 106 | 421 |
| 17 | 65 | 47 | 185 | 77 | 305 | 107 | 425 |
| 18 | 69 | 48 | 189 | 78 | 309 | 108 | 429 |
| 19 | 73 | 49 | 193 | 79 | 313 | 109 | 433 |
| 20 | 77 | 50 | 197 | 80 | 317 | 110 | 437 |
| 21 | 81 | 51 | 201 | 81 | 321 | 111 | 441 |
| 22 | 85 | 52 | 205 | 82 | 325 | 112 | 445 |
| 23 | 89 | 53 | 209 | 83 | 329 | 113 | 449 |
| 24 | 93 | 54 | 213 | 84 | 333 | 114 | 453 |
| 25 | 97 | 55 | 217 | 85 | 337 | 115 | 457 |
| 26 | 101 | 56 | 221 | 86 | 341 | 116 | 461 |
| 27 | 105 | 57 | 225 | 87 | 345 | 117 | 465 |
| 28 | 109 | 58 | 229 | 88 | 349 | 118 | 469 |
| 29 | 113 | 59 | 233 | 89 | 353 | 119 | 473 |
| 30 | 117 | 60 | 237 | 90 | 357 | 120 | 477 |

| CV1 | Base Address | CV1 | Base Address | CV1 | Base Address | CV1 | Base Address |
|---|---|---|---|---|---|---|---|
| 121 | 481 | 151 | 601 | 181 | 721 | 211 | 841 |
| 122 | 485 | 152 | 605 | 182 | 725 | 212 | 845 |
| 123 | 489 | 153 | 609 | 183 | 729 | 213 | 849 |
| 124 | 493 | 154 | 613 | 184 | 733 | 214 | 853 |
| 125 | 497 | 155 | 617 | 185 | 737 | 215 | 857 |
| 126 | 501 | 156 | 621 | 186 | 741 | 216 | 861 |
| 127 | 505 | 157 | 625 | 187 | 745 | 217 | 865 |
| 128 | 509 | 158 | 629 | 188 | 749 | 218 | 869 |
| 129 | 513 | 159 | 633 | 189 | 753 | 219 | 873 |
| 130 | 517 | 160 | 637 | 190 | 757 | 220 | 877 |
| 131 | 521 | 161 | 641 | 191 | 761 | 221 | 881 |
| 132 | 525 | 162 | 645 | 192 | 765 | 222 | 885 |
| 133 | 529 | 163 | 649 | 193 | 769 | 223 | 889 |
| 134 | 533 | 164 | 653 | 194 | 773 | 224 | 893 |
| 135 | 537 | 165 | 657 | 195 | 777 | 225 | 897 |
| 136 | 541 | 166 | 661 | 196 | 781 | 226 | 901 |
| 137 | 545 | 167 | 665 | 197 | 785 | 227 | 905 |
| 138 | 549 | 168 | 669 | 198 | 789 | 228 | 909 |
| 139 | 553 | 169 | 673 | 199 | 793 | 229 | 913 |
| 140 | 557 | 170 | 677 | 200 | 797 | 230 | 917 |
| 141 | 561 | 171 | 681 | 201 | 801 | 231 | 921 |
| 142 | 565 | 172 | 685 | 202 | 805 | 232 | 925 |
| 143 | 569 | 173 | 689 | 203 | 809 | 233 | 929 |
| 144 | 573 | 174 | 693 | 204 | 813 | 234 | 933 |
| 145 | 577 | 175 | 697 | 205 | 817 | 235 | 937 |
| 146 | 581 | 176 | 701 | 206 | 821 | 236 | 941 |
| 147 | 585 | 177 | 705 | 207 | 825 | 237 | 945 |
| 148 | 589 | 178 | 709 | 208 | 829 | 238 | 949 |
| 149 | 593 | 179 | 713 | 209 | 833 | 239 | 953 |
| 150 | 597 | 180 | 717 | 210 | 837 | 240 | 957 |

| CV1 | Base Address | CV1 | Base Address | CV1 | Base Address | CV1 | Base Address |
|---|---|---|---|---|---|---|---|
| 241 | 961 | 246 | 981 | 251 | 1001 | | |
| 242 | 965 | 247 | 985 | 252 | 1005 | | |
| 243 | 969 | 248 | 989 | 253 | 1009 | | |
| 244 | 973 | 249 | 993 | 254 | 1013 | | |
| 245 | 977 | 250 | 997 | 255 | 1017 | | |

For addresses above 1017 set CV9 = 1 and CV1 = 0 to 255 and add 1024 to the base address above.

Eg. for base address 1021 - CV9 = 1 and CV1 = 0, for base address 1024 CV9 = 1 and CV1 = 1

For CV9 = 0, the base address can be calculated by the following:

base address = (CV1 - 1) * 4 + 1

The CV1 value can be calculated by the following:

CV1 = (base address - 1) / 4 + 1

## CV programming for different aspect signals.

If you are only using 2 aspect signals then you can disregard this section.

The firmware is capable of controlling upto 4 aspect signals.

However you need to program CV's for the applicable outputs.

**Addendum**

# References.

PCB on pcbway.com:

https://www.pcbway.com/project/shareproject/RT_DCC_Pulse_8_Turnout_Decoder_with_capacitor_discharge_unit_26697a2a.html


Coloured light signal decoder firmware:

https://github.com/Rosscoetrain/RT-Signal-Decoder-Direct