

## 8.1 WEB Tools

There is a handy tool available to do most of the CV calculations. The tool can be downloaded to the local PC and used offline.

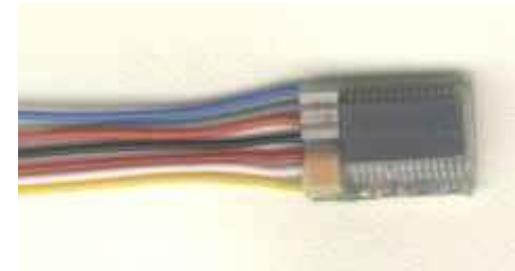
For CV29: <http://www.huebsch.at/train/Software/bincalc.htm>

For CV33-40: <http://www.huebsch.at/train/Software/function.htm>

## User's Guide

# Loco Decoder DCX73

## For N and H0 Scale



13x9x3,3mm (LxBxH)

Picture 1 The Decoder

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## 8 Windows Calc

Another handy method to do the work is to use the MS Windows calc.exe program. Just switch the tool into scientific mode which offers you binary, octal, decimal and hex mode. Switch to bin mode and enter the number "10110010":



Picture 6 Windows calc binary mode

Next just press the "Dec" button to see the decimal representation of the entered number:



Picture 7 Windows calc decimal mode

The line is summarized to the right:  $128 + 32 + 16 + 2$  equals 178 which is to be written into CV 29

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## 1 Introduction

The DCX73 can be used to drive all DC and AC motors. As a general rule the engine current should not exceed 0.8 amps for periods longer than 5 seconds.

The DCX73 offers high frequency output with 16kHz to reduce noise and drive highly efficient motors like Faulhaber. There is also an operation mode with 30-150 Hz.

The DCX73 supports 14, 28 and 128 speed steps and supports load compensation. It supports the full address range from 1 to 10240 and on the fly programming.

The DCX73 is fully NMRA compatible. You can use DCX73 decoder with all DCC systems. To name a few: Digitrax, Lenz, LGB, Uhlenbrock, Zimo, Roco 'digital is cool', NCE, SystemOne, etc.

**Special Feature:** The DCX73 supports ZIMO's extensions like "signal controlled speed limitation" and "Loco identification pulses" Another Feature offers flash software upgrades into the micro controller. This allows us to offer user the latest software as it become available. It is necessary to send the decoder back to CT Elektronik for the upgrades.

**Features DCX73:** 0.8 amp motor current, 2 amplified outputs with full NMRA function mapping support. Overload protection for all outputs, which supports directly connecting LEDs. We recommend use of a resistor to lower the current values.

## 7 Calculation of complex Variables

There are a couple of CV's which carry multiple on / off functions. To save space inside the decoder up to 8 of those single functions (bits) are combined together representing a byte which is stored in a CV. Typical CVs which use that technique are CV 29, CV 33-42, CV 57 and CV 58. It can be compared with a switch which can only stay on or off. If those switches are written down as 0 or 1 and written in a line it can be interpreted as a number in binary system. If that number is transferred into the decimal it represents the number which needs to be programmed into the decoder.

### 7.1 Transferring from binary into the decimal system

The table below should help you to do the job

Position / Bit	7	6	5	4	3	2	1	0
Wert	128	64	32	16	8	4	2	1
Bit Muster								
Zwisch.Wert								

Table 4 Transfer table

Just mark the columns where you have a function (bit) turned on. Next write down the values into the bottom line and summarize them to the right.

Example: Calculate CV 29, normal direction, 28 speed steps, only digital mode, free speed table, long addresses and 16kHz motor frequency.

position / bit	7	6	5	4	3	2	1	0
Value	128	64	32	16	8	4	2	1
Bits	x		x	X			x	
Interim value	128		32	16			2	
								178

Table 5 calculation example

- ? The required columns are marked with a "x"
- ? The values in the marked columns are transferred down 128 for Bit 7, 32 for Bit 5 ect.

58	<b>Mask for decoupler function:</b> defines which outputs should have that function enabled. Each bit represents one function output.	0	0, 1
59	<b>Signal controlled speed: "L"</b> <sup>4</sup> only available in ZIMO environment. This has no function in any other digital system	168	0-255
60	<b>Signal controlled speed: "U"</b> only available in ZIMO environment This has no function in any other digital system	84	0-255
61	<b>Signal controlled acceleration reaction time:</b> only available in ZIMO systems (unit: = 1/20 sec)	0	0-255
67-94	<b>Free speed table:</b> activated with CV 29 bit 4=1 Default values: 9,18,27,36,45,54,63,72,81,90,99, 108,117,126,135,144,153,162,171,180,189, 198,207,216,225,234,243,252 <b>Is not modified during hard reset!</b>	---	0-252
105	<b>User-CV:</b> free for remembering purchase date or similar user information	0	0-255
106	<b>User-CV:</b> free for remembering purchase date or similar user information	0	0-255

Table 3 CV Table

Please check out chapter 7 where the calculation of CV variables is explained.

CV 105 / 106 can be used to remember any user values, like purchase date or optimization version. The idea is to have a place to store information with the model, which can be read out easily without the need to open the loco.

<sup>4</sup> The DCX70 only supports U and L

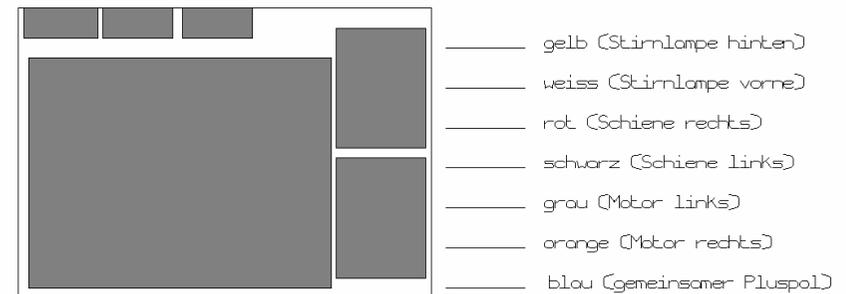
## 2 Technical Specifications

All outputs share one rectifier. This limits the overall current to 0.8A

Track voltage.....	12-18V
Maximum current (Motor) .....	0.8A
Peak current 5 sec .....	2A
Max current of all function outputs.....	0.8A
Operating temperature .....	-10 to 90°C
Size .....	LxWxH... 13 x 9 x 3,3 mm
HF output frequency .....	16 kHz
LF output frequency .....	30 to 150Hz
Dimming frequency .....	80Hz
Wire length .....	150 mm

Table 1 Technical Data

### 2.1 Connectors of DCX73



Picture 2 Connections

Braun = Brown (3rd and 4th function outputs), Rot = Red (right rail feed), Schwarz = Black (left rail feed) Gelb = Yellow (reverse light function) Weiss = White (forward light function, Blau = Blue (functions common), Orange (right motor lead), Grau = Gray (left motor lead)

## 2.2 8 Pin NMRA plug.

#	Connector		#
1	orange	red	8
2	yellow	blue	7
3	N/C	white	6
4	black	gray	5

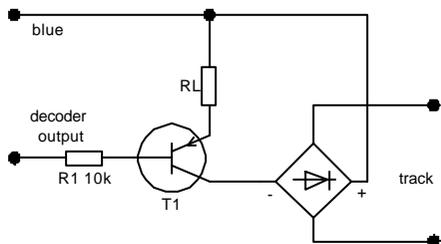
Table 2 NMRA connector

The DCX73 is just 13x9x3,3 mm which should allow an installation into most N scale models. The connection wires are color coded according to NMRA specs.

The decoder itself is wrapped with heat shrink sleeve to protect it against short circuits to ground. There are extra logic level outputs on the board which are not accessible without breaking that seal. Those logic level outputs can drive one TTL load. For model usage it is necessary to use a amplifier (see picture 3.)

## 2.3 Auxiliary amplifier circuit

The auxiliary outputs that are available on soldering pads on the board can drive an amplifier circuit shown in Picture 3



picture 3 Amplifier

Check out the CT-Electronic website for more information. CT-Electronic also offers amplifier modules.

30	<b>Error diagnoses:</b> identify where a short circuit was detected Motor short: 1 Short on one of the function outputs : 2 Short on both of the above : 3	0	0
33-42	<b>Function Mapping:</b> according to NMRA Function 7 controls shunting function (yard mode)	0	0, 1
49	<b>Reference voltage:</b> for EMF 160 = 16V track voltage	160	0 - 255
50	<b>EMF intensity:</b> how strong is EMF 0 = no influence, 255 = maximum. If you plan to use locomotives in consist then reduce the value set in CV 50. This avoids having models work against each other if they can't be configured to perform totally equal.	240	0 - 255
51	<b>P-Value:</b> optimizes EMF characteristic. Modify this variable to adapt to specific motor requirements or characteristics.	80	0 - 255
52	<b>I-Value:</b> optimizes EMF characteristic. Modify this variable to adapt to specific motor requirements or characteristics.	35	0 - 255
53	<b>Signal controlled deceleration reaction time:</b> only available in ZIMO systems. This has no function in any other digital system	3	0 - 255
54	<b>PWM for function output:</b> provides a dimming functionality CV54 = 50 means 50% of power	100	0 - 100
55	<b>PWM for decoupler:</b> represents the holding current for the decoupler, i.e. the reduced power for holding after the uncoupling impulse.	32	0 - 100
56	<b>Decoupler pulse time:</b> how long is the impulse on the decoupler with full power until it is reduced to the value defined CV 55. Time is set in 1/20 sec.	60	0 - 255
57	<b>Dim mask:</b> turns dimming (defined in CV 54) on and off for each function output. Each bit represents one function output.	255	0, 1

29	<p><b>Configuration Bits:</b> controls various features.          Bit 0 - direction: 0 = normal 1 = reverse          Bit 1 – speed step: 0 = 14, 1 = 28 (128 always supported)          Bit 2 – power: 0 = only digital mode                    1 = digital and analog          Bit 3: Loco identification<sup>3</sup>: 0 = off, 1 = on          Bit 4 – speed characteristic:                    0 = Default-controlled by CV 2, 5, 6                    1 = free table CV 67 - 94          Bit 5 - Addresses:                    0 = 1-128 stored in CV 1                    1 = 128 - 10240 stored in CV 17 + 18          Bit 6: MAN- Bit                    0 = off, 1 = on          Bit 7: PWM range                    0 = Low range PWM, 1 = 16 kHz PWM</p> <p><b>Attention:</b> CT-Electronik decoders use more bits in CV29 than other vendor's do</p>	10	0, 1
	<p>Bit calculation for CV29, see also chapter 7          Bit 0: on equals 1          Bit 1: on equals 2          Bit 2: on equals 4          Bit 3: on equals 8          Bit 4: on equals 16          Bit 5: on equals 32          Bit 6: on equals 64          Bit 7: on equals 128          Example: CV 29 = 11: reverse direction, 28 speed steps, only digital mode, loco ID on, CV2/5/6 activated, short address (CV1)</p>		

<sup>3</sup> only supported by ZIMO central units

### 3 Safety Protocols

All outputs of this decoder are protected against overload. This protection is intended to protect against internal shortcuts and overloads. This means engine shorts or a blown bulb. This does **not** protect against shorts to the track or against a faulty motor. Mixing engine and track wires damages the decoder immediately.

Capacitors between the engine connectors need to be removed. All filters between the decoder and the motor need to be removed. The decoder replaces their function. If the filters are left in EMF functionality might get interrupted or reduced. This leads to unsmooth motor movements especially in low speed operation.

The DCX73 decoder operates with track voltage of 12 to 18 volts. Faulty motors induce high voltage spikes of several hundred volts. Lowering the operating voltage also lowers those peaks, which reduced the risk for all involved electronics. Lower track voltage protects lamps and other electrical appliances in locos and cars.

The DCX73 is protected against incidental contact of the components of the chassis with a heat shrink sleeve. Never wrap the decoder with an insulating tape, this hinders heat flow and might lead to malfunction or destruction of the decoder. Use a double sided tape to mount the decoder in the model. Try to help to cool the decoder by helping air to flow around the module.

It is normal that the decoder warms up even if it is only powered up.

### 6 Configuration Variables (CV's)

CV	Description	DefaultValues	
1	<b>Address:</b> this is the number to identify the loco. CV 29 bit 5 set to 0 short address.	3	1 - 128
2	<b>Start Voltage:</b> describes the power for speed step 1 CV 29 Bit 4 = 0 (off) then CV2,5,6 are active	1	0 - 255
3	<b>Acceleration:</b> rate of acceleration. <sup>1</sup>	1	0 - 255
4	<b>Deceleration:</b> rate of deceleration <sup>2</sup>	1	0 - 255
5	<b>Maximum Speed:</b> defines the top speed, i.e. the speed at full throttle. Only valid with bit 4 = 0 in CV29	255	0 - 255
6	<b>Middle Speed:</b> it builds a 3point speed curve with CV2 and CV5. Only valid with bit 4 = 0 in CV29. CV6 = 0 means ignore middle speed value.	70	0 - 255
7	<b>Version:</b> read only represents firmware version of decoder.	-	varies
8	<b>Manufacturer ID:</b> read only, currently 13 until we receive our final ID.	-	117
9	<b>PWM:</b> 13-63 stepless from 30 to 150 Hz. 141-191 = 16kHz activated. The frequency is calculated: $f = 1953/CV9$ . If <b>CV 29 Bit 7 = 1 (on)</b> then PWM is always 16kHz. Bts 0 - 6 are then used to define the EMF sensing period.	150	13-63 141-191
17 + 18	<b>Extended Address:</b> also called long address. CV29 bit 5 = 1 (on).	0	128- 10240
19	<b>Consist address:</b> normally set to 0. Offers a second address to control multiple locos behind one common address.	0	1-128

<sup>1</sup> User can temporarily disable acceleration by activating function 7 (yard mode)

<sup>2</sup> User can temporarily disable deceleration by activating function 7 (yard mode)

## 5.2 Adapt definition file

Our WEBSITE at [www.tran.at](http://www.tran.at) carries the DCX73.DEC file to support Adapt (PfuSch in German). You can easily update Adapt to learn about the specifics of the DCX73 with that file. This dramatically simplifies programming and tuning your decoders. It might be used for any DCC decoder. Adapt decoder programming software currently only supports Zimo's MX1 Command Station and Uhlenbrok's Intellibox.

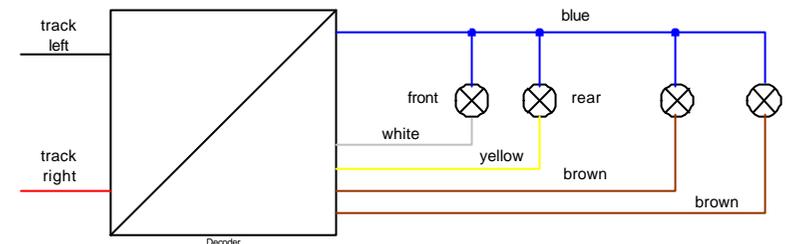
## 4 Installation

Before you install the decoder, check the model for proper function. Perfect mechanic function is mandatory for good performance.

Motor and lamps must not be connected to chassis. If this is not possible for lamps there is a special way described in section 4.2 to work around this problem.

Remove all filter electronics between decoder and motor.

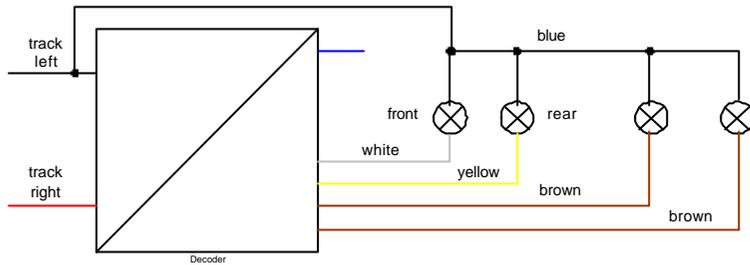
### 4.1 Lamp circuit with common power - blue wire



Picture 4 circuit with common +

### 4.2 Lamps circuit power to one side of rail (half phase)

Especially older models have one side of the lamps connected to the chassis. The DCCX73 supports this by connecting the desired output to the other side of the lamp. In this circuit the lamps are dimmed as they are reduced to 50% of the power.



Picture 5 lamp on one side on track potential

## 5 Programming and Operation

All decoders are set to default short address = 3. It is possible to use it immediately with this address.

For regular usage the address should be reprogrammed. Consult your DCC system user's guide to find out how this is done.

During programming the decoder acknowledges the commands by sending out a series of short pulses. For the DCX73 decoder to acknowledge programming that it is necessary to have at least some lamps or the motor as a load connected. If your motor load is a Faulhaber (coreless type) motor or LEDs, it might be necessary (depending on your DCC system) to connect an additional load. A 33-ohm resistor across the motor output should do the job.

Please consult the documentation from your DCC system about your specific programming procedure. "hard reset"

Programming the decoder to address = "0" executes a "hard reset". This restores all default values and sets the address to 3. The speed table (CV67-94) is not modified, the values there are preserved. See chapter 6 for details of programming.

The DCX73 complies with the NMRA recommendations but offers additional functionality. This is controlled via special, manufacturer specific CV's. Please check chapter 6 for details.

### 5.1 Special CT-Elektronik bits for CV29

The DCX73 uses more bits in CV29 than many other decoders. In this case bits 3,6 and 7 are used to control some advanced features. Please note this if you transfer parameters from other vendor's decoders.