



Multi-Protocol decoder with Load Regulation for DC and Faulhaber motors

Features

- Multi-protocol Load regulated decoder for DCC and Motorola
- Suitable for DC and bell armature motors to 1 A
- Quiet motor running by using 18.75 kHz control frequency
- 14, 27, 28, 128 speed steps, depending on data format
- Short addresses (1-127) and long addresses (for 128-9999)
- NMRA compliant
- Adjustable minimum, maximum and medium speeds
- Speed step tables for 14 and 28 speed step mode
- Main track programming (DCC)
- Shunting mode (half speed) toggled using F3
- Starting/brake inertia switched using F4
- Headlights switched using F0, dimmable
- 2 special function outputs switched using F1 and F2, dimmable or time restricted
- With SUSI sound interface (4 pole mini socket) for the connection of sound modules or other modules, controllable using auxiliary functions (f1 to f12)
- Produces the address identification for the control of the LISSY of mini transmitter 68 400
- Reacts to DCC conforming brake signal or brake sections with DC voltage
- Overheating protection, all output are short circuit protected
- Conventional DC or AC operation with automatic change
- All CV's are programmable with digital devices using DCC and/or Motorola formats
- In DCC layouts programmable using register, CV direct or page programming
- Updateable using Flash memory

Description

The locomotive decoder 76 420 is a small, efficient multi-protocol decoder. It can be used in DCC and Motorola systems and operates equally well in analog mode with DC or AC power and direction of travel change-over using high voltage pulse (Märklin system).

The decoder works with a frequency of 18.75 kHz and is not only suitable for DC motors, but also for bell armature motors (e.g. Faulhaber, Maxon, Escap) up to a continuous power of 1 A. Short term higher switching on current are tolerated well.

The motor characteristics are setup either by means of the minimum, middle and maximum speeds or by different CV's for the individual speeds. The load control can be individually adapted to different locomotive motors by setting these control parameters.

The decoder has two travel direction dependent lighting outputs, as well as two additional special function outputs, which are switched using function keys f1 and f2. Function keys f3 and f4 can be used to switch a shunting mode with extended low-speed operating range and the starting/brake inertia. The allocation of the switching tasks such as lighting, special function outputs, shunting mode and adjustable starting/brake inertia can be freely assigned to the function keys of the digital center (Function Mapping). The decoder is programmable with the Intellibox, DCC and Märklin controllers. All CV's are programmable with these devices.

In the default condition the decoder automatically recognizes the DCC and Motorola data formats, as well as the respective analog mode with DC or AC voltage. The desired operating mode can also be specified manually.

Ex-Factory Setting

Ex-factory the decoder is configured in DCC/Motorola operating mode. It switches between the two formats automatically. Additionally the decoder can be controlled with a DC device or AC transformer (Märklin System) in analogue 2-rail or 3-rail installations.

Installation of the decoder 76 420

Connection of the decoder

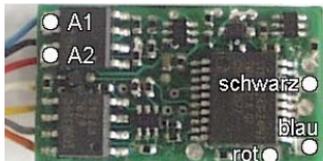
Remove the strapping plug from the locomotive and put the decoder's interface plug into the vacated socket.

If the lighting does not operate in the correct direction, then you must rotate the plug 180 degrees.

Note: If the driving direction does not correspond to that indicated in the digital center's display, then you can change this with CV29 Bit 0.

Connection of special functions

Besides lamps for lighting you can also use different items on the special functions outputs, such as smoke generator or Telex-coupling. For travel direction independent switching the outputs can be paralleled.



Additional special functions such as smoke generator, telex coupling or driver compartment lighting can be connected to the special function outputs A1 and A2. The feed to the device is soldered directly to the decoder circuit board. The return line is connected either to the blue wire of the decoder or the locomotive chassis.

Plug's pin assignment according to NEM 652 for DCC decoder

| | |
|---------|-----------------------------|
| 1 ● ● 8 | 1 Motor (orange) |
| 2 ● ● 7 | 2 Rear light (yellow) |
| 3 ● ● 6 | 3 Auxillary (green) |
| 4 ● ● 5 | 4 Left power pickup (black) |
| | 5 Motor (grey) |
| | 6 Front lights (white) |
| | 7 Lighting common (blue) |
| | 8 Right power pickup (red) |

Connection of an IntelliSound module or a LISSY mini transmitter 68 400

Alternatively a plug from an IntelliSound module or a LISSY mini transmitter can be inserted into the SUSI interface socket on the under side of the decoder. For controlling a LISST mini transmitter program Bit 1 in CV49 to 1 so that the decoder sends the identification address for the control of the LISSY mini transmitter to the SUSI interface. For operating a sound module on the SUSI-interface Bit 1 in CV49 must be set to 0 (Factory setting).

Mounting the decoder in the locomotive

Use the enclosed double-sided tape to fasten the decoder to any place in the locomotive. The sticking pad protects the decoder against conductive connections and holds it in place reliably.

Examine the correct installation with a continuity tester or an ohm meter. Make sure that the unit is placed in the vehicle where a conducting connection could not develop! Ensure that even after re-assembly of the locomotive no short-circuits occur from jammed wires.

A short-circuit in the area of the motor, lighting, pick-up and wheel contacts possibly destroys the component and electronics of the locomotive!

Digital and analog Operation

On digital layouts the decoder can be controlled in the Motorola or DCC data format. For the DCC operation 28 speed steps are preset.

If the decoder is used on conventional layouts it can be controlled either with a DC or an AC controller (system Märklin). All operating modes are automatically recognized by the decoder.

Märklin braking section

The decoder reacts to a Märklin brake section (brakes with analog power on the track), if CV29 bit 2 and CV49 bit 7 are set to 1 (factory setting 1 and 0).

Programming

The Configuration variables (CV's) form the basis of all possible operations of the decoder in accordance with the DCC standard. The decoder can be programmed with the Intellibox, DCC controllers and Motorola controllers.

Programming with the Intellibox

We recommend that, irrespective of the data format that will eventually be used, (xthat) the decoder be programmed using the menu for DCC decoders.

The Intellibox supports DCC programming with a user friendly input menu. Long addresses do not have to be calculated laboriously, as they can be entered directly. The Intellibox calculates the values for CV 17 and CV 18 automatically.

For precise instructions please read the appropriate chapter in the Intellibox manual.

Special case locomotive addresses 80 to 255 in Motorola format

In Motorola format the Intellibox supports an address range to 255. Addresses 1 to 80 can also be programmed freely using DCC programming. However if locomotive addresses higher than 80 are to be used, the locomotive address must be programmed according to the chapter "Programming with a Märklin controller".

After programming is complete CV 1 has a value of 0 and the decoder uses the Motorola address larger than 80.

Programming with DCC devices

Use the programming menu of its DCC controller, to select and program the decoders CV's by register, CV directly or page mode programming. With a DCC controller it is also possible to program the decoder using main line programming. For the exact procedure refer to the controller user manual.

Programming of long addresses without programming menu

If programming is to be done with controllers that do not support programming with an input menu, the values for CV 17 and CV 18 must be calculated. Here is a guide for programming of address 2000.

- Divide the address by 256 ($2000/256 = 7$ remainder of 208).
- Take the integer result (7) and add 192
- Program the result (199) into CV 17
- Program the remainder (208) into CV 18
- Important: Set bit 5 of CV 29 to 1, so that the decoder uses the long address.

Values for calculating the CV value

CV's 29 and 49 can be used to set the decoder into different modes. The value to be programmed is calculated by using the CV and adding the values of the desired functions.

Example

Normal driving direction Value = 0
28 speed steps Value = 2
Auto Analog/digital change over Value = 4
Speed steps using CV 2, 5, 6 Value = 0
Short address Value = 0
The sum of all values is 6.
CV 29 preset to this value ex factory.

| Bit | CV 29 function | Value |
|-----|--------------------------------------|-------|
| 0 | Normal driving direction | 0 |
| | Reverse driving direction | 1 |
| 1 | 14/27 speed steps | 0 |
| | 28/128 speed steps | 2 |
| 2 | Only digital operation | 0 |
| | Automatic analog/digital change over | 4 |
| 4 | Speed steps using CV2, CV5 and CV6 | 0 |
| | Characteristics using CV67-CV94 | 16 |
| 5 | Short address (CV1, register 1) | 0 |
| | Long address (CV17 and CV18) | 32 |

Programming with a Märklin Center except CS2 (see DCC)

With a Märklin center all CV's can be programmed, but not read.

1. Switch Center off and on.
2. Select the address of the decoder and switch the light on.
3. Operate the direction change-over 5 times in quick succession with the stationary locomotive (speed step 0), until the light turns off.
4. Enter the number of the CV that is to be programmed.
5. Briefly operate the direction change-over. The rear light flashes fast 4 times.
6. Enter the desired value for CV e.g. a locomotive address.
7. Briefly operate the direction change-over. The rear light flashes slowly 4 times.

If further CV's are to be programmed repeat points 4-7.

If programming is to be terminated switch the center to "STOP" or set the address to "80" and briefly operate the direction change-over.

Since a Motorola digital center from Märklin only accepts inputs of 01 to 80, the value "0" must be entered by entering the address as "80".

Page-Register for inputting CV-Numbers greater than 79

CV addresses larger than 79 can only be programmed with the help of the page register, CV66. If CV66 has a value higher than 0, then the contents of CV66 times 64 will be added to every address entered. The entered value must lie in the range 1 to 64. When leaving Motorola programming mode the page register (CV66) is automatically reset to zero.

Example

If CV82 is to be programmed with a value of 15, then CV66 must first be programmed with a value of 1. Subsequently, CV18 can be programmed with a value of 15. The decoder places the value 15 into CV82, which is derived from multiplying the contents of the CV66 (in the example 1) by 64 (thus 64) and then adding the entered CV address (18).

Offset-Register for entering CV values greater than 79

CV values larger 79 can be programmed only with the help of the offset register. The offset register is CV65. If CV65 contains a value > 0, then all following programmed values are calculated by multiplying the contents of CV65 by 4 and adding the result to the entered value. When leaving Motorola programming mode the offset register (CV65) is automatically reset to zero.

Example

CV49 is to be programmed with a value of 157, then CV65 must first be programmed with the value of 25. Subsequently, CV49 can be programmed with a value of 57. The decoder places the value $4 * 25 + 57$ into CV49.

Note: When programming CV65 and CV66 the contents of the offset and page registers have no effect.

Programming with a Mobile Station

The Programming Menu is available in the Mobile Station's Loco Menu, only for certain locomotives. A locomotive which is equipped with a programmable decoder must be selected from the Database. Proceed as follows:

1. Add a new locomotive and select Part No. 36330. The Display then shows locomotive Ee 3/3.
2. Press the "MENU/ESC" button and select the "LOK Change" ("LOK ÄNDERN") column. Here you will find the last function of Register Programming indicated by "REG". Use this function to change the decoder's CV's. You can only write to the CV's with this function.
3. Enter the number of the CV and confirm this with the reversing knob.
4. Enter the value for the CV and confirm this with the reversing knob. The Mobile Station then programs the CV with the desired value.

Attention: Before programming, remove all locomotives that are not to be programmed from the track!

Motor Regulation

The motor's load regulation can be adapted to suit the locomotive with CVs 53 to 58.

Here the individual CV's have the following purpose:

CV53 Motor regulation repetition rate

CV54 P constant for the PID regulator

CV55 I constant for the PID regulator

CV56 Regulation frequency

CV57 D constant for the PID regulator

CV58 Length of the time slot for measuring the back EMF voltage

Guide for changing the controller parameters P,I,D:

- 1.) Set CV54, 55 and 57 with factory setting of the decoders CV2, 5 und 6 (min., max. and middle Speed).
- 2.) Set CV55 and 57 to zero
- 3.) Set CV54 so that the locomotive just moves on speed step 2.
- 4.) Increase CV55 so that the locomotive moves off quickly, as desired, when changing the speed step from 0 to 1. (The step size should be 1.)
- 5.) Jerky behaviour with the change of speed step can be compensated for in CV57. (The step size should be 1.)
- 6.) If necessary adapt CV2, 5, 6 from step 2.) and start over with the adjustments.

If no satisfactory result can be obtained then you must

- a) change the regulation repetition rate in CV53.
- b) Increase the measuring time for the back EMF voltage in CV58. (With some motors smooth running can only be achieved at low speed in this way.)
- c) reduce the regulation frequency in CV56. (this is valid when the locomotive already runs at top speed at a speed step lower than the maximum and after no further change in speed occurs)

Make the respective changes to CV53, 56, 58 in small increments and if necessary repeat the PID regulation in points 1.) to 6.).

Table of CVs (Configuration Variables)

| CV | Description | Value range | Default value |
|-------|---|-----------------------|---------------|
| 1 | Locomotive address | DCC 1-127 Mot 1-80 | 3 |
| 2 | Minimum Speed | 1-63 | 1 |
| 3 | Acceleration 1 means that every 5 ms the actual speed is increased by 1 If the internal maximum speed is set to 200 (CV5=50 or CV94 = 200), then acceleration time from 0 to Fmax is 1sec. | 1-63 | 2 |
| 4 | Braking inertia (time factor CV3) | 1-63 | 2 |
| 5 | Maximum speed (must be greater than CV2) | 1-63 | 48 |
| 6 | Middle speed (must be greater than CV2 and less than CV5) | 1-63 | 24 |
| 7 | Software version (The processor can be updated) | - | varies |
| 8 | Manufacturer ID | - | 85 |
| 17 | Long locomotive address | 1-9999 | 2000 |
| 18 | 17 = high byte / 18 = low byte | 199-231/0-255 | 199/208 |
| 19 | Consist address (double traction) 0 = Consist address inactive When bit 7=1 the driving direction is reversed The desired speed CADR + 128 = reverse direction | 1-127 | 0 |
| 29 | Configuration for DCC | Value | 6 |
| | Bit 0=0 Normal direction | 0 * | |
| | Bit 0=1 reversed travel | 1 | |
| | Bit 1=0 14 speed steps | 0 | |
| | Bit 1=1 28 speed steps | 2 * | |
| | Bit 2=0 Only digital operation | 0 | |
| | Bit 2=1 automatic analog/digital switching | 4 * | |
| | Bit 3 Not used | - | |
| | Bit 4=0 Speed steps using CV 2, CV 5, and CV 6 | 0 * | |
| | Bit 4=1 Characteristics using CV 67 to CV 94 | 16 | |
| | Bit 5=0 Short address (CV 1) | 0 * | |
| | Bit 5=1 Long address (CV 17/18) | 32 | |
| | Bit 6/7 Not used | | |
| 33-42 | Allocation of the function outputs, which are to be activated with function keys like light and special functions | 0-63 | |
| | CV33 Light operation forwards | | 1 |
| | CV34 Light operation backwards | | 2 |
| | CV35 Function key f1 | | 4 |
| | CV36 Function key f2 | | 8 |
| | CV37 Function key f3 | | 16 |
| | CV38 Function key f4 | | 32 |
| | CV39 Function key f5 | | 0 |
| | CV40 Function key f6 | | 0 |
| | CV41 Function key f7 | | 0 |
| | CV42 Function key f8 | | 0 |
| | Assignment of the individual Bits | | |
| | Bit 0 Light output front | 1 | |
| | Bit 1 Light output back | 2 | |
| | Bit 2 Special function A1 | 4 | |
| | Bit 3 Special function A2 | 8 | |
| | Bit 4 Shunting mode | 16 | |
| | Bit 5 Start/brake inertia | 32 | |
| 47 | Speed correction forwards | 0-63 | 32 |
| 48 | Speed correction reverse | 0-63 | 32 |
| 49 | Locomotive decoder configuration | Value | 32 |
| | Bit 0=0 Motor load regulation On | 0 * | |
| | Bit 0=1 Motor load regulation Off | 1 | |
| | Bit 1=0 SUSI configured for Sound module | 0 * | |
| | Bit 1=1 SUSI configured for LISSY Mini transmitter | 2 | |
| | Bit 2=0 brakes to 0 in brake section | 0 * | |
| | Bit 2=1 brakes to speed step in CV52 | 4 | |
| | Bit 3=0 Data format DCC and Motorola | 0 * | |
| | Bit 3=1 Data format only DCC | 8 | |
| | Bit 4=0 Data format DCC and Motorola | 0 * | |
| | Bit 4=1 Data format only Motorola | 16 | |
| | Bit 5=0 Dimming for A1 and A2 Off | 0 * | |
| | Bit 5=1 Dimming for A1 and A2 On | 32 | |
| | Bit 6=0 Light outputs not swapped | 0 * | |
| | Bit 6=1 Light outputs swapped | 64 | |
| | Bit 7=0 Brake only with brake signal | 0 * | |
| | Bit 7=1 Brake with analog potential | 128 | |
| | Attention: When the Motorola data format is selected by Bit 3 and the DCC data format by Bit 4, the decoder no longer receives speed commands and can only be programmed. | | |
| 50 | Dimming of Function outputs A1, A2 and Light outputs | 0-63 | 32 |
| 51 | Configuration of analog operation 1 = only AC operation, 2 = only DC operation 3 = AC and DC operation with automatic recognition | 1-3 | 3 |
| 52 | Final speed in a braking section | 0-255 | 30 |

| CV | Description | Value range | Default value |
|-------|---|-------------|---------------|
| 53 | Motor regulation repetition rate | 0-63 | 35 |
| 54 | Motor regulation P Constant | 0-63 | 20 |
| 56 | Motor regulation I Constant | 0-63 | 10 |
| 56 | Regulation Frequency | 0-63 | 32 |
| 57 | Motor regulation D Constant | 0-63 | 12 |
| 58 | Time slot for AD transducer measurement | 0-63 | 2 |
| 59 | Reset to factory defaults If this CV is set to 1, the decoder will be returned to factory setting. | 0, 1 | 0 |
| 60 | Short circuit monitoring 0 = inactive, 9 = active (do not change) | 0, 9 | 9 |
| 61 | Shutdown temperature in °C 0 = Temperature monitoring Off | 0-255 | varies |
| 65 | Offset-Register For CV Programming with a Motorola center | 0-255 | 0 |
| 66 | Page Register For CV Programming with a Motorola center | 0-255 | 0 |
| 67-94 | Characteristic curve for speed steps 1-28 | 0-255 | varies |
| 98 | Timed switching of Outputs A1 and A2 0 = A1 and A2 have timed restriction 1 = A1 has timed switching 2 = A2 has timed switching 3 = A1 and A2 have timed switching | 0-3 | 0 |
| 99 | Length of the time switching In 100ms: A value of 10 represents 1 second | 0-255 | 0 |
| 115 | LISSY Train category | 1-4 | 1 |

Technical Data

Addresses: 1-9999 (long DCC address)

Max. current consumption/loading: 1 A*

Function outputs: 1 A each

Size: 22 x 12.5 x 5.5 mm

The decoders is preset to address 03, and 28 speed step mode and can be used and programmed in DCC- and Motorola data format.

* The constant loading capacity may vary after installation.

Guarantee declaration

Each component is tested for its complete functionality before distribution. If a fault should arise within the guarantee period area of 2 years, we will repair the component free of charge upon production of proof of purchase. The warranty claim is void if the damage was caused by inappropriate treatment.

Please you note that, according to EMV law, the component may only be installed in vehicles which carry the CE logo.

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Part No. 76 420

