Uhlenbrock digital

IntelliDrive 2 **Mini-Lokdecoder 73 416**

Multi-protocol decoder with 6-pin NEM 651 interface

The Decoder 73 416 is the logical further development of the Decoder 73 415.

Compared to its predecessor, it is characterized by significantly lower heating and thus a higher removable output power.

The firmware and thus also the programming and operating instructions have remained the same.

Connections of locomotive decoder 73416

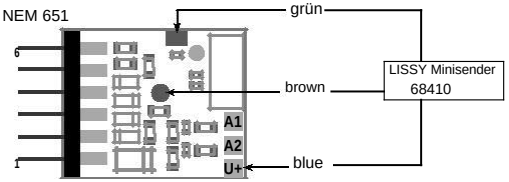
Remove the jumper plug from the NEM 651 interface of your vehicle. At the same place insert the locomotive decoder carefully into the interface socket. Please note the coding via PIN 1 (rear light, yellow).

Make sure that there is no conductive connection anywhere. Make sure that no short circuits can occur even after closing the locomotive. The first commissioning should take place on the programming track when the control panel's programming mode is called. When reading or programming, very small currents usually flow, which do not damage the decoder in the short-term.

Connection of special functions

Additional special functions such as smoke generator, telex coupling or driver's cab lighting can be connected to the special radio outputs A1 and A2. The supply line of the consumer is soldered directly to the decoder board. The return line is either soldered to the U+ connector of the decoder, or connected to the locomotive chassis (ground).

Connection of the LISSY mini-transmitter 68410



Connection of the energy accumulator 71800 The connection of the blue and brown cable of the energy accumulator is as shown in the picture below.

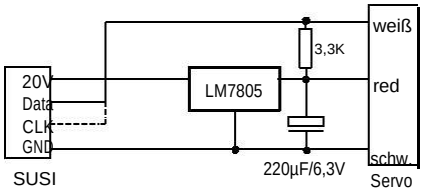
The microSUSI interface

To the microSUSI interface of the decoder can be connected either an IntelliSound module with microSUSI, or a suitable function decoder, or two servo circuits. In the soldering variant only one servo circuit.

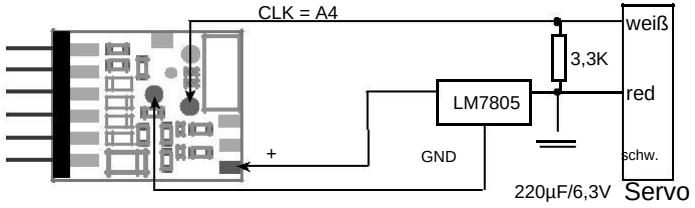
Please refer to the CV table which CV is to be programmed for the respective application.

In the factory setting, the decoder outputs data for an IntelliSound module at the microSUSI interface.

Servo circuits for operating a model building service on SUSI or solder pads (only for experts)



With the CV50, the SUSI connection is Logic inputs have been changed.
Data -> A3
CLK -> A4



ATTENTION: Soldering on the decoder should only be done by experienced professionals with the appropriate tools. For decoders that have been damaged due to improper handling, the warranty claim is void.

A short circuit in the range of engine, lighting, grinder and wheelsets destroys the building block and possibly the electronics of the locomotive!

Commissioning of the decoder

Enter address 3 at the control unit. The decoder runs in DCC mode with 28 speed steps or in Motorola mode, depending on the data format it was addressed with. If the decoder is used on conventional systems, it can be controlled with a DC drive. The operating mode is automatically recognized by the decoder. The status of the functions F0 - F12 can be set for analog operation via CVs 13 and 14.

Delivery condition

The decoder is preset to the address 03 and can be run and programmed in the DCC data format with 28 speed steps and in the Motorola data format. It automatically switches between both formats.
In addition, the decoder can be operated with a DC trolley on conventional DC systems.

Technical data

Addresses:	1-9999 (lange DCC Adresse)
Total load / Maximum motor current:	0.7 A, short-term up to 1.5 A
Function outputs:	je 0,4 A
Größe:	9.5 x 7.8 x 2.8 mm (without pins)

NOTE:

This product is not a toy and is not suitable for children under 14 years. Any liability for damages of any kind, which are caused by improper use, as well as by not observing this manual, is excluded.

Garantieerklärung

Each module is checked for its complete function before delivery. Should an error occur within the warranty period of 2 years, we will repair the component free of charge on presentation of the proof of purchase. The warranty claim is void if the damage was caused by improper handling.

Our advantages for you:

If you have any questions, we are here for you!

Internet:	FAQs can be found at www.uhlenbrock.de
E-Mail:	service@uhlenbrock.de
Hotline:	(0) 2045 8583-27, Wed from 4 pm to 6 pm and Mon - Tue - Thu - Fri from 2 pm +49 to 4 pm
Premium-Hotline:	**+49 (0) 900 1858327 Once it is urgent ...** Mon - Fri 10 - 16 o'clock, Chargeable (98cent/min German landline, mobile considerably more expensive)
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• Updatable via DigiTest • decoder programming lock • programmable via special • main track programming • Motorola programming • DCC CV programming • error memory for motor• All outputs against • Motorola with 3 addresses for • 2 - Programmer programming motor control types for • connections for LISSYLight effects such as Mars Light, • 8 modulation paths • fluorescent lamps • energy saving lamp effect• motor control mini • On, hide the light• Fire box with• transmitter 68410 Gyra Function outputs: 2 • Function outputs: Blinking outputs depending on • Extended function mapping, • Simple function mapping, • Second dimming for • light and function outputs • A1 & A2, **depending on direction of travel • 3 adjustable starting, • manoeuvring (half • Simple and extended • NMRA compliant • Short (1-127) and long • 14, 27, 28, 128 speed steps, Other features**

software (DCC) and function outputs short circuit secured the functions F1 - precise Light, Strobe for example American switch-on effect and function outputs Setting parameters Phases for alternating indicators with variable time linked conditions F0 - F44 for several F0 - F12 lighting, A1 and A2 adjustable for analog operation Braking delays Speed) switchable Speed characteristic (128-9999) Addresses depending on data format

u.a. F12

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Made in Germany

Waste electronics do not belong in household waste.

Art.-Nr. 73 416

13.01.21

Uhlenbrock digital

RailCom by Lenz Elektronik GmbH

SUSI

IntelliDrive 2 **Mini-Lokdecoder** *73 300, 73 310, 73 340 73 406, 73 416*

Description

This manual describes in detail the complete range of functions of your new locomotive decoder. To enjoy it as much as possible, please read the instructions carefully and completely.

This locomotive decoder is a small, very powerful multi-protocol decoder. It can be used in DCC, Motorola and Selectrix digital systems. It also operates in analog mode with DC voltage. The respective operating mode is automatically recognized, but it can also be set manually.

The decoder operates at a frequency of 18.75 kHz and is therefore not only suitable for direct current, but also for Bell-type armature motors (e.g., Faulhaber, Maxon, Escap) up to a continuous current consumption of 0.8 A

Motor currents up to 2 A are well tolerated.

The decoder is capable of RailCom® and RailCom Plus® and masters both ABC braking and ABC slow motion. The engine characteristic curve is adjusted via the minimum, medium and maximum speed (simple characteristic), or via the extended characteristic curve with individual settings for 28 speed steps.

The decoder has two direction-dependent lighting outputs and two additional special function outputs (not 73115). Its manoeuvring gear with extended slow travel range and the three possible start-up and brake decelerations can be switched via function keys. Ideal for use in American locomotive models is the possibility to activate special, typical American lighting effects (Mars Light, Gyra Light, Strobe, etc.).

The assignment of switching tasks such as lighting, special function outputs (not 73115), shunting gear and switchable start-up and brake deceleration (ABV) can be freely assigned to the function keys F0 - F12 of the digital control center (small function mapping). In addition, the decoder also supports advanced function mapping. In the extended function mapping, the simultaneous switching on or off of several outputs is possible depending on linked conditions (F-keys, direction of travel, locomotive standing / driving) with a function key assignment F0 - F44.

The decoder is programmable via all Intelliboxes, DCC and Märklin Steu devices. All CVs must be programmed with all devices. To facilitate programming, especially for advanced function mapping, the programming software "Lok-Tool" can be used, which is included in the digital programming and test station "DigiTest" from Uhlenbrock. This software is also available for free download on our website www.uhlenbrock.de.

As a further special feature, the decoder is updatable via the digital programming and test station "DigiTest" from Uhlenbrock. It can even remain in the closed vehicle. Even the playing of locomotive sounds on a connected IntelliSound 4 module can take place in this constellation in the installed state.

IMPORTANT: All information given in the operating instructions for the function outputs A1 & A2 do not apply **to the** decoder 73115 with 6-pin NEM 651 interface.

Analog operation with DC voltage

The locomotive decoder is suitable for analog operation with DC voltage, which is detected independently. **ATTENTION:** Operation with AC voltage leads to the destruction of the decoder!

NOTE: In DC mode, your vehicle will only start at a higher voltage (controller is turned on) than you might have been used to in operation with analog vehicles.

Function outputs in analog mode

It is possible to set the decoder so that the function keys F0 - F12, as assigned in the function mapping, can also be switched on in analog mode. To do this, the CVs 13 & 14 have to be programmed with a digital control panel. The corresponding values can be found in the CV table.

Engine control

The motor control preset in the decoder is ideally suited for most motor types. If the driving behavior of your vehicle does not meet your expectations, because it jerks at low speed, for example, you can change this standard setting of the engine control. Two control types are available for adjusting the motor control.

1. PID Regler
2. SX two-point controller

Within the CV51, the first three bits can be used to determine whether a controller should be active, if so, which controller should be active and whether a fixed or variable period duration is used (see Configuration CVs -> Table CV51, Bits 0 - 2).

CV51

Bit0 -> 0 = controller off, 1 = controller on
Bit1 -> 0 = PID-Regler, 1 = SX-Regler
Bit2 -> 0 = fixed period according to CV53, 1 = dynamic period CV53, 200, 201, 202
CV53 -> Period of motor control in 100µs steps
CV54 -> PID: P share
CV55 -> PID: I share
CV56 -> PID: D share
CV57 -> PID: Regler Offset
CV58 -> Measuring gap for EMC measurement in 100µs steps

Speed-dependent (dynamic) period duration of the engine control CV200
minimum speed (0-255) up to which the period duration = CV53 is set CV201
maximum speed (0-255) from which the period duration = CV202 is set CV202
maximum period duration in 100µs steps

With the variable control priority duration, the period duration for internal speed steps less than or equal to CV200 is set to the value from CV53. Up to the speed step according to CV201, the period duration is changed linearly up to the value in CV202. For all stages above CV201, the period duration is set to the value of CV202.

The engine control can be adapted to the locomotive via the CVs 53 to 58 and 200 to 202.

In order for the decoder to use the dynamic period, it must be switched on via the Bit2 of the CV51.

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

Before changing the control parameters, make sure that:

1. The transmission is smooth-running
2. The collector of the engine is not smeared
3. No capacitors from the motor to the chassis (ground) are present

Once these three points have been processed, you can start with the settings according to the following pattern.

) Activate PID controller, bit 1 in CV51 = 0

) Set PID controller offset CV57 = 0

) With the factory setting of the decoder CV2, 5 and 6 (min, max and medium speeds) preset the motor control via CV54, 55 and 56.

) Set the CV55 and 56 to zero
) Set the CV54 so that the locomotive starts straight at speed level 2
) Increase the CV55 in such a way that the locomotive moves quickly from speed step 0 to 1 and drives as desired at speed step 1. The increment of the change should be 1.
) Compensate for uneasy behaviour when changing the speed steps with the CV56. The increment of the change should be 1.
) If necessary, adjust CV2, 5, 6 and start the setting again from step 3).

If no satisfactory result is achieved, it may be necessary.
a) The period duration of the scheme can be changed in CV53.
b) The measuring gap for the EMC voltage in CV58 can be increased (With some motors, a quiet run at low speeds can only be achieved by this)
c) The slider offset can be changed.
Carry out the respective changes in small steps and, if necessary, adjust the PID controller again.

Motorola

In order to be able to reach the functions F1 - F12 when used with Motorola control panels (eg 6021), the decoder has 3 Motorola addresses, which are trinarily stored in CV47-49. These 3 addresses are also used for decoding. If an address is programmed decimal under CV1, the decoder up to address 79 automatically stores the trinary equivalent in CV47. For example, to use Motorola locomotive addresses up to 255, the CVs 47 - 49 must be programmed directly decimal via Motorola programming (e.g., 6021 or Intellibox)
On the DCC programming track, these CVs can be read, but not programmed.
If the CV47 is programmed by Motorola, the CV1 is not changed and therefore the DCC data format in CV12 is switched off so that the decoder cannot be accessed by 2 addresses.
If the Bit5 is set in the CV29 (DCC long address), then the Motorola data format is switched off except for the Motorola programming, so that the decoder cannot react to 2 addresses.

Konfigurations-CVs

In addition to the decoder address, the configuration CVs of a locomotive decoder are certainly the most important CVs. These are the CVs 29, 50 and 51 in the In-telliDrive 2 decoder. A configuration CV usually contains different settings of a decoder, which are displayed in a maximum of 8 bits (0 - 7). The value of a CV to be entered is calculated from the respective CV table by adding the values of the desired functions.
The following shows the meaning and content of the configuration CVs, as well as an example calculation of the value:

Bit	Konfiguration CV 29	Wert
0	Normal direction of travel Opposite direction of travel	0 1
1	14 / 27 speed steps 28 / 128 speed steps	0 2
2	only digital operation automatic analog/digital switching	0 4
3	RailCom from RailCom a	0 8
4	Speed steps via CV 2, CV 5, and CV 6 Use characteristic curve from CV 67-94	0 16
5	Kurze Adresse (CV 1, Register 1) Long address (CV 17 and 18)	0 32

Example calculation (CV 29)

Normal direction of travel	Wert = 0
28 speed steps	Wert = 2
automatic analog/digital switching	Wert = 4
RailCom off/on	Wert = 8
Speed steps via CV 2, 5, 6	Wert = 0
Kurze Adresse	Wert = 0

The sum of all values is 14.

This value is stored as default in CV 29.

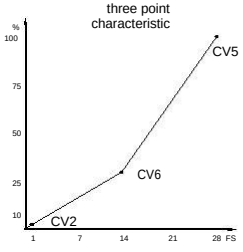
Bit	Konfiguration CV 50	Wert
0	Do not use Motorola 2nd address Use Motorola 2nd address	0 1
1	Do not use Motorola 3rd address Use Motorola 3 address	0 2
2	Do not exchange light outputs Exchange light outputs	0 4
3	Frequency Light, A1 and A2 = 156Hz Frequency Light, A1 and A2 = 24KHz	0 8
4	SUSI = SUSI SUSI = A3/A4 Logikpegel	0 16

Bit	Konfiguration CV 51	Wert
0	Engine control from Engine control a	0 1
1	Motor control PID - controller Motor control SX - controller	0 2
2	no dynamic period duration dynamic period duration	0 4
7	Light, A1/A2 PluX (73145) Light, A1/A2 cable/NEM (not 73145)	0 32

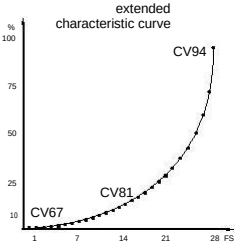
Speed step characteristic

The decoder is preset to a simple, three point characteristic curve, which determines the minimum, medium and highest speed. However, it can also be switched to the extended speed step characteristic for 28 speed steps (CV29, Bit4 = 1). This characteristic offers the possibility to set a speed for each of the 28 speed steps. The settings are entered in the CVs 67 to 94, whereby a CV is reserved for each of the speed steps 1 - 28.

three point characteristic



extended characteristic curve



RailCom®, RailCom Plus®

The basis of the RailCom® technology developed by the company LENZ® is the transmission of data from the decoder into the specially prepared (CutOut) DCC digital signal on the track. There must be detectors on the track which evaluate these decoder data and, if necessary, forward them to the control centre. Depending on the setting, the decoder sends out the decoder address and, when read out via the main track programming, CV values that can be displayed by the digital control panel (depending on the detector and control panel). In the decoder, bit 3 of the CV29 RailCom® can be switched on or off. Further RailCom® - settings can be made in the CV 28. For example, RailCom Plus® is switched on via bit 7. If RailCom Plus® is switched on, the decoder automatically registers at a RailCom Plus® capable control center (such as PIKO SmartControl) with its locomotive symbol, decoder names and special radio symbols within a few seconds. This RailCom Plus® technology means that no locomotive data has to be stored in the control center and no locomotive addresses have to be programmed into the decoder.

Braking behavior

Märklin Bremsstrecke

The decoder reacts to a Märklin braking section (brakes with analog DC voltage on the track) when CV29 bit 2 and CV27 bit 4 or bit 5 are set to 1 (factory setting 1 and 0).
CV27 bit 4 = 1 -> DC with opposite direction of travel
CV27 bit 5 = 1 -> DC with direction of travel equal

ABC - Brakes

If the decoder detects an ABC braking distance (not safe when using an Intellibox, or Power 3 - 8), a braking process begins. On which side of the rail the digital voltage should be more positive to activate the braking process can be set via the CV27:
CV27 Bit0 = 1, brake when right rail is more positive
CV27 Bit1 = 1, brake when left rail is more positive
CV27 Bit0 & Bit1 = 1, brake regardless of which rail is more positive
Bit 7 of the CV27 can be used to set whether the vehicle should only react to the ABC braking section in one direction (forward or backward). However, only one of the bits 0 or 1 may be set. Irrespective of the positions of bits 0 and 1 (one must at least be set to detect an ABC braking section), the vehicle can be driven in an activated ABC braking section when the shunting gear is switched on or the start-up braking delay is switched off. In the CV97 the voltage difference can be set, starting from which the decoder recognizes the ABC brake section. The desired difference corresponds to the CV value * 0.12V. If an ABC slow motion signal is detected according to a Lenz BM2 module, the decoder brakes to the internal speed step (0 - 255) which can be set in CV98.

Constant stopping distance in cm

The decoder offers the possibility for two adjustable, constant braking distances in centimeters, true to scale.
The constant braking distances can be triggered by various events. When braking with gear step 0 (for example, manual operation, LISSY or MARCo), it is possible to enter a gear step shaft, above which the constant braking distance is first carried out. If the internal speed of the locomotive decoder is smaller than the entered speed step threshold, the vehicle stops at set speed 0 with the set brake deceleration from CV4, or CV145, or CV147.
CV138 = 1 - 255 -> Momentary speed above which a constant braking distance is applied when the target speed is set to zero.

CV meanings

CV139 = stopping distance in cm
CV140 = alternative braking distance, can be activated via the CROSS bit (see "Extended Function Mapping")
CV141 = maximum speed of the model locomotive in cm/s
CV142 = If the value determined for the CV141 exceeds 255, the remainder is entered into the CV142 (possibly track 1, IIm (G))
CV143 = Constant stopping distance activation by:
Bit 0 = 1 -> nominal speed = 0, for current internal speed according to CV138 and higher (manual operation, LISSY, MARCO)
Bit 1 = 1 -> ABC brakes
Bit 2 = 1 -> DC brakes
Bit 3 = 1 -> DCC brake signal
CV143 = 0 -> no constant stopping distance
The meanings of the CVs 141 and 142 described here are valid from software version 23 (CV7) of the decoder. For older software versions, the 1st edition of this description remains valid.
If braking is initiated with constant braking distance, the decoder only reacts to driving instructions when the locomotive has come to a standstill. This process can be interrupted by switching on the shunting gear.

Determination of the maximum speed of the model locomotive

Program in the decoder the CV of the maximum speed to the maximum possible value (CV5 = 63, or when using the extended speed characteristic CV94 = 255)
Mark a starting point at a sufficiently long, straight track section, from which the vehicle approx. 2 seconds with the maximum speed possible. Place a scale (ruler) at the marked starting point. Now enter this section at maximum speed, that is to say the speed control set to highest speed. When you reach the starting point, start the time measurement for 2 seconds. After these 2 seconds, remember the position of the vehicle on the folding rule and read the value in cm. Divide this value by 2 and you get the speed in cm/s. In track gauges 1 and IIm (G), the determined value may exceed 255 for very fast vehicles. In this case, enter the value 255 in the CV141 and the rest of the determined value in the CV142.
After this measurement, the CV for the maximum speed (CV5 or CV94) can be set to the desired maximum speed for driving.

Switchable start-up and brake delays

In addition to the standard starting and braking delay (CVs 3 & 4) of the decoder, there are two alternative starting and braking delays that can be activated with function keys. The function keys F0 - F28 for the alternative ABV sets can be stored by the values 0 - 28 in the respective CVs 148 and 149 (for simple function mapping, CV96 = 0). The value 255 deactivates the respective alternative anti-lock system set.
CV144 = start-up delay 2 as replacement for CV3
CV145 = brake delay 2 as replacement for CV4
CV146 = start-up delay 3 as replacement for CV3
CV147 = brake delay 3 as replacement for CV4
CV148 = function key number for ABV 2 (0-12, 255=off)
CV149 = function key number for ABV 3 (0-12, 255=off)
In the extended function mapping (CV96 = 1), the alternative ABVs of the CVs 144 - 147 are activated via the possible conditions (see "Advanced Function Mapping").

Function outputs

Simple function mapping

The following settings of the decoder are only possible with the simple function mapping (CV 96 = 0).
In the simple function mapping, the assignments of the switching tasks such as lighting, special function outputs (not 73115), shunting gear and switchable start-up and brake delay can be freely assigned to the function keys F0 to F12 of the digital control center. The value that is written to a CV of the function mapping determines the functions that can be switched via a function key assigned to the CV. The CVs 33 to 46 serve this purpose according to the following scheme.

Assignment of function keys to CVs		Factory value
CV 33	Light function button F0 for forward travel	1
CV 34	Light function button F0 when reversing	2
CV 35	Function key F1	4
CV 36	Function key F2	8
CV 37	Function key F3	16

Assignment of the individual bits		Wert
Bit 0	Front light output	1
Bit 1	Rear light output	2
Bit 2	Function output A1	4
Bit 3	Function output A2	8
Bit 4	Function output A3 (SUSI/logic)	16

CV 38	Function key F4	32	Bit 5	Function output A4 (SUSI/logic)	32
CV 39	Function key F5	64	Bit 6	Rangiergang	64
CV 40	Function key F6	128	Bit 7	Start/brake deceleration	128
CV 41	Function key F7	0			
CV 42	Function key F8	0			
CV 43	Function key F9	0			
CV 44	Function key F10	0			
CV 45	Function key F11	0			
CV 46	Function key F12	0			

Example 1: The rear light output should only be switched with the function key F5.
The CV to be programmed is the CV39 for the function key F5, in which the value 2 (light output rear) is programmed. So that the rear light output is no longer switched backwards via the function button F0 in the direction of travel, the CV34 for the function button F0 must also be programmed backwards to the value 0.
Example 2: The function output A1 and the shunting mode should be switched together with the function key F10. The CV to be programmed is the CV44 for the function key F10. The value 4 (function output A1) plus the value 64 (shunting) is programmed into this CV44. So that the function output A1 is no longer switched via the function key F1 and the shunting gear via the function key F5, the CVs 35 for the function key F1 and 39 for the function key F5 must also be programmed to the value 0.

Switch off front and rear lighting on the train side (CV96 = 0)

In CV107 (front) and CV108 (rear) the numbers of the special functions 1 - 12 can be entered, which switch off the white and the red front or rear lighting. In addition, it can be entered here at which function outputs A1 and A2 the red train connection lighting is connected.
The function numbers entered here must be set via the function mapping so that they do not switch on any other outputs. In addition, it must be ensured that the outputs used for red lighting are not turned off or off by the function mapping of other function keys. The function mapping CV of the F keys used here must be set to zero. In order to switch off the light correctly, both CVs 107 and 108 must always be programmed as desired. If one of the CVs 107 or 108 is programmed with the value 0, the function is considered disabled.
The value for programming the CVs 107 and 108 consists of two conditions. On the one hand, the lighting to be switched off is connected to the outputs A1 or A2 and on the other hand, with which function key F1 to F12 the lighting is to be switched. Since a CV can only be described with a value, these conditions are combined into a value according to the following scheme:
Light assignment: A0v = white light front, A0h = white light rear
CV107 for red front lighting
CV108 for red rear lighting
Calculation: output * 16 + function button
Example: The red front light should be connected to A1 and switched with F5.
CV107=1*16+5=21
The red lighting at the rear is to be connected to A2 and switched with F6.
CV108=2*16+6=38

Switching off function outputs depending on direction of travel (CV96 = 0)

In the CVs 113 (forward direction of travel) and 114 (backward direction of travel), it can be determined which function output A1 - A4 (A3 & A4 logic on SUSI, CV50 bit 4 = 1) is to be switched off. If such an output is switched on via a function button, it is automatically switched off in the desired direction of travel.
CV113 = 2 -> A1 forward from CV113 = 4 -> A2 forward from CV113 = 8 -> A3 forward from CV113 = 16 -> A4 forward from CV114 = 2 -> A1 backwards from CV114 = 4 -> A2 backwards from CV114 = 8 -> A3 backwards from CV114 = 16 -> A4 backwards from A combination (sum of the single values) is possible.

Simple and advanced function mapping

The following settings of the decoder are possible with the simple (CV96 = 0) and the extended (CV96 = 1) function mapping.

Dimming of light and function outputs

The light and function outputs A1 & A2 can be adjusted to any dimming. These settings are stored in the CVs 116 (light), 117 (A1) and 118 (A2).

Softly show and hide light and function outputs

If the output is switched on or off, it is softly faded in or out.
In the CV186 you can specify which output should receive this glare function. CV186 = 1 -> light outputs with glare function, CV186 = 2 -> A1 with glare function, CV186 = 4 -> A2 with glare function. A combination (sum of the individual values) is of course also possible here.
The setting of the CV187 specifies how fast the glare function should work. The step width is CV value * 1ms.

Flashing of light and function outputs

The locomotive decoder has a flashing generator that can be assigned to the outputs. Both the turn-on time and the turn-off time of the flashing generator are separately adjustable.
In the CV109 you can specify which output should use the flashing generator. The CV110 can also be used to determine which output should use the 180° phase position of the flashing generator. For example, a changeover valve can be implemented.
CV109 = 1 -> light outputs blink, CV109 = 2 -> A1 blinks, CV109 = 4 -> A2 blinks. A combination (sum of the individual values) is of course possible.
CV110 = 1 -> light outputs flash with rotated phase, CV110 = 2 -> A1 flashes with rotated phase, CV110 = 4 -> A2 flashes with rotated phase. Again, of course, a combination is possible.
In the CV111 the switch-on time can be set in 100ms steps and in the CV112 the switch-off time in 100ms steps.

Energy-saving lamp effect when switching on the light and function outputs

When switching on an energy-saving lamp, it first generates a basic brightness before it slowly reaches the maximum brightness. This effect can be assigned to the outputs of the decoder as follows. CV183 = 1 -> effect for light outputs, CV183 = 2 -> effect for A1, CV183 = 4 -> effect for A2.
A combination (sum of the single values) is of course also possible here.
The basic brightness is adjustable via the CV184. The setting of the CV185 indicates how quickly the final value of the brightness (PWM1 in CVs 116 - 118) is to be reached. The step width is CV value * 5ms.

Activation effect of a neon tube / fluorescent lamp

The switch-on effect of a defective neon tube can also be output at the light and function outputs. This effect consists of an adjustable maximum number of flashes (a random flash to a maximum set number of flashes) and an adjustable flash time, so how fast the flashes should follow each other.
CV188 = 1 -> effect for light outputs, CV188 = 2 -> effect for A1, CV188 = 4 -> effect for A2.
A combination (sum of the single values) is of course also possible here.
The flash time is set via the CV 189 in 5ms steps. The maximum number of flashes in CV 190.

Firebox flickering

Random flickering can be assigned to the outputs light, A1 and A2. This effect is used, for example, for the flickering of a firebox.
CV181 = 1 -> flickering for light outputs, CV181 = 2 -> flickering for A1, CV181 = 4 -> flickering for A2.
A combination (sum of the single values) is of course also possible here.
In the CV182 the settings for the flickering rhythm and for the brightness change are entered as follows:
Bits 0 - 3 change the flicker rate (value range 1 to 15).
Bits 4 - 6 change brightness (range 16, 32, 48, 64, 80, 96, 112).
With the value 128 the output is always bright, but can be combined with the value range 16 to 112.
Since only one value can be programmed in a CV, the flickering results from the sum of the individual values of the flicker rhythm plus the sum of the individual values of the brightness (sum of bits 0 -3 plus sum of bits 4 - 6). The combination of all bits leads to different random flicker images. This applies: "try it".

Smoke generator control

A smoke generator can be connected to the outputs A1, A2, which is controlled by the decoder depending on the load.
When stationary, the smoke output has the PWM according to CV133. If the locomotive starts, the output receives the PWM=100%.
The engine can be stopped for 0-15 seconds (start-up delay), so that the smoke generator heats through when stationary. At the end of this time the locomotive starts, after which the output is controlled for another time (start-up time) with 100%. The smoke outlet is then transferred to the PWM in normal operation. In the event of a load increase, the smoke output is again controlled at 100% for the already defined starting time. The required load increase (load threshold) can be adjusted. For this purpose, the load size is used, which is also output for an IntelliSound module at the SUSI interface.

CV meanings

The CV130 specifies which of the two outputs A1, A2 is controlled with the smoke generator control and which time should apply to the starting delay. The value range 1-3 (1 = A1, 2 = A2, 3 = A1 & A2) determines the output and the value range 16 - 240 in 16 steps determines the start-up delay, whereby a 16 step means one second start-up delay. The sum of the single values results in the value for the CV130. Calculation: start-up delay * 16 + output
The load threshold is entered in the CV131 in a value range from 0 to 127. The greater the value in 0.1s steps, the more carrier the output reacts to a load change.
The CV132 determines the PWM for normal travel and the CV133 the PWM at a standstill.

Adjustable PWM - frequency of light and function outputs

The output voltage of a function output is modulated at a predetermined frequency pulse width (PWM).
The function outputs of the decoder work in factory setting with a frequency of 156 Hz. This frequency can be increased to 24 kHz for all outputs A0 to A2. A typical application is the electrical coupling of the company ROCO. Only with the higher frequency do these couplings no longer "flutter".
The frequency switching is adjustable in the CV50 in Bit3. Bit 3 = 0 -> 156Hz, Bit 3 = 1 -> 24KHz

Control of an electrical coupling

Electrical couplings consist of the finest copper wire windings. These usually react sensitively to constant current flow because they become relatively hot. With the appropriate settings, the decoder can ensure that the function outputs switch off automatically after an adjustable time without having to switch off the function button. Furthermore, the decoder can ensure that the coupling is only controlled for a short start-up torque with an adjustable high PWM in order to lift the coupling safely. After this moment, less energy is required to keep the clutch up. This, lower PWM, as well as the required holding time are also adjustable. If the used clutches do not decouple safely during the first attempt, a number of clutch restorations can also be set. When adjusting the clutch couplings, "as many as necessary, as few as possible" applies. In order that a permanent repetition does not lead to the destruction of the clutch windings, a switch-off time must be entered in 0.1s steps, which the decoder always waits for before performing a further decoupling operation.
CV124 = Number of clutch stops
CV125 = Turn-on time in 100ms steps with the PWM from CV117 (A1) or CV118 (A2)
CV126 = Holding time in 100ms steps
CV127 = switch-off time in 100ms steps, (0=no clutch control)
CV128 = holding PWM
CV129 = 2 -> clutch for A1, CV129 = 4 -> clutch for A2, CV129 = 6 -> clutch for A1 & A2

Shunting Tango, automatic uncoupling

A shunting tango can only be activated if the electric clutch control is activated via CV124-129. A shunting tango is triggered by one of the coupling outputs if the decoder mode = 0 is: Operation of a shunting tango:
1. Locomotive drives with adjustable speed for an adjustable time (T1) against the current direction of travel (pressing)
2. Locomotive stops and switches the direction of travel
3. Uncoupling process and locomotive travels with the same speed for an adjustable time T2 (disengagement)
4. Locomotive stops, now the locomotive has the original direction of travel again.

The CVs to be set are:
CV135 for the speed step of the shunting station (1-255). The value 0 specifies that no shunting tango takes place.
CV136 for the pressing time T1 in 100ms steps
CV137 for the withdrawal time T2 in 100ms steps

Modulation of the PWM - output for the light and function outputs

The brightness of the outputs can be modulated with the help of 64 different brightness values, which are periodically output as PWM at the outputs. The duration of the playback period is adjustable. It results from the value of CV178 multiplied by 64ms.
For the 8 PWM gradients with up to 64 individual values each, two banks (banks 3 & 4) with four PWM gradients are available. A total of 7 available CV banks with 256 CVs each are available in the decoder. For this variety of combination possibilities, so many CVs are necessary that programming in the conventional CV frame 1 to 1024 is no longer possible. Therefore, a special division into CV banks of 256 CVs (CV257 - 512) is necessary.
So the CVs 257 - 512 can be used several times. A similar procedure for handling CV banks already exists in our IntelliSound modules. If you have already made settings there, you will certainly find your way quickly.
Which of these CV banks is to be programmed depends on the respective value of two "pointers CVs", the CVs 31 and 32.
The values of these two CVs point to the corresponding CV bank, here banks 3 and 4.The values of the "pointers CVs do not change the meaning of CVs 1 - 256 and are not relevant for driving.
Setting of bank 3 for programming the courses 1 to 4: CV31=8,CV32=3 Setting of bank 4 for programming the courses 5 to 8: CV31=8,CV32=4 The following 8 PWM courses are stored here in the factory setting:
1 = Mars Light, 2 = Gyra Light, 3 = Oszi. Headlight, 4 = Stakato, 5 = Ditch Light, 6 = rotary Beacon, 7 = single Strobe, 8 = double Strobe

Since up to 64 brightness values can be entered in a gradient, 256 CVs are available for each bank. If a bank is selected for programming via the CVs 31 and 32, the single values are written into the CVs 257 - 512, each course having 64 CVs as follows:

Bank 3 (CV31=8,CV32=3)	**Bank 4 (CV31=8,CV32=4)**
Course 1: CVs 257 - 320	Course 5: CVs 257 - 320
Course 2: CVs 321 - 384	Course 6: CVs 321 - 384
Course 3: CVs 385 - 448	Course 7: CVs 385 - 448
Course 4: CVs 449 - 512	Course 8: CVs 449 - 512

The histories can be changed at any time, or replaced by custom histories, where the corresponding CVs are changed in a value range of 0 - 63.
Via the CVs 170 to 172, the outputs A0 to A2 can be assigned to one of these 8 PWM curves by entering the desired number 1 - 8 in the respective CV.
Each of the outputs light rear, A1 and A2 can be assigned one of 2 phase positions during playback. This allows two outputs to be generated, which blink in a changing clock. The required settings are entered in the CV179:

Bit	**Phase position of outputs CV179**	**Wert**
0	A0h, phase position 0°	0
	A0h, phase position 180°	1
1	A1, phase position 0°	0
	A1, phase position 180°	2
2	A2, phase position 0°	0
	A2, phase position 180°	4

Grade Crossing
If the bit7 (value 128) of the respective CV170 - 172 is set, the modulated effect is only activated if the CROSS output bit is set by function mapping (see extended function mapping). If the CROSS output bit is not set, the output is switched on constantly. If the CROSS output bit is switched off again by function mapping, the effect thus activated remains switched on until a hold time programmed in CV180 has expired. This holding time results from the value of the CV 180 multiplied by 100ms.

Servo control

The use of a servo on the decoder requires electronic expertise.
If a 1 is entered in CV166 and a function key number F0 - F28 is entered in CV167 (Servo1) and/or 168 (Servo2), a control signal for a model building service is output via the SUSI interface (Servo1 = Data, Servo2 = CLK, see graphic "Servo circuit for operating a servo on SUSI or solder pads")
The servo positions and the rotation time can be set with the following CVs:
CV160 Servo 1 position 1 (function key off)
CV161 Servo 1 position 2 (function key on)
CV162 Servo 1 Rotation time in 100ms steps
CV163 Servo 2 Position 1 (function key off)
CV164 Servo 2 position 2 (function key on)
CV165 Servo 2 Rotation time in 100ms steps

Advanced function mapping

The following settings of the decoder are only possible with the extended function mapping (CV 96 = 1).

The decoder handles the extended function mapping. In the extended function mapping, the simultaneous switching on or off of several outputs, starting and braking delays, shunting, second dimming of the function outputs, SUSI as logic level output, transfer of the function keys F22 to F28 to SUSI, and setting the CROSS bit. These functions can be switched on or off depending on linked conditions, such as function keys F0 to F44, direction of travel of the locomotive, as well as locomotive standing or driving. These combinations are stored in two CV banks. A total of 7 available CV banks with 256 CVs each are available in the decoder. For this variety of combination possibilities, so many CVs are necessary that programming in the conventional CV frame 1 to 1024 is no longer possible. Therefore, a special division into CV banks of 256 CVs (CV257 - 512) is necessary.
So the CVs 257 - 512 can be used several times. A similar procedure for handling CV banks already exists in our IntelliSound modules. If you have already made settings there, you will certainly find your way quickly.
Which of these CV banks is to be programmed depends on the respective value of two "pointers CVs", the CVs 31 and 32. The values of the "pointers CVs" do not change the meaning of the CVs 1 - 256 and are not relevant for driving.
Each CV bank of the extended function mapping consists of 16 lines with 16 entries. These 16 entries then form the combination of switching condition and output. Since two CV banks are available for the extended function mapping, a total of 32 combination possibilities for switching conditions and outputs can be realized.
TIP: Before programming the CVs 257 - 512, you should program the CVs 31 and 32 for the desired CV bank. It is recommended to read out these two "pointers CVs" before programming, so that wrong CV banks are not programmed accidentally.
To facilitate programming, especially for advanced function mapping, the programming software "Lok-Tool" can be used, which is included in the digital programming and test station "DigiTest" from Uhlenbrock. This software is also available for free download on our website www.uhlenbrock.de.
The CV programming of the extended function mapping in detail:
Pointers CVs:
CV31 = 8, CV32 = 0 for line 1 - 16 (bank 1)
CV31 = 8, CV32 = 1 for line 17 - 32 (bank 2)
Each line consists of 16 entries (bytes) with the following meaning:
Entries (bytes) 1 - 6 specify the functions that must be **enabled** for the condition to be met.
Entries (bytes) 7 - 12 specify the functions that must be **turned off** for the condition to be met.
Entries (bytes) 13 - 16 define **the output that** is turned on when the condition is fulfilled.
Each entry (byte) consists of a combination of 8 single conditions (bits)
The bits 0 - 7 in the respective entries (bytes) for **the switching conditions On (bytes** 1 - 6) and Off (**bytes 7** - 12) have the following meaning:

Byte / Bit	0	1	2	3	4	5	6	7
1 / 7	F1	F2	F3	F4	F0	n.b.	Fahr.	Vorw.
2 / 8	F5	F6	F7	F8	F9	F10	F11	F12
3 / 9	F13	F14	F15	F16	F17	F18	F19	F20
4 / 10	F21	F22	F23	F24	F25	F26	F27	F28
5 / 11	F29	F30	F31	F32	F33	F34	F35	F36
6 / 12	F37	F38	F39	F40	F41	F42	F43	F44

Fahr. Lok fährt Direction of travel
Vorw. Forward
n.b. unused

The bits in the respective entries (bytes) 13 - 16 for the output have the following meaning:

Byte / Bit	0	1	2	3	4	5	6	7
13	A1	A2						
14	A0v	A0h	S-CLK	S-Data	ABV	ABV2	ABV3	RG
15	A0-P2	A1-P2	A2-P2					
16	Cross	S-F22	S-F23	S-F24	S-F25	S-F26	S-F27	S-F28

A0v Front light output
A0h Rear light output
S-CLK Output SUSI CLK: (activate A4 logic, CV50 Bit4 = 1) or (activate Servo1, CV166 Bit0 = 1)
S-Data Output SUSI Data: (enable A3 logic, CV50 Bit4 = 1) or (enable Servo2, CV166 Bit0 = 1)
ABV Stop start-up, brake delay 1
ABV2 Start-up, brake delay 2
ABV3 Start-up, brake delay 3
RG Rangiergang
A0-P2 Light outputs, 2nd dimming
A1-P2 Function output1, 2nd dimming
A2-P2 Function output2, 2nd dimming
Cross CROSS-Bit für PWM-modulierte Ausgänge
S-F22 - S-F28 functions F22 - F28 on or off the SUSI interface, depending on the result of the conditions set in bytes 1 - 12. The state of these functions, as transmitted by the digital control center, is then no longer transferred to the SUSI interface.
The CV159 must be set accordingly for passing F22 - F28 to SUSI.

The CV number to be programmed is calculated from the

for lines 1 - 16
Base value 256
plus (row number minus 1) multiplied by 16
plus the number of the byte.

Formula: 256 + (row - 1) * 16 + byte

for lines 17 - 32
Base value 256
plus (line number minus 17) multiplied by 16
plus the number of the byte.

Formula: 256 + (row - 17) * 16 + byte

The bit structure and the values to be programmed in the CVs are comparable to the configuration CVs of the decoder. This means that there is a fixed value per set bit. If the bit is not set, the value for this bit remains 0.

Bit	**Wert**
Bit 0	1
Bit 1	2
Bit 2	4
Bit 3	8
Bit 4	16
Bit 5	32
Bit 6	64
Bit 7	128
Summe	255

The values for the individual CVs can now be derived from the above-mentioned information.

Examples:

The output A1 should **be switched on** when the function key **F1 is** switched on.
Bank 1, line 1 -> CV31 = 8, CV32 = 0
Two CVs to be programmed
First CV for the on condition (F1 on), second CV for the output (A1 on)
F1 key **on** -> CV number = 256 + (1 - 1) * 16 + 1= 257
F1 key **on** -> byte 1, bit 0 = 1 -> CV 257 = 1
Output **A1 switched on** -> CV number = 256 + (1 - 1) * 16 + 13 = 269
Output **A1 switched on** -> byte 13, bit 0 = 1 -> CV269 = 1

The front light output (A0v**)** should be switched on **when the function key** F0 is **switched on** and the locomotive is running.
Bank 1, line 2 -> CV31 = 8, CV32 = 0
Two CVs to be programmed
F0 key **on** + **driving -**> CV number = 256 + (2 - 1) * 16 +1 = 273
Key **F0 on** + **drive -**> byte 1, bit 4 = 1 + bit 6 = 1-> CV 273 = 16 + 64 = 80
Output **A0v switched on** -> CV number = 256 + (2 - 1) * 16 + 14 = 286
Output **A0v switched on** -> byte 14, bit 0 = 1 -> CV286 = 1

Start-up, brake **deceleration 2 (ABV2)** and output A2 should **be switched on** when the **locomotive is moving forward (forward) in the direction of** travel (forward), not stationary and **function F6 is switched** on.
Bank 1, line 3 -> CV31 = 8, CV32 = 0
There are four CVs to program
Fahr. + Vorw. -> CV-Nummer = 256 + (3 - 1) * 16 +1 = 289
Fahr. + Vorw. -> Byte 1, Bit 6 = 1 + Bit 7 = 1-> CV 289 = 64 + 128 = 192
F6 key **on** -> CV number = 256 + (3 - 1) * 16 +2 = 290
Key F6 on **->** byte 2, bit 1 = 1 -> CV 290 = 2
A2 switched on -> CV number = 256 + (3 - 1) * 16 + 13 = 301
A2 enabled -> byte 13, bit 1 = 1 -> CV301 = 2
ABV2 switched on -> CV number = 256 + (3 - 1) * 16 + 14 = 302
ABV2 enabled -> byte 14, bit 5 = 1 -> CV302 = 32
.
.
.

The output A0v should **be switched off** and **the outputs** A1 and **A2 should** be switched on. The second dimming for A2 (A2-P2) should also **be** switched on **and the CROSS** bit **set.**
These outputs should only be activated if the locomotive is running backwards **(Fahr.), the** function key **F14** is switched on **and the** function key F0 is switched off
Bank 2, line 17 -> CV31 = 8, **CV32 = 1**

There are four CVs for the output and three CVs for the conditions to be programmed

Lok fährt (**Fahr.**) -> CV-Nummer = 256 + (17 - 17) * 16 + 1 =
257 Lok fährt (**Fahr.**) -> Byte 1, Bit 6 = 1 -> CV 257 = 64
F14 key **switched on** > CV number = 256 + (17 - 17) * 16 + 3 = 259
F14 key switched on -> byte 3, bit 1 = 1 -> CV 259 = 2
Key **F0 switched off** + Locomotive backwards (Foreword) switched off **->** CV number = 256 + (17 - 17) * 16 + 7 = 263
Key **F0 switched off** + Locomotive backwards (Foreword) switched off **->** Byte 7, Bit 4 = 1 + Bit 7 = 1-> CV 263 = 16 + 128 = 144
A0v should be turned off **->** CV number = 256 + (17 - 17) * 16 + 14 = 270
A0v should be turned off **->** byte 14, bit 0 = 0 -> CV 270 = 0
A1 + A2 **switched on ->** CV number = 256 + (17 - 17) * 16 + 13 = 269
A1 + A2 **on ->** byte 13, bit 0 = 1 + bit 1 = 1-> CV 269 = 1 + 2 = 3
A2-P2 switched on -> CV number = 256 + (17 - 17) * 16 + 15 = 271
A2-P2 enabled -> byte 15, bit 2 = 1 -> CV 271 = 4
CROSS bit **set ->** CV number = 256 + (17 - 17) * 16 + 16 = 272
CROSS-bit **set ->** byte 16, bit 0 = 1 -> CV 272 = 1

To facilitate programming, especially for advanced function mapping, the programming software "Lok-Tool" can be used, which is included in the digital programming and test station "DigiTest" from Uhlenbrock. This software is also available for free download on our website www.uhlenbrock.de.

Second dimming of light and function outputs

The light and function outputs can be set to an alternative, second dimming (for a high beam, for example). The settings for the alternative dimming values are stored in the CVs 150 (light), 151 (A1) and 152 (A2). In the extended Function Mapping (CV96 = 1) the alternative dimming of the CVs 150 - 152 is activated via the possible conditions (see "Advanced Function Mapping).

Reset to factory setting (reset)

In order to bring the decoder back into factory settings, two (CV8, CV59) can be used in DCC programming, and one CV (CV59) in Moto-rola programming. In order not to rewrite all available areas, it can be decided which areas should be brought into factory settings. The value 1-4 to be programmed sets the following CVs in factory settings:

1 = CV0 - 256, and CV257 - 512 (RailCom® Bank 7)	CV31=0, CV32=255
2 = CV257 - 512 (RailCom Plus® Banken 5 & 6)	CV31=1, CV32=0 and CV31=1, CV32=1
3 = CV257 - 512 (extended function mapping banks 1 & 2)	CV31=8, CV32=0 and CV31=8, CV32=1
4 = CV257 - 512 (PWM modulation function outputs banks 3 & 4)	CV31=8, CV32=3 and CV31=8, CV32=4

Uhlenbrock digital

RailCom by Lenz Elektronik GmbH

SUSI

IntelliDrive 2 Mini-Lokdecoder 73 300, 73 310, 73 340, 73 406, 73 416 Programming

The configuration variables (CVs) form the basis of all the configuration options of the decoder. The decoder can be programmed with the Intellibox, DCC control panels and Motorola control panels.

Programming with the Intellibox

We recommend to program the decoder via the programming menu for DCC decoders, regardless of the format to be used later.

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

Locomotive addresses 80 to 255 in Motorola data format

The Intellibox supports an address range up to 255 in the Motorola data format. For the first Motorola address, addresses 1 to 80 can also be programmed easily via DCC programming. However, if locomotive addresses greater than 80 are to be used, the address must be programmed in the same way as in the chapter "Programming with a Märklin control panel". After this programming, the CV 1 contains the value 0 and the decoder uses the Motorola address greater than 80.

Programming with DCC devices

Use the programming menu of your DCC control panel to read and program the decoder CVs via register, CV directly or page programming. It is also possible to program the decoder via main track programming with a DCC digital control panel.

The exact procedure can be found in the manual of the used control center.

Programming of long addresses without programming menu

If the programming is carried out with control panels which do not support the programming with an input menu, the value for CV 17 and CV 18 must be calculated. Here the instructions for programming the address 2000.

- Divide the address value by 256 (2000:256 = 7 rest 208).
- Take the integer result (7) and add 192.
- Enter the result (199) as a value in CV 17.
- Enter the remainder (208) as a value in CV 18.
- Important: Set bit 5 of CV 29 to 1, so that the decoder uses the long address.

Programming lock (decoder programming lock)

The decoder programming lock is used for several decoders in a vehicle to change CVs to only one of the decoders with the same base address (CV1) or long address (CV17 and CV18). For this purpose, CV16 must be programmed in each decoder to a different number (index number) before the decoders are installed in the vehicle. To change or read the value of a CV in one of the installed decoders, program the corresponding index number in CV15 and then program the CVs of the selected decoder. The decoders compare the values in CV15 and CV16 and if both values match, the access to the CVs is released. If the comparison fails, no access to the CVs of this decoder is possible.

The following index numbers are recommended: 1 for motor decoders, 2 for sound decoders, 3 or higher for function decoders and other types of decoders.

Programming with a Märklin control panel (eg 6021)

With a Märklin control panel, all CVs can be programmed, but not read out. The decoder can be put into programming mode in two ways (a and b, depending on the control panel) and then programmed.

Switch the control panel off and on

1b.Â Set the control panel to "Motorola old" (6021 DIP 2 = off), switch the control panel off and on

Select the address of the decoder and turn on the light

2b.Â Set headquarters to "stop" and dial address 80

When the locomotive is stationary (speed 0), press the direction switch 5-8 times in succession until the lighting flashes

Press and hold the direction switch when the locomotive is stationary, set the control panel to "go" and wait for about 12 seconds

4. Enter the number of the CV to be programmed at the central office like a locomotive address
5. Briefly press the direction switch (5a and 5b). Now the rear lighting flashes 4 x fast (only 5a)
6. Enter the desired value for the CV like a locomotive address at the headquarters
7. Briefly press the direction switch (7a and 7b). Now the rear lighting flashes 4 x slowly (only 7a)

If further CVs are to be programmed repeat points 4-7

If programming is to be stopped, switch the control panel to "stop" or enter the address 80" and briefly press the direction switch.

Since programming with a Motorola digital control center from Märklin only inputs from 01 to 80 are possible, the value 0" must be entered via the address as 80".

Page register for entering CV numbers greater than 79

CV numbers larger than 79 can only be programmed with the help of the page register. This page tab is the CV64. If the CV64 is described with a value greater than 0, the contents of the CV64 times 64 are added to each subsequent address value entered. The entered value must be in the range 1 to 64.

After successful programming of all CVs greater than 79, the page register (CV64) must be reset to zero.

If, for example, the CV82 is to be programmed with the value 15, the CV64 must first be programmed with the value 1. Then the CV18 can be programmed with the value 15. In the decoder, the value 15 is now stored in the CV number 82, which results from the addition of the content of the CV64 (in the example 1) multiplied by 64 (i.e., 64) and the entered CV number at the control center (18).

Offset register for entering CV values greater than 79

CV values greater than 79 can only be programmed using the offset register. This offset register is the CV65. If the CV65 is described with a value > 0, the content of the CV65 is multiplied by 4 for all subsequent programming operations, added to each CV value programmed in the following and stored in the corresponding CV.

After successful programming of all CV values greater than 79, the offset register (CV65) must be reset to zero.

If, for example, the CV49 is to be programmed with the value 157, the CV65 must first be programmed with the value 25.

Then the CV49 can be programmed with the value 57. The decoder now stores the value 4 * 25 + 57.

Note: When programming the CV64 and CV65, the content of offset and page registers is not taken into account.

Programming with Mobile Station 1 & 2

Mobile Station 1: The programming menu is only available for certain locomotives in the locomotive menu. A locomotive with a programmable decoder must be selected from the database. Please proceed as follows:

1. Create a new locomotive and select the item 36330 from the database.
2. Press the "MENU/ESC" key and select the "CHANGE LOCOMOTIVE" section. Here you will find the last function Register programming with the designation "REG". Use this function to change the CVs of the decoder. You can only write the CVs with this function.
3. Enter the CV number and confirm it with the Shift button.
4. Then enter the value of the CV and confirm it with the toggle button. The Mobile Station now programs the CV with the desired value.

Mobile Station 2: For programming please use the DCC CV programming menu.

Warning: Before programming, remove all locomotives from the track that should not be programmed!

Table of CVs (Configuration Variables) of the decoder

IMPORTANT: All information given in the table about the outputs A1 & A2 do not apply **to the** decoder 73115

CV	Description		Range of values	Value ex works
1	Lokadresse		DCC 1-127 Mot 1-80	3
2	Minimum speed (change until the locomotive goes straight at speed step 1)		1-63	1
3	**start-up delay,** 1 means every 5 ms the current internal speed is increased by 1 If the internal maximum speed is 200 (CV 5 = 50 or CV 94 = 200), then the start-up time is from 0 to Fmax 1 second		0-255	5
4	**Braking delay (time factor** like CV 3)		0-255	5
5	**Maximum speed** (must be greater than CV 2)		1-63	48
6	**Average speed** (must be greater than CV 2 and less than CV 5)		1-63	24
7	**Software version** (The processor used can be updated)		-	different.
8	**Decoder** set, values as in CV 59		different	85
12	**Operating modes** Bit 0=0 DC (analog operation DC current) off Bit 0=1 DC (analog operation DC current) on Bit 2=0 Data format DCC from Bit 2=1 Data format DCC on Bit 3=0 Motorola data format off Bit 3=1 Motorola a data format Bit 4=0 Selectrix data format from Bit 4=1 Data format Selectrix a	Wert 0 1* 0 4* 0 8* 0 16*	0-29, 255	255
13	**Activate function keys in analogue mode** Bit 0-7 -> F1 to F8; bit = 0 function off, bit = 1 function on		0-255	0
14	**Activate function keys in analogue mode** Bit 0 and bit 4-7 -> F0 and F9 to F12; bit = 0 function off, bit = 1 function on		0-255	1
15	**Decoder programming lock**		0-255	1
16	**Decoder programming lock index number**		0-255	1
17,18	**Lange Lokadresse** 17 = higher value byte 18 = Low byte		128-9999 192-231 0-255	2000 199 208
19	**Consist address** (double traction) 0 = Consist address (CADR) is not active If bit 7 = 1 the direction of travel is reversed, so desired CADR + 128 = direction reversal		1-127	0
27	**Brake signal settings (automatic stop)** Bit 0 = 1 -> ABC right rail more positive Bit 1 = 1 -> ABC left rail more positive Bit 4 = 1 -> DC with opposite direction of travel Bit 5 = 1 -> DC with direction of travel equal Bit 7 = 0 -> ABC only driving direction forward if bit 0 = 1 or bit 1 = 1 Bit 7 = 1 -> ABC backwards only if bit 0 = 1 or bit 1 = 1	Wert 1 2 16 32 0 128	0-179	0
28	**RailCom® Konfiguration** bit 0 = 1 -> channel 1 bit 1 = 1 -> channel 2 Bit 7 = 1 -> RailCom Plus®	Wert 1 2 128	0-131	131
29	**Configuration according to DCC standard** Bit 0=0 Normal direction of travel Bit 0=1 Opposite direction of travel Bit 1=0 14 speed steps Bit 1=1 28 speed steps Bit 2=0 Only digital operation Bit 2=1 Automatic analog/digital switching Bit 3=0 RailCom® switched off Bit 3=1 RailCom® switched on Bit 4=0 Speed steps via CV 2, 5 and 6 Bit 4=1 Use characteristic curve from CV 67 - 94 Bit 5=0 Kurze Adresse (CV 1) Bit 5=1 Lange Adresse (CV 17/18)	Wert 0* 1 0 2* 0 4* 0* 8* 0* 16 0* 32	0-63	14
30	**Error memory for function outputs, motor and temperature monitoring** 1 = Error Initial outputs, 2 = Error Motor, 4 = Temperature exceedance		0-7	0

CV	Description			Range of values	Value ex works
31	Pointer CV for CV banks			0,1,8	0
32	Pointer CV for CV banks			0, 1, 3, 4, 5, 255	255
33-46	**Simple function mapping**			0-255	
	Assignment of function outputs to CVs				
	CV 33	Light function button (F0) for forward travel			1
	CV 34	Light function button (F0) when reversing			2
	CV 35	Function key F1			4
	CV 36	Function key F2			8
	CV 37	Function key F3			16
	CV 38	Function key F4			32
	CV 39	Function key F5			64
	CV 40	Function key F6			128
	CV 41	Function key F7			0
	CV 42	Function key F8			0
	CV 43	Function key F9			0
	CV 44	Function key F10			0
	CV 45	Function key F11			0
	CV 46	Function key F12			0
	Assignment of the individual bits		Wert		
	Bit 0	Front light output	1		
	Bit 1	Rear light output	2		
	Bit 2	Function output A1	4		
	Bit 3	Function output A2	8		
	Bit 4	Function output A3 (SUSI/logic)	16		
	Bit 5	Function output A4 (SUSI/logic)	32		
	Bit 6	Rangiergang	64		
	Bit 7	Start/brake deceleration	128		
47	**Motorola 1st trinary address (directly** only with Motorola programming method)			0-255	12
48	**Motorola 2nd trinary address (only** with Motorola programming method)			0-255	0
49	**Motorola 3rd trinary address (only** with Motorola programming method)			0-255	0
50	**Decoder Konfiguration 1**		Wert	0-63	0
	Bit 0=0	Do not use Motorola 2nd address	0*		
	Bit 0=1	Use Motorola 2nd address	1		
	Bit 1=0	Do not use Motorola 3rd address	0*		
	Bit 1=1	Use Motorola 3 address	2		
	Bit 2=0	Do not exchange light outputs	0*		
	Bit 2=1	Exchange light outputs	4		
	Bit 3=0	Frequency Light, A1 and A2 = 156Hz	0*		
	Bit 3=1	Frequency Light, A1 and A2 = 24KHz	8		
	Bit 4=0	SUSI = SUSI	0*		
	Bit 4=1	SUSI = A3/A4 output function mapping table	16		
51	**Decoder Konfiguration 2**		Wert	0-135	3, 131
	Bit 0=0	Engine control from	0		
	Bit 0=1	Engine control a	1*		
	Bit 1=0	Motor control PID - controller	0		
	Bit 1=1	Motor control SX - controller	2*		
	Bit 2=0	no dynamic period of engine control	0		
	Bit 2=1	dynamic period of engine control	4		
	Bit 7=0	Light, A1/A2 PluX12 decoder (73145)	0		
	Bit 7=1	Light, A1/A2 cable/NEM decoder (not 73145)	128		
53	Period of motor control in 100µs steps			0-255	40
54	Motor control P-constant of the PID controller			0-255	100
55	Motor control I-constant of the PID controller			0-255	40
56	Motor control D-constant of the PID controller			0-255	32
57	Regler Offset			0-255	6
58	Measuring gap for EMC measurement in 100µs steps			0-255	8
59	**Reset to factory settings** (also possible via CV8) 1 = CV 0 - 256, and CV257 - 512 (RailCom® Bank 7) 2 = CV 257 - 512 (RailCom Plus® Banken 5 & 6) 3 = CV 257 - 512 (extended function mapping banks 1 & 2) 4 = CV 257 - 512 (PWM modulation function outputs banks 3 & 4)			0-4	0
60	**Motor, function outputs, temperature monitoring.** On (do not change)			-	-
61	Constant for temperature shutdown			-	-
62	Constant of short-circuit detection of the output (do not change)			-	-
63	Constant of motor output short circuit detection (do not change)			-	-
64	**Page Register** for CV programming with a motor control panel			0-255	0
65	**Offset-Register** for CV programming with a motor control panel			0-255	0
66	Speed correction forward			0-255	0
67-94	**Extended speed control for speed steps 1 - 28**			0-255 each	different.
95	Speed correction backwards			0-255	0

CV	Description	Range of values	Value ex works
96	**Type of function mapping** 0 = simple function mapping, 1 = advanced function mapping	0-1	0
97	**ABC Brake** Voltage difference for diode line is about CV value * 0.12V	0-255	8
98	Speed in the ABC Slow Track	0-255	30
107	Switch off front lighting	0-44	0
108	Switch off rear lighting	0-44	0
109	**Flashing generator, assignment of phase 1 to the outputs** Bit 0-2 -> A0 to A2; Bit = 0 Blink phase 1 off, Bit = 1 Blink phase 1 on	0-7	0
110	**Flashing generator, assignment of phase 2 to the outputs** Bit 0-2 -> A0 to A2; Bit = 0 Blinkphase 2 off, Bit = 1 Blinkphase 2 on	0-7	0
111	Turn-on time in 100ms steps	0-255	5
112	Turn-off time in 100ms steps	0-255	5
113	**Switching off the function outputs A1 - A4 in the direction of travel forward** Bit 1-4 -> A1 - A4; bit = 0 output on, bit = 1 output off	0-31	0
114	**Switching off the function outputs A1 & A2 backwards** Bit 1-4 -> A1 - A4; bit = 0 output on, bit = 1 output off	0-31	0
115	Setting of the train category for LISSY	1-4	1
116-118	**Dimming of light and function outputs A1 & A2** 0=off, 63=100%	0-63	63
124	**Clutch Springs for Electric Clutches on A1 & A2** 0=no clutch	0-255	1
125	**Clutch** start-up time, value * 100ms	0-255	10
126	**Clutch holding time, value** * 100ms	0-255	20
127	**Clutch break time, value** * 100ms	0-255	10
128	**Retaining PWM**	0-255	30
129	**Assignment of outputs A1 & A2 electrical couplings (0=no coupler**.) Bit 1-2 -> A1 & A2	0-6	0
130	**Dynamic smoke generator control on A1 & A2** Wert 0=no smoke generator operation 0* bit 0=1 -> A1=smoke generator operation, 1 Bit 1=1 -> A2=smoke generator operation 2 Bit 4-7 = 1 -> start time = value * 200ms 16-240	0-243	0
131	Dynamic smoke generator control, load threshold	0-255	5
132	Dynamic smoke generator control, PWM normal operation	0-63	16
133	Dynamic smoke generator control, PWM idle (stand)	0-63	2
134	Dynamic smoke generator control, starting time in 100ms steps	0-255	30
135	**Shunting** tango (automatic uncoupling), speed step (0 = off)	0-255	0
136	**Shunting tango,** pressing time T1 * 100ms	0-255	10
137	**Shunting tango,** reverse time T2 * 100ms	0-255	10
138	**Constant stopping distance in cm,** speed step threshold Brake only above with constant stopping distance (0 = off)	0-255	0
139	Constant stopping distance in cm, first stopping distance	0-255	50
140	**Constant stopping distance in cm,** alternative stopping distance	0-255	25
141	**Constant braking distance in cm,** maximum speed of the prototype locomotive in km/h	0-255	40
142	**Constant stopping distance in cm,** residual value of the determined maximum speed	0-255	0
143	**Constant stopping distance in cm,** activated by: Bit 0 = 1 -> target speed = 0 Bit 1 = 1 -> ABC brakes Bit 2 = 1 -> DC brakes Bit 3 = 1 -> DCC brake signal	0-15	0
144	**Start-up delay** 2 (as replacement for CV3)	0-255	12
145	**Brake deceleration 2, (as** replacement for CV4)	0-255	12
146	**Start-up delay 3 (as** replacement for CV3)	0-255	24
147	**Brake Deceleration 3, (as** replacement for CV4)	0-255	24
148	Function key number for ABV 2 (255=off)	0-28	255
149	Function key number for ABV 3 (255=off)	0-28	255
150 - 152	**Second dimming of light and function outputs A1 & A2** 0 = off, 63 = 100%	0-63	10
159	Identification of functions F22 - F28 for transfer to SUSI Bit 0-6; Bit = 1 -> F22 - F28 is passed to SUSI	0-127	0
160	Servo control, Servo 1 position 1 (function key off)	0-255	20
161	Servo control, Servo 1 position 2 (function key on)	0-255	200
162	Servo control, Servo 1 Rotation time in 100ms steps	0-255	30
163	Servo control, Servo 2 position 1 (function key off)	0-255	20
164	Servo control, Servo 2 position 2 (function key on)	0-255	200

CV	Description		Range of values	Value ex works
165	Servo control, Servo 2 Rotation time in 100ms steps		0-255	30
166	Servo control via SUSI, 1 = on, 0 = off		0, 1	0
167	Function key number for Servo 1 SUSI-Data		0-28	7
168	Function key number for Servo 2 SUSI-CLK		0-28	8
170	**Assignment of PWM gradient for light output** History 1 - 8, Bit 7 = 1 -> History active only if CROSS output bit set		0-8 129-136	0
171	**Assignment of PWM profile for function output A1** History 1 - 8, Bit 7 = 1 -> History active only if CROSS output bit set		0-8 129-136	0
172	**Assignment of PWM profile for function output A2** History 1 - 8, Bit 7 = 1 -> History active only if CROSS output bit set		0-8 129-136	0
178	**PWM history,** playback period (value * 64ms)		0-255	15
179	**PWM profile,** phase position of the outputs Bit 0 = 0 A0h -> phase position 0° Bit 0 = 1 A0h -> phase position 180° Bit 1 = 0 A1 -> phase position 0° Bit 1 = 1 A1 -> phase position 180° Bit 2 = 0 A2 -> phase position 0° Bit 2 = 1 A2 -> phase position 180°	Wert 0* 1 0* 2 0* 4	0-7	0
180	**PWM** history, hold time, after the CROSS output bit off (value * 100ms)		0-255	0
181	**Fire cans flickering of light and function outputs A1 & A2** Bit 0-2 -> A0 to A2; bit = 0 flicker off, bit = 1 flicker on		0-7	0
182	**Firebox flicker, flicker settings** Bit 0-3 -> Change flicker rate (value range 1 to 15) Bit 4-6 -> Change brightness (value range 16, 32, 48, 64, 80, 96, 112) bit 7 = 1 -> output always bright (can be combined with bit 4-6)		0-255	0
183	**Energy saving lamp effect of light and function outputs A1 & A2** Bit 0-2 -> A0 to A2; bit = 0 effect off, bit = 1 effect on		0-7	0
184	**Energy** saving lamp effect, basic brightness		0-63	10
185	**Energy** saving lamp effect, time until maximum brightness is reached (value * 5ms)		0-255	100
186	**Show and hide the light and function outputs A1 & A2** Bit 0-2 -> A0 to A2; Bit = 0 Blend function off, Bit = 1 Blend function on		0-7	0
187	**Fade in and out,** glare time (value * 1ms)		0-255	30
188	**Switch-on effect of the light and function outputs A1 & A2** Bit 0-2 -> A0 to A2; bit = 0 effect off, bit = 1 effect on		0-7	0
189	**Turn-on** effect, flash time (value * 5ms)		0-255	20
190	**Neon lights Turn-**on effect, maximum number of flashes		0-255	20
200	**Motor control, speed-dependent period** minimum speed up to which the period = CV53 is set		0-255	10
201	maximum speed from which the period duration = CV202 is set		0-255	150
202	maximum period duration in steps of 100µs (min=CV53)		0-255	250

* factory set values

CV table for programming banks 1 - 4

CV	Bank 1, extended root mapping, lines 1 - 16 (CV31=8,CV32=0), factory values	Range of values
257-272	Condition ON: 144, 0, 0, 0, 0, 0, condition ON: 0, 0, 0, 0, 0, 0, output: 0, 1, 0, 0,	0 - 255 each
273-288	Condition ON: 16, 0, 0, 0, 0, 0, condition OFF: 128, 0, 0, 0, 0, 0, output: 0, 2, 0, 0,	0 - 255 each
289-304	Condition ON: 1, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 1, 0, 0, 0,	0 - 255 each
305-320	Condition ON: 2, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 2, 0, 0, 0,	0 - 255 each
321-336	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
337-352	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
353-368	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
369-384	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
385-400	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
401-416	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
417-432	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
433-448	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
449-464	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
465-480	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
481-496	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
497-512	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each

CV	Bank 2, extended root mapping, lines 17 - 32, (CV31=8,CV32=1), factory values	Range of values
257-272	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
273-288	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
289-304	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
305-320	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
321-336	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
337-352	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
353-368	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
369-384	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
385-400	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
401-416	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
417-432	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
433-448	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
449-464	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
465-480	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
481-496	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
497-512	Condition ON: 0, 0, 0, 0, 0, 0, condition OFF: 0, 0, 0, 0, 0, 0, output: 0, 0, 0,	0 - 255 each
	Bank 3, PWM modulations, progression 1 - 4, (CV31=8,CV32=3), factory values	
257 until 320	3, 8, 16, 24, 32, 48, 63, 63, 63, 63, 48, 32, 24, 16, 8, 3,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
	3, 8, 16, 24, 32, 48, 63, 63, 63, 63, 48, 32, 24, 16, 8, 3,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
321 until 384	3, 8, 16, 24, 32, 48, 63, 63, 63, 63, 48, 32, 24, 16, 8, 3,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
	3, 8, 11, 14, 22, 28, 32, 32, 32, 32, 28, 22, 14, 11, 8, 3,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
385 until 448	5, 15, 25, 35, 45, 55, 63, 63, 63, 55, 45, 35, 25, 15, 5, 0,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
449 until 512	8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8,	0 - 63 each
	32, 32, 32, 32, 32, 32, 32, 32, 32, 32, 32, 32, 32, 32, 32, 32,	0 - 63 each
	63, 63, 63, 63, 63, 63, 63, 63, 63, 63, 63, 63, 63, 63, 63, 63,	0 - 63 each
	48, 48, 48, 48, 48, 48, 48, 48, 48, 48, 48, 48, 48, 48, 48, 48,	0 - 63 each
	Bank 4, PWM modulations, course 5 - 8, (CV31=8,CV32=4), factory values	
257 until 320	3, 8, 16, 24, 32, 40, 48, 56, 63, 63, 63, 63, 63, 63, 63, 63,	0 - 63 each
	56, 50, 44, 40, 36, 33, 29, 26, 23, 21, 19, 17, 14, 12, 11, 10,	0 - 63 each
	9, 8, 7, 6, 5, 4, 3, 2, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
321 until 384	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16,	0 - 63 each
	63, 63, 63, 63, 63, 63, 63, 63, 16, 15, 14, 13, 12, 11, 10, 9,	0 - 63 each
	8, 7, 6, 5, 4, 3, 2, 1, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
385 until 448	63, 63, 63, 63, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
449 until 512	63, 63, 63, 63, 0, 0, 0, 0, 63, 63, 63, 63, 0, 0, 0, 0,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each
	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0 - 63 each