#56421 PIKO SmartDecoder 4.1 Sound PluX22 for diesel locomotives TGK2 H0 Multiprotocol

Description

The innovative PIKO Sound PluX22 SmartDecoder 4.1 is a compact, high-performance, multi-protocol next-generation sound decoder using 12-bit sound with a high sampling rate, 2.5-watt power output, and a significantly increased memory capacity. The decoder eliminates motor “hum” typical of older decoders, ensuring outstanding prototypical sound on multiple levels. It can be used on DCC, Selectrix, and Motorola digital systems as well as in analog mode with DC or AC power. The decoder is RailCom® and RailCom Plus® compatable. The PIKO SmartDecoder 4.1 automatically recognizes the layout’s operating mode (DCC or analog) and has multiple settings for a wide range of additional functions, including programming braking distances.

The load-regulated sound decoder operates on a motor frequency of 18.75 kHz and is therefore suitable for DC and bell-shaped armature motors (ie. Faulhaber, Maxon, Escap) that draw a 1.2A continuous current. Temporarily higher currents up to 2 A. are easily tolerated. The decoder masters both ABC braking and ABC slow speed mode. The motor speed curve is calibrated to minimum, average, and maximum speed (simple speed curve) or via an extended speed curve with individual settings for 28 speed steps. The decoder has two directional lighting outputs as well as seven additional special function outputs. Extended-range slow-speed switching (shunting), acceleration settings, braking delays, and numerous sound functions are activated via function keys.

Decoder properties

- Suitable for DC and bell-shaped armature motors rated up to 1.2A
- Ultra-quiet motor operation via 18.75 kHz operating frequency
- 14, 27, 28, and 128 speed steps, depending on the data format
- Supports short (1-127) and long (128-9999) addressing
- NMRA compliant
- RailCom® and RailCom Plus
- mfx®-capable (AC version)
- Adjustable minimum, average, and maximum speeds
- Adjustable extended-range speed curve
- Switching (shunting) mode gear
- 3 adjustable startup and braking delays, each activated via F0 - F28
- Dimmable, directional lighting outputs
- 7 adjustable special function outputs, dimmable and directional-dependent
- Adjustable light and function outputs for analog operation
- Adjustable secondary dimming functions for lighting outputs, activated via A1 to A7
- ESimple function mapping; F0 - F12 for lighting, A1 to A7 for acceleration, braking, and switching (shunting) modes
- Extended function mapping on F0 - F44 for activating or switching multiple linked outputs
- Passenger car lighting can be switched off
- Adjustable flash function with variable on/off timing
- Adjustable 2-phase blinking function
- Load-dependent smoke generator control
- Firebox lighting effect with adjustable parameters for brightness and flicker rhythm
- Switching (shunting) mode coupling and switching (shunting) tango
- Adjustable on/off option for hiding light and function outputs
- Fade in/out lighting effect: lamps reach their maximum brightness over an adjustable length of time
- Fluorescent lighting effect with switch-on flickering effect and adjustable flash time and number
- 8 PWM banks each with 64 modulation entries used, for example, for American lighting effects
- Automatic braking via DCC brake signals, braking with DC analog or ABC braking blocks
- ABC restricted speed movements via LENZ BM2 block stopping module
- 2 adjustable braking distances in centimeters that are activated via ABC, DC, or DCC braking signals, as well as via speed step 0 using an adjustable speed step threshold
- 2 motor control modes for precise motor control with numerous parameter settings
- Motorola-compliant operation with 3 addresses for functions F1 - F12 when used with a Motorola-based DCC system
- All outputs are protected against short circuits
- Error memory for motor and function outputs, as well as automatic overheating shutdown
- Conventional DC and AC analog operation that automatically switches to the respective operating mode
- All CVs must be programmed with a Motorola-based DCC digital device
- Programmable in DCC via register mode, direct CV programming, or page mode programming
- Programming On the Main (DCC))
- Decoder programming lock

Sound functions

- All sounds in 12-bit resolution
- 8-channel sound system
- 128 MB of sound memory for up to 495 seconds of digitized prototype sound
- 22.05 kHz sampling rate
- Powerful digital power amplifier with 2.5 watt output
- User activated and deactivated sound sequences when engine sound is switched on and off
- Up to 31individual sounds, switchable via 28 function keys
- Load-dependent sound variation (acceleration, upgrade, downgrade, braking, idling, etc.)
- Adjustable volumes for overall sound and for individual sounds
- Doppler effect sound (i.e. entering tunnel, grade crossings) Random sounds such as coal shoveling or engine fans
- Automatic brake squeal
- Adjustable speed thresholds for switching (shunting) sound
- Sound projects easily programmed via PIKO SmartProgrammer/Tester
- And much more..

Installing the PIKO SmartDecoder 4.1 Sound

Remove the jumper plug from the PluX22 interface of your model. Replace it with the Sound decoder, carefully inserting it into the interface socket. Note the missing PIN 11. Install the 4 - 16 Ohm speaker as shown in the „Spare parts list“ diagram. Make sure that no bare wires or wire tips are touching each other, and that there are no short circuits, even after replacing the model shell. The model should then be placed on a dedicated programming track, with programming mode activated on your DCC system. During programming or reading the model’s DCC address, a small amount of current will flow through the decoder that does not damage it, nor is it an indication of a short circuit.

Auxiliary functions A1 to A7

The Sound decoder’s auxiliary function outputs A1 to A7 can only be used if they are connected to auxiliary functions, and those functions are already connected to the PluX 22 interface in the model, or if solder pads are available on the main circuit board.

A short circuit in the motor, lighting, gearing, or wheelsets will destroy the decoder and possibly all the electronics of the model!

SUSI interface

The SUSI interface of this sound decoder is connected to the PluX22 interface. If the main circuit board of the model is equipped with a SUSI interface, another PIKO sound module with SUSI can be connected to it. The specific CVs that should be programmed for their respective applications can be found in the CV table.

ATTENTION: Soldering on the decoder itself should only be done by experienced modelers using the appropriate equipment. Decoders damaged by improper handling will not be covered by the warranty.

First-time use of the decoder (state of delivery)

Enter address 3 on your DCC control unit. Depending on the data format used, the sound decoder will operate in DCC mode with 28 speed steps or in Motorola mode. When using a RailCom Plus®-capable DCC system (eg PIKO SmartControl), the decoder is automatically recognized within seconds and can be operated immediately. If the decoder is used on an analog layout, it can be controlled with a traditional DC or AC throttle. The layout’s operating mode is detected automatically by the decoder.

Analog DC/AC operation

This sound decoder is suitable for analog DC or analog AC operation, which is detected automatically. Please note that trouble-free operation using PWM (Pulse Width Modulation)-equipped throttles cannot be guaranteed due to the large number of differing systems available on the market.

NOTE: On a DC analog layout, your model will only start at a higher voltage (the throttle must be turned up halfway or more) then you may be accustomed to when operating analog model trains.

Function outputs in analog mode

It is possible to program the decoder so that function keys F0 - F12, as they are assigned in the function mapping, can also be activated in analog mode. To do this, CVs 13 & 14 must first be programmed with a DCC system. The corresponding values can be found in the CV table.

Motorola

To access functions F1 - F12 when using a Motorola-format DCC system, the decoder has 3 trinary Motorola addresses, which are stored in CVs 47 - 49. These 3 addresses are also used for decoding. If an address is decimally programmed into CV1, the decoder automatically stores the trinary equivalent in CV47, up to address 79. For example, to use Motorola-format decoders up to 255, CVs 47 - 49 must be programmed directly in decimal via Motorola-format programming. On a DCC programming track, these CVs can be read but not programmed.

If CV47 is programmed via Motorola format, CV1 will not be changed and therefore the DCC data format will be switched off in CV12, so that the decoder cannot be inadvertently addressed via 2 different addresses.

If bit 5 is set in CV29 (DCC long address), the Motorola data format is switched off except for the Motorola programming so that the decoder cannot react to 2 addresses.

Configuration CVs

In addition to the decoder address, the configuration CVs of a locomotive decoder are the most important CVs. These are CVs 29, 50 and 51 in the PIKO SmartDecoder 4.1. As a rule, a configuration CV contains various 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. Below you will find the definition and content of each configuration CV, as well as a sample calculation of the value:

Bit	Configuration CV29	Value
0	Normal direction of travel Opposite direction of travel	0 1
1	14 / 27 Speed steps 28 / 128 Speed steps	0 2
2	Digital mode only Automatic Analog or Digital recognition	0 4
3	RailCom® turned off RailCom® turned on	0 8
4	Speed steps over CV 2, 5, and 6 Use characteristic curve from CV 67-94	0 16
5	Short address (CV 1, Register 1) Long Address (CV 17 und 18)	0 32

Bit	Configuration CV50	Value
0	Motorola 2nd address not used Motorola 2nd address used	0 1
1	Motorola 3rd address not used Motorola 3rd address used	0 2
2	Light outputs not changed Light outputs changed	0 4
3	Light frequency, A1 to A7 = 156Hz Light frequency, A1 to A5 = 24KHz	0 8
4	SUSI = SUSI SUSI = A3/A4 Logic level	0 16

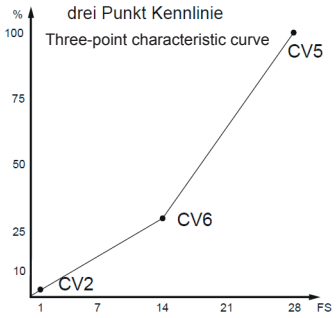
Example of a calculation (CV 29):

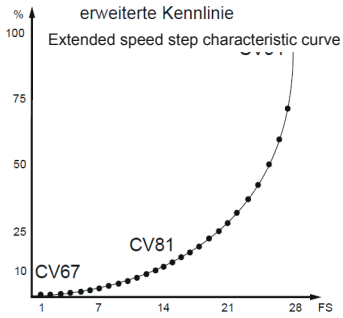
Normal direction of travel	value = 0
28 speed steps	value = 2
Automatic analog/digital changeover	value = 4
RailCom® switched on	value = 8
Speed steps over CV 2, 5, 6	value = 0
Short address	value = 0

The sum of all values is 14. This value is stored by default in CV 29, from the factory.

Speed step characteristic curve

The decoder is preset to a simple, 3-point characteristic curve that determines the minimum (CV2), average (CV6) and maximum (CV5) speeds. However, it can also be switched to an extended speed step characteristic curve for 28 speed steps (CV29, Bit 4 = 1). This characteristic curve gives you the option for programming individual settings for each of the 28 speed steps. The settings are entered in CVs 67 to 94, where one CV is reserved for each of the 28 speed steps.





RailCom®, RailCom Plus®

The basis for RailCom® technology developed by LENZ® is the transfer of data from the decoder to a specific (CutOut) DCC digital signal in the rails. Detectors have to be located along the track, which evaluate the decoder data and, if necessary, forward it to the command station. Depending on its settings, the decoder transmits its address and, when reading out via Programming On the Main (POM), CV values that can be displayed by the DCC control panel (depending on the detector and the control panel). In the decoder, RailCom® CV 29 can be turned on or off via bit 3. Further RailCom® settings can be changed in CV 28. For example, RailCom Plus® is turned on via bit 7. If RailCom Plus® is activated, the decoder is automatically recognized by a RailCom Plus®-capable DCC system (like PIKO SmartControl) with a locomotive icon, decoder address, and unique icons within a few seconds. With RailCom Plus® technology, no locomotive data needs to be stored in the command station and no locomotive addresses have to be programmed into the decoder.

Braking

Märklin braking distance

The decoder responds to a Märklin braking section (braking with analog DC voltage applied to a DCC-powered 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 equal direction of travel

ABC braking

If lower amperage of digital power is detected by the decoder on a section of track, then a braking process is initiated.

The braking process is activated by the rail that has greater positive voltage than the opposite rail. This can be adjusted via CV27:

CV27 = 1; brake when right rail is more positive

CV27 = 2, brake when left rail is more positive

CV27 = 3, braking regardless of which rail is more positive

Using bit 7 of CV27, it is possible to program whether the model should only react to ABC braking sections in one direction (forward or reverse). However, only one of bits 0 or 1 may be set for this purpose. Regardless of the positions of bits 0 and 1 (at least one must be set to detect an ABC braking section), it is possible for the model to move over an activated ABC braking section if the switching (shunting) gear is activated or the start-up braking deceleration is deactivated.

In CV97, the voltage difference can be set for which the decoder recognizes an ABC braking section. The desired voltage difference corresponds roughly to a CV value of * 0.12 V. If an ABC restricted-speed signal is detected in that is controlled by a Lenz BM2 module, the decoder will brake the model according to its CV98 internal speed setting (0 - 255).

Constant braking distance in cm

The decoder offers two adjustable, constant braking distances measured in centimeters; true to scale. The constant braking distances can be activated in several ways. These include an ABC brake signal, a brake signal from a DCC brake function, the brake signal of a DC braking section, and speed step 0. When braking with speed step 0 (i.e. manual mode), it is possible to cross a speed threshold, above which a constant braking distance is activated. If the internal speed of the locomotive decoder is less than the programed speed step threshold, the model will remain at speed step 0 with the current braking deceleration set from CV4, or CV145, or CV147.
CV138 = 1 - 255 -> The actual speed above which activates braking with a constant braking distance when the nominal speed is set to zero.
CV meanings
CV139 = braking distance in centimeters
CV140 = alternative braking distance, can be activated via the CROSS bit (see „Extended Function Mapping“)
CV141 = maximum speed of model in centimeters per second
CV142 = If the value determined for CV141 is above 255, the value exceeding 255 is transferred into CV142 (eventually in G scale and 1 scale)
CV143 = Activation of the constant braking distance by:
Bit 0 = 1 -> nominal speed = 0, with a current internal speed according to CV138 and greater
Bit 1 = 1 -> ABC braking
Bit 2 = 1 -> DC braking
Bit 3 = 1 -> DCC brake signal
CV143 = 0 -> no constant braking distance
If deceleration is initiated with a constant braking distance, the decoder will not respond to throttle commands until the model has come to a standstill. This process can be interrupted by activating the switching (shunting) mode.

Determining the maximum speed of the model

In the decoder, program the CV that controls maximum speed to the maximum possible value (i.e. CV5 = 63, or if using the extended speed step characteristic CV94 = 255). Mark off a starting point on a sufficiently long, straight section of track from which the model can run safely for approximately 2 seconds at maximum possible speed. Place a tape measure or a folding ruler at the starting point. Now run the model at maximum speed (i.e. the throttle turned all the way up) over this section. As soon as the model starts, begin timing it for 2 seconds. At the end of these 2 seconds, mark the location of the model on your tape measure and read the distance in centimeters. Divide this value by 2 and you will get the model's top speed in centimeters per second. This value is now entered into CV141. In G scale and 1 scale, the determined value may exceed 255. If it does, enter a value of 255 in CV141 and the remainder of the determined value in CV142.
After taking this measurement, the CV for maximum speed (CV5 or CV94) can be set to your desired maximum running speed..

Function outputs

Simple function mapping

The following decoder settings are only possible using simple function mapping (CV96 = 0). In simple function mapping, you can freely assign switchable functions such as lighting, special function outputs, switching (shunting) mode, and switchable acceleration and deceleration rates to function keys F0 to F12 of your DCC system. The value written to a CV contained in a mapped function determines what that function key can activate. CVs 33 to 46 serve this purpose according to this table

Assignment of function keys to CVs		Factory value
CV 33	Light function key F0 forward direction	1
CV 34	Light function key F0 reverse direction	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 individual bits		Value
Bit 0	Front light ouput	1
Bit 1	Rear light output	2
Bit 2	Function output A1	4
Bit 3	Function output A2	8
Bit 4	Function output A3	16
Bit 5	Function output A4	32
Bit 6	Switching (shunting)	64
Bit 7	startup/brake delay	128

Example 1: The rear light output should only be switched with function key F5. Function key F5 is programmed with CV39. A value of 2 (rear light output) is programmed into CV 39. To keep F0 from causing the rear light to be switched backwards in the direction of travel, CV34 for function key F0 must also be programmed backwards to 0, in the direction of travel.

Example 2: Function output A1 and switching (shunting) mode should be switched together with function key F10. Function key F10 is programmed with CV44. A value of 4 (function output A1) plus a value of 64 (shunting speed) create a total value 68, which is programmed into CV44. To keep function output A1 from continuing to be activated from function key F1 and the switching (shunting) mode from continuing to be activated by function key F5, both CV 35 for function key F1 and CV 39 for function key F5 must be reprogrammed to a value of 0.

Function mapping shift

CVs 33 to 46 contain function mapping. Since only 8 outputs (bits 0 - 7) can be activated with a CV, there are two more CVs with which the bitwise meaning in CVs 33 to 46 can be changed. CV100 changes the bitwise meaning in CVs 33-38 and CV101 in CVs 39-46. Each bit in CV100 / 101 alters the meaning of the bits in any of CVs 33-46. The following rules apply here:
If the respective bit in CV100 / 101 equals 0, then the bits in one of the CVs 33-46 get their meaning from the table above.
If the respective bit in CV100 / 101 is 1, then the bits in one of CVs 33-46 have the following meaning:

Assignment of individual bits		Value			Value
Bit 0	Function output A2	1	Bit 4	start up/braking delay	16
Bit 1	Function output A3	2	Bit 5	Function output A5	32

Bit 2	Function output A4	4	Bit 6	Function output A6	64
Bit 3	Switching (shunting)	8	Bit 7	Function output A7	128

Assignment of bits in CV100	Value	Assignment of bits in CV101	Value
Bit0 = Change of assignment in CV35 (F1)	1	Bit0 = Change of assignment in CV39 (F5)	1
Bit1 = Change of assignment in CV36 (F2)	2	Bit1 = Change of assignment in CV40 (F6)	2
Bit2 = Change of assignment in CV37 (F3)	4	Bit2 = Change of assignment in CV41 (F7)	4
Bit3 = Change of assignment in CV38 (F4)	8	Bit3 = ÄChange of assignment in CV42 (F8)	8
Bit4 = Change of assignment in CV33 (F0v)	16	Bit4 = Change of assignment in CV43 (F9)	16
Bit5 = Change of assignment in CV34 (F0r)	32	Bit5 = Change of assignment in CV44 (F10)	32
		Bit6 = Change of assignment in CV45 (F11)	64
		Bit7 = Change of assignment in CV46 (F12)	128

Example 3: Function output A6 needs to be switched with function key F6.
The first CV to be programmed for function key F6 is CV40. A value of 64 (A6) is programmed into CV40. In order to change function output A6 (instead of shunting speed {RG}) to a value of 64, bit 1 = 1 (change of the assignment in CV40) is set in CV101. That is, a value of 2 is entered (assignment of bits in FIG CV 101).

Activating front and rear train lighting (CV96 = 0)

Special functions 1 - 12 can be entered into CV107 (front) and CV108 (rear), which control the white and the red lights on the front or rear of the train. As well, function outputs A1 to A7 can also be programmed into CV107 and CV108, to control the red taillights.
Function numbers entered in these CVs must be set using Function Mapping so that they do not activate any other outputs. Care must also be taken to ensure that the taillight outputs used are not switched on or off via function mapping by other function keys. For example, function mapping CVs of function keys used must be set to zero. In order for the light to switch off properly, both CVs 107 and 108 must always be programmed as desired. If CVs 107 or 108 are programmed with a value of 0, the function is considered deactivated.
The value for programming CV 107 and CV 108 is determined by two factors. One factor is what outputs from A1 to A7 the lighting activation is connected to and the second factor is what function key from F1 to F12 is the lighting activation connected to. Since a CV can only have one value, these values are combined into a single value according to the following rules:
Light assignment: A0v = white light in front, A0h = white light in the back
CV107 for red lighting on the front
CV108 for red lighting on the rear
Calculation: output * 16 + function key
Example: The red front lights should be connected to A1 and switched to F5.
CV107 = 1 * 16 + 5 = 21
The red taillight should be connected to A2 and switched with F6.
CV108 = 2 * 16 + 6 = 38

Switching function outputs off depending on direction of travel (CV96 = 0)
In CVs 113 (forward) and 114 (reverse), it is possible to specify which function output in A1 - A7 should be switched off. If such an output is switched on via a function key, it is automatically switched off in the desired direction of travel.

CV 113:		Value	CV 114:		Value
Bit 1	A1 forward off	2	Bit 1	A1 reverse off	2
Bit 2	A2 forward off	4	Bit 2	A2 reverse off	4
Bit 3	A3 forward off	8	Bit 3	A3 reverse off	8
Bit 4	A4 forward off	16	Bit 4	A4 reverse off	16
Bit 5	A5 forward off	32	Bit 5	A5 reverse off	32
Bit 6	A6 forward off	64	Bit 6	A6 reverse off	64
Bit 7	A7 forward off	128	Bit 7	A7 reverse off	128

A combination (sum of the individual values) is possible in each case.

Simple and extended function mapping

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

Dimming the light and function outputs

Light functions and function outputs A1 to A7 can be set to any desired level of dimming. These settings are stored in CVs 116 (light), 117 (A1) through 123 (A7).

Fade-in/fade-out option for lighting and function outputs

When the output is switched on or off, it will fade in or fade out softly.
CV186 is used to specify which output should control this option.

CV 186:		Value			Value
Bit 0	light output with fade function	1	Bit 4	A4 with fade function	16
Bit 1	A1 with fade function	2	Bit 5	A5 with fade function	32
Bit 2	A2 with fade function	4	Bit 6	A6 with fade function	64
Bit 3	A3 with fade function	8	Bit 7	A7 with fade function	128

A combination (sum of the individual values) is possible in each case.

The value of CV187 determines how fast the fade function works. The step size is CV value * 10ms.

Blinking effects for lighting and function outputs

The model's decoder has a flashing option that can be assigned to the function outputs. Both the activation time and deactivation time of the flasher option can be set separately.

CV109 is used to specify which output the flasher option is connected to. Furthermore, the setting of CV110 determines which output will activate the flasher option, when, for example, the model reverses direction.

CV 109:		Value	CV 110:		Value
Bit 0	light output with flash option	1	Bit 0	light output with flash option 180°	1
Bit 1	A1 with flash option	2	Bit 1	A1 with flash option 180°	2

Bit 2	A2 with flash option	4	Bit 2	A2 with flash option 180°	4
Bit 3	A3 with flash option	8	Bit 3	A3 with flash option 180°	8
Bit 4	A4 with flash option	16	Bit 4	A4 with flash option 180°	16
Bit 5	A5 with flash option	32	Bit 5	A5 with flash option 180°	32
Bit 6	A6 with flash option	64	Bit 6	A6 with flash option 180°	64
Bit 7	A7 with flash option	128	Bit 7	A7 with flash option 180°	128

A combination (sum of the individual values) is possible in each case.

In CV111 the activation time is adjustable in 100millisecond steps and in CV112 the deactivation time in 100millisecond steps.

Switch-on effect for a neon light / fluorescent lamp

The switch-on effect of a defective fluorescent lamp can also be assigned to light and function outputs. This effect consists of an adjustable number of flashes (a random flash up to the maximum number of flashes) and an adjustable flash time (i.e. how fast the flashes should follow each another).

CV 188:		**Value**			**Value**
Bit 0	light output with fluorescent effect	1	Bit 4	A4 with fluorescent effect	16
Bit 1	A1 with fluorescent effect	2	Bit 5	A5 with fluorescent effect	32
Bit 2	A2 with fluorescent effect	4	Bit 6	A6 with fluorescent effect	64
Bit 3	A3 with fluorescent effect	8	Bit 7	A7 with fluorescent effect	128

A combination (sum of the individual values) is also possible here.

The flash time is set via CV 189 in 5millesecond steps. The maximum number of flashes is set in CV 190.

Energy-saving lighting effect when switching on light and function outputs

When switching on an energy-saving lamp, it first displays a basic brightness, before it slowly reaches maximum brightness. This effect can be assigned to the decoder outputs as follows.

CV 183:		**Value**			**Value**
Bit 0	light output as energy saving lamp	1	Bit 4	A4 as energy saving lamp	16
Bit 1	A1 as energy saving lamp	2	Bit 5	A5 as energy saving lamp	32
Bit 2	A2 as energy saving lamp	4	Bit 6	A6 as energy saving lamp	64
Bit 3	A3 as energy saving lamp	8	Bit 7	A7 as energy saving lamp	128

A combination (sum of the individual values) is possible here.

The basic brightness is adjustable via CV184. The setting of CV185 determines how fast the final intensity of the brightness (PWM1 in CVs 116 - 123) is reached. Each increment has a CV value * 5millesseconds..

Firebox flicker

Light outputs A1 to A7 can be assigned random flickering. This effect is typically used for the flickering inside a firebox.

CV 181:		**Value**			**Value**
Bit 0	light output with flicker	1	Bit 4	A4 with flicker	16
Bit 1	A1 with flicker	2	Bit 5	A5 with flicker	32
Bit 2	A2 with flicker	4	Bit 6	A6 with flicker	64
Bit 3	A3 with flicker	8	Bit 7	A7 with flicker	128

A combination (sum of the individual values) is also possible here.

Settings for the flicker rhythm, as well as for the intensity of brightness are entered in CV 182.

Bits 0 - 3 change the flicker rhythm (value range 1 to 15).

Bits 4 - 6 change the brightness (value range 16, 32, 48, 64, 80, 96, 112).

With a value of 128, the output is always bright, but this can be combined with a value range of 16 to 112.

Since only one value can be programmed into a CV, the flicker effect results from the sum of the individual values of the flicker rhythm plus the sum of the individual values of the brightness settings (sum of bits 0 -3 plus sum of bits 4 - 6).

The combination of all bits results in a differing, random flicker effect. You can experiment with different settings.

Smoke Generator control

A smoke generator can be connected to function outputs A1 to A7, which are controlled by the load-dependent decoder. The physical smoke output from the generator is governed by PWM (Pulse Width Modulation) which is controlled by CV133. When the locomotive moves, the function output receives 100% of the PWM signal. The locomotive motor can be stopped for 0-15 seconds (startup delay) so that the smoke generator heats up when the locomotive is stationary. After the delay, the locomotive starts, and the output is activated to a full 100%. At this point the smoke output is fully controlled by PWM. When the load on the locomotive increases, the PWM adjusts the smoke output again to reflect the heavier load. The required load threshold can be set by the user.

CV meanings:

CV130 determines which outputs from A1 to A7 are controlled by the smoke generator control, and when to activate the startup delay. Value range 1-7 defines the output and value range 16 - 240 defines the startup delay in 16-step increments. 16-step means a one second startuup delay. The sum of the individual values adds up to the value for CV130.

Calculation: starting delay * 16 + output

The load threshold is entered into CV131 from a value range of 0 to 127. The larger the value in 0.1 second increments, the slower the output responds to a load change. CV132 determines the PWM for normal running characteristics and CV133 determines the PWM when the locomotive is idling. Startup time is entered in 0.1 second steps in CV 134.

Adjustable PWM – frequency for the light and function outputs

The output voltage of a function output is Pulse Width Modulated at a given frequency.

The function outputs of the decoder operate at a factory setting of 156 Hz. frequency. This frequency can be increased for outputs A0 to A5 to 24 kHz. The frequency setting is adjustable in CV50 in bit 3. Bit 3 = 0 -> 156Hz, bit 3 = 1 -> 24KHz

Control for electric couplers

Electric coupler drives consist of fine copper wire windings that are sensitive to constant current flow, and because of that they heat up rapidly. With the appropriate settings, the decoder will automatically shut off current to a coupler drive without having to shut off the drive via the function key. Also, the decoder uses an adjustable high PWM to ensure that the coupler drive is only activated for a moment to raise the coupler loop. After the loop is raised, only a small amount of current is needed to keep it in the raised position. The lower PWM and required hold time are adjustable. If the coupler does not couple or uncouple properly on the first attempt, the decoder can be programmed to make several more attempts. When adjusting coupling/ uncoupling processes, the „as many as necessary; as few as possible“ rule applies. To prevent the coupler windings from burning up from constant current, an automatic shut-off time must be entered in 0.1 second increments, where the coupler drive will pause before carrying out another coupling operation.

CV124 = number of coupling operations
CV125 = Eactivation time in 100ms increments with PWM from CV117 (A1) to CV123 (A7)
CV126 = coupler in open position time in 100ms increments
CV127 = deactivation time in 100ms increments, (0 = no functioning)
CV128 = hold PWM

CV129 = EElectric coupler function output for A1 to A7

CV 129:		**Value**			**Value**
Bit 1	A1 for coupling	2	Bit 5	A5 for coupling	32
Bit 2	A2 for coupling	4	Bit 6	A6 for coupling	64
Bit 3	A3 for coupling	8	Bit 7	A7 for coupling	128
Bit 4	A4 for coupling	16			

Switching (shunting) tango, automatic cuopling/uncoupling manouvers
A switching (shunting) tango can only be carried out if the electric coupler control is activated in CV124 - 129. A switching tango is activated by one of the electric coupler outputs when the decoder speed step is at 0:

How a switching (shunting) tango works:
1. The locomotive travels forward for a programmable length and speed (T1)
2. The locomotive stops and switches its direction of travel
3. The locomotive uncouples and moves backward at the same speed for the same length (T2)
4. The locomotive stops and resumes the original direction of travel.

The CVs to be set are:
CV135 for switching (shunting) gear “switching tango” (1-255). A CV value of 0 specifies that no switching tango takes place.
CV136 for the reverse movement time T1 in 100ms steps
CV137 for the deactivation time T2 in 100ms steps

Switching tango with automatic coupling and uncoupling
Changing the function operation with two connected couplings on two outputs:
1.For the front coupler drive, CV129 is the least significant CV for outputs A1 to A7. So, if A1 and A2 are both used, A1 is for the front coupler and A2 is for the rear coupler. If more (or less) than 2 outputs are used, there is still no difference in the sequence for the different directions of travel (see automatic uncoupling movements).

2.If the locomotive is traveling forward and the front coupler drive is deactivated via a function key, the coupler drive is also deactivated when the direction of travel is reversed, and the locomotive is running in an automatic switching (shunting) sequence (coupling procedure). If the locomotive is traveling backwards and the rear coupler drive is deactivated, then the front coupler is activated. In either direction of travel, the electric coupler drive is controlled by its respective setting.

3. The amount of time that the electric coupler drive is activated is adjusted via CVs 124-127 to correspond with the switching (shunting) tango scenario, controlled by CVs 136 and 137. The following rule applies: CV124 multiplied with the sum of CV125 + CV126 + CV127 always must be bigger than the sum of CV136 + CV137. In this case and in other circumstances, additions must be made to the right side of the inequality, because, when the model is running in a switching tango mode, the decoder only reverses the direction of travel when it senses the model is in idle.

Servo control
Connecting a servo to the decoder requires electronics skill.

CV166 determines which output controls a servo. If the associated value is set, then a control signal for the servo is sent to the desired function output (A6 and/or A7, or SUSI). The following assignment applies to the connection pins of the SUSI interface: Servo1 = CLK, Servo2 = Data. The necessary wiring schemes for connecting servos to function outputs can be found in the Webshop of the PIKO website under the FAQ on „Questions about DCC.“ Look for the „H0“ category under „Servo connection to SUSI or solder pads for the PIKO SmartDecoder 4.1“.

CV 166:		**Value**
Bit 0	SUSI with servo signal	1
Bit 6	A6 with servo signal	64
Bit 7	A7 with servo signal	128

The respective function key numbers from F0 - F28 are entered into CV167 (SUSI Servo1) and/or CV168 (SUSI Servo2), to determine which servos are to be activated. Servo positions and running times can be set with the following CVs:

CV160 Servo 1, position 1 (function key off) CV163 Servo 2, position 1 (function key off)
CV161 Servo 1, position 2 (function key on) CV164 Servo 2, position 2 (function key on)
CV162 Servo 1, circulation time in 100ms increments CV165 Servo 2, circulation time in 100ms increments

Adjusting PWM output for lighting and function outputs (for experienced modelers)

Note: To facilitate programming, especially for adjusting PWM output, we recommend that you use the PIKO SmartProgrammer (# 56415) and the PIKO SmartTester (# 56416)

The brightness of the function outputs can be adjusted by means of 64 different brightness settings, which are periodically transmitted as PWM to the function outputs. The length of time for each transmission is adjustable. They are a result of the value of CV178 being multiplied by 64ms.
Two banks (banks 3 & 4) with four PWM curves are available for the 8 PWM curves that have up to 64 individual settings apiece. In total, there are 8 available CV banks with 256 CVs in the decoder. Because so many CVs are necessary to make this large combination of numbers possible, programming in the conventional CV frame from 1 to 1024 is no longer possible. Therefore, a split is required in CV banks of 256 CVs (CV257 - 512). CVs 257 - 512 can be used multiple times. Which of these CV banks is to be programmed depends on the respective value of two „pointer CVs;” CVs 31 and 32. The values of these two CVs point to the corresponding CV banks 3 and 4. The values of the „pointer CVs“ do not change the meaning of CVs 1 - 256 and are not relevant for normal operation.
Setting bank 3 to program sections 1 to 4: CV31 = 8, CV32 = 3
Setting bank 4 to program sections 5 to 8: CV31 = 8, CV32 = 4
The following 8 PWM sections are factory-set and stored here:
1 = Mars Light, 2 = Gyra Light, 3 = Occilating headlight, 4 = Staccato, 5 = Ditch Light, 6 = rotary beacon, 7 = single strobe, 8 = double strobes
Since up to 64 brightness values can be entered in one process, 256 CVs are available for each bank. If a bank has been selected for programming via the “pointer” CVs 31 and 32, the individual values are written into CVs 257-512, each section occupying 64 CVs as follows:

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

The sections can be changed at any time or substituted by changing the corresponding CVs between 0 and 63. Using CVs 170 to 177, outputs A0 to A7 can be assigned to one of the 8 PWM sections by entering 1 to 8 in the respective CV. Both taillight outputs and A1 to A7 can be assigned to one of 2 phase positions during operation. For example, two function outputs are activated, which flash in an alternating cycle. The required settings are entered into CV179:

CV 179:	**Value**		**Value**
Bit 0 A0h, phase position 0°	0	Bit 4 A4, phase position 0°	0
Bit 0 A0h, phase position 180°	1	Bit 4 A4, phase position 180°	16
Bit 1 A1, phase position 0°	0	Bit 5 A5, phase position 0°	0
Bit 1 A1, phase position 180°	2	Bit 5 A5, phase position 180°	32
Bit 2 A2, phase position 0°	0	Bit 6 A6, phase position 0°	0
Bit 2 A2, phase position 180°	4	Bit 6 A6, phase position 180°	64
Bit 3 A3, phase position 0°	0	Bit 7 A7, phase position 0°	0
Bit 3 A3, phase position 180°	8	Bit 7 A7, phase position 180°	128

CROSS

If bit 7 (value 128) of CV170-177 is set, the modulated effect is only activated if the CROSS output bit is set by means of extended function mapping (see extended function mapping). If the CROSS output bit is not set, the output is activated constantly. If the CROSS output bit is deactivated again by means of extended function mapping, the output that was activated remains activated until a hold time programmed in CV180 has expired. This hold time is a result of the value of CV 180 multiplied by 100ms.

Extended function mapping (for experts only)

Note: To facilitate easier programming, especially for advanced function mapping, we recommend you use the PIKO SmartProgrammer (# 56415) and PIKO SmartTester (# 56416) testing and programming devices.

The following decoder setting options are only possible with extended function mapping (CV 96 = 1). In extended function mapping, you can set the simultaneous activation of several outputs, set startup and braking delays, set switching (shunting) scenarios, set dimming for function outputs, use SUSI as logic level output, transfer function keys F22 - F28 to SUSI, and set the CROSS bits.

These functions can be switched on or off depending on their cross-linked state, like function keys F0 to F44, the model's direction of travel, or determining if a model will move or stand idle. These combinations are stored in two CV banks.

In total there are 8 available CV banks with 256 CVs in the decoder. Because so many CVs are necessary to make this large combination of numbers possible, programming in the conventional CV frame from 1 to 1024 is no longer possible. Therefore, a split is required in CV banks of 256 CVs (CV257 - 512). CVs 257 - 512 can be used multiple times.

Which of these CV banks is to be programmed depends on the respective value of two „pointer CVs"; CVs 31 and 32. The values of these two CVs point to the corresponding CV bank, here 1 and 2. The values of the „pointer CVs" do not change the meaning of CVs 1 - 256 and are not relevant for normal operation.

Each CV bank for extended function mapping consists of 16 lines with 16 entries. These 16 entries then form a combination of switching condition and output. Since two CV banks are available for extended function mapping, a total of 32 combination options for switching conditions and outputs can be implemented.
TIP: Before programming CVs 257 - 512, you should program CVs 31 and 32 for the desired CV bank. It is advisable to read these two „pointer CVs" before programming, so that you do not accidentally program the wrong CV bank.
CV programming for extended Function Mapping in detail:
Pointer 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 meanings:
Entries (bytes) 1 - 6 specify the functions that must be activated for the command to be carried out.
Entries (Bytes) 7 - 12 specify the functions that must be deactivated for the command to be carried out.
Entries (Bytes) 13-16 specify the outputs that are activated when the command is carried out.

Bits 0 - 7 in their respective entries (bytes) for operating conditions On (bytes 1 - 6) and Off (bytes 7 - 12) have the following meaning:

Bit / Byte On / Off	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

Move: the model is moving
Forw: the model is moving forward
n.u.: not used

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

Bit / Byte	0	1	2	3	4	5	6	7
13	A1	A2	A3	A4	A5	A6	A7	A8
14	A0v	A0h	S-CLK	S-Data	ABV	ABV2	ABV3	RG
15	A0-P2	A1-P2	A2-P2	A3-P2	A4-P2	A5-P2	A6-P2	A7-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
A1 to A8	Function outputs 1 - 8
S-CLK	Output SUSI CLK: (activate A4 logic, CV50 Bit4 = 1) or (enable servo 1, CV166 Bit0 = 1)
S-Data	Output SUSI Data: (activate A3 logic, CV50 Bit4 = 1) or (activate Servo2, CV166 Bit0 = 1)
ABV	Startup, switch off braking delay 1
ABV2	Start-up, switch on braking deceleration 2
ABV3	Switch on start-up, braking deceleration 3
RG	Switching (shunting)
A0-P2 to A7-P2	LLight and Function Outputs 1 - 7, 2; Dimming
Cross	CROSS bit for PWM modulated outputs
S-F22 to S-F28	Functions F22 - F28 switch on or off on the SUSI interface, depending on the result of the conditions set in bytes 1 - 12. The status of these functions, as t ransmitted by the DCC command station, is then no longer transferred to the SUSI interface. CV159 must be set to SUSI to transfer F22 - F28, accordingly.

The CV number to be programmed is calculated from the following formulas

for lines Zeilen 1 - 16:
Basic value 256
plus (Number of the line minus 1) multiplied by 16
plus the number of the bytes.

Formula: 256 + (line - 1) * 16 + Byte

for lines 17 - 32:
Basic value 256
plus (Number of the line minus 17) multiplied by 16
plus the number of the bytes.

Formula: 256 + (line - 17) * 16 + Byte

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

Bit	Value
Bit 0	1
Bit 1	2
Bit 2	4
Bit 3	8
Bit 4	16
Bit 5	32
Bit 6	64
Bit 7	128
Sum	255

From the information given, the values for the individual CVs can now be derived..

Examples:

1. Output A1 should be activated when function key F1 is activated. Bank 1, line 1 -> CV31 = 8, CV32 = 0
There are two CVs to program;
The first CV is for the activated state (F1 on) and the second CV is for the output (A1 on)
Function key F1 in activated state. -> CV number = 256 + (1 - 1) * 16 + 1 = 257
Function key F1 activated -> byte 1, bit 0 = 1 -> CV 257 = 1
Output A1 activated -> CV number = 256 + (1 - 1) * 16 + 13 = 269
Output A1 activated -> byte 13, bit 0 = 1 -> CV269 = 1

2. The front light output (A0v) should be activated when function key F0 is activated and the model is moving. Bank 1, line 2 -> CV31 = 8, CV32 = 0
There are two CVs to program:
Function key F0 activated + move .-> CV number = 256 + (2 - 1) * 16 +1 = 273
Function key F0 activated + move. -> byte 1, bit 4 = 1 + bit 6 = 1-> CV 273 = 16 + 64 = 80 Output A0v activated -> CV number = 256 + (2 - 1) * 16 + 14 = 286
Output A0v activated -> byte 14, bit 0 = 1 -> CV286 = 1

Secondary dimming of the lighting and function outputs (CV96 = 1)
The lighting and function outputs can be set to alternative dimming settings (for example, a high beam). The settings for the alternative dimming values are stored in CVs 150 to 157 for A0 to A7. In extended function mapping (CV96 = 1), the alternative settings for CVs 150 - 157 are activated via the settings programmed there (see „Extended Function Mapping“).

Sound section of the PIKO SmartDecoder 4.1 Sound

Description

The PIKO SmartDecoder 4.1 Sound delivers digital prototype sound in 12-bit resolution, with a 22.05 kHz sampling rate. Through intelligent sound control, sound is adapted to the current operating state of the model. For example, on grades the sound reflects the current engine load. If operating sound is activated via a function key, the first thing you will hear is the locomotive's start-up sequence. If the locomotive should start running and the sound is not synchronized to the model's speed, the circuitry in the sound-decoder will stop the motor until the sound function has synchronized with the model's speed. The sound of the diesel engine growls to life before the locomotive starts moving. When the locomotive stops, the brakes squeal. Various operating sounds like the air compressor, coal shoveling, or additional equipment are randomly activated when the model is in idle. These random sounds can also be manually activated using their respective function key. In railcars with manual transmissions or electric locomotives with induction stages, the shifting sounds are activated according to the model's acceleration or braking. If the operating sound is switched off during operation, then the corresponding shut-down sound is also heard, including the sound of a closing door, when the engineer leaves the cab. Thanks to 8-channel technology, the operating sounds of each model such as whistle, horn, bell, etc. can be activated simultaneously via function keys F0 – F28. If the model leaves the visible area of a layout (for example, it moves to a shadow station), the Soundfader function can be activated so that the locomotive sound fades out, and then fades back in when the train returns to the visible portion of the layout. Almost all sound volumes are individually adjustable by programming their CVs and can be mapped to any function key up to F28. During train operation, it is possible to use a function key to change the overall volume of the sound decoder in three steps.

In analog mode, only the model's running sound can be heard. Please note that trouble-free sound operation using analog electronic speed control throttles (PWM operation) cannot be guaranteed due to the large number of often unstable systems available on the market.

Volume settings

The overall volume of the PIKO SmartDecoder 4.1 Sound can be changed in SUSI-Bank 2 (CV 1021 = 2) via CV 900. For this reason, CV 1021 is first programmed to a value of 2 and then CV 900 to the value of the desired volume.

The individual sounds of the sound decoder are stored in so-called slots, of which up to 32 are available, depending on the type of model. The volume of each sound can be adjusted via CVs 900 - 931 in SUSI Bank 4 (CV 1021 = 4). For this reason, CV 1021 is first programmed to a value of 4, and then CVs 900 – 931, belonging to each respective sound, are set to the value of the desired volume.

Function mapping Sound

Function key assignments for the individual sounds are set in SUSI Bank 8 via local CVs 900 - 931. For this reason, CV 1021 is first programmed to a value of 8 and then CVs 900-931, belonging to each respective sound, are set to the value of the desired function key, up to F28.

Adjustable times for random sounds

The frequency of reproduction for random sounds like the fan sound of an electric locomotive or coal shoveling in a steam locomotive are adjustable by two CVs. CV 905 of SUSI Bank 2 can be used to set a minimum amount of time before a random sound can be played again. CV 906 of SUSI Bank 2 can be used to determine the maximum amount of time that elapses before a random sound is repeated.

RFactory reset

CAUTION! When the decoder is reset, all factory-programmed, specific settings are erased. Only perform a reset if it is absolutely necessary! If you do decide to reset the decoder, functions programmed at the factory may no longer function and you will have to reprogram the individual Function Mapping settings. (see FAQ)

To return the decoder to factory settings, two CVs (CV8 and CV59) are used in DCC programming, while CV59 is used in Motorola programming. To keep from having to rewrite all decoder settings, it is possible to decide beforehand which areas of the decoder should be reset to factory settings.

Programming a value of 1 - 5 returns the following CVs to 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 und CV31=1, CV32=1
3 = CV257 - 512 (extended function mapping banks 1 & 2)	CV31=8, CV32=0 und CV31=8, CV32=1
4 = CV257 - 512 (PWM modulation function outputs banks 3 & 4)	CV31=8, CV32=3 und CV31=8, CV32=4

The sound-generating area of the sound decoder can also be reset to factory settings, regardless of the decoder's other settings. To do this, you must first program CV 1021 to a value of 0 and then CV 905 to a value of 1. The order of programming must be strictly adhered to.

Technical specifications

Addresses:	1-9999 (long DCC address)
Max. motor current / total load:	1,2 A* Short-term up to 2 A
Function outputs:	0,4 A each
Sound resolution:	12 Bit
Number of sound channels:	8
Sampling rate:	22,05 kHz
Output power:	2,5 watts
Size:	30,2 x 16 x 3,8 mm (1.2" x 0.6" x 0.1")

* Constant load; may vary depending on the installation situation

Programming

The basis of all the decoder's settings are the configuration variables (CVs). The decoder can be programmed with the PIKO SmartControlight, PIKO SmartControl, or other DCC command stations, as well as with Motorola-prototcol command systems.

Programming with DCC devices

Use the programming menu of your DCC control panel to read and program the decoder CVs via register-style programming, direct CV programming, or page programming. It is also possible to program the decoder via a Programming On the Main (POM) option of a DCC system.
Programming procedures can be found in your DCC system's owner's manual.

Programming long addresses without a programming menu

If programming is done with DCC systems that do not support the programming of long addresses using an input menu, the value for CV 17 and CV 18 needs to be calculated.

Here is a sample guide for programming address 2000.

- Divide the address value by 256 (2000: 256 = 7 remainder 208).
- Take the result (7) and add 192.
- Enter the result (199) as the value in CV 17.
- Enter the remainder (208) as the value in CV 18.
- Note: Set bit 5 of CV 29 to 1 for the decoder to use the long address as well.

Programming lock (decoder programming lock)

The decoder programming lock is used on models that have more than one decoder installed, to change CVs in only one of the decoders with the same base address (CV1) or long address (CV17 and CV18). To do this, CV16 must first be programmed to a different index number in each decoder before the decoders are installed in the model. To change or to 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 their CV15s and CV16s and if both values match, access is granted to the CVs. If the comparison fails, no access to the CVs of the decoder is possible.
The following index numbers are recommended:
1 for a motor decoder, 2 for a sound decoder, 3 or higher for functional and other types of decoders.

Programming with a Marklin control unit (item 6021)

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

1a. Switch the power off and then back on.

1b. Set the central unit to „Motorola old" (6021 DIP 2 = off), switch the central unit off and on.

2a. Select the address of the decoder and switch on the light.

2 B. Set the central station to „stop" and select address 80.

3a. With the model in neutral (speed 0), switch the direction of travel 5-8 times in succession until the lights flash.

3b. When the model is stationary, press and hold the direction switch, set the central unit to „go" and wait approx. 12 seconds.

4. Enter the number of the CV to be programmed (like a locomotive address) on the control panel.

5. Press the direction switch briefly (5a and 5b). Now the rear lights will quickly flash 4 times (only 5a).

6. Enter the desired value for the CV as a locomotive address on the control panel.

7. Briefly switch the direction of travel (7a and 7b). Now the rear lights will slowly flash 4 times (only 7a).

If further CVs are to be programmed repeat steps 4-7.

If you wish to stop programming, switch the control panel to „stop“ or enter address „80“ and briefly change the direction of travel. As only inputs from 1 to 80 are possible when programming with a Motorola digital central unit from Märklin, a value of „0“ must be entered for address „80.“

Page register programming for entering CV numbers greater than 79

CV numbers greater than 79 can only be programmed using the page register. This page register is CV64. If CV64 is programmed with a value greater than 0, then the contents of CV64 times 64 are added to each subsequently entered address values in all subsequent programming operations. The entered value must be in the range of 1 to 64.

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

Should, for example, CV82 be programmed with a value of 15, then CV64 must first be programmed with a value of 1. Now CV18 can be programmed with a value of 15. Then, in the decoder, a value of 15 is stored in CV82, which is a result of the addition of the contents of CV64 (Example 1) multiplied by 64, and the entered CV number on the command station: 18.

Offset register for entering CV values greater than 79

CV values greater than 79 can only be programmed using the offset register. The offset register is CV65. If CV65 is programmed with a value greater than 0, then in all subsequent programming the content of CV65 is multiplied by 4, 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.

Should, for example, CV49 be programmed with a value of 157, then CV65 must first be programmed with a value of 25. Now, CV49 can be programmed with a value of 57. The decoder will now store a value of 4 * 25 + 57.

Note: When programming CV64 and CV65, the contents of offset and page registers are ignored.

Programming with Mobile Station 1, 2 & 3

Mobile station 1: The programming menu is only available in the locomotive menu for certain locomotives. From the database, a locomotive must be selected which has a programmable decoder. Proceed as follows:

1. Create a new locomotive and select item no. 36330 from the database. The display shows locomotive Ee 3/3.
2. Press the „MENU / ESC“ key and select the „CHANGE LOCATION“ heading. Here you will find among other things the last function of the register programming with a designation of „REG“. You can change this function to change the CVs of the decoder. You can only program the CVs with this function.
3. Enter the CV number and confirm it with the shift key.
4. Then enter the value of the CV and confirm it with the shift key. The Mobile Station will now program the CV with the desired value.

Mobile Station 2 & 3: To program, use the DCC CV programming menu. Caution: Remove all locomotives from the track that do not need to be programmed!

CV tables (Configuration Variables) for the sound decoder

CV	Description	Range	Value*
1	**Locomotive address**	DCC: 1 - 127 Motorola: 1 - 80	3
2	**Minimum speed** (change, until the locomotive starts at speed step 1)	1 - 63	1
3	**Start-up delay**, 1 means every 5 ms the current internal speed (0 - 255) is increased by 1. If the internal maximum speed is e.g. 200 (CV 5 = 50 or CV 94 = 200), the starting time from 0 to maximum is 1 second 0-255 5	0-255	20
4	**Braking delay** (time factor like CV3)	0-255	24
5	**Maximum speed** (must be greater than CV 2) 1 - 63 48	1 - 63	35
6	**Average speed** (must be greater than CV 2 and less than CV 5) 1 - 63 24	1 - 63	10
7	**Software version** (The processor being used can be updated) - different	-	different
8	**Manufacturer** identification decoder reset, values as in CV 59 - 162	-	162
12	**Modes** Value *Bit 0=1 DC (Analog operation DC) On* 1* *Bit 1=1 AC (Analog operation AC) On Bit 2=1* 2* *Data format DCC On* 4* *Bit 3=1 Data format Motorola On* 8* *Bit 4=1 Data format Selectrix On* 16* *Caution: If all dataformats are switched off, the decoder can only be programmed in digital mode.* 32*	0-63, 255	255
13	**Function keys activated in analog mode** Bit 0-7 -> F1 to F8; Bit = 0 Function Off, Bit = 1 Function On	0-255	1
14	**Function keys activated in analog 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	**DDecoder Programming lock index number**	0-255	1
17 18	**Long locomotive address** 17 = High value byte 18 = Low value byte	128 - 9999 192 - 231 0 - 255	2000 199 208
19	**Consist Address (Double heading)** 0 = Consist Address (CADR) is not active When bit 7 = 1 the direction of travel is reversed, and when 128 is added to the CADR, the direction is reversed.	1-127	0
27	**Brake signal settings (automatic stop)** Value Bit 0 = 1 -> ABC right rail positive 1 Bit 1 = 1 -> ABC left rail positive 2 Bit 4 = 1 -> DC in opposite direction of travel 16 Bit 5 = 1 -> DC in equal direction of travel 32 Bit 7 = 0 -> ABC forward direction of travel if Bit 0 = 1 or Bit 1 = 1 0 Bit 7 = 1 -> ABC rearward direction of travels, if Bit 0 = 1 or Bit 1 = 1 128	0-130	0
28	**RailCom® Configuration** Value Bit 0 = 1 -> Channel 1 On 1* Bit 1 = 1 -> Chaennl 2 On 2* Bit 7 = 1 -> RailCom Plus® On 128*	0-131	131

CV	Description		Range	Value*
29	**Configuration according to DCC rules**	Wert	0-63	14
	Bit 0=0 Normal direction of travel	0		
	Bit 0=1 Opposite direction of travel	1		
	Bit 1=0 14 Speed steps	0		
	Bit 1=1 28 Speed steps	2*		
	Bit 2=0 Digital opperation only	0		
	Bit 2=1 Automatic digital-to-analog changeover Bit 3=0 RailCom® turned off	4*		
	Bit 3=1 RailCom® turned on	0		
	Bit 4=0 Speed steps over CV 2, 5 and 6	8*		
	Bit 4=1 Characteristic curve from CV 67 – 94 in use	0		
	Bit 5=0 Short address (CV 1)	16		
	Bit 5=1 Long address (CV 17/18)	0		
		32		
30	**Error memory for function ouputs, motor, and temperature monitor** 1 = Funtion output fault, 2 = Motor fault, 4 = Overheating protection		0-7	0
31	1. Pointer CV for CV banks		0, 1, 8	0
32	2. Pointer CV for CV banks		0,1,3,4,5,255	255
33-46	**Simple Function Mapping**		0-255	
	Assignments of function outputs to CVs CV 33			
	Light function key (F0) for forward travel CV 34 Light function key (F0) for			1
	reverse travel CV 35 Function key F1			2
	CV 36 Function key F2			4
	CV 37 Function key F3			8
	CV 38 Function key F4			16
	CV 39 Function key F5			32
	CV 40 Function key F6			64
	CV 41 Function key F7			128
	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 individual bits (via CV100/101 bit x = 0, standard)	Value		
	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	16		
	Bit 5 Function output A4	32		
	Bit 6 Switching (shunting)	64		
	Bit 7 Startup/Braking delay	128		
	Assignment of individual bits (via CV100/101 bit x = 1, func. mapping shift)	Value		
	Bit 0 Function output A2	1		
	Bit 1 Function output A3	2		
	Bit 2 Function output A4	4		
	Bit 3 Switching (shunting)	8		
	Bit 4 Startup/Braking delay	16		
	Bit 5 Function output A5	32		
	Bit 6 Function output A6	64		
	Bit 7 Function output A7	128		
47	**Motorola 1. trinary address** (with Motorola Programming only)		0-255	12
48	**Motorola 2. trinary address** (with Motorola Programming only)		0-255	0
49	**Motorola 3. trinary address** (with Motorola Programming only)		0-255	0
50	**Decoder Configuration 1**	Value	0-63	0
	Bit 0=0 Motorola 2nd address not used	0		
	Bit 0=1 Motorola 2nd address used	1		
	Bit 1=0 Motorola 3rd address not used	0		
	Bit 1=1 Motorola 3rd address used	2		
	Bit 2=0 Light outputs not changed	0		
	Bit 2=1 Light outputs changed	4		
	Bit 3=0 Frequency light, A1 to A7 = 156Hz	0		
	Bit 3=1 Frequency light, A1 to A5 = 24KHz	8		
	Bit 4=0 SUSI = SUSI	0		
	Bit 4=1 SUSI = A3/A4 Output Extended Function Mapping -Table	16		
51	**Decoder Configuration 2**	Value	0-7	3
	Bit 0=0 Motor control Off	0		
	Bit 0=1 Motor control On	1		
	Bit 1=0 Motor control PIDController	0		
	Bit 1=1 Motor control SX Controller	2		
	Bit 2=0 Non dynamic cycle time of motor control	0		
	Bit 2=1 Dynamic cycle of motor control	4		
53	Cycle of motor control in 100µs steps		0-255	35
54	Motor control P-constant of the PID control		0-255	95
55	Motor control I-constant of the PID control		0-255	40
56	Motor control D-constant of the PID control		0-255	32
57	Controller offset		0-255	6
58	Mesurement gap for EMF measurement in 100µs steps		0-255	8

CV	Description	Range	Value*
59	**Reset to factory settings** (also possible via CV8) 1 = CV 0 - 256, as well as CV257 - 512 (RailCom® Bank 7) 2 = CV 257 - 512 (RailCom Plus® banks 5 & 6) 3 = CV 257 - 512 (Simple Function Mapping banks 1 & 2) 4 = CV 257 - 512 (PWM-Modulation Function outputs banks 3 & 4)	0 - 4	0
60	**Short circuit monitor for motor, function outputs, and overheating monitor** Turned On (do not change)	-	-
61	Constant for overheating monitor	-	-
62	Constant for short circuit monitor for function outputs (do not change)	-	-
63	Constant for short circuit monitor for motor output (do not change)	-	-
64	**Page Register** For CV programming with a Motorola-based DCC system	0-255	0
65	**Offset-Register** For CV programming with a Motorola-based DCC system	0-255	0
66	Speed correction forward	0-255	0
67-94	**Etended speed step characteristic curve for speed steps 1 - 28**	each 0-255	various
95	Speed correction backwards	0-255	0
96	**Type of function mappings** 0 = simple function mapping, 1 = extended function mapping	0, 1	0
97	**ABC brakes** Voltage distance for diode path is approx. CV Value * 0,12V	0-255	8
98	Speed in ABC-restricted speed sections	0-255	30
100	**Function Mapping Shift (F0 - F4)** Value Bit 0 Change of assignment in CV35 (F1) 1 Bit 1 Change of assignment in CV36 (F2) 2 Bit 2 Change of assignment in CV37 (F3) 4 Bit 3 Change of assignment in CV38 (F4) 8 Bit 4 Change of assignment in CV33 (F0v) 16 Bit 5 Change of assignment in CV34 (F0r) 32	0-63	0
101	**Function Mapping Shift (F5 - F12)** Value Bit 0 Change of assignment in CV39 (F5) 1 Bit 1 Change of assignment in CV40 (F6) 2 Bit 2 Change of assignment in CV41 (F7) 4 Bit 3 Change of assignment in CV42 (F8) 8 Bit 4 Change of assignment in CV43 (F9) 16 Bit 5 Change of assignment in CV44 (F10) 32 Bit 6 Change of assignment in CV45 (F11) 64 Bit 7 Change of assignment in CV46 (F12) 128	0-255	0
102	**Analog mode configuration** Value Bit 0/1 00 = max. speed without controller 0 01 = max. speed via CV106 1 10 = Throttle voltage and CV103 and CV104 used 2* Bit 2 0 = Controller OFF, 1 = Controller ON 4* Bit 3 0 = PID controller, 1 = SX-controller 8* Bit 4 1 = Dynamic repitition rate value 16*	0-31	30
103	**Analog:** minimum throttle voltage for Vsoll = 0	0-255	150
104	**Analog:** maximum throttle voltage for Vsoll = Vmax	0-255	180
105	**Analog:** Hysteresis (lag time)	0-255	30
106	**Analog:** maximum voltage	0-255	200
107	Front lights deactivated	0-124	0
108	Rear lights deactivated	0-124	0
109	**Flash generator, assignment of phase 1 to the outputs** Bit 0-7 -> A0 to A7; Bit = 0 -> flash phase 1 off, Bit = 1 -> flash phase 1 on	0-255	0
110	**Flash generator, assignment of phase 2 to the outputs** Bit 0-7 -> A0 to A7; Bit = 0 -> flash phase 2 off, Bit = 1 -> flash phase 2 on	0-255	0
111	Flash generator activation time in 100ms intervals	0-255	5
112	Flash generator deactivation time in 100ms intervals	0-255	5
113	**Switching off function outputs A1 - A7 in forward direction** Bit 1-7 -> A1 - A7; Bit = 0 -> output on, Bit = 1 -> output off	0-254	0
114	**Switching off function outputs A1 - A7 in reverse direction** Bit 1-7 -> A1 - A7; Bit = 0 -> output on, Bit = 1 -> output off	0-254	0
116-123	**Dimming of light and output functions A1 - A7** 0 = output off, 63 = output at 100%	0-63	63
124	**Coupler repeating for electric couplers on A1 - A7** 0 = no coupler	0-255	1
125	**Activation time for coupler operation**, value * 100ms (with PWM from CV117 - 123)	0-255	10
126	**Holding time for coupler operation**, value * 100ms	0-255	20
127	**Pause time for coupler operation**, value * 100ms	0-255	10
128	**Holding- PWM**	0-255	30
129	**Assignment of outputs A1 - A7 for electric couplers** (0 = no coupler.) Bit 1-7 -> A1 - A7	0-254	0
130	**Dynamic smoke generator control on A1 - A7** Value 0 = no smoke generator operation 0 Bit 0-3 -> 1=A1, 2=A2, 3=A3, 4=A4, 5=A5, 6=A6, 7=A7 1-7 Bit 4-7 = 1 -> Start time = Value * 200ms 16-240	0-247	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 state	0-63	2
134	Dynamic smoke generator control, activation time in 100ms increments	0-255	30

CV	Description	Range	Value*
135	**Switching tango** (automatic uncoupling movement), speed steps (0 = off)	0-255	0
136	**Switching tango**, (pushing movement) T1 * 100ms	0-255	10
137	**Switching tango**, (reverse movement) T2 * 100ms	0-255	10
138	**Constant braking distance** in cm, speed step threshold Only the above is braked with a constant braking distance (0 = off)	0-255	0
139	**Constant braking distance** in cm, first braking diatance	0-255	50
140	**Constant braking distance** in cm, alternative braking distance (activated through cross-bit)	0-255	25
141	**Constant braking distance** in cm, maximum speed of the model in cm/s	0-255	40
142	**Constant braking distance** in cm, residual value of the determined maximum speed	0-255	0
143	**Constant braking distance** in cm, activation by (0 = off): Bit 0 = 1 -> nominal speed = 0 Bit 1 = 1 -> ABC braking Bit 2 = 1 -> DC braking Bit 3 = 1 -> DCC braking signal	15	0
144	**Startup delay 2** (as replacement for CV3)	0-255	12
145	**Braking delay 2**, (as replacement for CV4)	0-255	12
146	**Startup delay 3** (as replacement for CV3)	0-255	24
147	**Braking delay 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
150-157	**Second Dimming setting for lighting and function outputs A1 - A7** 0 = off, 63 = 100%	0-63	10
159	KIdentification of functions F22 - F28 for transfer to SUSI Bit 0-6; Bit = 1 --> F22 - F28 is transfered 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 cycle time in 100ms increments	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
165	Servo control, Servo 2 cycle time in 100ms increments	0-255	30
166	Servo control via: SUSI = 1, A6 = 64, A7 = 128	0-192	0
167	Function key number for Servo 1 on SUSI-CLK	0-28	7
168	Function key number for Servo 2 on SUSI-Data	0-28	8
170-177	**Assignment of PWM-memory for light output, A1 - A7** memory 1 - 8, Bit 7 = 1 -> memory only active if CROSS output bit is set	0-8 129-136	0
178	**PWM-memory**, waveform, playback time (value * 64ms)	0-255	15
179	**PWM-memory**, output phase Bit 0-7 = 0 A0h - A7 -> phase position 0° Bit 0-7 = 1 A0h - A7 -> phase position 180°	0-255	0
180	**PWM-memory**, hold time, after CROSS-output bit is turned off (value * 100ms)	0-255	0
181	**Firebox flicker of light and function outputs A1 - A7** Bit 0-7 -> A0 - A7; Bit = 0 -> flicker off, Bit = 1 -> flicker on	0-255	0
182	**Firebox flickering, flicker settings** Bit 0-3 -> change of flickering rythem (value range 1 to 15) Bit 4-6 -> change of brightness (value range 16, 32, 48, 64, 80, 96, 112) Bit 7 = 1 -> output is always bright (it is possible to combine with Bits 4-6)	0-255	0
183	**Energy saving lamp effect for lighting and function outputs A1 - A7** Bit 0-7 -> A0 - A7; Bit = 0 -> effect off, Bit = 1 -> effect on	0-255	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	**Fade-in and fade-out of lighting and function outputs A1 - A7** Bit 0-7 -> A0 - A7; Bit = 0 -> fade function off, Bit = 1 -> fade function on	0-255	0
187	**Fade-in, fade-out time** (value * 10ms)	0-255	30
188	**Neon light switch-on effect for lighting and function outputs A1 - A7** Bit 0-7 -> A0 - A7; Bit = 0 -> effect off, Bit = 1 -> effect on	0-255	0
189	**Neon light switch-on effect**, flash time (value * 5ms)	0-255	20
190	**Neon light switch-on effect**, maximum number of flashes	0-255	20
200	**Motor control, speed-dependent period** Minimum speed step up to which the period of CV53 is set	0-255	10
201	Maximum speed from which the period duration of CV202 is set	0-255	150
202	Maximum period in 100µs increments (min=CV53)	0-255	250

* Factory set values

CV table for programming banks 1 – 4

CV	Bank 1, Extended function mapping, lines 1 - 16 (CV31=8,CV32=0), Factory values	Wertebereich
257-272	State ON: 144, 0, 0, 0, 0, 0, State OFF: 0, 0, 0, 0, 0, 0, Output: 0, 1, 0, 0,	each 0 - 255
273-288	State ON: 16, 0, 0, 0, 0, 0, State OFF: 128, 0, 0, 0, 0, 0, Output: 0, 2, 0, 0,	each 0 - 255
289-304	State ON: 1, 0, 0, 0, 0, 0, State OFF: 0, 0, 0, 0, 0, 0, Output: 1, 0, 0, 0,	each 0 - 255
305-320	State ON: 2, 0, 0, 0, 0, 0, State OFF: 0, 0, 0, 0, 0, 0, Output: 2, 0, 0, 0,	each 0 - 255.
321-336	BState ON: 0, 0, 0, 0, 0, 0, State OFF: 0, 0, 0, 0, 0, 0, Output: 0, 0, 0, 0,	each 0 - 255
337-352	State ON: 0, 0, 0, 0, 0, 0, State OFF: 0, 0, 0, 0, 0, 0, Output: 0, 0, 0, 0,	each 0 - 255
353-368	State ON: 0, 0, 0, 0, 0, 0, State OFF: 0, 0, 0, 0, 0, 0, Output: 0, 0, 0, 0,	each 0 - 255
369-384	State ON: 0, 0, 0, 0, 0, 0, State OFF: 0, 0, 0, 0, 0, 0, Output: 0, 0, 0, 0,	each 0 - 255
385-400	State ON: 0, 0, 0, 0, 0, 0, State OFF: 0, 0, 0, 0, 0, 0, Output: 0, 0, 0, 0,	each 0 - 255

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

CV table for programming SUSI-Banks 1 - 8 (Sound section)

SUSI-Bank (CV 1021)	CV	Description	Range	Value*
0 (read only)	900	Manufacturer ID	-	162
	901	Version number	-	various.
	902	Reset of the Sound CVs (to reset, use a value greater than 0)	0, 1	0
1 (read only)	900	Hardware ID	-	16
	901	Minor version number	-	various.
2	900	Total volume	0 - 255	180
	905	Minimum random time	0 - 255	40
	906	Maximum random time	0 - 255	80
	910	Function key assignment for sound fader	0 - 28	25
	911	Volume control function key assignment	0 - 28	24
3	900 - 928 929 - 939	Speed step thresholds for switchable sounds, in linear 9 steps	0 - 255	0 - 252 255

SUSI-Bank (CV 1021)	CV	Description	Range	Value*
4	900 - 931	**Volume settings for singular sounds**		
	900	Volume - engine sound	0 - 255	128
	901	Volume - Bell	0 - 255	255
	902	Volume - Handbrakes, apply/release	0 - 255	192
	903	Volume - Sander	0 - 255	192
	904	Volume - Flange squeal on/off	0 - 255	192
	905	Volume - Rail joint clack on/off	0 - 255	255
	906	Volume - Couplers	0 - 255	192
	907	Volume - Air brake release	0 - 255	192
	908	Volume - Cooler Flap	0 - 255	192
	909	Volume - Cab door, open/shut	0 - 255	192
	910	Volume - Cab window, open/shut	0 - 255	192
	911	Volume - Radio 1	0 - 255	255
	912	Volume - Radio 2	0 - 255	255
	913	Volume - Radio 3	0 - 255	255
	914	Volume - Radio 4	0 - 255	255
	915	Volume - brake squeal	0 - 255	128
	931	Volume - Random sound	0 - 255	92
8	900 - 931	**Function mapping for individual sounds**		
	900	Function key - Engine sound	0 - 28	1
	901	Function key - Bell	0 - 28	2
	902	Function key - Handbrakes, apply/release	0 - 28	5
	903	Function key - Sander	0 - 28	15
	904	Function key - Flange squeal on/off	0 - 28	16
	905	Function key - Rail joint clack on/off	0 - 28	17
	906	Function key - Couplers	0 - 28	10
	907	Function key - Air brake release	0 - 28	9
	908	Function key - Cooler Flap	0 - 28	6
	909	Function key - Cab door, open/shut	0 - 28	7
	910	Function key - Cab window, open/shut	0 - 28	8
	911	Function key - Radio 1	0 - 28	11
	912	Function key - Radio 2	0 - 28	12
	913	Function key - Radio 3	0 - 28	13
	914	Function key - Radio 4	0 - 28	14

* Factory-set values

Function key assignments

F0	Lights on/off	F8	Cab window, open/shut	F16	Flange squeal on/off
F1	Engine sound	F9	Air brake release	F17	Rail joint clack on/off
F2	Bell	F10	Couplers	F18	Train lighting: locomotive pushes
F3	Cab light	F11	Radio 1	F19	Train lighting: locomotive pulls
F4	Switching (shunting) gear	F12	Radio 2	F20	Volume control
F5	Handbrakes, apply/release	F13	Radio 3	F21	Sound fader (tunnel mode)
F6	Cooler Flap	F14	Radio 4		
F7	Cab door, open/shut	F15	Sander		

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Note: This product is not a toy and is not suitable for children under 14 years. Any liability for damage of any kind caused by improper use or failure to comply with this manual is hereby excluded.

If you have any questions, we are here for you!
Internet: www.piko.de
E-Mail: info@piko.de
Hotline: Tue + Thu 4 pm-6pm, Tel.: 03675 897242

Service: In the event of a defective decoder module, please send us the module along with the proof of purchase, a short description of the problem, and the decoder address.

Warranty Statement
Each decoder module is thoroughly tested before delivery. Nevertheless, should a defect occur within the warranty period of 2 years, we will repair the module free of charge on presentation of the proof of purchase. The warranty is void if the damage was caused by improper handling. Please note that, according to the German EMC law, the module may only be used inside models bearing the CE mark.

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