#56627 PIKO SmartDecoder XP Sound PluX22 for ML 4000 diesel locomotive multi-protocol fits mfx® capable

Decoder overview

The state-of-the-art PIKO SmartDecoder XP Sound inside in this PIKO locomotive is a compact yet powerful multi-protocol PluX22 sound decoder. It features high fidelity, 12 bit 8-channel sound with 2.5 watts of output that ensures distortion-free sound at all levels. It complies with the current RCN standards in all areas. The decoder can be used on DCC, mfx®, and Motorola® digital systems as well as traditional DC or AC analog layouts. It automatically senses what operating mode is used on your layout and is RailCom®/RailCom Plus® and mfx®-compatible. The PIKO SmartDecoder XP Sound features several programmable braking distances in addition to numerous other programmable functions.

The PIKO SmartDecoder XP Sound is load-regulated and features auto-adaptive motor control that works with traditional or modern DC motors as well as 1 Amp coreless motors, for silky smooth operation. The decoder will also tolerate a temporary current draw up to 2 Amps. The motor speed table can be set using the minimum, median, and maximum motor speed curve, or by the user-programmable 28-speed step extended curve. The decoder features two directional lighting outputs and seven additional special function outputs that can be activated using function keys F0 to F68 (DCC). The switching (shunting) gear with extended slow speed range, three possible starting and braking delays, and locomotive sounds are also switchable via function keys. The sound module can control specified function outputs as well as the decoder's motor output. An illustration of this is the flickering headlight effect when the engine is started. In the event of short-term voltage loss, the PIKO SmartDecoder XP is kept functioning by sophisticated power management circuitry.

Decoder attributes

- Suitable for DC motors and AC bell-armature motors rated up to 1 A
- Nearly silent operation thanks to auto-adaptive motor control
- 14, 28, and 128 speed step levels, depending on data format
- Short (1-127) and long (128-10239) addressing
- RCN and NMRA compliant
- RailCom® and RailCom Plus®-capable
- fits mfx® capable
- Adjustable minimum, medium, and maximum speed levels
- Adjustable extended speed curve
- Switching (shunting) speed gear (half speed).
- 3 adjustable acceleration and braking delays, each switchable via F0 - F68
- Directional light outputs, dimmable
- 7 special function outputs, direction-dependent and dimmable
- F0 - F12 can be programmed for use on analog layouts
- Two adjustable light dimming settings for outputs A1 to A7
- Simple function mapping for lighting functions in F0 - F12 and A1 to A7
- Extended function mapping in F0 - F68 for switching multiple outputs depending on linked conditions
- Locomotive tail lights can be switched off
- Speed-dependent deactivation of function outputs
- Four adjustable flashing patterns for function outputs
- Load- or speed-dependent smoke generator control
- Firebox flicker
- Function outputs A4 and A5 can be used for remote coupling and switching (shunting) scenarios
- Showing and hiding the light and function outputs, adjustable
- Adjustable light illumination time: light reaches full brightness after a while
- Fluorescent lamp switch-on effect with adjustable flash time
- Various other adjustable lighting effects like North American locomotive lighting arrays
- Recognizes DCC brake signals, brake districts using DC analog voltage and ABC brake districts
- Recognizes LENZ BM2 brake signals
- ABC automatic shuttle train operation with adjustable halt times and slow speed sections
- Adjustable braking distances measured in centimeters, which are activated via ABC, DC analog, DCC brake signals, or speed step 0
- Customizable throttle settings for precise control of older motor types
- 4 Motorola addresses for functions F1 - F16 when used with Motorola-format command stations
- Short circuit protection for each function output
- Error memory for motor and function outputs
- Temperature overload protection
- Automatic detection of conventional DC or AC operating mode
- All CVs programmable only in DCC and Motorola formats
- In DCC mode, programmable via register, CV direct, or page programming
- DCC Programming on the Main (POM)
- Decoder programming lock

Sound module

- 12 bit resolution sound
- 8-channel sound system
- 128 MBit sound storage for up to 495 seconds of digitized original sound
- 22.05 kHz audio sampling rate
- Powerful digital amplifier with 2.5 watt output
- Engine start-up/shutdown sequences
- Up to 32 switchable sounds accessed via function keys up to F68
- Load-dependent sound change (starting, uphill, downhill, braking, stationary, etc.)
- Adjustable volumes for overall sound and individual sounds
- Sound fade function with adjustable volume
- Random sounds like shoveling coal or cooling fans
- Automatic brake squeal with adjustable speed threshold
- Automatic flange squeal with adjustable speed threshold
- Adjustable speed level thresholds for switching noises
- Adjustable number of cylinders for steam locomotive sounds
- Loading locomotive projects via PIKO SmartProgrammer / SmartTester
- and much more

Connecting the PIKO SmartDecoder XP Sound

Remove the jumper plug from the PluX22 interface of your model and insert the sound decoder.

Note the location of PIN 11, which is blank/missing. Install the 4 - 16 ohm speaker as shown in the illustration in the spare parts list. Make sure that no wires are crossed which could cause a short circuit when you put the shell back on the chassis.

The model's first start-up should be on the programming track, with your control system's programming mode activated. When reading or programming, very small currents will flow through the decoder, which are entirely normal and will not damage the decoder.

Special functions A1 to A7

Special function outputs A1 to A7 can only be used if the desired devices are already connected to the PluX 22 interface in the model, or there are solder pads for the devices on the model's circuit board. The PluX22 decoder only controls the rear light (F0r), the engine room lighting (A3) and the fans (A5/A6). An additional light controller controlled via SUSI controls the remaining light functions! NOTE: Additional light controllers (LC) are used in this model to control all light functions. The function outputs of the decoder are therefore not used.

A short circuit anywhere in your model can destroy the decoder and other electronics in your model!

SUSI interface

The SUSI interface of the sound decoder is implemented via the PluX22 interface. If the model's main circuit board is already equipped with a SUSI interface (i.e. another PIKO sound module with SUSI, two functions with their own amplifier circuit or two servo circuits can be connected to it). CV47 defines the application for which the application the SUSI interface is to be used. Please refer to the CV table for the value to be programmed into CV 47.

CAUTION: Soldering on the decoder itself or inside the model should only be carried out by experienced modelers with the appropriate tools. Decoders that have been damaged from improper handling are not covered under the warranty.

First-time use (state of delivery)

Enter address 3 on your command system. Depending on the data format it is addressed with, the sound decoder will work in 28-speed step DCC mode or in Motorola mode. When using a RailCom Plus®-compatible digital control center (i.e. PIKO SmartControl) or an mfx®-compatible digital control center, the decoder will log on automatically and can

be used immediately. If the decoder is used on conventional analog layouts, it can be operated with an analog DC or analog AC throttle. The decoder will automatically recognize the operating mode.

Analog operation with DC or AC power

The sound decoder can be operated on conventional DC or AC analog layouts, and it will automatically recognize that it is being used on a conventional analog layout. Not all of the decoder's sound and light functions will be available in analog operation. Please note that trouble-free operation cannot be guaranteed on an analog layout that is controlled by a Pulse Width Modulation (PWM) throttle, which sends an unstable electronic signal to locomotive motors.
NOTE: In DC analog mode, your model will not begin to move until the voltage is turned up higher than what you are used to with DC analog models. This is because decoder-equipped models only begin to function at a higher voltage level than analog models.

Function outputs in analog operation

It is possible to set the decoder so that functions F0 - F12 can be switched on in analog mode. To do this, CVs 13 & 14 must first be programmed to operate in analog mode. Their corresponding values can be found in the CV table.

Motorola®

In order to use functions F1 - F16 with Motorola-based control systems, the sound decoder has been equipped with 4 Motorola® addresses for each of these functions. The three subsequent addresses for functions F5 - F16 are in ascending order to the decoder address and can be activated in CV 61 as required by the values 1 (F5 - F8), 2 (F5 - F12), or 3 (F5 - F16).

Configuration CVs

In addition to it's DCC address, configuration CVs are the most important CVs of a decoder. These are CVs 12 and 29. A configuration CV normally contains setting options for a decoder which are represented in a maximum of 8 bits (0 - 7). The value to enter when programming a CV is calculated from the CV table (see below) by adding up the values for each desired function. The following tables give you examples of how a configuration CV is configured:

Bit	CV12 operational state	value
0	DC analog off DC analog on	0 1
2	DCC format off DCC format on	0 4
4	AC analog off AC analog on	0 16
5	Motorola® format off Motorola® format on	0 32
6	mfx® format off mfx® format on	0 64

Bit	CV29 operational state	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 operation only Automatic analog/digital switchover	0 4
3	RailCom® switched off RailCom® switched on	0 8
4	Speed steps via CV 2, 5 and 6 Speed steps via CV 67-94	0 16
5	Short address (CV 1) Long address (CV 17 and 18)	0 32

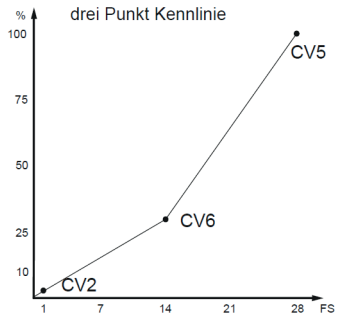
Example for calculating CV 29:

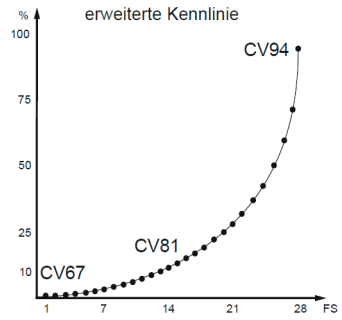
Normal direction of travel	Value = 0
28 speed steps	Value = 2
Analog or digital operation	Value = 4
RailCom® activated	Value = 8
Speed steps via CV 2, 5, 6	Value = 0
Short DCC addressing	Value = 0

The sum of all values is 14. CV 29 is factory set to a value of 14.

Motor speed table settings

The decoder is factory set to a simple 3-point speed curve, where the minimum speed is set in CV 2, the medium speed is set in CV 6, and the maximum speed is set in CV 5. You can change the factory settings to a customized, 28-step extended speed curve by going to CV 29 and entering a value of 1 into Bit 4. This will allow you to define the speed for each one of the 28 speed steps. The 28 individual steps are controlled by CVs 67-94, which control steps 1 to 28 respectively. For example, to change speed step 1, you would enter a value into CV 67. To change speed step 28, you would enter a value into CV 94.





Trim speed

The motor speed curves for forward direction of travel and backward direction of travel can be trimmed separately from each other. For example, the forward speed curve of a steam locomotive can be set to match the exact acceleration of it's prototype. The same can be done for the reverse speed curve. So, the model could actually travel at different speeds (depending on the direction it is going) even though the throttle is set to the same speed step. The forward trim speed is set in CV 66 while the backward trim speed is set in CV 95, with both CVs using a value range from 1 - 255 (0 = off). The factory setting of both CVs is a value of 128, which corresponds to the factor 1.

RailCom®, RailCom Plus®

RailCom® is a decoder technology developed by LENZ® that allows for the transfer of data from the decoder via a special "CutOut" DCC digital signal to whatever track the model is on. Obviously, the track must have detectors installed that evaluate this data and, if necessary, forward it to the DCC command station. This system allows for easier train identification on a dispatcher's screen and makes Programming On the Main simpler. RailCom® is activated or deactivated in CV 29, Bit 3. Additional RailCom® settings are made in CV 28. There, for example, you can activate RailCom Plus® in Bit 7. If RailCom Plus® is activated, the decoder will automatically send it's address, locomotive symbol, and function icons to a RailCom Plus®-capable DCC command center (like PIKO SmartControlwlan) and its function symbols will appear on the control screen within a few seconds. With RailCom Plus® technology, no locomotive data has to be stored in the command center and no locomotive addresses have to be programmed into the decoder.

fits mfx®

The PIKO XP SmartSound Decoder is also configured for the mfx® data format and is fits mfx® certified. If your command station is mfx-capable, the decoder will automatically transmit its decoder address, locomotive symbol, and all function symbols to your command station. As is the case with RailCom Plus ®, there is no need to store any locomotive data in the command station or assign an address to a decoder.

Acceleration and braking

Acceleration and braking delay (ABV)

The PIKO XP SmartDecoder can be programmed to use three different acceleration and braking delays (ABV - ABV1 - ABV2), each selected from a range of 0 - 255. In order to prevent jump starts, the decoder has a “soft start” feature that can be set in CV 53. Once the “soft start” takes place, the respective ABV delay kicks-in. The first ABV is set in CV 3 (start-up delay) and CV 4 (braking delay). ABV1 and ABV2 are set in CVs 150 - 153. If simple function mapping is used (CV 96 = 1), then you can determine from CV 156 which function key (F0 - F68) should turn off the ABV. ABV1 and ABV2 are mapped to any function key from F0 - F68 by using CVs 154 and 155.

Switching (shunting) mode)

The switching (shunting) mode function can be mapped to any key between F0 - F68 by using CV 157. Your model will run at half speed when switching mode is activated.

Märklin® braking section (section of a DCC layout where analog DC power is fed to a track to initiate train brakes)

The decoder will react to a Märklin® braking section if CV 27 bit 4 or bit 5 is set to 1. (This setting is switched off at the factory).
CV 27 = 16 (bit 4 = 1) -> DC analog braking in opposite direction of travel
CV 27 = 32 (bit 5 = 1) -> DC analog braking in the normal direction of travel
CV 27 = 48 (bits 4 & 5 = 1) -> DC analog braking in either direction of travel

ABC (Automatic Brake Control) braking

The decoder can detect a lower amplitude of the digital voltage on one side of the track and initiate a braking process. Which side of the track it detects the lower amplitude on can be set via CV 27:

CV 27 = 1, brake when the right rail is more positive
CV 27 = 2, brake when the left rail is more positive
CV 27 = 3, brake regardless of which rail is more positive

Regardless of which rail is selected, an active ABC braking section can still be used in the opposite direction.

The difference in rail voltage from which the decoder recognizes an ABC braking distance is set in CV 48. The formula for determining this difference is approx. 1.6V + CV value * 0.1 V.
Further options for ABC braking sections are set in CV 49

CV49:
Bit 0 = 1, restricted speed if the right rail is positive
Bit 1 = 1, restricted speed if the left rail is positive
Bit 2 = 1, restricted speed in an active ABC braking section
Bit 3 = 1, ABC shuttle traffic is active
Bit 4 = 1, acceleration and braking using ABV 1
Bit 5 = 1, acceleration and braking using ABV 2

If the decoder is set to ABC restricted speed via CV 49 and an ABC restricted speed signal is detected on a Lenz BM2 module, the decoder brakes to an internal speed level (0-255) that is set in CV 50.

If the decoder is set to ABC shuttle traffic via CV 49, then, after stopping in an ABC braking section, it will change the train’s direction of travel after the time set in CV 51 has elapsed. The train will then accelerate in the ABC braking section either to its original speed or to restricted speed, if this is activated in bit 2 of CV 49.

Constant braking distance (distance at which a train will run at restricted speed) in centimeters:

The XP decoder allows you the option of setting a constant braking distance that is measured in centimeters. This constant braking distance can be triggered in several ways, which include an ABC brake signal, a brake signal from a DCC brake generator, a brake signal from a DC analog braking section, or by turning your throttle back to speed step 0.
The speed at which the train travels in a constant braking section is controlled by CV 140. When the locomotive enters the braking section at normal track speed, it will then either accelerate or brake to the speed set in CV 140. After this acceleration or deceleration, the train will brake even further just before it comes to a stop (usually in front of a red signal or maybe a passenger station).
The value range for CV 140 is between 0 and 255. The value you give CV 140 is a fraction of the approx. 2400 internal speed steps of the decoder. A value of 255 means that the decoder sets the vehicle to approx. 11% of its maximum possible speed. (255 is almost 11% of 2400)
Two further CVs are available for fine-tuning the constant braking distance. The braking distance can be adjusted using CV 143 for higher speeds and CV144 for lower speeds.
In order to test the braking distance settings without using a braking section, you can enter a function key (F1 - F68) into CV 142. You can then test the braking distance by activating whatever function key you entered into CV 142

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CV definitions:
CV 140 = reduced speed
CV 141 = braking distance in centimeters
CV 142 = activation of constant braking distance using a function key (F1 - F68)
CV 143 = 0 -> higher speeds adjustment
CV 144 = 0 -> lower speeds adjustment
CV 145 = activation of constant braking distance by:
Bit 0 = 1 -> ABC braking
Bit 1 = 1 -> DC braking
Bit 2 = 1 -> DCC brake signal (broadcast)
Bit 3 = 1 -> Throttle speed step 0

Multiple-unit operation (Consisting)

The XP SmartSound decoder is easily programmed for locomotive consisting by accessing its multiple-unit address. This address is stored in CV 19 in a value range from 1 - 127. When this address is activated on your throttle, the decoder no longer reacts to its original DCC address. Use bit 7 (value 128) of CV 19 to reverse the model’s direction of travel while it is included in a consist.

Function outputs in a locomotive consist are set via CV 21 (F1 - F8) and CV 22 (F0, F9 - F12).

CV 21 determines whether functions F1 - F8 are controlled via the address of the locomotive consist in CV 19. For each bit, a value of 1 means that the corresponding function is addressed via the locomotive consist’s address. A value of 0 defines that the function is only addressed via the individual model’s address, which has been set in CV1 or CVs 17 & 18. Bit 0 to bit 7 correspond to function keys F1 to F8.

CV 22 determines whether functions F0 and F9 - F12 are controlled via the address of the locomotive consist in CV19. For each bit, a value of 1 means that the corresponding function is addressed via the locomotive consist’s address. A value of 0 defines that the function is only addressed via the individual model’s address, which has been set in CV1 or CVs 17 & 18. Bit 0 corresponds to F0 while the consist is moving forward while bit 1 corresponds to F0 while the consist is moving in reverse. Bit 2 to bit 5 correspond to function keys F9 to F12.

Fault memory

If the decoder detects a motor malfunction or overheated component, it responds by flashing the model’s headlights on both ends. If the lights flash quickly (approx. 4x per second), the decoder has detected a motor fault. If the lights flash slowly (approx. 2x per second), the decoder has detected that something has overheated. When the decoder detects a fault, CV 30 (the fault memory) can be checked to determine what the fault is.

CV30 -> 1 = motor fault, 2 = overheated decoder, 4 = function output error

Once the fault has been corrected, the error memory (CV 30) should be reset to a value of 0.

Function outputs

Simple function mapping (switched off at the factory)

The following decoder settings can only take place when CV 96 is set to 1.

In simple function mapping, you can assign “switchable” functions like lighting, sound, or auxiliary outputs to function keys F0 to F12. CVs 33 to 46 control the settings of these keys (RCN225). Their CV values determine whether the function can be switched on or off, as is shown in the following table. Keep in mind that the XP has only 7 function outputs, of which the higher ones are highlighted in gray in the table below:

CV / F-key	Bit 7 (128)	Bit 6 (64)	Bit 5 (32)	Bit 4 (16)	Bit 3 (8)	Bit 2 (4)	Bit 1 (2)	Bit 0 (1)	Value
33 / F0v	A6	A5	A4	A3	A2	A1	F0h	F0v	1
34 / F0r	A6	A5	A4	A3	A2	A1	F0h	F0v	2
35 / F1	A6	A5	A4	A3	A2	A1	F0h	F0v	4
36 / F2	A6	A5	A4	A3	A2	A1	F0h	F0v	8
37 / F3	A6	A5	A4	A3	A2	A1	F0h	F0v	16
38 / F4	A9	A8	A7	A6	A5	A4	A3	A2	4
39 / F5	A9	A8	A7	A6	A5	A4	A3	A2	8
40 / F6	A9	A8	A7	A6	A5	A4	A3	A2	16
41 / F7	A9	A8	A7	A6	A5	A4	A3	A2	32
42 / F8	A9	A8	A7	A6	A5	A4	A3	A2	64
43 / F9	A12	A11	A10	A9	A8	A7	A6	A5	16
44 / F10	A12	A11	A10	A9	A8	A7	A6	A5	32
45 / F11	A12	A11	A10	A9	A8	A7	A6	A5	64
46 / F12	A12	A11	A10	A9	A8	A7	A6	A5	128

Example: Function key F3 should only control whether the rear light output (F0h) can be switched on or off.
The CV to program for F3 is CV 37. A value of 2 (F0h, rear light output) is programmed into CV 37. To keep F0 from causing the rear light output from illuminating when the locomotive switches directions, program CV 34 (for function key F0) to a value of 0.

The function outputs are switched off, depending on the direction of travel (When CV 96 has a value of 1)

In CV 97 (forward direction of travel) and CV 98 (backward direction of travel) you can specify which function outputs A1 - A7 should be switched off. If any of functions A1 - A7 are switched on via a function key, they are automatically switched off in the desired direction of travel.

CV 97:		**Value**	**CV 98:**		**Value**
Bit 0	A1 forward off	1	Bit 0	A1 backwards off	1
Bit 1	A2 forward off	2	Bit 1	A2 backwards off	2
Bit 2	A3 forward off	4	Bit 2	A3 backwards off	4
Bit 3	A4 forward off	8	Bit 3	A4 backwards off	8
Bit 4	A5 forward off	16	Bit 4	A5 backwards off	16
Bit 5	A6 forward off	32	Bit 5	A6 backwards off	32
Bit 6	A7 forward off	64	Bit 6	A7 backwards off	64

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

Pointer CVs 31 and 32 (all mentioned values of CVs 31 & 32 from firmware version 1.3.0, i.e. CV7 >= 3)

To expand the number of usable CVs, the CV range from 257 - 512 was configured for block-by-block addressing. Block-by-block addressing means there are several blocks (banks) in the decoder with a CV range of 257-512. To program a specific CV bank, CV 31 and CV 32 must first be programmed as “pointer CVs” to the respective bank!

Simple and Extended Function Mapping

The following decoder settings are possible with simple (CV 96 = 1) or extended (CV 96 = 6) function mapping.

NOTE: Programming all XP decoder settings is made much easier with the PIKO SmartProgrammer (# 56415) and the PIKO SmartTester (# 56416).

Setting options for function outputs (for expert modelers)

The settings for each function output‘s intensity are stored in a separate CV bank (CV block) in CVs 257 - 512. In order to reach this CV bank for programming, two „pointer CVs“ (CV 31 and CV 32) must be set beforehand.

CV31 = 18
CV32 = 0

A variety of settings can be assigned to each function output of the SmartDecoder XP, via ten defined CVs. A list of each CV and its associated output is found in the CV table. Basically, there are two parameter sets (A & B), each with five CVs, that are structured according to the following scheme (the following example concerns the front light function output F0v):

CV 257, output F0v effect A -> effect number according to the list below
CV 258, output F0v PWM A -> 1st light intensity setting (dimming)
CV 259, output F0v flags A -> additional automatic switch-off options including fade-in and -out
CV 260, output F0v parameter 1 A -> additional setting parameter if required
CV 261, output F0v parameter 2 A -> additional setting parameter if required
CV 262, output F0v effect B -> effect number according to the list below
CV 263, output F0v PWM B -> 2nd light intensity setting (dimming)
CV 264, output F0v flags B -> additional automatic switch-off options including fade-in and -out
CV 265, output F0v parameter 1 B -> additional setting parameter if required
CV 266, output F0v parameter 2 B -> additional setting parameter if required

These output parameter settings can be assigned to specific function keys by function mapping.

Effects:
The following table lists numbered effects used for programming the various function outputs. The respective effect number is required for assigning the effect to the function output and if necessary, to be programmed into the first CV of the respective parameter set. There are additional settings listed below the table, for effects shown in italics.

0: no effect	10: Mars light	30: Single flash	40: *Load-regulated smoke output*	60: Front clutch
1: *Flash pattern 1*	11: Gyro light	31: Multiple flashes	41: *Speed-regulated smoke output*	61: Rear clutch
2: *Flash pattern 2*	12: Blinking headlight	32: Shift light	42: *Smoke permanently on*	
3: *Flash pattern 3*	13: Stepped blinking pattern	33: Random linear	50: *Servo1 configuration*	
4: *Flash pattern 4*	14: Reduced intensity	34: Fire box	51: *Servo2 configuration*	
	15: Rotating beacon	35: *Fluorescent lamp*	52: *Servo3 configuration*	80: Motor
	16: Repeating single flash	36: *Malfunctioning Fluoresc. lamp*	53: *Servo4 configuration*	
	17: Repeating double flash	37: *Energy saver lamp*	54: *Servo5 configuration*	
	18: Repeating multi flash	38: TV	55: *Servo6 configuration*	255: Output/effect shut off

Dimming (PWM):
Light and function outputs A1 - A7 can be set to any dimming level within a value range of 0 - 64. The factory setting for each function output is 64.

Flags:
Flags are programming options that enable an output to be switched off automatically under certain conditions as well as to be displayed or hidden.

Bit	Value	Bit	Value
0: Auto-off backwards	1	4: Auto-off fast	16
1: Auto-off forward	2	5: Auto-on	32
2: Auto-off STOP	4	6: Fade in	64
3: Auto-off Slow	8	7: Fade out	128

Bit 0 and/or Bit 1 must be set and Bit 2 and/or Bit 3 and/or Bit4 must be set!

The speed threshold for „Auto-Off Slow“ or „Auto-Off Fast“ can be set in CV 179 „Speed Threshold“ in a value range from 0-255.
Fade-in and fade-out times are set via CVs 177 (fade-in time) and CV 178 (fade-out time) in steps of 20 milliseconds in a value range from 0 to 255.
If an output has been switched off via an „Auto-Off“ configuration, then Bit 5 „Auto-On“ can be used to decide whether this output should be automatically switched on again when the switch-off condition is no longer met.

Fade-in and fade-out light or function outputs:

When an output is switched on or off, it gradually fades-in or fades-out.

CV 177 -> fade-in time in 20 millisecond steps
CV 178 -> fade-out time in 20 millesecond steps
An output that is selected to receive the fade-in / fade-out function is set with the flags described above, in its associated parameter set.

Flash patterns for light and function outputs:

The locomotive decoder has four flash patterns that can be assigned to the outputs. The respective flash interval can be set in CVs 173 (flash pattern 1) - 176 (flash pattern 4), in 20 millisecond steps. If an output is to use one of these flash patterns, the effect is assigned to the desired output using effect numbers 1 - 4.

Fluorescent lamp, defective fluorescent lamp effect:

The switch-on effect of a fluorescent lamp (multiple flashes before the light is fully turned on) or a defective fluorescent lamp (light does not illuminate consistently) can be assigned to the light or function outputs. The duration of the switch-on effect (start time) can be set in CV 172 in 100 millesecond steps. The flash interval for a defective fluorescent lamp is fixed. The fluorescent lamp switch-on effect is assigned to an output using effect numbers 35 (fluorescent lamp) or 36 (defective fluorescent lamp).

Energy-efficient lamp effect:

When an energy-efficient lamp is switched on, it takes a while to reach full brightness. This effect's initial brightness level can be set in a value range from 0 - 64 in CV 170. The fade-in time to maximum brightness can be set in 100 millisecond steps in CV 171.

Smoke generator control:

A smoke unit can be controlled from any function output either by the speed of the locomotive or the weight it is pulling. The intensity (PWM) of the smoke output (when the smoke unit has sufficient smoke fluid in it!) in either operating mode is set by using the values listed below and storing them as parameters in the corresponding CVs of the chosen function output.

Load-regulated smoke output:
Effect number 40
PWM: standing idle (value approx. 25)
Flags: not used
Parameter 1 = smoke output under load (value approx. 55)
Parameter 2 = threshold value for detecting a load on the locomotive (~ 20)

Speed-regulated smoke output:
Effect number 41
PWM: standing idle (value approx. 25)
Flags: not used
Parameter 1 = smoke output increases with speed
Parameter 2 = threshold value for detecting train movement

Servo control:

Connecting a servo to the decoder requires advanced knowledge of electronics and should not be attempted by those unfamiliar with such procedures.

A maximum of six servo circuits can be connected to the PIKO SmartDecoder XP. Settings for the two stop positions and the speed of the servo movement can be set in three CVs that control the function output to which the servo is connected. A list of the CVs associated with each servo is found in the CV table. Whichever servo configuration number (1 - 6) is used for an output is entered into the parameter set of the associated output using the effect numbers 50 (servo configuration 1) - 55 (servo configuration 6).

Configuration CVs using the example of servo 1:
CV 202 -> Servo1 speed in a value range from 0 -255. The larger the value, the higher the speed.
CV 203 -> Servo1 left stop, value 128 = 1 millisecond servo pulse
CV 204 -> Servo1 right stop, value 128 = 2 millisecond servo pulse

Timer-controlled shut-offs for function outputs:

The front light (F0v) and rear light (F0h) function outputs as well as outputs A1 - A7 can be shut off automatically following an adjustable time. This adjustable time can be individually set for each output in half-second steps from a value range of 0 - 255 in the following CVs.

CV180 -> Automatic shut-off time for F0v
CV181 -> Automatic shut-off time for F0h
CV182 -> Automatic shut-off time for A1
CV183 -> Automatic shut-off time for A2
CV184 -> Automatic shut-off time for A3
CV185 -> Automatic shut-off time for A4
CV186 -> Automatic shut-off time for A5
CV187 -> Automatic shut-off time for A6
CV188 -> Automatic shut-off time for A7

The flags of a parameter set can be used to set the conditions under which the respective output should shut off automatically following an assigned time.

At least one flag connected with direction of travel and one speed flag must be set.

If an output is to switch off following a set time since it was switched on, then all five flags must be set.

Example: The front light function output (F0v) should shut off after 5 seconds.

CV 180 = 10 (time for automatic shut off of F0v = 5s)
CV 31 = 18 (pointer CVs)
CV 32 = 0
After the light shuts off:
CV 257 = 0 (no effect)
CV 259 = 31 (all direction and speed flags are set)

Digitally-activated (European style) coupler control (A4 and A5)

PIKO locomotives can be equipped with digitally-activated front and rear European-style couplers. These couplers are connected to decoder outputs A4 and A5. If you run the locomotive in a pre-programmed switching scenario, then output A4 must be used for the front coupler and A5 for the rear coupler. Which of the two function outputs A4 and A5 should be activated for a digital coupler is set in CV 47 using bits 2=1 (A4) and 3=1 (A5). If the front and rear couplers are accidentally connected to the wrong outputs, (i.e. A4 to the rear and A5 to the front), the problem can be corrected by setting CV 47 bit 4 to 1. The SmartDecoder XP also allows you to activate the digital couplers by pressing the "coupler clash" sound icon on your DCC throttle. See "Sound Option1" in the Sound section's CV table.

Digital couplers raise or lower their hooks based on the state of fine copper windings that are mounted next to the coupler's armatures. These copper windings are very sensitive to electric current and will become hot and expand when exposed to continuous current. CV 130 can be set to shut off the coupler function after a certain time (without pressing a key) to keep the copper windings from burning out from too much current. The decoder can also be set to apply a high PWM for an instant, so that the coupler hook is lowered into position, and then stays in position with a lower PWM. The lower PWM is adjustable in CV 135.

CV130 -> Uncoupling activation time in 100 millisecond steps (0 - 255)
CV135 -> PWM hold time (0 - 255)

Switching (shunting) scenario with automatic uncoupling movement:

NOTE: An automatic uncoupling movement can only be activated if the digital coupling function is activated in CV 47. Please also note that an automatic uncoupling movement can only be initiated after the model has come to a complete stop:

Here's how it works:
1. The locomotive shoves (pushes) against the cars. The shoving motion is carried out at an adjustable speed for an adjustable time (T1).
2. The locomotive stops and switches it's direction of travel, yet does not move.
3. The locomotive's coupler uncouples from the car it was coupled to, and the locomotive backs away from the cars it just uncoupled from. The speed and running time of this move are both adjustable (T2).
4. The locomotive now stops, and then resumes its original direction of travel.

CV 131 is used to set the speed level of the switching scenario by programming it with a value of 1-255. If you program 0 into CV 131, then no switching scenario can be carried out.
CV 132 determines the length of time of the shoving move (T1) in 100 millisecond increments while CV 133 determines the length of time for move T2, again in 100 millisecond increments. A value of 0 means that no moves take place at all.
CV 134 determines the length of time that the locomotive backs away from the cars (T2), in 100 millisecond increments.
The overall length of time for the switching scenario is determined in CV 130, although individual steps can be adjusted in CVs 131 - 134

SUSI (Serial User Standard Interface)

The SUSI module on the decoder has activation options in CVs 115 and 116 that determine which commands are passed on from the decoder to outputs connected to SUSI. The PIKO SmartDecoder XP can pass on the following commands if the corresponding bit is set to 1.

CV115, Bit 0 -> actual speed, Bit 1 -> setpoint speed, Bit 2 -> relative load and Bit 7 -> function group 1 (F0 - F4)

CV116, Bit 0 - Bit 7, function groups 2 - 9, also functions F5 - F68 in blocks of eight ascending per bit.

Extended Function Mapping (CV96 = 6)

NOTE: Due to the complex nature of extended function mapping, it is not feasible to use manual CV programming for extended function mapping. For working in extended function mapping, we strongly recommend using the PIKO SmartProgrammer (# 56415) and the PIKO SmartTester (# 56416) devices.

Sound module of the PIKO XP Smart Sound decoder

Overview

PIKO XP SmartSound decoder provides distortion-free prototypical sound in 12 bit resolution at a 22.05 kHz audio sampling rate. The decoder's intelligent sound control adapts each sound to the operating state of the model. For example, when the model is going uphill, the engine sound will be more labored. When the model is at standstill, the engine sound changes to idle. The decoder keeps engine sound in-sync with the state of the motor. When the sound key is pressed, the model will not begin moving until the engine start-up sequence has played out. If the train stops, the brakes will squeal. Random sounds such as air compressors or coal shoveling will play when the model is running or in idle. These sounds can also be activated using their respective function keys. When the model is stopped and the sound key is switched off, the decoder will play engine shut-down sounds and sounds like a door closing as the engineer leaves the cab. The decoder's 8-channel technology allows for multiple sounds such as horns, whistles, bells, and doors to be individually activated while the engine sound is activated. A sound fader function can be activated if the model leaves the visible area of a layout, and the sound can fade-in again as the model returns to visible trackage. Nearly all the sound functions have individually adjustable volumes that are programmed in CV settings, and they can be assigned to any function key from F0 to F68. The overall sound volume can be set to one of five levels while the model is in operation, with a function key.

The model's engine sound will function while the model is running in analog mode, but individual sounds like whistles or horns cannot be activated by the operator. Please note that PIKO cannot guarantee distortion-free sound when running the model with analog PWM throttles due to their unstable electrical signals.

Volume settings:

The master volume of the PIKO SmartDecoder XP Sound can be adjusted directly as desired by programming CV63 within a value range of 0–255 or it is changed in a special CV bank. To access this bank, pointer CV 31 must be set to 2 and pointer CV 32 must equal 0, and then CV 257 can be set to the desired volume. Further sound options like flange squeal and the five volume levels for each individual sound can be set in this bank. Please refer to the CV table for each respective CV.

Function Mapping Sound

Function key assignment for individual sounds can only be done with extended function mapping and cannot be programmed using individual CVs (see note on extended function mapping).

Custom sound files

In order to load a custom PIKO sound file onto the decoder, you will need the PIKO SmartProgrammer (# 56415) and (optional) the PIKO SmartTester (# 56416).

Factory reset

To restore the sound decoder to factory settings, please program CV 8 to a value of 8:

Technical specifications:

Addresses:	1-10239 (long DCC address)
Max. Motor current / total load:	1 A * Short-term up to 2 A
Function outputs:	0.4 Amps each
Sound resolution:	12 bit
Number of sound channels:	8
Audio sampling rate:	22.05 kHz
Output power:	2.5 watts
Size:	28.5 x 16 x 4 mm (1.1 in. x 0.6 in. by 0.2 in.)

* Continuous load, can vary depending on the installation situation

Programming

Configuration variables (CVs) form the basis of all decoder settings. The decoder is easily programmed with the PIKO SmartControllight, PIKO SmartControl, and other DCC control systems as well as with Motorola based DCC control systems.

Programming with DCC devices:

Use the programming menu of your DCC device to read and program the decoder CVs. This can be done by register programming, directly accessing each CV on your device, or page programming. The decoder can also be programmed using Programming On the Main (POM), if your DCC system allows for it. Consult your DCC system's owner's manual for more information on POM.

Programming long addresses without using a programming menu:

If you want to program the decoder yet your DCC system does not support long addressing, you can still program the decoder using CVs 17 and 18. First you must calculate the value for CVs 17 and 18. The following is an example of how to calculate the values of CVs 17 and 18 if the DCC address for your model is 2000:

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

Programming lock (decoder programming lock):

The decoder programming lock is used with several decoders in a model to transfer CVs to only one of the decoders with the same base address (CV 1) or long address (CV 17 and CV 18). For this purpose, CV 16 must be programmed to a different number (index number) in each decoder before the decoder is installed in the model.
To change or read the value of a CV in one of the installed decoders, program the corresponding index number in CV 15 and then program the CVs of the selected decoder. The decoders compare the values in CV 15 and CV 16 and if both values match, access to the CVs is enabled. If the comparison fails, then there is no way to access the CVs of the decoder.
The following index numbers are recommended:
1 for motor decoders, 2 for sound decoders, 3 or higher for functional and other types of decoders.

Programming with a Märklin command center (e.g. 6021)

Something to keep in mind when using a Märklin command center for programming is they can program all the CVs of a decoder but they do not read them out on-screen. To program the SmartDecoder XP Sound using a Marklin command center, the decoder can be switched to programming mode in one of two ways (A or B, depending on the command center) and then programmed.
1A. Switch the control center off and on
2A. Select the address of the decoder and switch on the light
3A. With the model at a standstill (speed step 0), switch the direction of travel 5-8 times in quick succession until the headlight flashes. Now, go to step 4.
or
1B. Set the command center to „Motorola old" (6021 DIP 2 = off) and then switch the command center off and on
2B. Set the command center to „stop" and select address 80
3B. With the model at a standstill, switch the direction of travel and hold it, set the command center to „go" and wait approx. 12 seconds. Now go to step 4.
4. Enter the number of the CV to be programmed into the command center (e.g. a locomotive address)
5. Briefly switch the direction of travel. Now the rear lights flash 4 times quickly (only when using method A).
6. Enter the desired value for the CV (like a locomotive address) into the command center
7. Briefly switch the direction of travel. Now the rear lights flash 4 times slowly (only when using method A).
If more CVs need to be programmed, repeat steps 4-7
When finished programming, switch the command station to „stop" or enter address „80" and briefly switch the direction of travel.
Since only values from 01 to 80 can be entered when programming with a Motorola command center from Märklin, the value "0" must be entered as value "80".

Page programming for CV values greater than 79

CV values greater than 79 can only be entered using page programming. The page register is contained in CV 64. If CV 64 is given a value greater than 0, then the content of CV 64 times 64 is added to each subsequent entered address value in all subsequent programming processes. The entered value must be in the 1 to 64 range.

After successful programming of all CVs greater than 79, the page register (CV 64) must be set to zero again.

To program CV 82 to a value of 15, CV 64 must first be set to a value of 1. Then, CV 18 is set to a value of 15. The decoder now stores a value of 15 in CV 82, which is the result of adding the content of CV 64 multiplied by 64 (i.e. 64) and the CV number entered at the control center (18).

Offset register for programming CV values greater than 79

CV values greater than 79 can only be programmed using the offset register, which is contained in CV 65. If CV 65 is given a value greater than 0, then in all subsequent programming, the content of CV 65 is multiplied by 4 and added to each CV value programmed below and stored in the corresponding CV.

After successfully programming all CV values above CV 79, the offset register (CV 65) must be set to zero again.

An example of using the offset register is programming CV 49 with a value of 157. To do this, CV 65 must first be programmed to a value of 25. Then CV 49 can be programmed with a value of 57. A value of 4 x 25 + 57 is now stored in the decoder.

NOTE: When programming CV 64 and CV 65, the content of the offset register and page register is not taken into account.

Programming with Mobile Station 1, 2, & 3

Mobile Station 1: The programming menu is only available in the locomotive menu for certain models. A model that has a programmable decoder must be selected from the database.The following example shows how to do this:
1. Create a new locomotive and select item no. 36330 from the database. The Ee 3/3 electric locomotive is now displayed on the screen.
2. Press the „MENU / ESC" key and select the „CHANGE LOCO" option. The last function you will see here is the programming tab labeled „REG". Use this function to change the CVs of the decoder. This function only allows you to write CVs.
3. Enter the CV number and confirm it with the toggle button.
4. Enter the value of the CV and confirm it with the toggle button. The Mobile Station will now set the CV to the desired value.

Mobile Station 2 & 3: Use the DCC CV programming menu for programming.

CAUTION: Before programming, remove all models from the programming track that do not need to be programmed!

CV - table for the XP Smart Sound Decoder

CV	Description		Range	Value*
1	**Address**		DCC: 1 - 127 Motorola: 1 - 80	3
2	**Minimum speed** (speed setting for when model starts moving at speed step 1)		0-255	0
3	**Start-up delay**		0-255	50
4	**Braking delay**		0-255	60
5	**Maximum speed** (must be greater than CV 2)		0-255	195
6	**Medium speed** (must be greater than CV 2 and less than CV 5)		0-255	135
7	**Software version** (can be updated)		-	varies
8	**Manufacturer ID,** decoder reset via CV 8 =8		-	162
12	**Operating modes** Bit 0=1 DC (analog operation, direct current) on Bit 2=1 DCC data format on Bit 4=1 AC (analog operation, alternating current) on Bit 5=1 Motorola® data format on Bit 6=1 mfx® data format on *Please note: If all the above data formats are switched off, the decoder can can only be programmed in digital mode.*	Wert 1* 4* 16* 32* 64*	0-117	117
13	**Function key activation in analog mode** Bit 0-7 -> F1 to F8; When a Bit = 0, the function is off. When a Bit = 1, the function is on		0-255	0
14	**Function key activation in analog mode** Bit 0 - 5 -> F0v, F0r and F9 to F12; When a Bit = 0, the function is off. When a Bit = 1, the function is on		0-63	3
15	**Decoder programming lock**		0-255	1
16	**Decoder programming lock index number**		0-255	1
17 18	**Long decoder address** 17 = Higher value byte 18 = Lower value byte		128 - 9999 192 - 231 0 - 255	1000 195 232
19	**Consisting address (locomotive consisting)** A value of 0 means the consisting address (CADR) is not active When Bit 7 = 1, the direction of travel is reversed. So, the CADR + 128 reverses the direction of travel		1-127	0
21	**Function control for a Locomotive Consist** Bits 0-7 => F1 to F8, Bit = 0 function off, Bit = 1 function on		0-255	0
22	**Function control for a Locomotive Consist** Bits 0-5 => F0v, F0r and F9 to F12, Bit = 0 function off, Bit = 1 function on		0-63	0
27	**Brake signal settings (train stops before red signal)** 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 the same direction of travel	Wert 1 2 16 32	0-51	0
28	**RailCom® configuration** Bit 0 = 1 -> channel 1 is on Bit 1 = 1 -> channel 2 is on Bit 2 = 1 -> channel 1 is automatically off Bit 4 = 1 -> broadcast address Bit 7 = 1 -> RailCom Plus® is on	Wert 1* 2* 4* 16* 128*	0-151	151
29	**DCC standard configuration** 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 Digital only operation Bit 2=1 Automatic analog / digital switchover 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 motor speed table from CVs 67 - 94 Bit 5=0 Short address (CV 1) Bit 5=1 Long address (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 thermal overload protector** 1 = Motor error, 2 = Thermal overload, 4 = Function output error		0-7	0
31	**1st pointer CV for CV banks**		0, 1, 2, 4	0
32	**2nd pointer CV for CV banks**		0, 1	0
33-46	**Simple function mapping** (see “Simple Function Mapping” table for value assignment) **Assignment of function outputs to CVs** CV 33 Light function key (F0) when moving forwards CV 34 Light function key (F0) when moving backwards CV 35 Function key F1 CV 36 Function key F2 CV 37 Function key F3 CV 38 Function key F4 CV 39 Function key F5 CV 40 Function key F6 CV 41 Function key F7 CV 42 Function key F8 CV 43 Function key F9 CV 44 Function key F10 CV 45 Function key F11 CV 46 Function key F12		0-255	 1 2 4 8 16 4 8 16 32 64 16 32 64 128

CV	Description		Range	Value*
47	**Special function assignment** Bit 0=0 SUSI = Logic1 and Logic2 Bit 0=1 SUSI = SUSI Bit 1=0 When Bit 0 = 0, then SUSI = Logic1 and Logic2 Bit 1=1 When Bit 0 = 1, then SUSI = Servo1 and Servo2 Bit 2=1 A4 for digital coupler Bit 3=1 A5 for digital coupler Bit 4=1 Digital coupler outputs A4 and A5 are reversed Bit 5=1 Use wheel sensor	Wert 0 1 0 2 4 8 16 32	0-63	1
48	**ABC braking voltage difference** The voltage difference between both rails of an ABC braking track has an approximate CV value of * 0,1V + 1,6V		0-255	0
49	**ABC braking track: special configurations** Bit 0 = 1 -> ABC-reduced speed section; right rail more positive Bit 1 = 1 -> ABC-reduced speed section; left rail more positive Bit 2 = 1 -> Reduced train speed in dedicated slow speed zone (like a shuttle route) Bit 3 = 1 -> ABC-shuttle train operation on Bit 4 = 1 -> ABV1 in ABC-braking track Bit 5 = 1 -> ABV2 in ABC-braking track	Wert 1 2 4 8 16 32	0-63	0
50	**ABC braking track; maximum slow speed**		0-255	50
51	**ABC Stop time when changing direction in shuttle operation** Value * 100 milliseconds		0-255	30
52	**General stop time when changing direction** Value * 100 milliseconds		0-255	50
53	**Initial "soft" start and braking ramp** (takes effect before Start-up delay or after Braking delay)		0-255	255
54	**Load detection threshold** (Sensitivity of the load detector for sound and smoke unit outputs)		0-255	128
55	**Zero load hysteresis** (lag time from when decoder detects no load until it plays the correct sounds)		0-255	5
56	**Load gradient** (factor for load detection)		0-255	112
58	**Peak operational load**		0-255	50
61	**Motorola configuration** (number of additional Motorola addresses for F5 - F16)		0-3	0
62	**Throttle configuration for motor control** Bit 0=1 for lower quality motors / bell armature motors Bit 2=1 for lower quality motors without a flywheel Bit 3=1 min./max. adaptive	Wert 1 4 8	0-15	2
63	**Overall sound volume** for mfx® command stations (auxiliary CV)		0-255	255
66	**Forward speed trim**		0-255	128
67-94	**Extended speed step characteristic for speed steps 1 - 28**		each 0-255	varies
95	**Reverse speed trim**		0-255	128
96	**Type of function mapping** 1 = simple function mapping, 6 = extended function mapping		1, 6	6
97	**Function outputs „Off" in forward direction** (simple function mapping) Bit 0-7 -> A1 to A8; Bit = 1 output off		0-255	0
98	**Function outputs „Off" in reverse direction (**simple function mapping) Bit 0-7 -> A1 to A8; Bit = 1 output off		0-255	0
101	**Hysteresis analog operation** 100 corresponds to a 1V voltage change for internal speed step changes		0-255	100
102	**Analog voltage threshold for Sound operation** values * 100mV		0-255	10
103	**Analog voltage threshold for motor operation** values * 100mV		0-255	10
104	**Analog voltage for maximum speed** values * 100mV		0-255	150
115	**SUSI send option 1** Bit 0=1 Send actual speed via SUSI Bit 1=1 Send setpoint speed via SUSI Bit 2=1 Send relative load via SUSI Bit 7=1 Send function group 1 (F0 - F4) via SUSI	Wert 1* 2* 4* 128*	0-135	135
116	**SUSI send option 2** Bit 0-7 -> function groups 2 - 9 (F5 - F68) in groups of eight ascending functions		0-255	0
120	**SUSI clock rate** values * 1µs + 10µs		0-255	0
130	**Activation period for digital couplers in A4 & A5**, value * 100 milliseconds (if activated in CV47)		0-255	30
131	**Switching (shunting) scenario speed level** (0 = no coupler activation)		0-255	0
132	**Switching (shunting) scenario forward travel time T1** (coupler is free) value * 100 milliseconds		0-255	15
133	**Switching (shunting) scenario forward travel time T2 with coupler activation** value * 100 milliseconds		0-255	40
134	**Switching (shunting) scenario reverse travel time T2 when uncoupling** value * 100 milliseconds		0-255	30
135	**PWM hold time for digital couplers A4 & A5**		0-255	0
140	**Constant braking distance in cm**, A reduced speed value of 255 corresponds to approximately 11% of the maximum possible highest speed		0-255	128
141	**Constant braking distance in cm**, braking distance in cm		0-255	30
142	**Constant braking distance in cm**, function key for test function (0 = off)		0-68	0
143	**Constant braking distance in cm**, calibration for high speed		0-255	100
144	**Constant braking distance in cm**, calibration for low speed		0-255	10
145	**Constant braking distance in cm**, activation by (0 = off): Bit 0 = 1 -> ABC braking Bit 1 = 1 -> DC analog braking Bit 2 = 1 -> DCC brake signal (broadcast) Bit 3 = 1 -> Targeted speed level = 0 (DCC address)	Wert 1 2 4 8	0-63	0
147	**Alternative maximum forward speed**		0-255	0
148	**Alternative maximum reverse speed**		0-255	0
149	**Function key alternative maximum speed** (255 = off)		0-68, 255	255
150	**Alternative acceleration delay 1** (as a replacement for CV 3)		0-255	50
151	**Alternative braking delay 1**, (as a replacement for CV 4)		0-255	50
152	**Alternative acceleration delay 2** (as a replacement for CV 3)		0-255	80

CV	Description		Range	Value*
153	**Alternative braking delay 2**, (as a replacement for CV 4)		0-255	80
154	**Function key number for ABV 1** (255=aus)		0-68	255
155	**Function key number for ABV 2** (255=aus)		0-68	255
156	**Deactivate function key number for ABV** (255=off)		0-68	255
157	**Function key number for switching (shunting) mode** (255=off)		0-127	255
160	**Chuff rate calibration per wheel revolutions** (Sound)		0-255	160
162	**Engine RPM sound change calibration per locomotive speed** (good for diesels, electrics, and cab cars)		0-255	0
163	**Number of cylinders of a steam locomotive** (used to determine chuffs for either 2- or 3-cylinder steam locomotives)		0-255	0
170	**Energy-efficient lamp;** starting brightness		0-255	30
171	**Energy-efficient lamp** fade-in time in 100ms		0-255	100
172	**Fluorescent lamp** switch-on time *activation in 100ms		0-255	20
173	**Flash generator 1** flash interval value * 20ms		0-255	50
174	**Flash generator 2** flash interval value * 20ms		0-255	100
175	**Flash generator 3** flash interval value * 20ms		0-255	150
176	**Flash generator 4** flash interval value * 20ms		0-255	200
177	**Fade-in for function outputs** fade-in time in * 20ms		0-255	30
178	**Fade-out for function outputs** fade-out time in * 20ms		0-255	30
179	**Speed threshold for automatic switch-off of function outputs**		0-255	50
180	**Time period for automatic shut-off of F0v** value * 500ms		0-255	6
181	**Time period for automatic shut-off of F0r** value * 500ms		0-255	6
182	**Time period for automatic shut-off of A1** value * 500ms		0-63	6
183	**Time period for automatic shut-off of A2** value * 500ms		0-255	6
184	**Time period for automatic shut-off of A3** value * 500ms		0-255	6
185	**Time period for automatic shut-off of A4** value * 500ms		0-255	6
186	**Time period for automatic shut-off of A5** value * 500ms		0-255	6
187	**Time period for automatic shut-off of A6** value * 500ms		0-255	6
188	**Time period for automatic shut-off of A7** value * 500ms		0-255	6
202	**Servo 1 speed**		0-255	20
203	**Servo 1 adjustment for position 1**		0-255	128
204	**Servo 1 adjustment for position 2**		0-255	128
208	**Servo 2 speed**		0-255	20
209	**Servo 2 adjustment for position 1**		0-255	128
210	**Servo 2 adjustment for position 2**		0-255	128
214	**Servo 3 speed**		0-255	20
215	**Servo 3 adjustment for position 1**		0-255	128
216	**Servo 3 adjustment for position 2**		0-255	128
220	**Servo 4 speed**		0-255	20
221	**Servo 4 adjustment for position 1**		0-255	128
222	**Servo 4 adjustment for position 2**		0-255	128
226	**Servo 5 speed**		0-255	20
227	**Servo 5 adjustment for position 1**		0-255	128
228	**Servo 5 adjustment for position 2**		0-255	128
232	**Servo 6 speed**		0-255	20
233	**Servo 6 adjustment for position 1**		0-255	128
234	**Servo 6 adjustment for position 2**		0-255	128
240	**Measurement gap CV** (measurement of BEMF motor offset)		0-32	12
241	**Control factor digital / DC** Increasing proportionally Limit digital / DC		0-255	160
242	**Control factor digital / DC** Increasing proportionally Limit AC analog		0-255	2
243	**Minimum control package width,** offset throttle, control		0-50	12
244	**Control factor digital / DC** proportionally decreasing Limit digital / DC		0-255	200
245	**Control factor digital / DC** DC decreasing proportionally Limit AC analog		0-255	128
250	**Compatibility with various DCC systems** Bit0 = 1 Functions are retained if no more data can be recognized Bit1 = 1 STOPP only 28 speed stepsn Bit2 = 1 Only accept 1x prog. command (e.g. Intellibox1) Bit3 = 1 Functions on with RESET Bit5 = 1 Linear conversion between DCC28 and DCC128	Wert 1 2 4 8 32	0-47	35

* factory set values

CV - table for programming function output effects (CV31 = 18, CV32 = 0, Bank 1024)

NOTE: The decoder‘s function outputs are not used in this model!
A detailed CV table for the light controller used in this model can be found in the FAQs in the PIKO web shop under ‘Questions about H0’.

CV	Description	Range	Value*
257	Output F0v Effect A	0 - 255	0
258	Output F0v PWM A	0 - 64	64
259	Output F0v Flags A	0 - 255	0
260	Output F0v Parameter 1 A	0 - 255	0
261	Output F0v Parameter 2 A	0 - 255	0
262	Output F0v Effect B	0 - 255	0
263	Output F0v PWM B	0 - 64	10
264	Output F0v Flags B	0 - 255	0
265	Output F0v Parameter 1 B	0 - 255	0
266	Output F0v Parameter 2 B	0 - 255	0
267	Output F0h Effect A	0 - 255	0
268	Output F0h PWM A	0 - 64	64
269	Output F0h Flags A	0 - 255	0
270	Output F0h Parameter 1 A	0 - 255	0
271	Output F0h Parameter 2 A	0 - 255	0
272	Output F0h Effect B	0 - 255	0
273	Output F0h PWM B	0 - 64	10
274	Output F0h Flags B	0 - 255	0
275	Output F0h Parameter 1 B	0 - 255	0
276	Output F0h Parameter 2 B	0 - 255	0
277	Output A1 Effect A	0 - 255	0
278	Output A1 PWM A	0 - 64	64
279	Output A1 Flags A	0 - 255	0
280	Output A1 Parameter 1 A	0 - 255	0
281	Output A1 Parameter 2 A	0 - 255	0
282	Output A1 Effect B	0 - 255	0
283	Output A1 PWM B	0 - 64	10
284	Output A1 Flags B	0 - 255	0
285	Output A1 Parameter 1 B	0 - 255	0
286	Output A1 Parameter 2 B	0 - 255	0
287	Output A2 Effect A	0 - 255	0
288	Output A2 PWM A	0 - 64	64
289	Output A2 Flags A	0 - 255	0
290	Output A2 Parameter 1 A	0 - 255	0
291	Output A2 Parameter 2 A	0 - 255	0
292	Output A2 Effect B	0 - 255	0
293	Output A2 PWM B	0 - 64	10
294	Output A2 Flags B	0 - 255	0
295	Output A2 Parameter 1 B	0 - 255	0
296	Output A2 Parameter 2 B	0 - 255	0
297	Output A3 Effect A	0 - 255	0
298	Output A3 PWM A	0 - 64	64
299	Output A3 Flags A	0 - 255	0
300	Output A3 Parameter 1 A	0 - 255	0
301	Output A3 Parameter 2 A	0 - 255	0
302	Output A3 Effect B	0 - 255	0
303	Output A3 PWM B	0 - 64	10
304	Output A3 Flags B	0 - 255	0
305	Output A3 Parameter 1 B	0 - 255	0
306	Output A3 Parameter 2 B	0 - 255	0
307	Output A4 Effect A	0 - 255	0
308	Output A4 PWM A	0 - 64	64
309	Output A4 Flags A	0 - 255	0
310	Output A4 Parameter 1 A	0 - 255	0
311	Output A4 Parameter 2 A	0 - 255	0
312	Output A4 Effect B	0 - 255	0
313	Output A4 PWM B	0 - 64	10
314	Output A4 Flags B	0 - 255	0
315	Output A4 Parameter 1 B	0 - 255	0
316	Output A4 Parameter 2 B	0 - 255	0
317	Output A5 Effect A	0 - 255	80
318	Output A5 PWM A	0 - 64	14
319	Output A5 Flags A	0 - 255	128
320	Output A5 Parameter 1 A	0 - 255	255
321	Output A5 Parameter 2 A	0 - 255	45
322	Output A5 Effect B	0 - 255	0
323	Output A5 PWM B	0 - 64	10
324	Output A5 Flags B	0 - 255	0

CV	Description	Range	Value*
325	Output A5 Parameter 1 B	0 - 255	0
326	Output A5 Parameter 2 B	0 - 255	0
327	Output A6 Effect A	0 - 255	80
328	Output A6 PWM A	0 - 64	14
329	Output A6 Flags A	0 - 255	128
330	Output A6 Parameter 1 A	0 - 255	255
331	Output A6 Parameter 2 A	0 - 255	45
332	Output A6 Effect B	0 - 255	0
333	Output A6 PWM B	0 - 64	10
334	Output A6 Flags B	0 - 255	0
335	Output A6 Parameter 1 B	0 - 255	0
336	Output A6 Parameter 2 B	0 - 255	0
337	Output A7 Effect A	0 - 255	0
338	Output A7 PWM A	0 - 64	64
339	Output A7 Flags A	0 - 255	0
340	Output A7 Parameter 1 A	0 - 255	0
341	Output A7 Parameter 2 A	0 - 255	0
342	Output A7 Effect B	0 - 255	0
343	Output A7 PWM B	0 - 64	10
344	Output A7 Flags B	0 - 255	0
345	Output A7 Parameter 1 B	0 - 255	0
346	Output A7 Parameter 2 B	0 - 255	0

CV - table for programming the sound settings (CV31 = 16, CV32 = 0, Bank 512)

CV	Description	Range	Value*
257	Overall volume	0 - 255	200
258	Volume tunnel mode	0 - 255	0
259	Volume control level 3	0 - 255	196
260	Volume control level 2	0 - 255	128
261	Volume control level 1	0 - 255	64
270	**Sound Option1** (switching sound flags on/off) Bit0 = 1 Drive-Stop Bit1 = 1 Drive-Slow Bit2 = 1 Drive-Hold Bit3 = 1 Drive-Lock Bit4 = 1 Coupler sound activates digital coupler Bit5 = 1 Drive-Lock switched off in analog mode	0-63	15
273	**Flange squeal** Speed threshold above which activates flange squeal	0 - 255	10
274	**Brake squeal** Speed threshold below which activates brake squeal	0 - 255	30
289	Volume Sound Slot 1 **Motor**	0 - 255	180
290	Volume Sound Slot 2 **Horn**	0 - 255	200
291	Volume Sound Slot 3 **Bell**	0 - 255	60
292	Volume Sound Slot 4 **Sander Valve**	0 - 255	30
293	Volume Sound Slot 5 **Cab Chatter 1**	0 - 255	30
294	Volume Sound Slot 6 **-**	0 - 255	200
295	Volume Sound Slot 7 **Short Horn**	0 - 255	200
296	Volume Sound Slot 8 **Curve Squeal**	0 - 255	50
297	Volume Sound Slot 9 **-**	0 - 255	100
298	Volume Sound Slot 10 **Coupler**	0 - 255	60
299	Volume Sound Slot 11 **Crade Crossing Horn**	0 - 255	200
300	Volume Sound Slot 12 **-**	0 - 255	200
301	Volume Sound Slot 13 **-**	0 - 255	200
302	Volume Sound Slot 14 **Brake Squeal**	0 - 255	50
303	Volume Sound Slot 15 **-**	0 - 255	200
304	Volume Sound Slot 16 **Air Compressor**	0 - 255	30
305	Volume Sound Slot 17 **Radiator Fan**	0 - 255	40
306	Volume Sound Slot 18 **Release compressed air**	0 - 255	200
307	Volume Sound Slot 19 **-**	0 - 255	200
308	Volume Sound Slot 20 **Cab Chatter 2**	0 - 255	30
310	Volume Sound Slot 22 **Dynamic brake**	0 - 255	150
311	Volume Sound Slot 23 **Direction turner**	0 - 255	100
312	Volume Sound Slot 24 **Double horn**	0 - 255	255

* factory set values

Function key assignment

F0	Headlights	F10	Dual White Gyralite	F20	Radiator Fan Sound
F1	Bell	F11	Red Gyralite	F21	Sander Valve Sound
F2	Horn - Playable	F12	-	F22	Cab Chatter
F3	Short Horn	F13	Cab Interior Light	F23	Cab Chatter
F4	Dynamic Brake Sound	F14	Engine Room Light	F24	Air Compressor Sond
F5	Manual Notch Up	F15**	Lighting double traction	F25	Control Stand Light
F6	Manual Notch Down	F16	Volume Stepper - 4 Steps	F26	Crade Crossing Horn
F7	Headlight Dimmer	F17	Couple/Uncouple Sound	F27	-
F8**	Motor Sounds	F18	Brake Squeal/Release	F28	Switching Mode/Half Speed
F9**	Indicators & Marker Lights	F19	Curve Squeal Sound		

**Note: This sound decoder features several „multi-step“ functions. Each successive press of the button activates a different condition of that function, as noted here:

F8 Motor Sounds

1x 1 Motor
2x 2 Motors
3x Motors off
4x Sound off

F9 Indicators & Marker Lights

1x Loco ID boards on in forward mode
2x Loco IDs and white classification on in forward mode
3x Loco IDs and green classification on in forward mode
4x red classification on in reverse mode
5x reset F9 sequencer to 0

F15 Lighting double traction

1x all front lights off
2x all rear lights off
3x both sides off
4x reset F15 sequencer to 0, all lights on

NOTE: This product is not a toy and is not suitable for children under 14 years of age. PIKO is not liable for any damage caused by improper handling and/or failure to follow these instructions.

Service:
If you have any questions, please contact us through the internet or e-mail
Internet: www.piko.de
E-Mail:info@piko.de

In the unlikely event you should find your model defective, please send us the model along with a proof of purchase (copy) and the completed complaint form, which you can find in our online shop under ‚Withdrawal and Return‘ → ‘Cancellation and returns’ → ‘complaint form‘.

Warranty Statement
Every PIKO model is tested for functionality and reliability before leaving the factory. This model is covered under warranty for two years. Should your model need service after the warranty period has expired, we may repair the model free of charge on submission of proof of purchase.
This warranty does not cover damage caused by improper handling. Please note that according to the German EMC (electromagnetic interference) law, this decoder can only be installed in models bearing the CE mark.

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56627-90-7101_2026