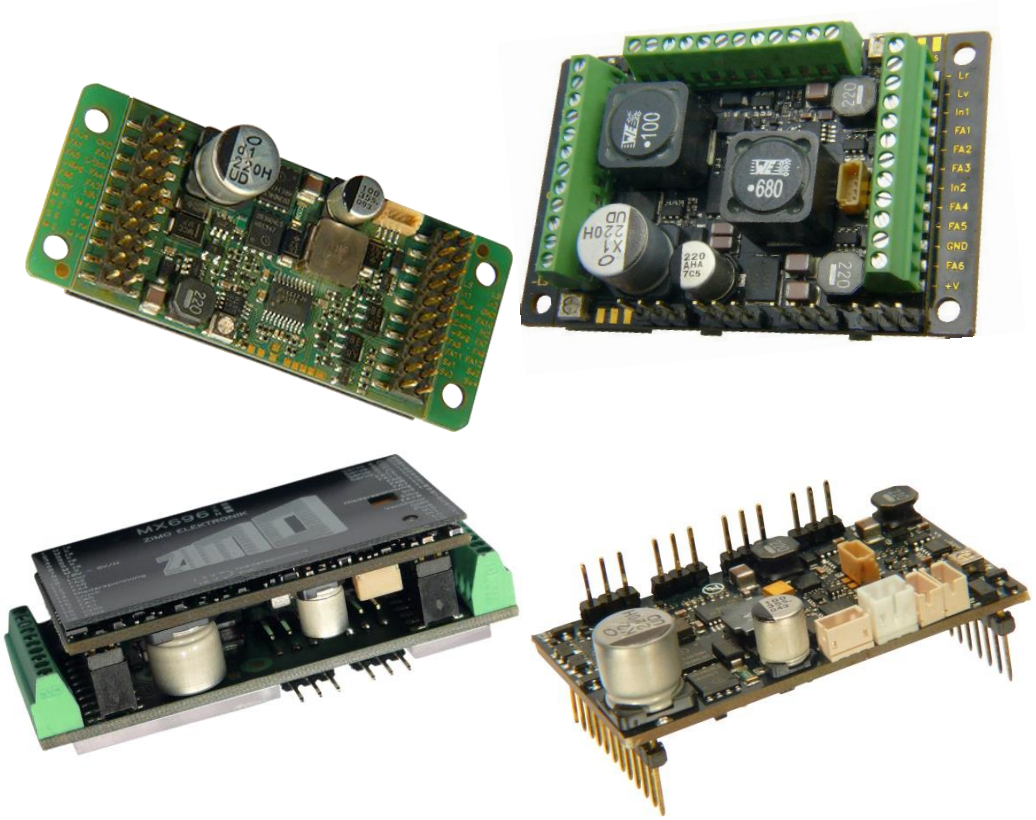
Instruction Manual



LARGE-SCALE DECODER WITH & W/O SOUND

MX695KV, -KS, -LV, LS

and NON-SOUND LARGE-SCALE DECODER ***MX695KN***

MX696V, -S

and: Combinations of loco boards and decoder *MX696KS, MX696KV*

and NON-SOUND LARGE-SCALE DECODER ***MX696KN***

MX697V, -S

MX699KV, -KS, -LV, -LM

EDITION

2011 05 01
2011 08 15
SW-Version 31 --- 2012 08 15
Including the new MX696 decoder --- 2012 11 30
SW-Version 33.0 --- 2013 04 30
with chapter about loco boards --- 2013 05 20
2014 10 12
2015 06 01
2015 07 07
2015 09 23
2018 04 20

ZIMO decoders contain a microprocessor with appropriate software. The software version can be read out from CV #7 and #65. The current version may not yet capable of all the functions mentioned in this manual. As with other computer programs, it is also not possible for the manufacturer to thoroughly test this software with all the possible applications. Installing new software versions later can add new functions or correct recognized errors. SW updates can be done by the end user for all ZIMO decoders since production date October 2004, see chapter “Software Update”! Software updates are available at no charge if performed by the end user (except for the purchase of a programming module); Updates and/or upgrades performed by ZIMO are not considered a warranty issue and are at the expense of the customer. The warranty covers hardware damage exclusively, provided such damage is not caused by the user or other equipment connected to the decoder. For update versions, see www.zimo.at.

1 Product - Overview

The MX695 large-scale decoder is available in 5 standard versions, 4 of them are equipped with sound. Special versions for specific high-volume applications with slightly modified features are also available (i.e. customized number of outputs for a specific project).

ZIMO decoders primarily operate in the **NMRA-DCC data format** with any NMRA-DCC compatible system, as well as the **MOTOROLA protocol (MM)** within Märklin systems and other MOTOROLA command stations. ZIMO decoders also operate **in DC analog mode** with DC power packs (including PWM) as well as **AC analog** (Märklin Transformers with over-voltage pulses for direction change).

In addition to the types presented below, there are also loco-board and large-scale decoder combinations available: see chapter 4

51 x 40 x 13 mm

MX695K …	**Sound-Decoder** (and non-sound decoder) **with screw terminals**

MX695KV

Full version: 36 Screw terminals
14 Function outputs (including headlights)
1 Special output for smoke generator fan
3 Low-voltage outputs: 5 V, 10 V, variable
4 Servo outputs (3-pin plugs: Control, ground, + 5 V)
2 Pot-meters (for volume and low voltage settings)
1 Connection for external capacitor
1 Speaker connection (4 or 8 Ohm at 10 Watt)

MX695KS

Reduced version: 28 Screw terminals (2 x 12 and 1 x 4)
8 Function outputs (including headlights)
1 Special smoke fan output
1 Low-voltage function output: 10 V
1 Connection for external capacitor
1 Speaker connection (4 or 8 Ohm at 10 Watt)

MX695KN

Non-Sound-Decoder with screw terminals

32 Screw terminals (1 x 8 and 2 x 12)
14 Function outputs (including headlights)
1 Special smoke fan output
3 Low-voltage outputs: 5V, 10V, variable
4 Servo outputs (3-pin plugs: control, ground, + 5 V)

51 x 40 x 13 mm

MX695L …	**Sound-Decoder with pin connectors**

MX695LV

Full Version: 3 Pin connectors, 12-pins each
14 Function outputs (including headlights)
1 Special output for smoke generator fan
3 Low-voltage outputs: 5 V, 10 V, variable
4 Servo outputs (3-pin plugs: control, ground, + 5 V)
2 Potentiometers (volume, low voltage adjustment)
1 Connection for external capacitor
1 Speaker connection (4 or 8 Ohm at 10 Watt)

MX695LS

Reduced Version: 2 Pin connectors, 12-pins ea. (matching ESU-interface)
1 Special output for smoke generator fan
1 4-pin socket for additional connections
8 Function outputs (including headlights)
1 Low voltage output: 10 V
1 Connection for external capacitor
1 Speaker connection (4 or 8 Ohm at 10 Watt)

55 x 29 x 16 mm

MX696…	**Sound and NON-Sound Decoder with narrow body style**

MX696V

Full Version: 2 20-pin connectors
14 Function-outputs (including headlights)
1 Special smoke fan output
2 Low-voltage outputs: 10V and variable *
4 Servo outputs (control lines)
1 Speaker connection (4 or 8 Ohm at 10 Watt)

MX696S

Reduced: 1 20-pin connector & 1 10-pin connector
1 Low-voltage function output: 10V
8 Function-outputs (including headlights)
1 Speaker connection (4 or 8 Ohm at 10 Watt)

MX696N

Non-Sound-Decoder, identical size and connections as the MX69

1 20-pin connector
8 Function outputs (including headlights)
1 Low-voltage output: 6 V (Servo supply!)
4 Servo outputs (Control lines)

) ATTENTION: The sound decoder MX696V** does not have a fixed 5V output (as does the MX695KV/MX695LV), but the variable output can be set between 5 – 6V to supply servos with power.*

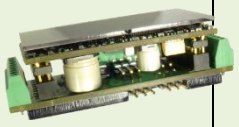
*OR: Use the MX696**KV** (MX696V combined with LOKPL96KV board), which does have a fixed 5V output.*

68 x 29 x 20 mm

MX696K…

Narrow large-scale sound decoder with screw terminals
(Decoder and loco board combinations)

MX696KV



Full Version: 30 Screw terminals
14 Function outputs (including headlights)
1 Special smoke fan output
2 Low-voltage outputs: 5 V, variable
4 Servo outputs (3-pin plugs: Control, ground, + 5 V)
1 Potentiometers (for low voltage outputs)
1 Connection for external capacitor
1 Speaker connection (4 or 8 Ohm at 10 Watt)

MX696KS

Reduced Version: 20 Screw terminals
8 Function outputs (including headlights)
1 Special smoke fan output
4 Servo control outputs on solder pads (no 5 V supply)
1 Connection for external capacitor
1 Speaker connection (4 or 8 Ohm at 10 Watt)

See the chapter "Loco adaptor boards for large-scale decoders" for more information about these boards.

56 x 32 x 21mm

MX697

Large-scale sound decoder for US interfaces
(Bachmann, Aristocraft)

MX697V

Full Version: 2 12-pin connectors
10 Function outputs (including headlights)
1 Special smoke fan output
3 Low-voltage outputs: 5 V, 10V, variable
4 Servo outputs (3-pin plugs: Control, ground, + 5 V)
1 Connection for external capacitor
1 Speaker connection (4 or 8 Ohm at 10 Watt)

MX697S

Reduced Version: 2 12-pin connectors
10 Function outputs (including headlights)
1 Special smoke fan output
1 Low-voltage output: 10V
4 Servo control outputs (no 5 V supply)
1 Connection for external capacitor
1 Speaker connection (4 or 8 Ohm at 10 Watt)

51 x 40 x 13 mm

MX699K …

Large-scale sound decoder with screw terminals

MX699KV

Full Version: 38 Screw terminals
15 Function outputs (including headlights)
2 Special smoke fan output
3 Low-voltage outputs: 5 V,10 V, variable
1 Low-voltage switch (4 fixed values)
4 Servo outputs (3-pin plugs: Control, ground, + 5 V)
1 Speaker connection (4 or 8 Ohm, 10 Watt)
1 Connection for external volume control
3 Internal super caps (total 1F/8V)
1 Additional connection for external capacitor module

MX699KS

Reduced Version: 30 Screw terminals
8 Function outputs (including headlights)
1 Special smoke fan output
3 Low-voltage outputs: 5 V,10 V, variable
4 Servo control outputs on solder pads (no 5 V supply)
1 Speaker connection (4 or 8 Ohm at 10 Watt)
1 Connection for external volume control
3 Internal super caps (total 1F/8V)
1 Additional connection for external capacitor module

MX699L …

Large-scale sound decoder with pin connectors

MX699LV, -LM

-LM: Direct fit for the 2 x 14 – pin Märklin interface with extra pins on top

Full Version: 3 14-pin connectors
15 Function outputs (including headlights)
1 Special smoke fan output
3 Low-voltage outputs: 5 V,10 V, variable
1 Low-voltage switch (4 fixed values)
4 Servo outputs (3-pin plugs: Control, ground, + 5 V)
1 Speaker connection (4 or 8 Ohm, 10 Watt)
1 Connection for external volume control
3 Internal super caps (total 1F/8V)
1 Additional connection for external capacitor module

MX699LS

-LS: Direct fit for the 2 x 14 – pin Märklin interface

Reduced Version: 2 14-pin connectors
8 Function outputs (including headlights)
1 Special smoke fan output
3 Low-voltage outputs: 5 V,10 V, variable
4 Servo outputs (3-pin plugs: Control, ground, + 5 V)
1 Speaker connection (4 or 8 Ohm, 10 Watt)
1 Connection for external volume control
3 Internal super caps (total 1F/8V)
1 Additional connection for external capacitor module

Note to the Märklin interface: one of the female terminals on the vehicle decoder board may be used as a key to prevent a wrong installation and may therefore be plugged. The relevant decoder pin („Switch input 1) must be cut off in such cases. This is not done at the factory because the pin is needed for non-Märklin applications.

2 Technical Information

.

Track Voltage in digital mode (DCC) ..... 10 - 30 V
(peak) in analog mode (High voltage pulse for direction reversal) ..... 35 V
Threshold voltages in analog mode - see below!

Maximum continuous motor output = maximum continuous total output MX695..... 6 A
Maximum continuous motor output = maximum continuous total output MX696, MX697..... 4 A
Maximum continuous motor output = maximum continuous total output MX699..... 6 A
Maximum peak current (Motor only or total) ..... 10 A
Number of function outputs MX695KV, MX695LV, MX695KN, MX696V 14
MX699KV, MX699LV 15
MX695KS, MX695LS, MX696S, MX696N, MX699KS, MX699LS .8
MX697V, MX697S 10

Maximum continuous function output current ..... 2 A
Maximum continuous output for low-voltage functions (5 V, 10 V, adjustable) ..... each 1 A
Voltage range for adjustable low-voltage functions (MX695KV, -LV) ..... 1.5 to 16 V

Maximum current at special output for Smoke-Ventilator (5 V - Motor) with brake function . 200 mA

Storage capacity for sound samples ..... 32 Mbit
Playback frequencies according to sound sample ..... 11 or 22 kHz
Number of simultaneously playable sound channels 6
Sound-amplifier output at 4 Ohm ..... Sinus 10 W
Loudspeaker impedance..... 8 Ohm, 2 x 8 Ohm parallel or 4 Ohm

Externally connectable energy storage device . .....charging voltage 17 V
for standard electrolytic capacitors ..... >= 20 V, any capacity
Gold-caps (pack with 7 pieces at 2,5 V ea. - in series) >= 17 V, max. 1 F
Rechargeable battery (only with special circuitry) ..... 14.4 V pack

Charge current for external energy storage ..... 80 mA

Analog mode (DC or AC) *) .....Threshold-voltage headlights..... @ 4 V
Threshold-voltage sound..... @ 5 V
Threshold-voltage motor .....@ 6 V

Operating temperature..... - 20 to 100 °C

Dimensions (L x W x H including screw terminals) **) MX695-, -99KV, -KS ..... 50 x 40 x 13 mm
(L x W x H including pins).....MX695-, -99LV ..... 50 x 40 x 13 mm
in cases of long plug-in pins for ESU-loco boards with MX695LS ..... 50 x 40 x 20 mm
MX696 ..... 55 x 29 x 16 mm
MX697 ..... 56 x 32 x 21 mm

*) Actual analog-characteristics depend heavily on the type of power pack and the locomotive's drive train (because the transformer output voltage may collapse more or less under load)
**) Length given without break-away mounting brackets; these increase the length by 2 x 6 mm

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Tel ++43 (1) 81 31 007 0

The decoder type can be identified if necessary by reading out CV #250:

200 MX82	201 MX620	202 MX62	203 MX63	204 MX64	205 MX64H	206 MX64D	207 MX680	208 MX690
209 MX69	210MX640	211 MX630-P2520		212 MX632	213 MX631	214 MX642	215 MX643	216 MX647
217 MX646	218 MX630-P25K22		219MX631-P25K22		220 MX632-P25K22		221 MX645	222 MX644
223 MX621	224 MX695 RevB		225 MX648	226 MX685	227 MX695 RevC	228 MX681	229 MX695N RevC	
230 MX696	231 MX696N	232 MX686	233 MX622	234 MX623	235 MX687	236 MX621 Fleischmann		237 MX633
238 MX820	240 MX634	241 MX686B	242 MX820 RevB		243 MX618	244 Roco NextG		245 MX697
246 MX658	247 MX688	248 MX821	249 MX648 RevC		250 MX699			

OVERLOAD PROTECTION

The motor and function outputs of the ZIMO large-scale decoders are designed with large reserve capacities and are additionally protected against over-currents and short circuits. Automatic shutoff will occur in case of overload followed by automatic reboot attempts (which often results in flashing lights).

These safety precautions do not mean that the decoder is indestructible. Please pay attention to the following:

Faulty decoder hook-up *(mixed up connection wires) and improper electric connections between the motor terminal and chassis are not always recognized and can lead to output driver damage or even total destruction of the receiver.*

Unsuitable or defective motors *(e.g. with short-circuited turns or collectors) are not always recognizable by their high consumption of electricity (only peaks may register) and can lead to decoder damage, sometimes long term effects can cause output driver defects.*

The decoders output drivers (for the motor and function outputs) are not only at risk through over-current but also through ***voltage spikes*** *as they are delivered from the motor and other* ***inductive consumers.*** *Depending on track voltage, such spikes can reach several hundred volts and are absorbed by special protection circuits inside the decoder. The capacity and speed of such elements is limited and so unnecessarily high track voltage should not be used. Never use a higher voltage than recommended for a particular vehicle. Only in exceptional cases should the ZIMO adjustable range (up to 24 V) be utilized.*

THERMAL PROTECTION

All ZIMO decoders come equipped with a sensor that detects the actual temperature. Once the maximum permissible value (ca. 100 °C on the circuit board) has been reached, power to the motor will be shut off. Rapidly flashing headlights (at ca. 10 Hz) will signal that a shut-off has occurred. Motor operation will resume automatically after a drop in temperature of about 20 °C, typically after 30 to 60 sec.

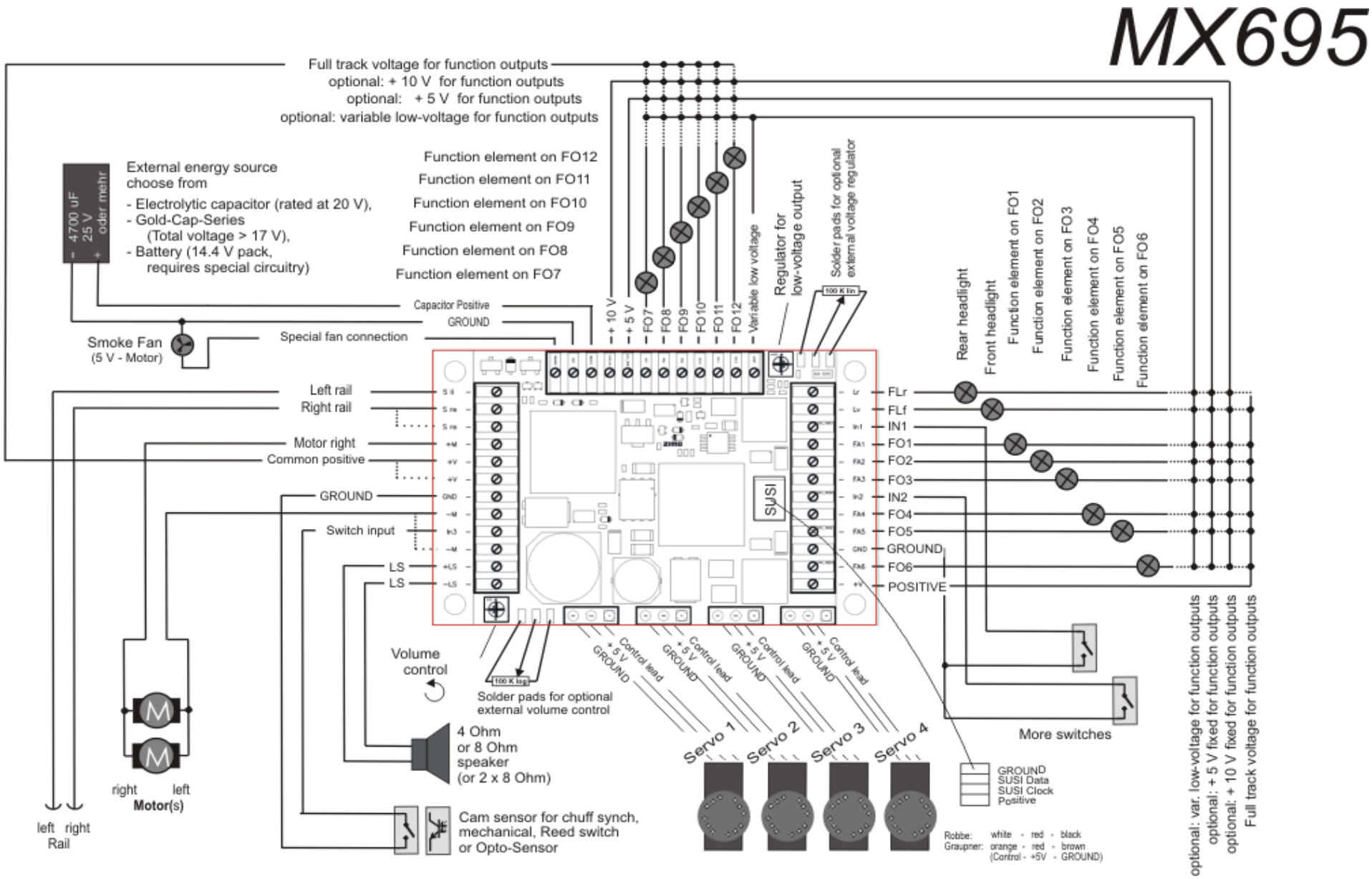
SOFTWARE UPDATE

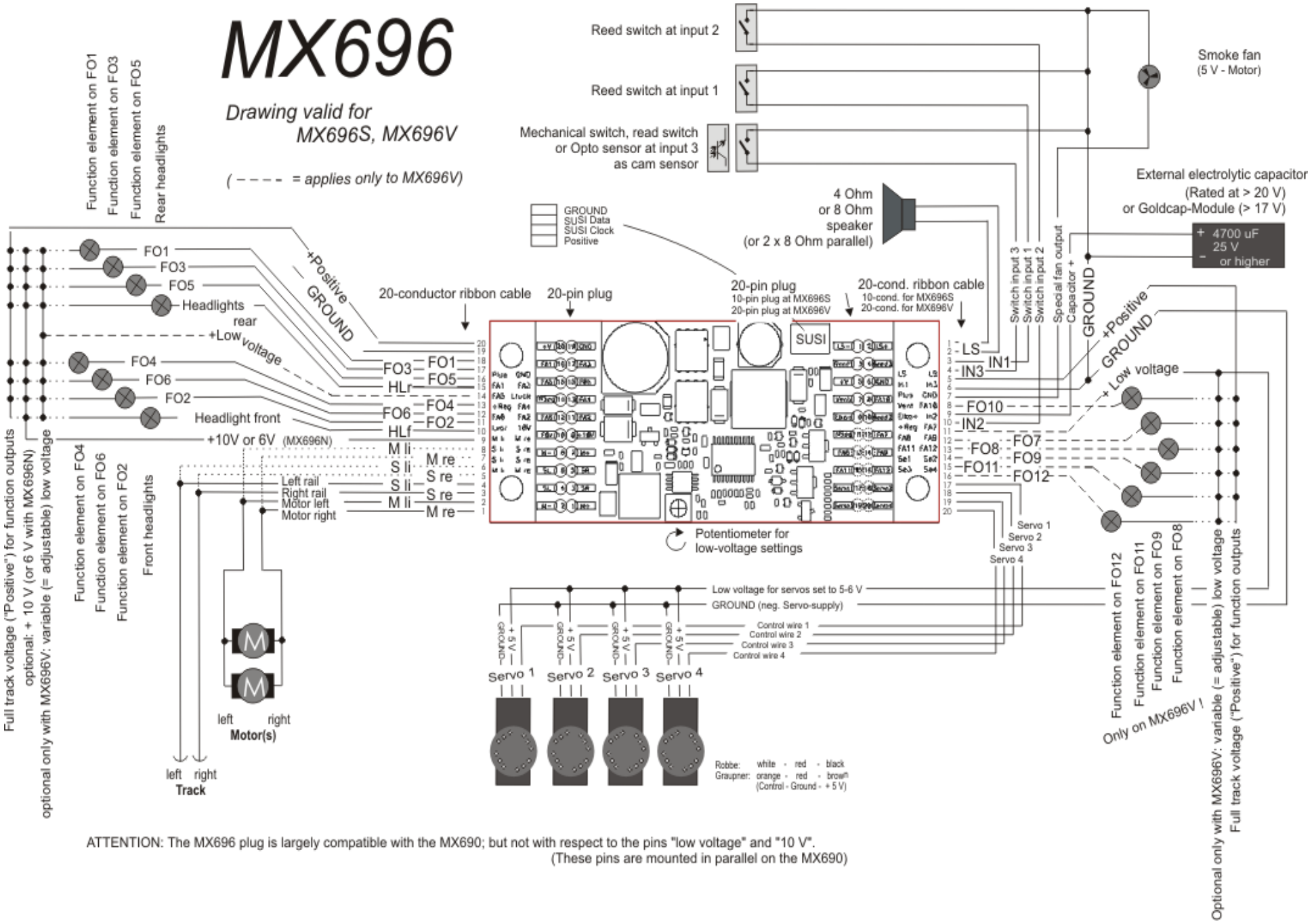
ZIMCO decodes are designed so that software updates can be completed by the user. This requires a device with an update function (ZIMO decoder update module **MXDECUP**, or **MXULF**, or "central system cab" **MX31ZL/MX32ZL**, or command station **MX10**).The update itself is carried out via a USB stick (MXULF, MX31ZL, MX32ZL, MX10) or via a computer with the "ZIMO Sound Programmer" **ZSP** software or "ZIMO Rail Center" **ZIRC** software.

There is no need to remove the decoder; the locomotive does not need to be opened; it can be placed onto the update-track (connected to the update-device) without any changes and can then be updated via a USB stick or a computer.

Note: Locomotive accessories that are directly connected to a track (not controlled by the decoder) may interfere with the update; in that case the locomotive will have to be opened and removed from the track.

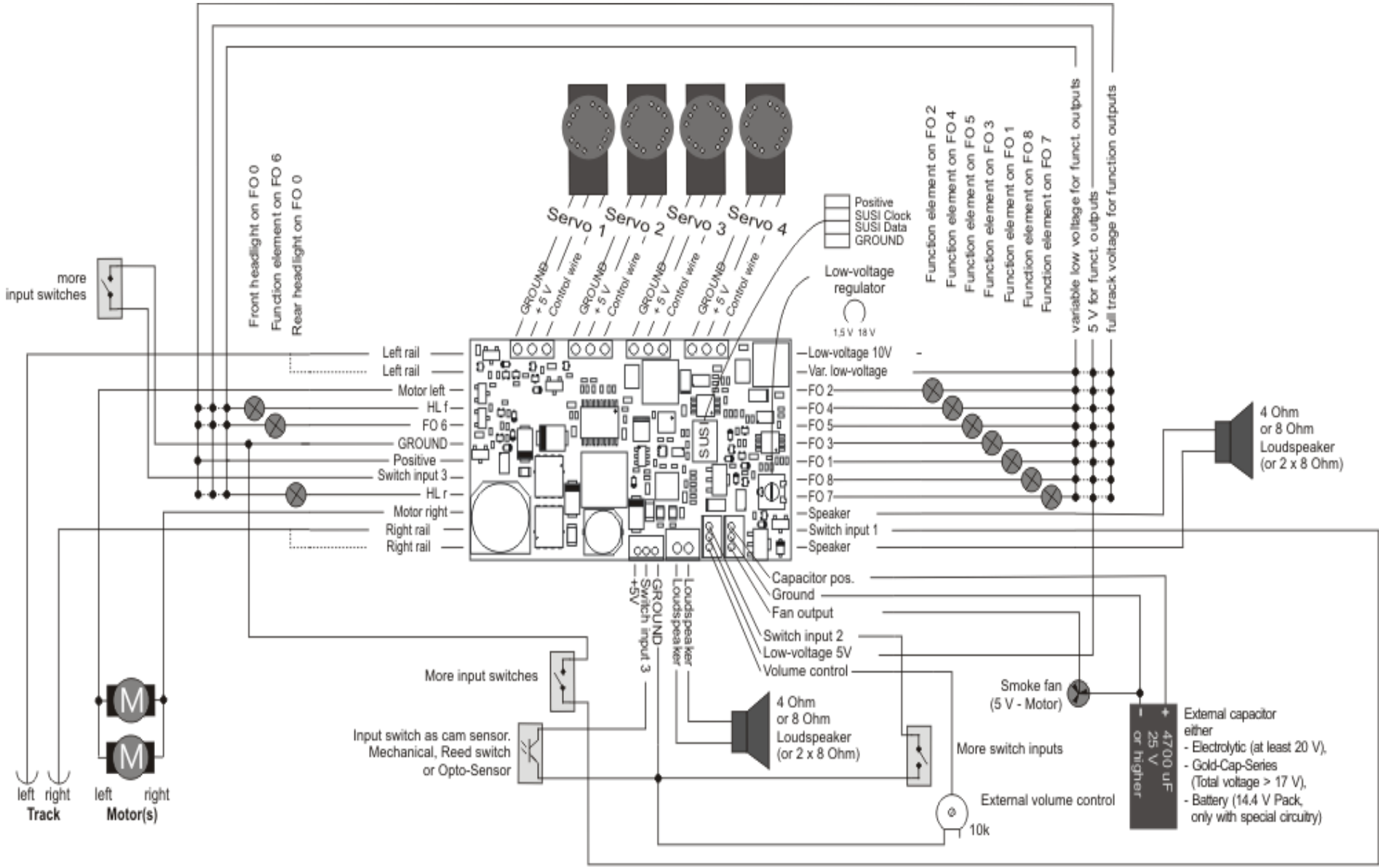
3 Installation and Wiring of the MX695 - MX699

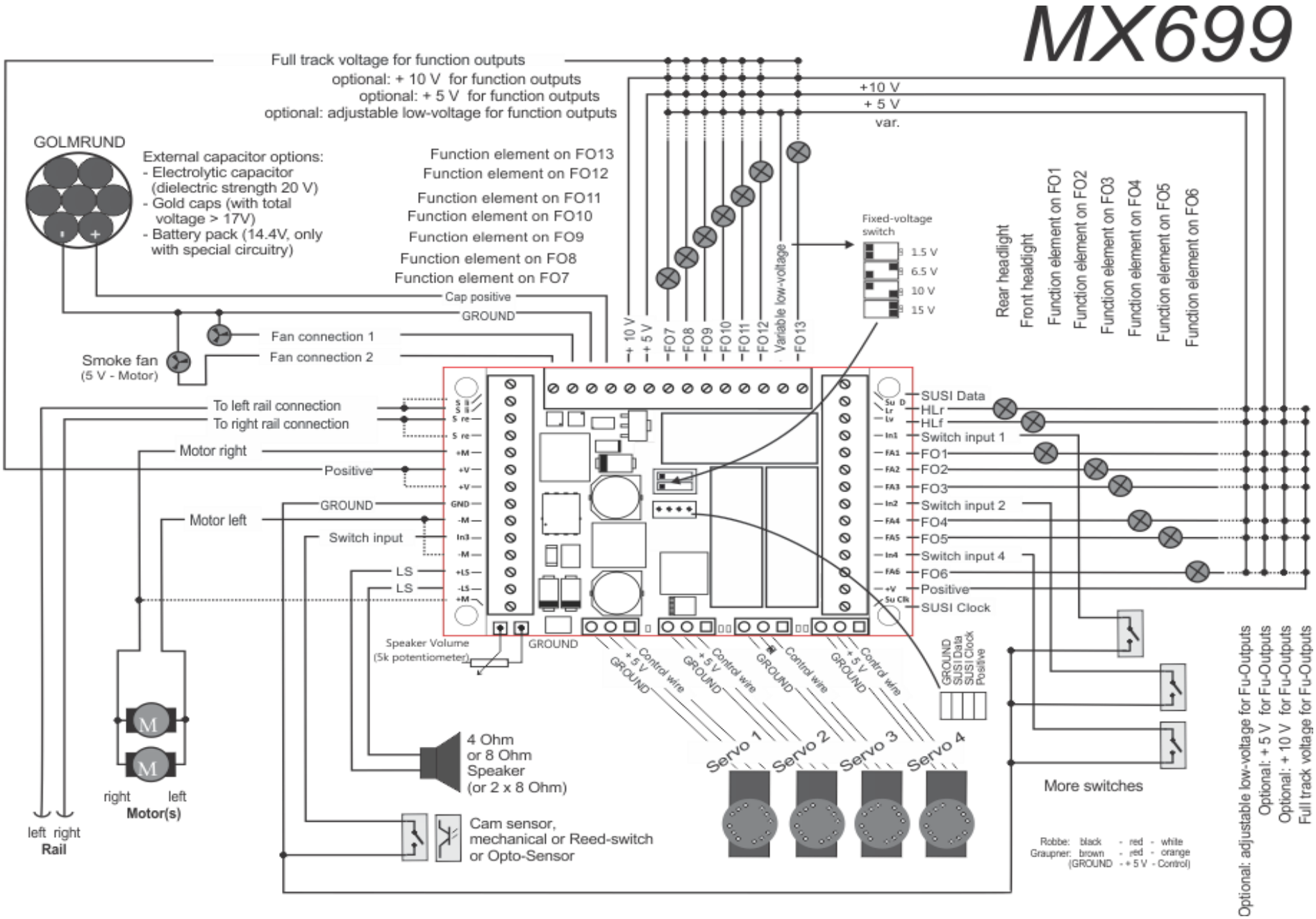




ATTENTION: The MX696 plug is largely compatible with the MX690; but not with respect to the pins "low voltage" and "10 V".
(These pins are mounted in parallel on the MX690)

MX697


Servo 1
Servo 2
Servo 3
Servo 4
GROUND
+ 5 V
Control wire
Positive
SUSI Clock
SUSI Data
GROUND
Low-voltage regulator
1,5 V 18 V
Front headlight on FO 0
Function element on FO 6
Rear headlight on FO 0
Function element on FO 2
Function element on FO 4
Function element on FO 5
Function element on FO 3
Function element on FO 1
Function element on FO 8
Function element on FO 7
variable low voltage for funct. outputs
5 V for funct. outputs
full track voltage for function outputs
more input switches
Left rail
Left rail
Motor left
HL f
FO 6
GROUND
Positive
Switch input 3
HL r
Motor right
Right rail
Right rail
Low-voltage 10V
Var. low-voltage
FO 2
FO 4
FO 5
FO 3
FO 1
FO 8
FO 7
Speaker
Switch input 1
Speaker
4 Ohm
or 8 Ohm
Loudspeaker
(or 2 x 8 Ohm)
Capacitor pos.
Ground
Fan output
Switch input 2
Low-voltage 5V
Volume control
+5V
Switch input 3
GROUND
Loudspeaker
Loudspeaker
More input switches
Input switch as cam sensor.
Mechanical, Reed switch
or Opto-Sensor
4 Ohm
or 8 Ohm
Loudspeaker
(or 2 x 8 Ohm)
Smoke fan
(5 V - Motor)
More switch inputs
External volume control
10k
4700 uF
25 V
or higher
External capacitor
either
- Electrolytic (at least 20 V),
- Gold-Cap-Series
(Total voltage > 17 V),
- Battery (14.4 V Pack,
only with special circuitry)
left right
Track
left right
Motor(s)

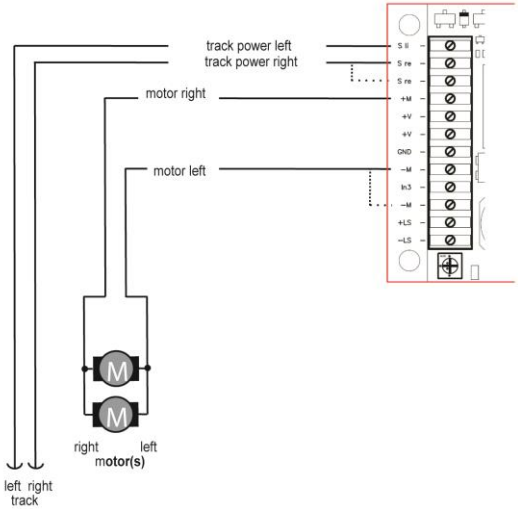

MX699
Full track voltage for function outputs
optional: + 10 V for function outputs
optional: + 5 V for function outputs
optional: adjustable low-voltage for function outputs
+10 V
+ 5 V
var.
GOLMRUND
External capacitor options:
- Electrolytic capacitor (dielectric strength 20 V)
- Gold caps (with total voltage > 17V)
- Battery pack (14.4V, only with special circuitry)
Function element on FO13
Function element on FO12
Function element on FO11
Function element on FO10
Function element on FO9
Function element on FO8
Function element on FO7
Fixed-voltage switch
1.5 V
6.5 V
10 V
15 V
Rear headlight
Front headlight
Function element on FO1
Function element on FO2
Function element on FO3
Function element on FO4
Function element on FO5
Function element on FO6
Cap positive
GROUND
Fan connection 1
Fan connection 2
Smoke fan
(5 V - Motor)
+ 10 V
+ 5 V
FO7
FO8
FO9
FO10
FO11
FO12
Variable low-voltage
FO13
To left rail connection
To right rail connection
Motor right
Positive
GROUND
Motor left
Switch input
LS
LS
SUSI Data
HLr
HLf
Switch input 1
FO1
FO2
FO3
Switch input 2
FO4
FO5
Switch input 4
FO6
Positive
SUSI Clock
Speaker Volume
(5k potentiometer)
GROUND
Control wire
+ 5 V
GROUND
Servo 1
Servo 2
Servo 3
Servo 4
4 Ohm
or 8 Ohm
Speaker
(or 2 x 8 Ohm)
Cam sensor,
mechanical or Reed-switch
or Opto-Sensor
More switches
right left
Motor(s)
left right
Rail
Robbe: black - red - white
Graupner: brown - red - orange
(GROUND - + 5 V - Control)
Optional: adjustable low-voltage for Fu-Outputs
Optional: + 5 V for Fu-Outputs
Optional: + 10 V for Fu-Outputs
Full track voltage for Fu-Outputs

The MX695 is used as an example in the following connection diagrams!

Although the connections on the MX696/MX697/MX699 are arranged differently, the functionality is the same.

3.1 Track and Motor(s)

There has to be enough free space inside the engine so that the decoder can be mounted without exerting mechanical stress. Pay particular attention that no pressure is applied to the decoder when the loco housing is being reinstalled and the wires can't get caught by movable parts.



All direct connections that are present in the original wiring configuration between the power pick-ups (wheels and wipers) and the motor must be isolated; otherwise the motor end stage may get damaged at power-up.

The same goes for the headlights and other additional accessories, which must be completely isolated.

Track (wheel pick-ups) and motor are connected to the screw terminals or pins as shown in this picture. Some connections are provided twice. These may be used if needed but can also be left open.

Virtually all types of DC motors found in model trains can be used.

If several motors are found in a locomotive, connect them in parallel to the same decoder.

A parallel connection provides an automatic motor synchronization, provided the motors and gearboxes are identical. The MX695 is strong enough in almost all cases to handle two or more motors.

See configuration (CV's) for motor regulation!

Note for MX696 decoders:

There are two pins each for the track and motor connections so that the full power can be sent through the relatively thin conductors of the ribbon wire. Using a single pin/wire for each is sufficient for currents of up to 2A maximum.

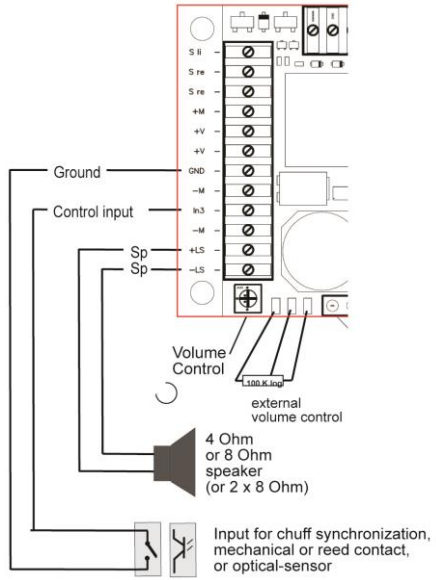
3.2 Speaker, Cam Sensor and Volume Control

Any 4 Ohm and 8 Ohm speakers can be used as well as several speakers connected in parallel, as long as the combined impedance is not below 4 Ohms.

The MX695 sound amplifier operates at 10.8V and has a sinus output of 12W with a 4 Ohm speaker; about 5W with 8 Ohm speakers.

Tweeters used in parallel to the main speaker should be connected via an audio crossover (i.e. a 10 uF capacitor).

Naturally, the speakers must also be able to cope with this power that is the volume must be reduced for speakers with lower wattage specifications.



A cam sensor (for synchronizing chuff sounds with wheel rotations) is not necessary in most cases, because the software-generated virtual cam sensor is sufficient.

If, however, a "real" cam sensor is to be used, the following are suitable for connecting to the switch input "IN 3": mechanical switch, optical switch or Hall-effect switch. The switch must establish a low-impedance connection (< 10K) between the switch input and the ground terminal "MASSE", with every wheel trigger.

The volume control on the decoder board or an external control connected to the appropriate decoder pins can be used to set the volume alternatively or in addition to the CV volume settings (see CV #266).

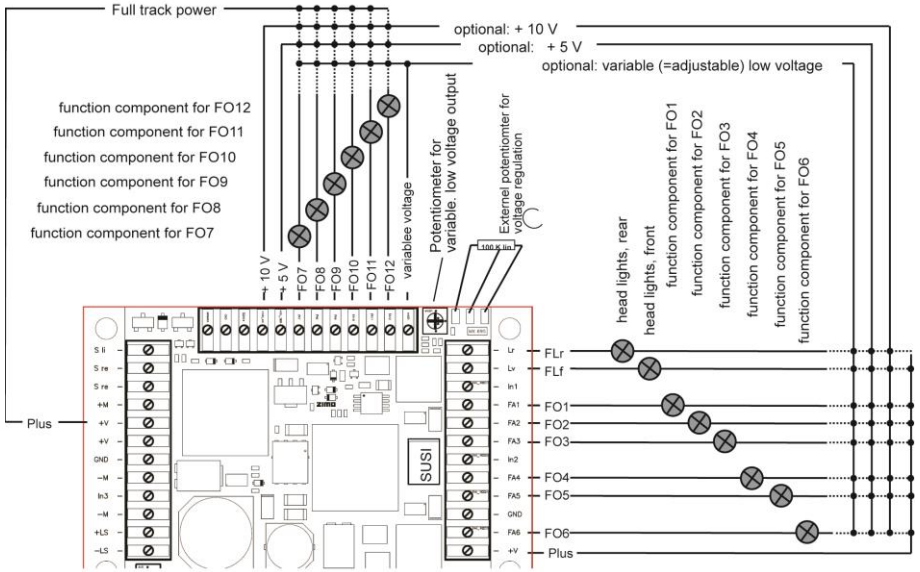
If such an external regulator (100 K, preferably logarithmic) is used, the on-board regulator should be set to full volume (left stop) unless its intended use is to limit the maximum volume to protect a low-power speaker.

Notes to MX696, MX697 and MX699 decoders:

These large-scale decoders (all except the MX695) don't have a built-in volume control. However, external controls (10 K potentiometer) can be connected to the MX697 and MX699 decoders.

3.3 Function-Components and Low-Voltage Outputs

"Function Components" is any equipment that is connected to the function outputs FLf, FLr, and FO1 (FO1)...FO12 (FO12). This is mostly lighting equipment (light bulbs and LEDs) but also solenoids, small motors, relays, etc.



Each function-component (bulbs, groups of bulbs etc.) connects between the corresponding function output (negative) and one of up to four positive voltage supply sources.

- Positive terminal = full track voltage: the rectified constant track voltage; which is often unstable, depending on the DCC system's capability of keeping the track voltage stable, i.e. track voltage varies with track current.
- Low voltage = 10 V: this is the voltage which is generated by the decoder mainly for the sound amplifier. ATTENTION: excessive or sudden increase in current draw of function components on the 10 V - power source can affect the sound quality. A short circuit at the 10 V - connection can cause the decoder to "crash". USE ONLY IF NECESSARY (i.e. if adjustable low-voltage output is already used for something else).
- Low voltage = 5 V: this voltage is available for servos and other components, i.e. for the commonly used 5 V - bulbs.

Note: *Only available in the MX695KV, MX695LV and other V – type models!*

- Variable low voltage: The function output voltage can be set between 1.5 V and full track voltage using the potentiometer on the decoder circuit board, or if desired an external regulator (100K lin) connected to the three solder pads.

Only available in the MX695KV, MX695LV and other V – type models!

Note: *The use of a true low-voltage source is often preferred over the software-controlled dimming (CV #60) because this "dimming" is achieved by PWM (Full track power with corresponding duty cycles), which may be damaging to bulbs with duty cycles higher than 2 (LEDs are not effected).*

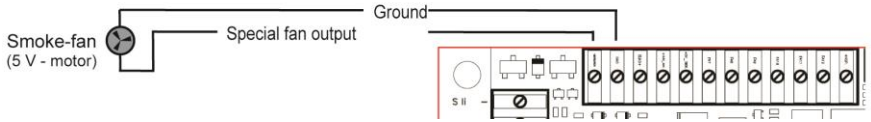
See the decoder configuration chapter (CV's) for "Function mapping", "Function effects", "Electric couplers" (Krois system, Heyn) etc.

Note MX696:

The MX696 does NOT have the (fixed) 5 V low-voltage. If 5V is required (e.g. for servos), the adjustable low-voltage output must be used (only with MX696V).

Note MX696N (non-sound - version):
These have a 6V low-voltage output (instead of the 10 V the sound decoder provides). This output can also be used to power the servos directly.

3.4 Special Connection for Smoke Fan



This output is used to drive the fan motor of a pulsed smoke generator, as it is used in many modern locomotives.

A special feature of this output (which is different from "normal" function outputs) is the possibility of braking the fan motor. This stops the motor immediately between motor pulses and therefore improves the smoke effect.

The output is designed for a 5 V motor with up to 100 mA constant-current (the starting current may be much higher).

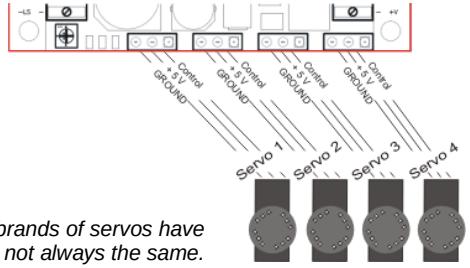
Note for MX699 decoder:

The MX699 decoders have two fan outputs (i.e. for articulated steam engines).

3.5 Servos

The MX695 offers 4 sockets for standard servos that can be used for uncouplers, pantographs and other mechanical devices.

The control output of each socket is controlled separately but the power outputs (+ 5 V, Ground) are internally parallel.



ATTENTION: *Although all the different brands of servos have these three wires, the order and color is not always the same.*

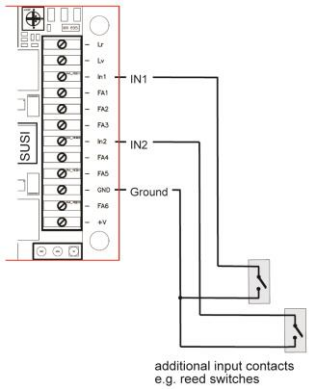
See the chapter dealing with decoder configurations regarding servo mapping and adjustments.

The 5 V supply for servos is only available in the MX695KV, MX695LV and other V – type models!
The control wires though are usable with all sound decoder versions; if necessary, use an external 5V power source to power the servo.

3.6 Switch Inputs

In addition to the input “IN 3” (see chapter 3.2, Speakers and Cam Sensor) there are two more inputs available (“IN 1” and “IN 2”), which can be connected to reed switches and used for sound triggering for example.

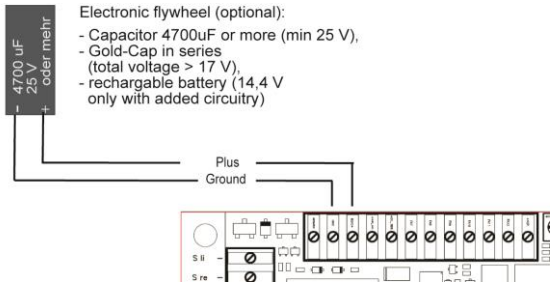
See the chapter on decoder configurations (CV’s), regarding sound in particular.



3.7 External Energy Source

With the help of a capacitor (electrolytic or Gold-Cap) or a re-chargeable battery the:

- drivability on dirty track (or dirty wheels) is improved,
- flickering lights due to power interruptions (frogs...) is reduced,
- engines won’t stall when driving slow or over “dead” frogs, especially in conjunction with ZIMO’s “smart stopping” software feature *), which is available in all ZIMO decoders.
- energy loss due to “RailCom gaps” and “HLU gaps” is eliminated, the associated motor noise is reduced and at the same time the RailCom signal quality (= readout quality) is improved.



*) If power to the decoder is interrupted due to dirty rails, wheels or insulated frogs, the decoder automatically keeps the engine going even if it is supposed to stop. Only when power to the decoder is restored, is the engine allowed to come to a full stop. Once stopped the decoder tests again for track power and if necessary moves the engine another very short distance until track power again is restored.

e effectiveness of this feature increases with increased capacity; an effect is t approximately 1000 uF (uF = microfarad), approximately 100’000 uF is recommended for large engines if enough space is available; Gold-Cap modules of about 1 F (Farad) are even better. Capacities that are too large, however, do have a drawback: the charging time becomes very long. This is why ZIMO advises no more than .5 F for Gold-Cap modules (based on the total voltage of approximately 15 to 25 V derived from the series connection of 6-10 elements, each with 2.5 V; an individual gold cap therefore with up to 3 F).

Special components on the ZIMO large-scale decoders ensure that external capacitors DO NOT cause problems during decoder programming, software updates, the ZIMO train number identification or RailCom.

The charging current for external capacitors is approx. 100 mA; charging a 10,000 uF capacitor takes about 5 sec, a .5 F Gold-Cap takes about 3 min to fully charge.

The most often used ZIMO gold cap module ***GOLMRUND*** (as well as the GOLMLANG) is made up of 7 gold caps with 1F / 2.5V each, which results in ***140‘000 µF / 17.5 V.*** The charging circuit on the capacitor positive connection of the decoder ensures that the charging voltage does not go too high.

The installation of a battery instead of a capacitor is currently only recommended for professionals (experienced electronic hobbyists); it is especially important that a total discharge is prevented after a loss of track power.

> ***Suggestion****: use a relay powered by track voltage, with holding capacitor, which disconnects the wires to the battery about 1 min. after loss of track power****.***

Note for the MX699 decoder:

The large-scale sound decoder MX699, in contrast to the other decoder types, also comes with and internal power storage, comprised of 3 super caps with 3 F / 2.7V each, for a total of 1 F but at only 8V. This is enough for driving across “dead” spots even at reduced speed. The available 8V are stepped up to 10V so that the sound is fully maintained when driving under power from the capacitor.

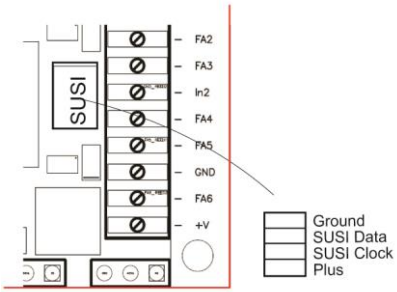
Connecting external energy storage such as the *GOLMRUND* can still make sense, precisely because it is charged to a higher voltage level (17.5V instead of 8V). Accordingly, there will then be more voltage and power available for the motor and functions.

3.8 The SUSI Interface

The “SUSI” interface developed by Dietz defines the connection to add-on modules, mostly sound, which are typically used with non-sound decoders.

Currently there are hardly any SUSI modules available, except for sound modules and using them with a sound decoder such as the MX695 does not make much sense, but together with the non-sound decoder MX695KN it would.

But not just for sound modules: currently there are digital couplers on the marked that operate with SUSI as well as pantographs...
SUSI is also used for fast sound project uploads (as ZIMO currently does at the factory as well as the user with the MXULF; in this case it is not the actual SUSI protocol that is used, but rather a much faster communications protocol).



4 Loco Adapter Boards for Large-Scale Decoder

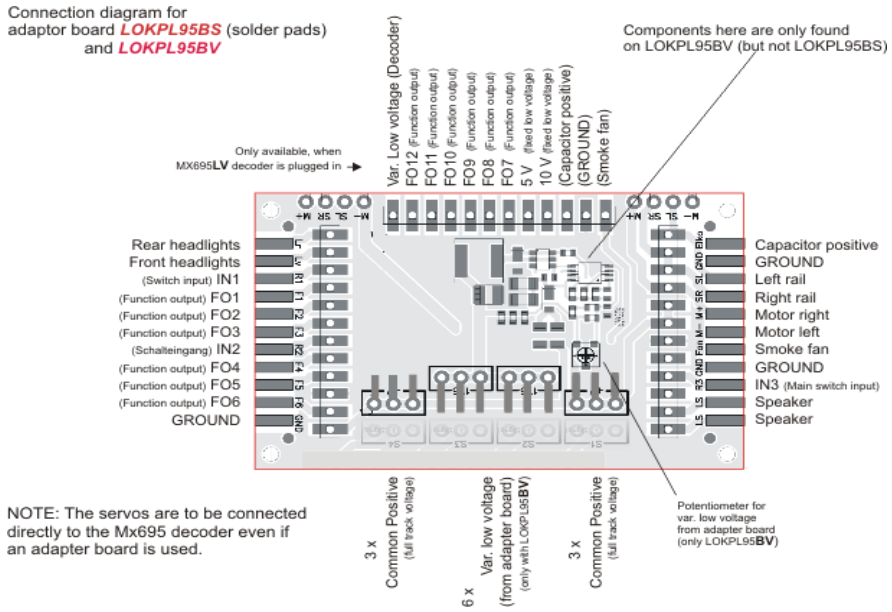
Locomotive adapter boards serve as an "intermediate part" between the engine and the decoder, to facilitate the decoder installation and connection to the various loco components. It also allows for an easy exchange of the decoder when necessary. Additionally, some loco boards also offer a low voltage output (i.e. for servos).

Note: Adapter boards for ZIMO large-scale decoders DO NOT contain an additional synchronous rectifier to increase power, as do the boards for "small" decoders (for N, HO etc., see operating manual for MX618, MX621...MX648 decoder). This would be redundant due to the very strong and low-loss synchronous rectifier already present in large-scale decoders.

Because of the very different needs, there are a relatively large number of types or versions of these locomotive boards available. In addition to the standard types described below, special designs are also manufactured (for a minimum-order quantity of about 50, mostly for vehicle manufacturers) that are based on the standard printed circuit boards, but with different or differently arranged connectors.

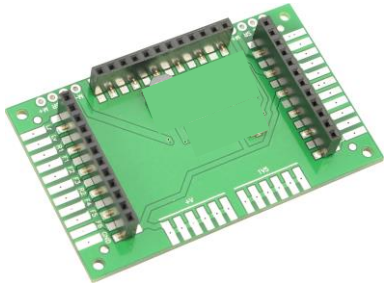
*Loco boards LOKPL**95BS, -BV** with solder pads, designed for the large-scale decoders MX6**95**LS and MX6**95**LV*

The wires from the locomotive (motor, track, lights, speakers...) are soldered directly to the solder pads and an appropriate decoder is plugged into these boards. Depending on the type of the loco board (-BS or BV), these are either simple circuit boards (no other electronic components on the board) or a board with "additional benefits" (in this case a voltage regulator for low voltages, which is often useful to have):



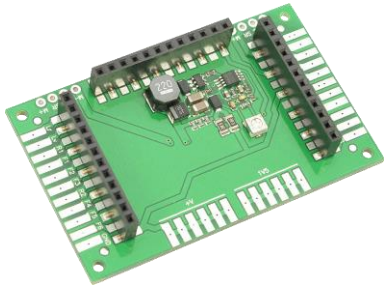
LOKPL95BS

circuit board with solder pads, usabilty of upper connector row depends on the decoder type plugged in



LOKPL95BV

with additional variable low voltage (Adjustable from 1.5 V to track voltage), otherwise identical



Loco board LOKPL95BV with decoder MX695 plugged in →

NOTE: The servo connections are NOT accessible on the loco board. They are therefore directly plugged in to the decoder (at the 3-pin sockets of the MX695).

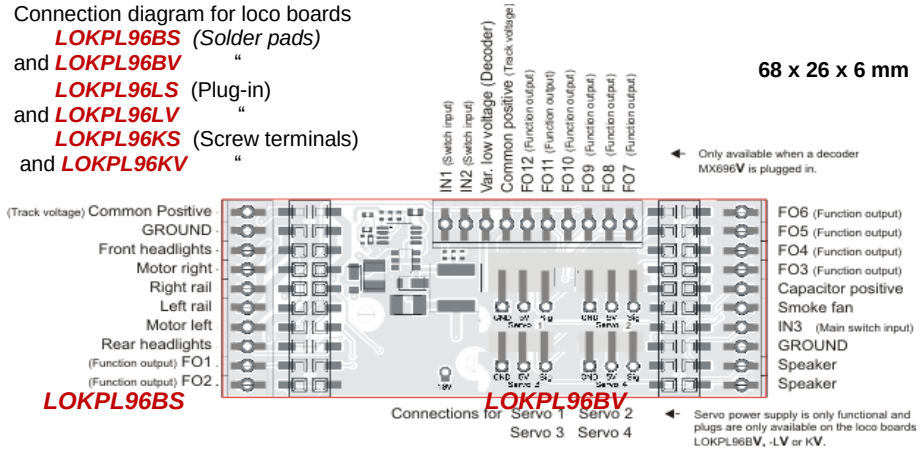
Special applications may also contain servo connectors on the loco board (i.e. with special board layouts that have enough room on the underside).

*Loco boards LOKPL**96...** designed for large-scale decoders MX6**96**S and MX6**96**V*

The large-scale decoder family MX696 differs from the MX695 by their narrow designs (29 mm instead of 40 mm). The slightly lower rating (4 A instead of 6 A) is not all that significant, but the MX696 is not equipped as well with low voltage outputs as the MX695, in particular the 5 V – supply is lacking. The loco boards LOKPL96.V therefore offer a 5 V source (and the complete servo connectors), but no variable low-voltage as the ...PL95.

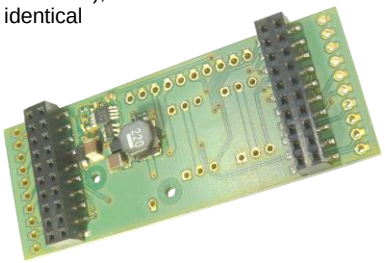
Connection diagram for loco boards
LOKPL96BS *(Solder pads)*
and ***LOKPL96BV*** "
LOKPL96LS (Plug-in)
and ***LOKPL96LV*** "
LOKPL96KS (Screw terminals)
and ***LOKPL96KV*** "

68 x 26 x 6 mm



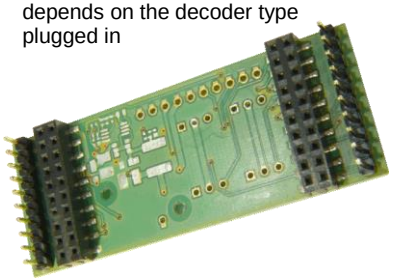
circuit board with solder pads,
usability of upper connector row depends on the decoder type plugged in

with additional 5 V low voltage (for servos), otherwise identical

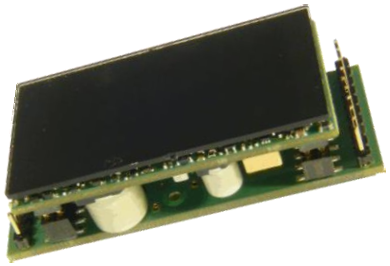


LOKPL96LS

Circuit board with
10-pin plugs,
usability of upper connector row depends on the decoder type plugged in

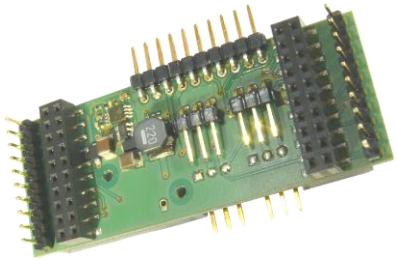


This version (-LS) is designed to combine with the MX696S decoder:



LOKPL96LV

with additional 5 V low voltage (for servos), complete servo connections, and third 10-pin plug (angled)



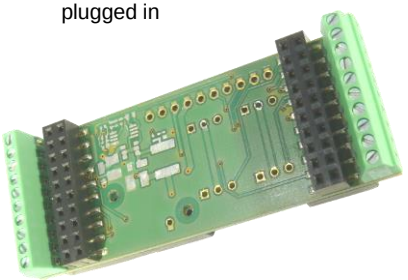
This version (-LV) is designed to combine with the MX696V decoder. The angled pins (at the back for the higher FO's and in the front for servo's) must be bent or cut off if space is limited.

The 10-pin plugs can be connected with the locomotive using cable and crimp sockets (also available from ZIMO). The 3-pin servo connectors accept the typical servo plugs (sequence: GROUND - 5V - control).

Suitable for **LGB locos with 10-pin "DCC interface",** which has the exact mirror image of the LOKPL96LS (or LV) board's left connector. The connecting cable is therefore particularly easy to produce.

LOKPL96KS

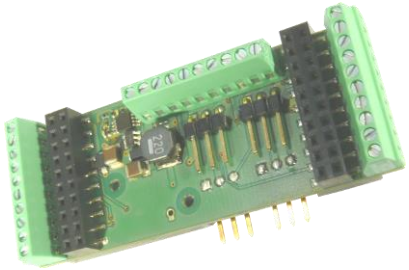
Circuit board with
10-pin screw terminals,
usability of upper connector row depends on the decoder type plugged in



This version (-KS) is designed to combine with the MX696S decoder.

LOKPL96KV

with additional 5 V low voltage (for servos), complete servo connections, and a third row of screw terminals



This version (-KV) is designed to combine with the MX696V decoder. The angled servo pins must be bent or cut off if space is limited.

Sold as a single decoder type - Combinations of loco board and decoder

Particularly useful combinations of loco board and decoder are treated as separate decoder types (with their own names, part numbers and prices): this is especially true for

LOKPL96KS + MX696S = MX696KS

This decoder combination is similar to the type MX69**5**KS in terms of functions and connectivy (Screw terminals) but is much narrower (29 instead of 40 mm).

LOKPL96KV + MX696V = MX696KV

This decoder combination is similar to the type MX69**5**KV in terms of functions and connectivy (Screw terminals) but is much narrower (29 instead of 40 mm).mm).

Combination LOKPL96KV + MX696V = MX696KV

Loco Board and Large-Scale Sound Decoder: A proper solution for any large-scale engine

The Combinations:

Solder Pads for all connections

wide design (40 mm) | narrow design (29 mm) | single rows wide design (40 mm)

8 Function Outputs

MX695LS + LOKPL95BS

MX696S + LOKPL96BS

MX695LS
Decoder w/o loco board

can be plugged in to ZIMO loco boards (see far left) as well as ESU loco boards.

8 Function Outputs +
5V Low-voltage +
4 complete (0V, 5V, Control) **Servo Connections**

MX695LS + LOKPL95BV

MX696S + LOKPL96BV

14 Function Outputs

MX696V + LOKPL96BS

MX695LV
Decoder w/o loco board

14 Function Outputs +
5V Low-voltage +
4 complete **Servo Connections**

MX695LV + LOKPL95BS

MX695LV + LOKPL95BV

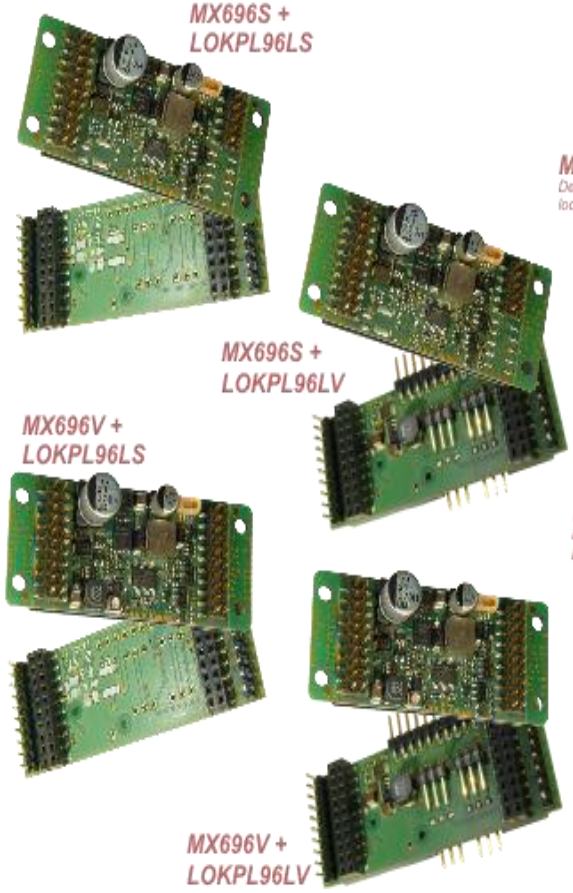
MX696V + LOKPL96BV

var. Low-voltage
(adjustable from 1.5 V to about 18 V)

Plug-in sockets for **Ribbon cable**
narrow design (29 mm)

Double row sockets for **Ribbon cable**
narrow design (29 mm) wide desing (40 mm)

Screw terminals
narrow desing (29 mm)



MX696S + LOKPL96LS

MX696S + LOKPL96LV

MX696V + LOKPL96LS

MX696V + LOKPL96LV

MX696S
Decoder w/o loco board

Left plug is suitable for a 1:1 connection to the 10-pin LGB "DCC interface".

MX696V
Decoder w/o loco board

ATTENTION:
5 V for servos is only available at the variable low-voltage output.

MX695KS
Decoder w/o loco board

MX695KV
Decoder w/o loco board

MX696S + LOKPL96KS

*This combination is available under part number **MX696KS** (see page 23)!*

MX696V + LOKPL96KS

MX696S + LOKPL96KV

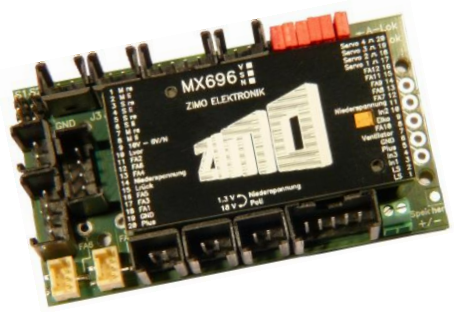
MX696V + LOKPL96KV

*This combination (Loco board LOKPL96KV with plugged-in Decoder MX696V) is available under part number **MX696KV** (see page 23), with similar characteristics as the MX695KV, but in a narrow desing!*

Special loco board LOKPL**SHMAL**
as carrier of the large-scale decoders MX6**96**S or MX6**96**V

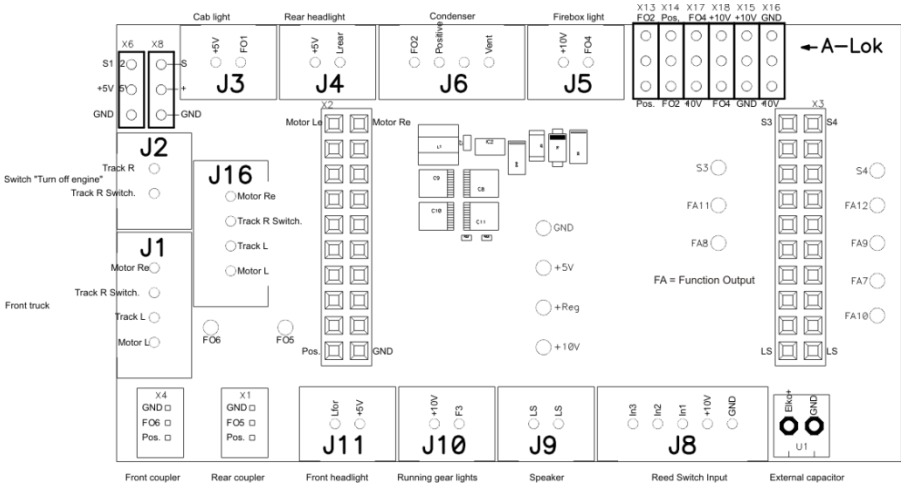
This board is a special development for the “HSB Mallet 995901” engine from TrainLine, but can also be used by other engine manufacturers, workshops as well as private model railroaders.

100 x 56 x 20 mm



Loco board *LOKPLSHMAL*
with plugged-in decoder MX696S →

Connection diagram for
loco board *LOKPLSHMAL*



NOTES for LOCO-CONVERSION (using the example of the Train Line HSB Mallet 995 901):

The original board in the vehicle is removed and replaced by the Zimo "Special Loco board" (with inserted decoder MX696S). The Zimo loco board has the same connectors (but no connection for a potentiometer) and also the same holes for the mounting screws as the Train Line original board. The plugs are labeled on the Zimo loco board the same as the original board, i.e. J1, J2, J3, etc. The exchange of the loco board is therefore very easy. It is recommended to first mark the cables - at least the two-pole – in order to make the correct connections on the Zimo loco board ... It makes sense to previously remove the decoder (for better accessibility of the loco board connectors) and to plug it back in after finishing the installation of the loco board.

The ZIMO loco board, in contrast to the TrainLine original board, offers a connection (double screw terminal in the lower right corner) for an energy storage device: preferably a ZIMO gold cap module *GOLMRUND* or *GOLMLANG*.

Additionally: connections for uncouplers (for servos or Massoth uncouplers).

The conversion of the "analog version" ("A-Lok" that comes without a decoder, but does have a loco board and connection board installed, which both have to be removed) is the same as for the "digital" version ("D-Lok" which includes a factory-installed decoder); they differ mainly with respect to the smoke generator. It is therefore necessary to place the 6 jumpers on the loco board accordingly; ideally BEFORE the installation – the loco board, as delivered, is set for the “analog version” (”A-Lok”).

The decoder offered for the HSB Mallet already contains a particularly high quality sound project from Heinz Däppen and is optimized for this model. The decoder is also provided with a valid load code to facilitate possible future firmware upgrades or an improved version of the sound project. The “ZIMO & Däppen” sound offers a number of advantages for this vehicle, compared to the manufacturer’s original digital version: prototypical chuff beats (not exaggeratedly hard), cylinder typical “load sounds”, Mallet-typical sound even in the lower speed range, sound of auxiliary units from the actual locomotive.
More info ... in special document "Upgrading Notes"

The upgraded locomotive: Goldcap-Module on the left, decoder on the right.

*Loco board LOKPL**99** with solder pads,*
*for large-scale decoders MX6**99**LS and MX6**99**LV*

When installing these loco boards, all wires (track, motor, speaker, bulbs...) are soldered to the loco board and after that, the approrpiate decoder is plugged in.

Connection diagram for
loco board ***LOKPL99*** *(with solder pads)*

62 x 40 x 10 mm

WILL BE ADDED LATER

NOTE: The servos are connected directly to the decoder MX695. For this reason, the loco board has special cut-outs

LOKPL99 →

WILL BE ADDED LATER

WILL BE ADDED LATER

← *Loco board LOKPL99 with decoder MX699LS or –LV plugged in*

5 Configuring the MX695 - MX699

ZIMO decoders can be programmed in
- "Service Mode" (on the **programming track**) for assigning a new address or reading and writing CV content, or in

- "Operations Mode" (a.k.a. "Programming on the main" or "PoM"), which is done on the **main track;** programming CV's "on the main" is always possible in operations mode. However, an acknowledgement of successful programming steps or when reading out CV's is only possible with a DCC system capable of **"RailCom".**

5.1 "Service mode" programming *(on the programming track)*

Before programming is possible, it must be unlocked with

CV #144 = 0 or = 128 (the latter allows programming but prevents decoder updating).

This (CV #144 = 0) is normally the default setting, but the programming lock is activated in many sound projects to prevent accidental changes. It is therefore recommended to check that CV, especially when attempted programming has already failed.

Successful programming steps as well as CV read-outs on the programming track are acknowledged by decoder-generated power pulses, by briefly turning on the motor and/or headlights. If the motor and/or headlights do not draw power (i.e. they are not connected) or don't draw enough power, acknowledgments for successful programming or CV read-outs are not possible.

To make acknowledgments possible in such cases activate CV #112 bit 1, which enables the decoder to use an alternate acknowledgment by sending high frequency pulses from the motor end stage. Whether this method is successful though depends on the DCC system used.

CV	Designation	Range	Default	Description
#144	**Programming and Update Lock** Note: The programming lock has no effect on CV #144, which is therefore always accessible for unlocking.	Bits 6, 7	0 or 255	= 0: Update and programming lock not active Bit 6 = 1: No programming possible in "service mode": protection against unintentional programming. Note: Programming in "Operations Mode" is not locked because any such programming only applies to the active loco address and re programming the wrong locomotive is therefore not possible. Bit 7 = 1: Software updates via MXDECUP, MX31ZL or other means are locked.
#112	**Special ZIMO configuration bits**	0 - 255	4 = 00000100 That is Bit 1 = 0 (normal)	Bit 1 = 0: Normal "service mode" acknowledgement; i.e. motor and headlights are pulsed. = 1: High frequency pulses instead of normal acknowledgments from motor and headlights. Bit 2 = 0: loco number recognition off etc,

Attention: The CV values of a sound decoder in the delivery state do NOT correspond with the default values in the following chapters, but rather the initial values of the **loaded sound project!**
This applies most often to
CV #29 – analog operation is usually turned off (Bit 3 = 0); CV #29 = 14 turns this on if desired.
CV #144 – the update lock may be activated (Bit 7 = 1), sometimes even the programming lock (Bit 6 = 1); before updating or programming a decoder, set this CV to CV #144 = 0.
CV #3, 4 – acceleration and deceleration CV's are often set to higher values (i.e. 12).
CV #33 and following – the functions are often mapped to a specific loco model.
…and of course the sound CV's (from CV #265) and (less frequently) all other CV's.

5.2 "Operations mode" programming (on-the-main)

Programming in "Operations mode", otherwise known as "Programming-on-the-main" = PoM
"Programming-on-the-fly".

According to the current NMRA DCC standards it should only be possible to program and read CV's on the main track, but not assign new vehicle addresses. However, certain DCC systems (among them ZIMO beginning with the system generation MX10/MX32) will allow addresses to be modified on the main track with the help of bidirectional communication.

All ZIMO decoders are equipped with bidirectional communication (**"RailCom"**) and can therefore (with a corresponding DCC system such as ZIMO MX31ZL and all devices of the new MX10/MX32 generation) read, program and acknowledge successful CV programming steps in operations mode (on the main track). This requires RailCom to be activated, which is the case if the following CV's are set as:

CV #29, Bit 3 = 1 AND CV #28 = 3

This is usually the default setting, but in certain sound projects or OEM CV sets it may be turned off by default and must first be turned on again.

CV	Designation	Range	Default	Description
#28	**RailCom Configuration**	0 - 3	3	Bit 0 - RailCom Channel 1 (broadcast) 0 = off 1 = on Bit 1 - RailCom Channel 2 (Data) 0 = off 1 = on
#29	**Base Configuration** Configuration data	0 - 63	14 = 0000 1110 That is Bit 3 = 1 ("RailCom" is on)	Bit 0 – train direction 0 = normal, 1 = reversed Bit 1 - number of speed steps 0 = 14, 1 = 28 Bit 2 – DC operations (analog mode) 0 = disabled 1 = enabled Bit 3 - RailCom ("bi-directional communication") 0 = off 1 = on Bit 4 – individual speed table 0 = off, CV #2, 5 and 6 are active. 1 = on, according to CV 's #67 – 9494 Bit 5 – Decoder address (DCC) 0 = primary address as per CV # 1 1 = ext. address as per CV's #17+18

5.3 Decoder-ID, Load-Code, Decoder-Type and SW-Version

CV	Designation	Range	Default	Description
#250, #251, #252, #253	Decoder-ID also contains **Decoder type in CV #250** (see chapter 1, "Product Overview" for decoder type code)	read only	-	The decoder ID (serial number) is automatically entered during production: the first byte (CV #250) denotes the decoder type; the three other bytes contain the serial number. The decoder ID is primarily used for automatic address assignment when an engine is placed on the layout track (future function) as well is in conjunction with the "load code" for "coded" sound projects (see CV #260 – 263)
#260, #261, #262, #263	**Load-code** for "coded" sound projects	-	-	New ZIMO sound decoders can be ordered for a small fee with the "load code" pre-installed, which entitles the user to install "coded" sound projects of a selected sound "bundle". The load code can also be bought and installed at a later date: see www.zimo.at or ZIRC.
#8	**Manufacturer ID** and **HARD RESET** with CV #8 = "8" or CV #8 = 0 or ACTIVATION of special CV sets	Read only Reading out the decoder always shows "145", which is ZIMO's assigned number. For pseudo programming see the description on the right.	145 (= ZIMO)	Reading out this CV always result in "145" ("10010001"), the number issued for ZIMO by the NMRA. This CV is also used to execute various resets with the help of Pseudo-Programming. Pseudo-Programming means that the entered value is not really stored, but rather used to start a defined action. **CV #8 = "8" → HARD RESET** (NMRA standard); all CV's reset to the last active **CV set** (incl. sound project), or the default values as listed in this CV table if no such set was active before. CV #8 = "9" → HARD RESET to old LGB-MZS system (14 speed steps, pulse chain commands). Further options: see chapter "CV Sets"!
#7	**SW version number** Also see CV #65 for sub-version number and special programming procedures with "Lokmaus-2" and other "low level" systems	Read only For pseudo programming see the description on the right	-	This CV holds the main number of the currently loaded decoder software (firmware). It is also used via "pseudo programming" to program decoders with DCC systems of limited numbers range (typ. example: old Lokmaus): Ones digit = 1: Subsequent programming value + 100 = 2: ... + 200 Tens digit = 1: Subsequent CV number + 100 = 2: … + 200 etc. = 9: … + 900 Hundreds digit = 0: Revaluation applies only once = 1: … until power-off
#65	**SW sub-version num.** See also CV #7 for main version number	Read only	-	This CV indicates a possible sub-version number of a main version noted in CV #7. The entire SW version number is thus composed of CV #7 and #65 (i.e. 28.15).

5.4 Engine address(es) in DCC mode

Decoders are usually delivered with default **address 3 (CV #1 = 3)**, for the DCC as well as MM protocol. All aspects of operations are possible with this address but it is recommended to change to a different address as soon as possible.

The address space required for DCC exceeds the range of a single CV, up to 10239 in fact. Addresses higher than 127 are stored in CV #17 and #18. Bit 5 in CV #29 is used to select between the short address in CV #1 and the long address in CV's #17/18.

☞ Most digital systems (with the possible exception of very old or simple products) automatically calculate the value for the CV's involved and also set Bit 5 in CV #29 to the proper value when writing the address, so that the user does not have to deal with the necessary coding.

CV	Designation	Range	Default	Description
#1	**Short address**	DCC: 1 - 127 MM: 1 - 80	3	The "short" (1-byte) loco address (DCC,MM) In the case of DCC: The address in CV #1 is only valid if CV #29, Bit 5 = 0. Otherwise, if CV #29 Bit 5 = 1, the long address in CV #17 + #18 applies.
#17 + #18	**Extended Address**	128 - 10239	0	The long DCC address applies to addresses >127. It is only active if CV #29 Bit 5 = 1.
#29	**Base Configuration**	0 - 63	14 = 0000 1110 with Bit 5 = 0 (for short address)	Bit 0 – Train direction: 0 = normal, 1 = reversed Bit 1 - Number of speed steps: 0 = 14, 1 = 28 Bit 2 – DC operation (analog mode) 0 = disabled 1 = enabled Bit 3 - RailCom ("bi-directional communication") 0 = deactivated 1 = activated Bit 4 – Individual speed table 0 = off, CV #2, 5 and 6 are active. 1 = on, according to CV 's #67 – 9494 Bit 5 - Decoder address selection: 0 = short address as per CV #1 1 = long address as per CV #17+18

Decoder-controlled consisting (a.k.a. "advanced consisting")

The combined operation of two or more locomotives (consisting) can be organized by

- the DCC system (common practice with ZIMO systems, without changing any decoder CV's) or
- by programming the following decoder CV's individually, which can also be managed by some DCC systems (often the case with American made systems).

This chapter covers only the latter; the decoder controlled consisting!

CV	Designation	Range	Default	Description
#19	**Consist address**	0 - 127	0	A consist address common for 2 or more engines can be entered in this CV to each loco of the same consist. If CV #19 > 0: Speed and direction is governed by this consist address (not the individual address in CV #1 or #17+18); functions are controlled by either the consist address or individual address, see CV's #21 + 22. Bit 7 = 1: Driving direction reversed
#20	Extended consist address From SW version 36.6	0 - 255	0	The value of CV20 multiplied with 100 added together with the value of CV 19 which result is the address at consist. e.g. CV20= 12, CV19=34 is address. 1234 CV20=100, CV19=00 is address 10000
#21	**Consist Functions F1 - F8**	0 - 255	0	Functions selected with this CV will be controlled by the consist address. Bit 0 = 0: F1 controlled by individual address = 1: …. by consist address Bit 1 = 0: F2 controlled by individual address = 1: …. by consist address …….. F3, F4, F5, F6, F7 Bit 7 = 0: F8 controlled by individual address = 1: …. by consist address
, #22	**Consist Functions F9 – F27 and headlight control**	0 - 191	0	Select whether headlights and/or functions F9 – F12 are controlled via consist address or single address. Bit 0 = 0: F0 (forw.) controlled by individual address = 1: …. by consist address Bit 1 = 0: F0 (rev.) controlled by individual address = 1: …. by consist address Bit 2 = 0: F9 (forw.) controlled by individual address = 1: …. by consist address Bit 3 = 0: F10 (forw.) controlled by individual address = 1: …. by consist address Bit 4 = 0: F11 (forw.) controlled by individual address = 1: …. by consist address Bit 5 = 0: F12 (forw.) controlled by individual address = 1: …. by consist address Bit 7 = 1: F13 – F27 (all !) …. by consist address

5.5 Analog operation

All ZIMO decoders are capable of operating in **DC analog** on conventional layouts (with DC power packs, including PWM throttles) as well as in **AC analog** (Marklin transformers with high voltage pulse for direction change).

To allow analog operation

CV #29, Bit 2 = 1

must be set. This is usually the case by default (CV #29 = 14, which includes Bit 2 = 1), but analog operation may be turned off in many sound projects (sound decoders). Check this CV first to ensure that the analog mode is enabled if the engine won't run on an analog layout. **It is recommended to set CV #29, Bit 2 = 0 when operating in a DCC environment only!**

The new large scale decoders (MX695/6/7) are very well designed for analog operation because they can turn on lights, sound and the motor at a very low track voltage, by "raising" the track voltage internally to a certain degree. See the chapter titled "Technical Data". This effect is achieved by applying stepped threshold voltages that is, the headlights will come on first, the sound at a slightly higher voltage and only after that will the motor start.

The actual behavior during analog operation however, is strongly influenced by the locomotive controller (power pack). Especially in conjunction with a weak transformer, it is easy possible that the track voltage collapses when the decoder (motor) starts to draw power which, in the worst case, may lead to intermittent performance. There are a number of adjustment possibilities for analog operations where motor control and function outputs are concerned; these CV's can of course be read-out or programmed only with a DCC system or other programming devices.

CV	Designation	Range	Default	Description
#13	**Analog Functions** F1-F8	0 - 255	0	Defines function outputs that should be "ON" in analog mode. Bit 0 = 0: F1 is OFF in analog mode = 1: …ON in analog mode Bit 1 = 0: F2 is OFF in analog mode Bit 1 = 1: …ON in analog mode ……..F3, F4, F5, F6, F7 Bit 7 = 0: F8 is OFF in analog mode Bit 7 = 1: …ON in analog mode
#14	**Analog functions** F9 – F12, **Analog momentum** and **Regulated Analog**	0 - 255	64 (Bit 6 = 1)	Defines function outputs that should be "ON" in analog mode. Bit 0 = 0: F0 (forw) is OFF in analog mode = 1: …ON in analog mode Bit 1 = 0: F0 (rev) is OFF in analog mode Bit 1 = 1: …ON in analog mode Bit 2 = 0: F9 is OFF in analog mode Bit 2 = 1: …ON in analog mode ----------F10, F11 Bit 5 = 0: F12 is OFF in analog mode Bit 5 = 1: …ON in analog mode Bit 6 = 0: Analog operation with acceleration and deceleration according to CV #3 and #4. Bit 6 = 1: Analog operation without acceleration and deceleration according to CV #3 and #4.

CV	Designation	Range	Default	Description
				Bit 7 = 0: unregulated DC operation = 1: regulated DC operation
, #29	**Base Configuration**	0 - 3	0	Bit 0 – Train direction: 0 = normal, 1 = reversed Bit 1 - Number of speed steps: 0 = 14, 1 = 28 Bit 2 – DC operation (analog mode) 0 = disabled 1 = enabled Bit 3 - RailCom ("bi-directional communication") 0 = deactivated 1 = activated Bit 4 – Individual speed table 0 = off, CV #2, 5 and 6 are active. 1 = on, according to CV 's #67 – 9494 Bit 5 - Decoder address selection: 0 = short address as per CV #1 1 = long address as per CV #17+18

Note: Actual decoder settings may differ from the default values if a sound project is on the decoder; in particular, the motor regulation (CV #14, Bit 7) is often enabled. The regulation only works well with power packs that apply "clean" DC voltage (i.e. with an LGB 50 080); otherwise it is better to turn the motor regulation off.

5.6 Motor control and regulation

The Speed Curve

There are two ways of programming the speed curve:

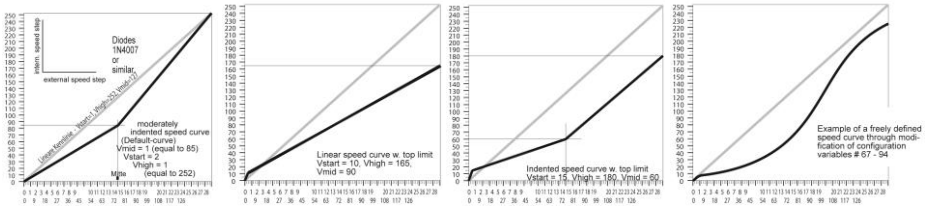
CV #29, Bit 4 = 0: three-step curve (defined by 3 CV's)

... = *1*: 28-step curve (defined by 28 CV's)

Three-step curve: the lowest, highest and medium speed is defined by the Configuration Variables #2 (Vstart), #5 (Vhigh) and #6 (Vmid). This is a simple way to quickly establish a speed range and its curvature.

☞ The three-step curve is usually sufficient.

28 – step curve (a.k.a. free programmable speed curve): with the help of CV's #67 - 94, all 28 external speed steps can be freely assigned to the 128 internal speed steps. These 28 CV's apply to all speed step modes (14, 28 and 128). If 128 external speed steps are used, the decoder adds the missing intermediate values by interpolation.



CV	Designation	Range	Default	Description
#2	**Vstart** (Lowest speed) three step curve if CV #29, Bit 4 = 0	1 - 255	1	Internal speed step (1 … 255) applied as **lowest** external speed step (= speed step 1) (applies to 14, 28, or 128 speed step modes) = 1: lowest possible speed
#5	**Vhigh** (Maximum speed) three step curve if CV #29, Bit 4 = 0	0 - 255	1 equivalent 255	Internal speed step (1 … 255) applied as **highest** external speed step (14, 25 or 128, depending on the speed step mode selected in CV # 29, Bit 1) = 1 (same as 255): fastest top speed possible.
#6	**Vmid** (Medium speed)	1, ¼ to ½ of the value in CV #5	1 (= @ 1/3 of top speed)	Internal speed step (1 … 255) applied as **medium** external speed step (that is, speed step 7, 14 or 63 depending on the speed step mode selected in CV #29, Bit 1) "1" = default curve (Medium speed is set to one third of top speed. I.e., if CV #5 = 255 the curve is the same as if CV #6 would be programmed to 85). The speed curve resulting from CV #2, 5 and 6 is automatically smoothed out.
#29	**Basic Configuration** Configuration data	0 - 63	14 = 0000 1110 Bit 2 = 0 (three step speed curve)	Bit 0 - Train direction: 0 = normal, 1 = reversed Bit 1 - Number of speed steps: 0 = 14, 1 = 28/128 Bit 2 - DC operation (analog): 0 = disabled 1 = enabled Bit 3 - RailCom ("bidirectional communication") 0 = deactivated 1 = activated Bit 4 - Individual speed table: 0 = off, CV # 2, 5 and 6 are active. 1 = on, according to CV 's # 67 – 94 Bit 5 - Decoder address: 0 = primary address as per CV #1 1 = ext. address as per CV #17+18
#67 …… #94	**Individual Speed Curve,** if CV #29, Bit 4 = 1	0 - 255	*)	User programmable speed table. Each CV corresponds to one of the 28 external speed steps that can be "mapped" to internal steps (1 – 255). *) The 28-point default curve is also bent in the lower speed range.
#66 #95	**Directional Speed Trimming**	0 - 255 0 - 255	0 0	Speed step multiplication by "n/128" (n = trim value) for forward (CV # 66) or reverse direction (# 95).

Reference Voltage for motor control

CV # 57 specifies the voltage, which is used as a base for motor regulation. For example: if 14V is selected (CV value: 140) the decoder tries to send the exact fraction of this voltage, given by the speed regulator position, to the motor regardless of the voltage level at the track. As a result the speed remains constant even if the track voltage fluctuates, provided the track voltage (more precisely, the rectified and processed voltage inside the decoder, which is about 2V lower) doesn't fall below the absolute reference voltage.

☞ The default value “0” in CV #57 selects the “relative reference”, which automatically adjusts the reference voltage to the available track voltage. This setting is only useful though if the system can keep the track voltage constant at all times (stabilized track output) and the resistance along the track kept to a minimum. All ZIMO systems keep the track voltage stable even older systems, but not every system from other manufacturers do, especially the relatively cheap systems built before 2005. It is not recommended to set CV #57 to “0” with systems that don’t keep track voltage stabilized. Instead set this CV about 2V below track voltage (i.e. 140 for 16V).

☞ CV #57 can also be used as an alternative to CV #5 (top speed), which has the advantage that the full resolution of the 255 speed steps remains available.

CV	Designation	Range	Default	Description
#57	**Voltage Reference**	0 - 255	0	Absolute voltage in tenth of a volt applied to the motor at full speed (max. throttle setting). Example: A system without stabilized track voltage is set to 22V at idle but drops to 16V under load: A good setting would be CV #57 = 140…150. CV #57 = 0: automatically adjusts to the track voltage; only useful with stabilized track voltage.

Tweaking the motor regulation

The motor’s performance, especially at crawling speeds (should be a smooth as possible), can be fine-tuned with the following CV’s:

CV #9 – Motor control frequency and EMF sampling rate

The motor is controlled by pulse with modulation that can take place at either low or high frequency.

Low frequency (30 – 159Hz) is only useful for very few locomotives with very old motors (i.e. AC motors with field coils instead of permanent magnets).
High frequency (**20 kHz** by default, up to 40 kHz as per CV #112) on the other hand is **quiet** and **easy on the motor.**

Power to the motor is interrupted periodically (50 – 200 times/sec.), even when operating at high frequency, in order to determine the current speed by measuring back-EMF (voltage generated by the motor). The more frequent this interruption takes place (sampling rate), the better the load compensation performs; but that also causes power loss and increased noise. By default, the sampling frequency varies automatically between 200Hz at low speed and 50 Hz at maximum speed.

CV #9 allows the adjustment of the sampling frequency as well as the sampling time. The default value of 55 represents a medium setting.

CV # 56 – The PID regulation

The motor regulation can be tailored to motor type, vehicle weight and so on, by using different *P*roportional-*I*ntegral-*D*ifferential values. In reality however, changing the differential value can be omitted.

CV #56 allows the proportional value (tens digit) as well as the integral value (ones digit) to be set individually. The default value of 55 represents a medium setting, at which a certain automated fine-tuning is performed by the decoder software.

CV	Designation	Range	Default	Description
#9	**Motor control frequency** and **EMF sampling rate** (Algorithm)	55 high frequency, medium scanning rate algorithm 01 - 99 high frequency with modified EMF scanning rate algorithm 255-176 low frequency	55 high frequency, medium scanning rate algorithm	= 55: Default motor control with high frequency (20/40kHz), medium EMF sampling rate that automatically adjusts between 200Hz (low speed) and 50Hz and medium EMF sampling time. <> 55: Modification of automatic adjustments with: tens digit for sampling rate and ones digit for sampling time. Tens digit 1 - 4: Lower sampling rate than default (less noise!) Tens digit 6 - 9: Higher sampling rate than default (to combat jerky movements!) Ones digit 1 – 4: Shorter EMF sampling time (good for coreless motors, less noise, more power) Ones digit 5 - 9: Longer EMF sampling time (may be needed for 3-pole motors or similar). Typical test values against jerky driving: CV #9 = 55 (default) → 83, 85, 87, ... CV #9 = 55 (default) → 44, 33, 22, … = 255 - 178: Low frequency (for old motors only!) – PWM according to formula (131+ mantissa*4) *2exp. Bit 0-4 is “mantissa”; Bit 5-7 is “exp”. Motor frequency is the reciprocal of the PWM. Examples: #9 = 255: frequency at 30 Hz, #9 = 208: frequency at 80 Hz, #9 = 192: frequency at 120 Hz.
#112	**Special ZIMO Configuration bits**	0 - 255	4 = 00000100 Bit 5 = 0 (20 kHz)	Bit 1 = 0: Normal acknowledgement. = 1: High frequency acknowledgement Bit 2 = 0: Loco number recognition OFF = 1: ZIMO loco number recognition ON Bit 3 = 0: **12-Function Mode** = 1: **8-Function Mode** Bit 4 = 0: Pulse chain recognition OFF = 1: Pulse chain recognition (for old LGB) Bit 5 = 0: 20 kHz motor control frequency = 1: 40 kHz motor control frequency Bit 6 = 0: normal (also see CV #29) = 1: „Märklin brake mode
#56	**P- and I- Value** for BEMF motor regulation	55 medium PID setting 01 - 199 modified settings	55	= 55: Default setting using medium PID parameters. = 0 - 99: Modified settings for “normal” DC motors (Bühler etc.). = 100 - 199: Modified settings for coreless motors (Faulhaber, Maxon etc.) Tens digit 1 - 4: Lower proportional value than default Tens digit 6 - 9: Higher proportional value than default Ones digit 1 - 4: Lower integral than default Ones digit 6 - 9: Higher integral than default Typical test values against jerky driving: CV #56 = 55 (default) → 33, 77, 73, 71...

Fine-tuning suggestions (if default settings are not satisfactory):

Vehicle, Type of Motor	CV #9	CV #56	Remarks
LGB-Loco with Bühler-motor(s)	(55)	(55)	The default settings are usually sufficient for good vehicle performance.
Loco with Faulhaber motor (Maxon)	12	111	Relatively rare and short EMF sampling times, "soft" regulation, special Fauhaber procedure, quiet!
Märklin Gauge 1 (i.e. V100)	65	12	Slightly above average EMF sampling times, but also "soft" regulation.
PIKO VT98 (light construction)	91	91	High sampling rate (but short EMF sampling times), high P-value (but not I-value).
PIKO Taurus (relatively heavy)	64	63	Marginally higher sampling rate and P-value (between LGB and PIKO VT98).
DEMKO Herkules, O-scale	71	141	Higher sampling rate, otherwise typical for Faulhaber.

Tips on how to proceed in finding the optimal CV #56 settings:

Start with an initial setting of CV #56 = **11**; Run the engine at low speed while holding it back with one hand. The motor regulation should compensate for the higher load within half a second. If it takes longer than that, increase the ones digit gradually: CV #56 = 1**2**, 1**3**, 1**4**...

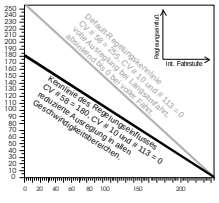
With the locomotive still running at a low speed, increase the tens digit in CV #56 one step at the time. For example: (if the test above resulted in CV #56 = 1**3**) start increasing the tens digit CV #56 = **2**3, **3**3 ,**4**3…
As soon as jerky driving is detected, revert back to the previous digit → this would be the final setting.

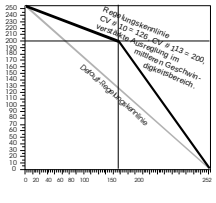
Load Compensation, Compensation Curve and Experimental CV's

The goal of load compensation, at least in theory, is to keep the speed constant in all circumstances (only limited by available power). In reality though, a certain reduction in compensation is quite often preferred.

100% load compensation is useful within the low speed range to successfully prevent engine stalls or run-away under light load. Load compensation should be reduced as speed increases, so that at full speed the motor actually receives full power. Also, a slight grade-dependent speed change is often considered more prototypical.

Locomotives operated in consists should never run at 100% load compensation in any part of the speed range, because it causes the locomotives to fight each other and could even lead to derailments.





The overall intensity of load compensation can be defined with *CV # 58* from no compensation (value 0) to full compensation (value 255). Useful values range from 100 to 200.

For a more precise or more complete load compensation over the full speed range use CV #10 and CV #113 together with CV #58 to define a 3-point curve.

CV	Designation	Range	Default	Description
#58	**BEMF intensity**	0 - 255	255	Intensity of back-EMF for lowest speed step. If required, an "intensity curve" can be defined for the medium speed using CV #10, 58 and 113. EXAMPLES: CV # 58 = 0: no back-EMF CV # 58 = 150: medium compensation CV # 58 = 255: maximum compensation
#10	**EMF Feedback Cutoff** This CV is seldom used	0 - 252	0	Assigns an internal speed step where back EMF intensity is reduced to the level defined in CV #113. CV #10, #58 and #113 together define a back-EMF curve. = 0: default curve is valid (as in CV #58).
#113	**BEMF reduction** This CV is seldom used	0 - 255	0	The BEMF intensity is reduced to this value at the speed step defined in CV #10. CV #113 together with CV's #58 and #10 form a 3-point BEMF curve. = 0: actual cutoff at speed step in CV #10. Usually CV #10 is also set to 0.
#147 #148 #149 #150	**Experimental CV's** for test purposes, to find out whether certain automatic settings have a negative effect on motor regulation. Using these experimental CV's will deactivate the automatic settings. CV's #147 – 149 will likely be removed again from the decoder SW at some time.		0 0 0 0	--- CV #147 Sampling time --- Useful initial value: 20; Too small a value leads to jerky behavior. Too large a value leads to poor low speed control. 0 = automatic control (CV #147 has no effect) --- CV #148 D-Value --- Useful initial value: 20; Too small a value leads to poor regulation (regulates too little, too slow, engine jerks (rather slowly). Too large a value leads to over compensation, the engine runs rough/vibrates. 0 = automatic control (CV #148 has no effect) --- CV #149 P-Value --- 0 = automatic control (CV #149 has no effect) 1 = P-Value is fixed as per CV #56 (tens digit) --- CV #150 Load compensation at top speed --- Load compensation at top speed is normally always 0. This can be changed with CV #150. Example: CV #58 = 200, CV #10 = 100, CV #113 = 80 und CV #150 = 40 --> Result: Regulation at speed step 1 is 200 (of 255, almost 100%), at speed step 100 it is 80 (@1/3rd of 255), at speed step 252 (full speed) it is 200 (of 255, almost fully regulated). **We kindly ask for your cooperation. Please send us your test results!**

The Motor Brake

This brake is useful for vehicles without worm gears to prevent them from rolling away on inclines, picking up speed on declines as well as to prevent a heavy train from pushing a standing engine downhill.

CV	Designation	Range	Default	Description
#151	**Motor Brake**	0 - 9	0	= 0: Brake not active = 1 … 9: The motor brake is gradually actuated (over a period of 1, 2 … 8 seconds, up to full braking power by shorting both motor end stages) if the target speed is not held (not slowing down), even though the motor is no longer energized. The higher the value, the faster and harder the brake is being applied.

5.7 Acceleration and Deceleration:

The basic acceleration and deceleration times (momentum) are set with

CV's #3 and #4

according to the relevant NMRA standard, which demands a linear progression (the time between speed step changes remains constant over the whole speed range).

For simple smooth drivability use values 3 or higher but for really slow starts and stops start with a value of 5. Values over 30 are rarely practical!

☞ A sound project in sound decoders always comes with different values in CV's #3 and #4 (as well as many other CV's) than what is listed in the CV charts. Often the sound can only be played back correctly in conjunction with the acceleration times provided by the sound project (or certain minimum values), so the sound project's default values should therefore not be changed too much.

Acceleration and deceleration behavior, especially starting and stopping, can be further improved by the "exponential" and "adaptive" acceleration/deceleration features (CV's #121, 122 and 123).

To eliminate a start-up jolt after changing the direction, caused by gear backlash in gearboxes, use CV #146:
Some free play between gears of a drivetrain is essential to prevent them from binding. This creates backlash and may be more severe on some engines than on others, especially when fitted with a worm gear or an excessively worn gearbox.
Excessive backlash leads to a peculiar behavior especially after changing the direction: When the motor starts turning in the opposite direction it doesn't move the engine right away because it has to eliminate the backlash first. And to make matters worse, the motor starts to accelerate already during this phase. When the engine finally starts moving, the motor's speed has exceeded the normal start-up rpm, which results in an unpleasant jolt. This can be avoided with the help of CV #146.

CV	Designation	Range	Default	Description
#3	**Acceleration Rate**	0 - 255	(2)	The value multiplied by 0.9 equals' acceleration time in seconds from stop to full speed.
				The effective default value for sound decoders is usually not the value given here, but is determined by the loaded sound project.
#4	**Deceleration Rate**	0 - 255	(1)	The value multiplied by 0.9 equals' deceleration time in seconds from full speed to a complete stop. The effective default value for sound decoders is usually not the value given here, but is determined by the loaded sound project.
#23	**Acceleration Trimming**	0 - 255	0	To temporarily adapt the acceleration rate to a new load or when used in a consist. Bit 0 - 6: entered value increases or decreases acceleration time in CV #3. Bit 7 = 0: adds above value to CV #3. = 1: subtracts above value from CV #3.
#24	**Deceleration Trimming**	0 - 255	0	To temporarily adapt the deceleration rate to a new load or when used in a consist. Bit 0 - 6: entered value increases or decreases deceleration time in CV #4. Bit 7 = 0: adds above value to CV #4. = 1: subtracts above value from CV #4.
#121	**Exponential Acceleration**	0 - 99	0	Acceleration time (momentum) can be stretched in the lower speed range: Tens digit: Percentage of speed range to be included (0 to 90%). Ones digit: Exponential curve (0 to 9). EXAMPLE: CV #121 = 11, 23 or 25 are typical initial test values.
#122	**Exponential Deceleration**	0 - 99	0	Deceleration time (momentum) can be stretched in the lower speed range: Tens digit: Percentage of speed range to be included (0 to 90%). Ones digit: Exponential curve (0 to 9). EXAMPLE: CV #122 = 11, 23 or 25 are typical initial test values.
#123	**Adaptive Acceleration and Deceleration**	0 - 99	0	Raising or lowering the speed to the next internal step occurs only if the preceding step is nearly reached. The tolerance for reaching the preceding step can be defined by this CV (the smaller this value the smoother the acceleration/deceleration) Value = 0: no adaptive acceleration or deceleration Tens digit: 0 - 9 for acceleration Ones digit: 0 - 9 for deceleration = 11: strongest effect; sometimes makes the start impossible (engine won't move)
#394	**Bit 4: Quicker acceleration** From SW-Version 33.25	0 - 255	-	Bit 0 = 1: Light flashes at switch gear sound. Bit 4 = 1: Quicker acceleration with sound playing back "heavy load when speed regulator is moved rapidly to full speed. Bit 5 = 1: Overlapping of chuff beats

CV	Designation	Range	Default	Description
#309	**Brake key** From SW-Version 33.25	0 - 28	0	The key defined here starts a braking the engine according to the brake time defined in CV #349 (the normal – higher – deceleration time in CV #4 is being ignored.
#349	**Deceleration time for brake key** From SW-Version 33.25	0 - 255	0	For the desired effect to work, the normal deceleration time in CV #4 must be set to a very high value (i.e. 50…250) and the deceleration time in CV #349 to a rather low value (i.e. 5…20). Moving the speed regulator to 0 with these settings simulates a coasting effect while pressing the brake key brings to engine to a rapid stop.
#146	**Compensation for gear backlash** during direction changes in order to reduce start-up jolts	0 - 255	0	= 1 to 255: the motor spins at minimum rpm (according to CV #2) for a specific time and only starts to accelerate after this time has elapsed. This CV will only be executed after a direction change. How much time is required to overcome the backlash depends on various circumstances and can only be determined by trial and error. Typical values are: = 100: the motor turns about 1 revolution or a maximum of 1 second at the minimum speed. = 50: about ½ a turn or max. ½ second. = 200: about 2 turns or max. 2 seconds. Important: The minimum speed must be set correctly, so that the motor actually turns at the speed step defined as the lowest step in CV #2. Also, CV #146 is only useful if the load regulation is set to maximum or at least close to it (i.e. CV #58 = 200 – 255).

Note: The actual **acceleration and deceleration** rates for HLU brake sections (ZIMO signal controlled speed influence) are also determined by CV #49 and #50.

Momentum – explained in more detail:

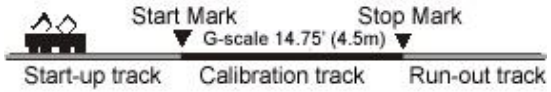
The momentum (acceleration and deceleration rates) according to CV #3 and #4 refers to the 255 internal steps which are spaced equally from 0 to full speed. The selected speed table, whether 3-step or 28-step, does not influence the momentum behavior.

The momentum CANNOT be changed by bending the speed curve in the speed tables, but is very much possible with the "exponential acceleration/deceleration" in CV #121 and #122.

5.8 *Special Operating Mode "km/h – speed regulation"*

The km/h (Kilometer per hour) speed regulation is an alternative method of driving with prototypical speeds in all operating situations: the cab's speed steps (1 to 126 in the so-called "128 speed step mode") will be directly interpreted as km/h.
However, ZIMO decoders do not simply convert the speed steps to a km/h scale but rather ensure that the desired speed is held, by recalculating the already traveled distance and automatically make the necessary adjustments.

A CALIBRATION RUN must be performed with each engine:
First, we need to determine the calibration distance: a section of track that measures 100 scale meters (plus the necessary acceleration and deceleration distances before and after), of course without inclines, tight radii and other obstacles; for example, for HO (1:87) 115cm; for G-scale (1:22.5) 4.5m. Mark the start and end points of the calibration section.



Step 1. Set the engine on the track, with the proper travel direction selected, about 1 to 2 meters (3 – 6 ft) before the start marker and the function F0 (headlights) **turned off.** Acceleration times (in CV #3 of the decoder as well as settings in the cab) should be set to 0 or a very small value.
Step 2. Start the calibration mode by programming **CV #135 = 1** (operations mode programming). This is a pseudo-programming because the value of 1 does not replace the value already stored in CV #135.
Step 3. Set the speed regulator to a **medium speed** position (1/3 to ½ of full speed); the loco accelerates towards the start marker.
Step 4. As the engine passes the **start marker, turn on** the function **F0** (headlights); **turn F0 off** again when passing by the **end marker.** This ends the calibration run and the loco may be stopped.
Step 5. CV #136 can now be read out for checking purposes. The calibration "result" stored in that CV doesn't mean very much by itself. If however, several calibration runs are performed, the value in CV #136 should approximately be the same every time, even if the traveling speed was different.

Km/h Speed Regulation in Operation:

CV # 135 controls the selection between "normal" or km/h operation:

CV # 135 = 0: The engine is controlled in "normal" mode; a possible km/h calibration run performed earlier has no effect but the calibration results remain stored in CV #136.

CV #135 = 10, 20 or 5: each external speed step (1 to 126) becomes 1 km/h, 2 km/h or 0.5 km/h: see CV table below!

The speed regulation in km/h is not just useful for direct throttle control, but also for speed limits through the "signal controlled speed influence" (CV's 51 – 55). The values entered to those CV's are also being interpreted in km/h.

CV	Designation	Range	Default	Description
#135	**km/h – speed regulation** activating, control and range definition	2 - 20	0	= 0: km/h – regulation turned off; the "normal" speed regulation is in effect. "Pseudo-Programming" („Pseudo" = programmed value is not being stored): CV #135 = 1 → Initiates a calibration run (see above) Continue with "normal" programming of CV #135 (programmed value will be stored): = 10: each step (1 to 126) represents 1 km/h: that is step 1 = 1 km/h, step 2 = 2 km/h, step 3 = 3 km/h… = 20: each step represents 2 km/h;

				step 1 = 2 km/h, step 2 = 4 km/h, last step 126 = 253 km/h. = 5: each step represents .5 km/h; step 1 = .5 km/h, step 2 = 1 km/h, last step 126 = 63 km/h.
#136	**Km/h – Speed regulation** - Control number read-out or speed setting confir-mation	Calibration run or RailCOm read-out factor	Read value 128	A numeric value can be read-out after a successful calibration run, which was used to calculate the speed. It should remain unchanged (or vary only slightly) even after multiple calibration runs. or correction factor for speed confirmation via RailCom or other method of bidirectional communication.

Mph (miles per hour) instead of km/h:
Extending the calibration distance accordingly results in a mph speed regulation!

5.9 The ZIMO "signal controlled speed influence" (HLU)

ZIMO digital systems offer a second level of communication for transmitting data to vehicles in specific track sections. The most common application for this is the "signal controlled speed influence" for stopping trains and applying speed limits in 5 stages, with data sent to the track sections as needed in the form of HLU cut-outs prepared by MX9 track section modules or its successors. This feature only operates within ZIMO systems.

If the "signal controlled speed influence" is being used (only possible within a ZIMO system), the speed limits "U" and "L" (and the intermediate steps if needed) can be set with configuration variables CV's #51 to #55 as well as acceleration and deceleration values (momentum) with CV #49 and #50.

Please note that the signal controlled acceleration and deceleration times in CV #49 and #50 are always **added** to the times and curves programmed to CV #3, 4, 121, 122 etc. Signal controlled accelerations and decelerations compared to cab controlled momentum can therefore only progress either at the same rate (if CV #49 and #50 is not used) or slower (if CV #49 and/or #50 contain a value of >0), but never faster.

In order to have a properly functioning train control system using the signal controlled speed influence, it is important that all tracks are laid out correctly, especially the stopping and pre-braking/deceleration sections of the track. Please consult the MX9 instruction manual.

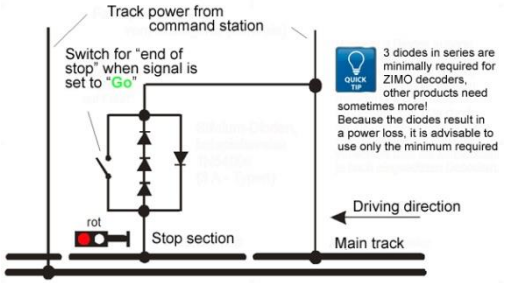
It is of utmost importance for a flawlessly working train control system using the signal controlled speed influence that the stop and related brake section lengths are arranged properly and consistently everywhere on the layout. Please consult the MX9 instruction manual.

The deceleration (often CV #52 for "U" limit) and brake (CV #4 and #50) characteristics should be set so that all locos come to a complete stop within about 2/3 of the stop section, which in large-scale is typically 2' - 2 ½' before the end of a stop section. Setting the loco up to stop precisely within the last inch of a stop section is not recommended.

CV	Designation	Range	Default	Description
#49	**Signal controlled (HLU) acceleration**	0 - 255	0	Entered value multiplied by .4 equals acceleration time in seconds from stop to full speed when: "ZIMO signal controlled speed influence" with ZIMO MX9 track section module or successor or "asymmetrical DCC signal" method (Lenz ABC) is employed
#50	**Signal controlled (HLU) deceleration**	0 - 255	0	Entered value multiplied by .4 equals deceleration time in seconds from full speed to complete stop when: "ZIMO signal controlled speed influence" with ZIMO MX9 track section module or successor or "asymmetrical DCC signal" method (Lenz ABC) is employed
#51 #52 #53 #54 #55	**Signal dependent (HLU) speed limits** #52 for "U", #54 for "L", #51, 53, 55 for intermediate steps	0 - 255	20 40 (U) 70 110 (L) 180	ZIMO "signal controlled speed influence" method (HLU) using MX9 or successor: Defines the internal speed steps for each of the 5 speed limits generated via HLU.
#59	**Signal dependent reaction time**	0 - 255	5	ZIMO signal controlled speed influence (HLU) with ZIMO MX9 track section module or future module or when using the "asymmetrical DCC signal" stopping method (Lenz ABC): Time in tenth of a second until the locomotive starts to accelerate after receiving a higher signal controlled speed limit command.

5.10 "Asymmetrical DCC-Signal" stops (Lenz ABC)

The "asymmetrical DCC signal" is an alternative method for stopping trains at a "red" signal. A simple circuit made up of 4 or 5 commercially available diodes is all that is required.



Usually **3 - 5 diodes in series plus one Schottky diode in parallel in opposite direction is connected** to the stop section. The different voltage drops across the diodes results in an asymmetry of about 1 to 2V. The direction in which the diodes are mounted determines the polarity of the asymmetry and with it the driving direction a signal stop is initiated.

The asymmetrical DCC signal stop mode needs to be activated in the de-

coder with CV #27. Normally Bit 0 is set, that is CV #27 = 1, which results in the same directional control as the “Gold” decoder from Lenz.

The asymmetrical threshold (0.4V by default) can be modified with CV #134 if necessary (i.e. if the DCC signal of a given command station is already offset to begin with). At the time of this writing, the “asymmetrical DCC signal” has not been standardized and many DCC systems pay no attention to this feature.

NOTE: ZIMO decoders do not support the usual ABC slow speed step as used by Lenz (with Lenz-Module BM2 for instance).

CV	Designation	Range	Default	Description
#27	**Position dependent stops** with asymmetrical DCC signal (Lenz “ABC” method)	0, 1, 2, 3	0	Bit 0 = 1: Stops are initiated if voltage in right rail is higher than left rail (in direction of travel). This setting, CV #27 = 1, IS THE COMMON APPLICTION for this feature (provided the decoder is wired to the rail correctly). Bit 1 = 1: Stops are initiated if voltage in left rail is higher than right rail (in direction of travel). Stopping is directional if only one of the two bits is set (not both). Traveling in the opposite direction will have no effect. Use the other bit In case the train stops in the wrong direction! Bit 0 and Bit 1 = 1 (CV #27 = 3): Stops in both directions, regardless of rail polarity.
#134	**Asymmetrical threshold** for stopping with asymmetrical DCC signal (Lenz ABC method)	1 - 14, 101 - 114, 201 - 214 = 0,1 - 1,4 V	106	Hundredths digit: Sensitivity adjustment, changes the speed with which the asymmetry is being recognized. = 0: fast recognition (but higher risk of errors, i.e. unreliable stopping). = 1: normal recognition (approx. 0.5 sec), fairly reliable (default). = 2: slow recognition (approx. 1 sec), very reliable Tens and ones digit: Asymmetrical threshold in tenths of a volt. The voltage difference between the two half waves of the DCC signal defines the minimum required to be recognized as asymmetrical that starts the intended effect (usually braking and stopping of a train). = 106 (Default) therefore means 0.6 V. This value has proven itself to be appropriate under normal conditions; by using 4 diodes to generate the asymmetry.
#142	High-speed correction for the ABC asymmetrical stop method	0 - 255	12	A delayed recognition (see CV #134), but also unreliable electrical contact between rails and wheels, have a larger effect on a stop point at higher speeds than at lower speeds. This effect is corrected with CV #142. = 12: Default. This setting usually works fine if CV #134 is also set to default.

5.11 DC Brake Sections (Märklin brake mode)

These are the “classic” methods of automated layout control or stopping at a “red” signal. The required settings for ZIMO decoders are spread over several CV’s.

CV	Designation	Range	Default	Description
#29, #124, #112	Single Bits in each of these CV’s are responsible for the correct reaction to the **DC and Märklin** brake sections.	-	-	When using track-polarity dependent **DC brake sections** set CV #29, Bit 2 = “0” and CV 124, Bit 5 = “1”! For polarity independent DC braking (**Märklin brake sections**) set CV #29, Bit 2 = “0” and CV 124, Bit 5 = “1” and additionally CV #112, Bit 6 = “1”!

5.12 Distance Controlled Stopping - Constant Stopping Distance

After the type of constant stopping method has been selected with CV #140 (= 1, 2, 3, 11, 12, 13), the stopping distance will be kept as close as possible to the one defined in

CV #141,

independent of the speed at the start of the braking procedure.

This method is especially suitable in connection with automated stops in front of a red signal (CV #140 = 1 or 11) with the help of the **ZIMO HLU** signal controlled speed influence or the **Lenz ABC** asymmetrical DCC-signal (see above).

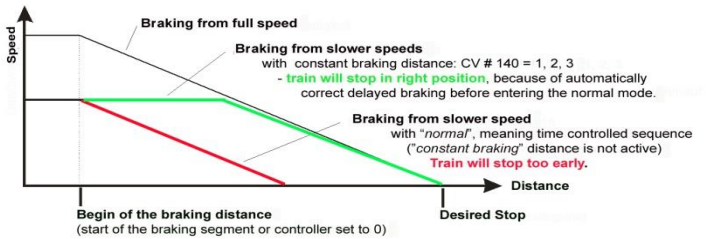
Although of lesser practical value, distance controlled stopping for **manual driving** can also be activated (by programming CV #140 with appropriate values of 2, 3, 12, or 13), which is executed whenever the speed is set to 0 (by the cab, throttle, computer...).

CV	Designation	Range	Default	Description
#140	**Distance controlled stopping** (constant stopping distance) **Select a braking method and braking process**	0 - 255	0	Activates distance controlled stopping as per CV #141 instead of time-constant braking according to CV #4. = 1: automatic stops with ZIMO HLU (signal controlled speed influence) or ABC (asymmetrical DCC signal). = 2: manual stops using the cab. = 3: automatic and manual stops. The start of braking is delayed in all cases above (= 1, 2 or 3) when the train travels at less than full speed, to prevent unnecessary long “creeping” (recommended). On the other hand: = 11, 12, 13 same meaning as above, but braking always starts immediately after entering the brake

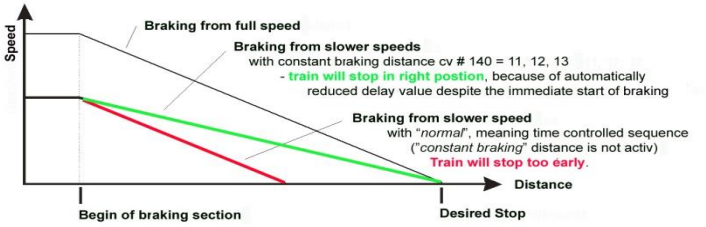
				section.
#141	**Distance controlled stopping** (constant stopping distance) **Setting the distance**	0 - 255	0	This CV defines the "constant stopping" distance. The right value for the existing stop sections has to be determined by trial. Use these figures as a starting point: CV #141 = 255 is about 500m (500 yards) for a real train or 6m (18 ft) in HO. CV #141=50 about 100 m (100 yards) for a real train or 1.2m in H0 (4 ft.). Use the appropriate scale factor for other scales.
#142	**High-speed compensation** using the ABC method	0 - 255	12	A delayed recognition (see CV #134), but also unreliable electrical contact between rails and wheels, have a larger effect on a stop point at higher speeds than at lower speeds. This effect is corrected with CV #142. = 12: Default. This setting usually works fine if CV #134 is also set to default.
#143	**… compensation using the HLU method**	0 - 255	0	The HLU method is more reliable than the ABC method; no recognition delay is usually required in CV #134; this CV can remain at default value 0.

The distance controlled stopping can take place in two possible ways; see diagram below: **The first** is the **recommended method (CV #140 = 1, 2 ,3),** where a train entering at less than full speed continues at the same speed for some time before it starts braking at a "normal" deceleration rate (same rate as would be applied at full speed).

In the second method (CV #140 = 11, 12, 13), the train immediately starts braking when entering the stop section, even when entering at a lower speed, which may lead to an unprototypical behavior. It may however be useful to use this method if used together with decoders from other manufacturers that do not have the capability mentioned above, in order to harmonize the brake sequences.
The second method may also be the preferred method if distance controlled stopping is used manually (CV #140 = 2 or 12), so that the train reacts immediately to speed changes from the throttle.



First method for a constant stopping distance



Second method for a constant stopping distance

"Distance controlled stopping", when activated, is **exclusively** applied **to decelerations leading to a full stop,** but not to speed reductions without stopping (these are still handled by CV #4). Neither is there any influence to acceleration events.

The traveled distance is constantly being recalculated in order to get as close as possible to the desired stop point. The deceleration rate within distance controlled stopping is always applied exponentially, that is the deceleration rate is high in the top speed range followed by gentle braking until the train comes to a full stop; which in this case is *not* governed by CV #122! The application of CV #121 for exponential acceleration however remains unchanged.

5.13 Shunting, Half-Speed and MAN Functions

On the one hand, defining the different Configuration Variables (#3, 4, 121, 122 and 123) offers prototypical acceleration and deceleration behavior, but is on the other hand often obstructive for quick and easy shunting.

This is why the momentum can temporarily be reduced or eliminated altogether with a function key of your choice. Also, during shunting maneuvers it is sometimes helpful to cut the speed range of the throttle in half.

For historical reasons, the assignments of these "shunting-key functions" are summarized in CV #124, which is associated with restrictions and also relatively confusing.

From today's perspective, CV's #155, #156 and #157 are the preferred CV's for these settings, where function keys can be selected in a systematic and unlimited manner for each of the shunting and MAN functions. However, Bits 0 and 1 in CV #124 still need to be set for the desired momentum deactivation effect, even if the relevant keys are defined with CV's #155 - 157.

CV	*Designation*	*Range*	*Default*	*Description*
#124	**Shunting key functions**: Low gear and Momentum reduction or deactivation NOTE: Further selection for shunting keys in CV's #155, 156	Bits 0 - 4, 6	0	Select a function key for LOW GEAR ACTIVATION: Bit 4 = 1 (and Bit 3 = 0): F3 as half-speed key Bit 3 = 1 (and Bit 4 = 0): F7 as half-speed key Select a function key for MOMENTUM DEACTIVATION: Bit 2 = 0 (and Bit 6 = 0): "MN" key for deactivation, Bit 2 = 1 (and Bit 6 = 0): F4 key for deactivation Bit 6 = 1 (Bit 2 is irrelevant): F3 for deactivation. Effect of above key (MN, F3 or F4) on MOMENTUM: Bit 1, 0 = 00: no effect on momentum = 01: removes momentum of CV #121 + #122 = 10: CV #3 + #4 reduced to ¼. = 11: removes all momentum above. EXAMPLES: F3 for half speed-key: CV #124 = 16. F3 for half speed-key and F4 to remove momentum completely: Bits 0, 1, 2 & 4 = 1; that is CV #124 =23. F3 for half-speed key and removing momentum:

	Bit 5 DC stopping			Bits 0, 1, 4 &6 = 1; that is CV #124 = 83. **Bit 5 = 1:** "DC stopping"
#155	**Half-speed key selection**	0 - 28	0	Expanding on the settings of CV #124; if another key is required than F3 or F7: CV #155: Defines a function key for half-speed activation (= top speed cut in half). If a key is assigned through CV #155, a possible assignment through CV #124 is void. CV #155 = 0 doesn't mean that the F0 key is assigned but rather that the setting in CV #124 is active.
#156	**Momentum-deactivation key selection**	0 - 28	0	Expanding on the settings of CV #124; if another key than F3, F4 or MAN is required for momentum deactivation: CV #156: Defines the function key that deactivates or reduces the acceleration and deceleration times in CV's #3, 4, 121 and 122. Whether the momentum is deactivated or reduced and by how much is still defined in CV #124: CV #124, Bit 1, 0: = 00: no effect on momentum = 01: removes momentum of CV #121 + #122 = 10: CV #3 + #4 reduced to ¼. = 11: removes all momentum. In order to deactivate all momentum, CV #124 is typically set to a value of 3 (the value may be different if other Bits in CV #124 are also set). A possible key assignment for momentum deactivation in CV #124 remains inactive if CV #156 > 0.
#157	**Selects a function key for the MAN function** Only needed for non-ZIMO cabs that don't have the MN key.	0 - 28	0	The MAN function (or MAN key on ZIMO cabs) was originally designed for ZIMO applications only, in order to cancel stop and speed limit commands applied by the signal controlled speed influence system (HLU). This function was expanded in later software versions to include "asymmetrical DCC signal stops" (Lenz ABC). If ZIMO decoders are used with non-ZIMO systems, a function key can now be assigned with CV #157 to cancel a signal controlled speed limit or stop command.

5.14 The NMRA-DCC function mapping

ZIMO large-scale decoders have 8 or 14 function outputs (FO). The loads connected to these outputs (head lights, smoke generators, etc.) are turned on or off using the function keys on the cab (throttle). Which function key controls which function output can be specified with the NMRA function mapping

CV's #33 to #46

Unfortunately, this function mapping also has its limitations (only one 8-Bit register is available for each function, which leaves only 8 outputs to select from) and the headlight is the only function that can switch with direction.

Function key	Numerical Key on ZIMO throttle	CV	Additional Function Outputs for Models MX695KV, MX695LV						Function Outputs of all MX695 Models							
			FO12	FO11	FO10	FO9	FO8	FO7	FO6	FO5	FO4	FO3	FO2	FO1	rear light	front light
F0	1 (L) forward	# 33							7	6	5	4	3	2	1	0●
F0	1 (L) reverse	# 34							7	6	5	4	3	2	1●	0
F1	2	# 35							7	6	5	4	3	2●	1	0
F2	3	# 36							7	6	5	4	3●	2	1	0
F3	4	# 37				7	6	5	4	3	2	1●	0			
F4	5	# 38				7	6	5	4	3	2●	1	0			
F5	6	# 39				7	6	5	4	3●	2	1	0			
F6	7	# 40				7	6	5	4●	3	2	1	0			
F7	8	# 41	7	6	5	4	3	2●	1	0						
F8	9	# 42	7	6	5	4	3●	2	1	0						
F9	0	# 43	7	6	5	4●	3	2	1	0						
F10	↑1	# 44	7	6	5●	4	3	2	1	0						
F11	↑2	# 45	7	6●	5	4	3	2	1	0						
F12	↑3	# 46	7●	6	5	4	3	2	1	0						

The black dots in the table above indicate the default settings at the time of delivery, where each function key corresponds to the same numbered function output. Therefore the following values were written to the configuration variables:

CV # 33 = 1
CV # 34 = 2
CV # 35 = 4
CV # 36 = 8
CV # 37 = 2
CV # 38 = 4
CV # 39 = 8
CV # 40 = 16
CV # 41 = 4
etc.

EXAMPLE of a function mapping modification: The F2 key (ZIMO #3 key) should switch in addition to output FO2 also output FO4. Moreover, F3 and F4 should NOT switch FO3 and FO4 but rather FO7 and FO8 (this could be couplers, for example). New values are to be entered into the relevant configuration variables as follows:

CV # 36=40
CV # 37 = 32
CV # 38 = 64

F2	3	# 36						7	6	5●	4	3●	2	1	0
F3	4	# 37			7	6	5●	4	3	2	1	0			
F4	5	# 38			7	6●	5	4	3	2	1	0			

5.15 The modified NMRA Function mapping

Since the original NMRA function mapping does not allow for some desirable configurations, an extension is offered by ZIMO decoders, which is described on the following pages. Most of these options are related to the special ZIMO

CV #61

Note: Some of the CV #61 variations (1, 2, 3…) have been replaced over the years by other more practical applications.

Programming

CV #61 = 97 *offers an* ***Alternative "function mapping" without left shifts:***

CV #61 = 97 abolishes the left shift of higher CV's (#37 and up, according to the original NMRA function mapping), which allows higher function keys to be mapped with lower function outputs (i.e. Function output 1 (FO1) cannot be mapped with function key F4 using the NMRA function mapping, but is possible with the ZIMO extended mapping).

				FO6	FO5	FO4	FO3	FO2	FO1	Rear Light	Front Light
F0	1 (L) for	# 33		7	6	5	4	3	2	1	0 ●
F0	1 (L) rev	# 34		7	6	5	4	3	2	1●	0
F1	2	# 35		7	6	5	4	3	2●	1	0
F2	3	# 36		7	6	5	4	3 ●	2	1	0
F3	4	# 37		7	6	5	4 ●	3	2	1	0
F4	5	# 38		7	6	5 ●	4	3	2	1	0
F5	6	# 39		7	6 ●	5	4	3	2	1	0
F6	7	# 40		7 ●	6	5	4	3	2	1	0
F7	8	# 41		7	6	5	4	3	2	1	0
F8	9	# 42		7	6	5	4	3	2	1	0

NOTE: The earlier options CV #61 = 1, 2, 11…15 as well as CV #61 = 98 were discontinued with SW-Version 34 and replaced with the "Swiss Mapping" (see next chapter).

Tip: Directions dependent taillights with special effect CV's:

With the NMRA function mapping it is only possible to have function F0 directional and was intended for the headlights, so they automatically switch between "front" and "rear" when changing direction. All other functions are controlled independent of direction.

The special effect CV's #125 … 132, #259 and #160 (see chapter "Special function output effects"), each assigned to a function output (up to FO8), make it possible to have more direction dependent functions. To utilize the directional capabilities of these CV's use only the directional Bits (0 or 1) without the actual effect Bits.

Example 1: A couple of **red taillights** are connected to function outputs FO1 and FO2 (front and rear of engine). Both are to be actuated with F1 but should also change with direction. This requires the following CV settings:

CV #35 = 12 (Bit 2 for FO1 and Bit 3 for FO2), as well as
CV #127 = 1 (for FO1) and CV #128 = 2 (for FO2).

Therefore FO1 is only activated in forward direction and FO2 only in reverse, and only if the function is turned ON with the function key F1.

Example 2: Contrary to example 1 where the red taillights were switched independent from the white headlights, in this example the headlights and taillights are switched ON/OFF together at the proper end of the locomotive with F0 or F1 (depending on which end the loco is coupled to the train).

This can be done as follows:
Connect: White front headlights connected to function output "front headlights"
Red front taillights to function output FO2
White rear headlights to function output FO1
Red rear taillights to function output "rear headlights" (!).

CV #33 = 1 and CV #34 = 8 front white headlights on F0forw and front red taillights on F0rev!
CV #35 = 6 (both white headlights as well as red taillights in the rear on F1!)

CV #126 = 1 / CV #127 = 2 (Direction dependence for rear white and red lights by means of "Special Effects" CV).

5.16 "Unilateral Light Suppression"

This new feature (since SW version 30.7, expanded in 33.18), asked for by many users, makes it possible to switch off all lighting on one side of a locomotive with the push of one function key (usually on the "train side", i.e. where cars are coupled to the locomotive).

CV	Designation	Range	Default	Description
#107	Light suppression (i.e. front headlights AND additionally defined function output) at cab side 1 (front)	0 - 255	0	The value of this CV is calculated as follows: The number of a function output (FO1…FO28) **x** 32 **+** number of a function key (F1, F2…F28) **=** Value of CV #107 Function Key: The key (F1…F28) which should turn off ALL lights on the cab side 1 (front side) AND Function Output: i.e. taillights on the same side.
#108	Cab side 2 (rear)	0 - 255	0	Same as CV #107 but for other locomotive side.
#109	Additional FU-output, cab side 1	1 - 6	0	Fu-output turns off together with CV #107.
#110	Additional FU-output, cab side 2	1 - 6	0	Fu-output turns off together with CV #108.

5.17 The “Swiss Mapping” *(from SW version 32)*

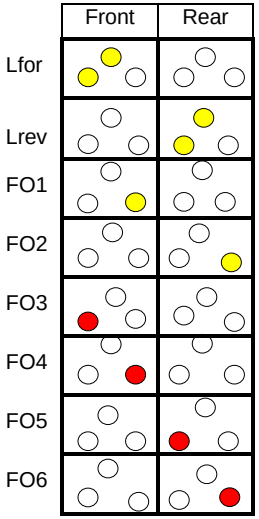
The “Swiss mapping” is a function mapping that allows the **loco lighting** to be operated as is required by Swiss locomotives, which is of course also useful for locos of other countries.

The purpose of the "Swiss mapping" is to switch the various states of the locomotive lighting with different function keys, i.e. for situations like driving a single locomotive, cars coupled on driver’s cab 1, or at the driver's cab 2, push-pull, shunting, etc.

Using this relatively complex method is of course only worthwhile if the vehicle is equipped with many independently connected lights (or LED’s) and the decoder offers as many function outputs, at least 6. ZIMO decoders offer indeed between 6 and 10 function outputs (with the exception of a few miniature decoders), large-scale decoders even more.

The desired lighting states are defined by **a total of 13 CV groups**, each group **containing 6 CV’s** (= 78 CV’s; CV #430 - #507). The principle is simple in itself, in that the first CV of each group contains the number (1 to 28) for a function key F1...F28, and the other CVs define which function outputs are to be switched on when pressing this key, each dependent on the direction of travel.

CV	Designation	Range	Default	Description
#430	Swiss Mapping Group 1 “F-Key”	0 - 28, 29 (for F0)	0	The key defined here switches the function outputs listed under A1 (forward or reverse) or A2 (forward or reverse) ON or OFF. 1 – 28 for function keys F1 – F28, F29 is for F0.
#431	Swiss Mapping Group 1 “M-Key”. or Special high-beam setting (from SW version 34)	Bit 0 - 6: 0 - 28, 29 (for F0) and Bit 7 or 255	0	The “normal function mapping” for the “M-key” defined here will be deactivated (that is the relevant outputs such as the headlights for example) when the “F-key” is switched on. Bit 7 = 1: additionally, the outputs listed under A1 and A2 should only switch ON if the F and M key is ON. = 157: is an often used value for CV #431, because F0 (= 29) is usually selected as the “M-key” with Bit 7 = 1. F0 then acts as a general ON/OFF key. = 255 (Special **high-beam** setting!): the Fu-Outputs defined in the following four CVs are switched to full intensity, provided that they are controlled via the "normal function mapping", and dimmed with CV # 60; this function is used, for example, to switch the headlights of a Swiss locomotive to high-beam, without switching the white taillight to high-beam. Depending on CV #399 setting (see also below): Switches to high-beam only when speed is higher than value given in this CV (in 255 speed steps).
#432	Swiss Mapping Group 1 “A1” forward	1 - 12 14 (FO0f) 15 (FO0r)	0	Function output to be turned ON in forward direction under the conditions set out for the “F” and “M” keys.
#433	Swiss Mapping Group 1	1 - 12 14 (FO0f)	0	Additional function output to be switched ON in forward direction under the conditions set out for the “F”
	“A1” forward	15 (FO0r)		and “M” keys.
#434	Swiss Mapping Group 1 “A2” reverse	1 - 12 14 (FO0f) 15 (FO0r)	0	Function output to be turned ON in reverse direction under the conditions set out for the “F” and “M” keys..
#435	Swiss Mapping Group 1 “A2” reverse	1 - 12 14 (FO0f) 15 (FO0r)	0	Additional function output to be switched ON in reverse direction under the conditions set out for the “F” and “M” keys.
#436 - 441	. . . Group 2.	. . .	0	All 6 CV’s of Group 2 are defined the same way is the 6 CV’s in group 1.
#442 - 447	. . . Group 3	. . .	0	All 6 CV’s of Group 2 are defined the same way is the 6 CV’s in group 1.
#448 - 453	. . . Group 4	. . .	0	. . .
#454 - 459	. . . Group 5	. . .	0	. . .
#460 - 465	. . . Group 6	. . .	0	. . .
#466 - 471	. . . Group 7	. . .	0	. . .
#472 - 477	. . . Group 8	. . .	0	. . .
#478 - 483	. . . Group 9	. . .	0	. . .
#484 - 489	. . . Group 10	. . .	0	. . .
#490 - 495	. . . Group 11	. . .	0	. . . *(Groups 11, 12, 13 with SW version 34 or higher)*
#496 - 501	. . . Group 12	. . .	0	. . .
#502 - 507	. . . Group 13	. . .	0	. . .
#399	Speed dependent headlights (Rule 17)	0 - 255	0	In conjunction with the “Swiss Mapping’s” special setting “high-beam”, see CV #431 = 255; applies to each of the 13 CV groups (CV #437, 443..): High-beam only turns on when the speed exceeds the value in this CV; based on the decoder internal 255 speed steps. EXAMPLE: = 0: High-beam at any speed (incl. stand-still), controlled only by the F-key (i.e. as per CV #430). =1: High-beam only while driving (OFF at stand-still), provided the defined F-key is ON. = 128: Switches to high-beam when reaching medium speed.



The application of the "Swiss Mapping" is shown here with the ***example*** of an SBB Re422 engine.

◀ The function outputs together with the connected lights or groups of lights are shown here as they exist in a typical SBB (Swiss) electric locomotive.

The task of the "Swiss Mapping", with the help of the function keys

F0 (General ON/OFF), and

F15, F16, F17, F18, F19 and F20,

is to correctly switch the lighs in all possible operating conditions (of course in both directions).

This results in the table on the right, for which the Swiss Mapping CV's are configured as follows: ▶

#33 = 133	#34 = 42				
#430 = 15	#431 = 157	#432 = 14	#433 = 1	#434 = 15	#435 = 1
#436 = 15	#437 = 157	#438 = 2	#439 = 0	#440 = 2	#441 = 0
#442 = 16	#443 = 157	#444 = 14	#445 = 1	#446 = 2	#447 = 4
#448 = 17	#449 = 157	#450 = 5	#451 = 6	#452 = 15	#453 = 2
#454 = 18	#455 = 157	#456 = 6	#457 = 0	#458 = 4	#459 = 0
#460 = 19	#461 = 157	#462 = 2	#463 = 0	#464 = 1	#465 = 0
#466 = 20	#467 = 157	#468 = 0	#469 = 0	#470 = 0	#471 = 0

Explanation:

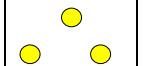
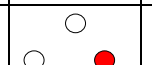
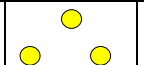
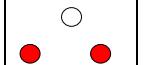
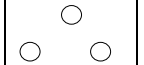
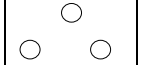
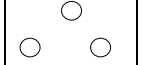
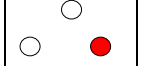
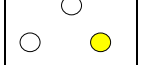
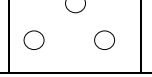
The normal NMRA function mapping in CV #33 and CV #34 (front and rear headlight) determines the lighting in case where F0 is ON and function keys F15 – F20 are OFF:
CV #33 = 133 (= Lfor, FO1, FO6) and CV #34 = 42 (= Lrev, FO2, FO4).

The following CV groups (1. Group: CV #430 – 435, 2. Group: CV #436 – 441 etc.), each group shown on one line, contain the "F-key" F15, F16, F17, F18, F19, F20 in the first CV of each row. Following that (in each group) are the CV's for the "M-key" and function outputs to be switched.

Note that there are two groups for F15 (CV #430… and #436…) because 3 function otuputs are switched simultanesouly but only 2 can be entered per group (A1,A2 for each direction); one group is sufficient for all other "F-Keys".

All "M-Keys" (the second CV in each group) are set to "157"; this means that "F0" **and** the condition (of Bit 7) must be met and results in the outputs listed only be turned ON if the F and M key is ON.

The third to sixth CV's in each group contain the numbers of the function outputs to be actuated (where the headlights are coded with "14" and "15", for all other outputs just use the digit in FO1, FO2…).

Functions, Keys	Outputs		Front	Rear
F0, forward (Cab 1 forward)	Lfor FO1 FO6	Locomotive only		
F0, reverse (Cab 2 forward)	Lrev FO2 FO4	Locomotive only		
F0 + F15, forward (Cab 1 forward)	Lfor FO1 FO2	Train, cars coupled at cab 2, standard train without pilot car.		
F0 + F15, reverse (Cab 2 forward)	Lrev FO1 FO2	Train, cars coupled at cab 1, standard train without pilot car.		
F0 + F16, forward (Cab 1 forward)	Lvor FO1	Train, cars coupled at cab 2, standard train with pilot car or first engine in a double header.		
F0 + F16, reverse (Cab 2 forward)	FO3 FO4	Loco pushing, cars coupled to cab 2, with pilot car or first engine in a double header. (prototypical since 2000)		
F0 + F17, reverse (Cab 1 forward)	Lrev FO2	Loco pulling, cars coupled to cab 1, train with pilot car or first eingine in a double header.		
F0 + F17, forward (Cab 1 forward)	FO5 FO6	Loco pushing, cars coupled to cab 1, with pilot car (prototypical since 2000).		
F0 + F18, forward, (Cab 1 forward)	FO6	Loco pushing, cars coupled to cab 1, with pilot car or last engine in a double header. (prototypical up to 2000)		
F0 + F18, reverse (Cab 2 forward)	FO4	Loco pushing, cars coupled to cab 2, with pilot car or last engine in a double header. (prototypical up to 2000)		
F0 + F19, forward (Cab 1 forward)	FO2	Loco pulling as last engine in consist, cars coupled to cab 2.		
F0 + F19, reverse (Cab 2 forward)	FO1	Loco pulling as last engine in consist, cars coupled to cab 1.		
F0 + F20, forward/reverse	---	Engins(s) inside a consist		

5.18 The ZIMO "Input-Mapping"

SW versions 34 and up, also for outputs via SUSI

The NMRA function mapping limitations (only 8 functions to select from per function key) can be overcome with the ZIMO "input mapping". In addition, the function keys (= **external functions)** can quickly be adapted to the wishes of the operator and that for both, function outputs and sound functions, without the need of changing **internally mapped functions** and especially without changes to the sound projects: *CV's #400 … 428*

CV	Designation	Range	Default	Description
#400	**Input-Mapping for internal F0** that is, which function key switches the internal function F0?	0, 1 - 28, 29 30 – 187. 254, 255	0	= 0: Key F0 (that is, F0 received from the DCC-packet) is forwarded to the internal (decoder) F0 (1:1). = 1: Key F1 forwarded to the internal F0. ….. = 28: Key F28 forwarded to the internal F0. = 29: Key F0 forwarded to the internal F0. = 30: Key F1 to F0, only in forward direction. ….. = 57: Key F28 to F0, only in forward direction. = 58: Key F0 to F0, only in forward direction. = 59: Taste F1 to F0, only in reverse direction. ….. = 86: Key F28 to F0, only in reverse direction. = 87: Key F0 to F0, only in reverse direction. = 101: Key F1-inverted to internal F0 ….. = 187: Key F0- inverted from int. F0, in reverse dir. = 254: Directions Bit to internal F0, in forward dir. = 255: Directions Bit to internal F0, in reverse dir.
#401 - #428	**Input-Mapping for internal F1 … F28**	0, 1 - 28, 29, 30 - 255	0	Same as input mapping above, but: CV #401 = 0: Key F1 to internal F1 = 1: Key F1 to internal F1 and so on.

5.19 Dimming, Low beam and Direction Bits

Some things connected to function outputs may not always be operated with full track voltage, as is the case for example with 18V bulbs and a track voltage of 24V (quite common on large scale model railroads). Other times you simply want to reduce the brightness of the headlights.

The best solution in such cases is to connect the positive side of such devices to the low voltage supply of the decoder (see chapter "Installation and wiring"). These outputs are fully stabilized so the voltage does not fluctuate with changes in track voltage.

Alternatively or in addition to this, the PWM voltage reduction is also available with

CV #60,

which defines the PWM duty cycle (Pulse With Modulation; the dimming is not only effective when a consumer is connected to the positive terminal with full track voltage, but also relative to a low-voltage function output). Of course, this kind of voltage reduction is also interesting because it is easy to change at any time by changing the value in CV #60.

☞ ATTENTION: Bulbs with voltage ratings as low as 12V can be dimmed with this PWM dimming function without damage even if track voltages are considerably higher; but **not** bulbs rated below that such as 5V or 1.2V bulbs. These must be connected to one of the decoder's low-voltage supply pins instead of a "normal" positive pin (see chapter "Installation and Wiring").

☞ LED's, on the other hand, always require a series resistor; if however, the resistor is designed to operate at 5 V, the PWM dimming is also sufficient at a track voltage of 25V (in this case the setting would be CV #60 = 50, so a reduction by one fifth, 1/5th).

CV #60 affects all function outputs but specific outputs can be excluded from the dimming function using the dim mask CV's (see table).

CV	Designation	Range	Default	Description
#60	**Reduced function output voltage (Dimming).** Affects all function outputs.	0 - 255	0	Reduction of effective voltage on the function outputs per PWM (pulse width modulation); Useful to dim headlights for instance EXAMPLE VALUES: CV # 60 = 0: (equivalent to 255) full voltage CV # 60 = 170 2/3 of brightness CV # 60 = 204: 80% brightness
#114	**Dim mask 1** = Excludes certain function outputs from dimming per CV # 60 For higher function outputs go to CV #152	Bits 0 - 7	0	Enter function outputs that are **not** to be **dimmed** as per CV #60. These outputs will receive the full voltage from the pin they are connected to that is, either full track voltage or low voltage from a low-voltage pin. Bit 0 - front headlight, Bit 1 - rear headlight, Bit 2 - function output FO1, Bit 3 - FO2, Bit 4 - function output FO3, Bit 5 - FO4 Bit 6 - function output FO5, Bit 7 - FO6 Respective Bit = 0: Output will be dimmed to the value defined in CV #60. Respective Bit = 1: Output will not be dimmed. EXAMPLE: CV #114 = 60: FO1, FO2, FO3 and FO4 will not be dimmed; front and rear headlights will be dimmed according to CV #60.
#152	**Dim Mask 2** (Excludes specific function outputs from dimming as per CV #60) Continuation of CV #114 and FO3, FO4 as direction bit mapping	Bits 0 - 5 and Bit 6, Bit 7	0 0	… Continuation of CV #114. Bit 0 - function output FO7, Bit 1 - function output FO8, Bit 2 - function output FO9, Bit 3 - function output FO10, Bit 4 - function output FO11, Bit 5 - function output FO12. Bit 6 = 0: „normal" = 1: Direction bit mapped to FO3 and FO4 that is, FO3 is switched on when driving in reverse and FO4 when driving forward (normal mapping for FO3 and FO4 is invalid when this Bit is set). Bit 7 = 1: "Direction bit" for FO9 active in Fwd direc.

Low/high beam with the help of the low beam mask

One of the function keys F6 (CV #119) or F7 (CV #120) can be defined as a low beam key. Selected function outputs can be dimmed as required with the function turned ON or OFF (inverted action with Bit 7).

CV	Designation	Range	Default	Description
#119	Low beam mask for F6 = Output assignment for (example) low/high beam headlights ATTENTION: Certain settings in CV #154 (Special output configurations) change the meaning of CV's #119 and #120 and therefore will no longer be a low-beam mask.	Bits 0 - 7	0	Selected outputs will dim, according to the dim value in CV #60, when the F6 key is actuated. Typical application: Low/high beam Bit 0 - front headlight, Bit 1 - rear headlight, Bit 2 - function output FO1, Bit 3 - function output FO2, Bit 4 - function output FO3, Bit 5 - function output FO4. Respective Bit = 0: Output will not be dimmed, Respective Bit = 1: Output will be dimmed with F6 to value defined in CV #60. Bit 7 = 0: normal action of F6. = 1: inverted action of F6. EXAMPLE: CV #119 = 131: Function key F6 toggles headlights between low and high beam.
#120	Low beam mask for F7	Bits 0 - 7		Same as CV #119 but with F7 as low beam key.

A "second dim value" with the help of the uncoupler CV

If more function outputs need to be dimmed than CV #60 allows or if some function outputs require a different voltage and the uncoupler function is not needed on the same vehicle then

CV #115

can be used for an alternative low voltage supply. The respective function outputs must be defined as "uncoupler output" in the corresponding CV's #125…#132, #159 and #160 (see "Special effects for function outputs).

CV	Designation	Range	Default	Description
#115	Uncoupler control or Second dim value	0 - 9	0	Only active if "uncoupler" function is selected (value 48) in CV #125 …132, 159 or 160: Tens digit = 0: when used for dimming applications Ones digit (0 to 9): PWM – voltage reduction (0 to 90%)
#127 - #132 #159 #160	Effects on FO1, FO2, FO3, FO4, FO5, FO6 on FO7, FO8		0 0	Value = 48 for dimming application #127 → FO1 #128 → FO2 #129 → FO3 #130 → FO4 #131 → FO5 #132 → FO6 #159 → FO7 #160 → FO8

NOTE: Dimming can also be achieved with the help of CV's #137, 138 & 139 (see chapter 3.23)

5.20 Flasher Effect

Flashing is actually a light effect just like all the others which are summarized in the CV's starting with #125; but for historical reasons, CV's #117 and #118 are used.

CV	Designation	Range	Default	Description
#117	Flasher functions Outputs are assigned in CV #118.	0 - 99	0	Duty cycle for flasher function: Tens digit = ON time / Ones digit = OFF time (0 = 100msec, 1 = 200msec…..9 = 1 sec) Example: CV #117 = 55: Flashes evenly at 1 a second interval.
#118	Flashing-Mask = Defines which outputs operate as flashers. Rhythm is defined in CV #117	Bits 0 - 7	0	Selected function outputs will flash when turned ON. Bit 0 - front headlights Bit 1 - rear headlights Bit 2 - function output FO1, Bit 3 - …FO2 Bit 4 - …FO3, Bit 5 - function output FO4. Respective Bit = 0: No flasher Respective Bit = 1: Output flashes when turned ON. Bit 6 = 1: FO2 flashes inverse! Bit 7 = 1: FO4 flashes inverse! (for alternate flashing, i.e. wig-wag) EXAMPLE: CV #118 = 12: FO1 and FO2 are defined as flashers. CV #118 = 168: Alternate flashing of FO2 and FO4, if both are switched on.

5.21 F1-Pulse Chains (Only for old LGB products)

CV	Designation	Range	Default	Description
#112	Special ZIMO configuration Bits	0 - 255	4 = 00000100 (i.e. Bits 4 and 7 = 0)	…. Bit 3 = 0: **12-Function mode** = 1: **8-Function mode** Bit 4 = 0: Pulse chain recognition OFF = 1: Pulse chain recognition ON (use with old LGB systems) … Bit 7 = 0: No pulse chain generation = 1: Generates pulse chain commands for LGB sound modules.

5.22 Special Effects for Function Outputs

(US and other light effects, smoke generator, uncouplers etc.)

Special effects can be assigned to a total of 10 function outputs with

CV's #125, #126, #127 … #132, #159, #160

for F0fr., F0rear. FO1 ..... FO6 , FO7 , FO8

The values that can be programmed into the effect CV's consist of

the 6-bit - effects code and the 2-bit - directions code

Bits 1,0 = 00: bidirectional (active in both directions)
= 01: active in forward direction only (+ 1)
= 10: active in reverse direction only (+ 2)

Bits 7 ... 2 =
- = 000000xx No effect, except for direction = **(0), 1, 2** (bidirectional, forward, reverse)
- = 000001xx Mars light + direction = **4, 5, 6** (bidirectional, forward, reverse)
- = 000010xx Random Flicker + direction = **8, 9, 10** (ditto, ditto, ditto)
- = 000011xx Flashing headlight + direction = **12, 13, 14**
- = 000100xx Single puls strobe + direction = **16, 17, 18**
- = 000101xx Double puls strobe + direction = **20, 21, 22**
- = 000110xx Rotary beacon simul + direction = **24, 25, 26**
- = 000111xx Gyralite + direction = **28, 29, 30**
- = 001000xx Ditch light type 1, right + direction = **32, 33, 34**
- = 001001xx Ditch light type 1, left + direction = **36, 37, 38**
- = 001010xx Ditch light type 2, right + direction = **40, 41, 42**
- = 001011xx Ditch light type 2, left. + direction = **44, 45, 46**
- = 001100xx Uncoupler as defined in CV #115, automatic disengagement in CV #116 = **48, 49, 50**
- = 001101xx "Soft start" = slow power-up of function output = **52, 53, 54**
- = 001110xx Automatic stoplights for street cars, stoplight-off delay, see CV #63. = **56, 57, 58**
- = 001111xx Function output turns itself off at speed >0 (i.e. turns off cab light when driving). = **60, 61, 62**
- = 010000xx Function output turns itself off after 5 minutes (i.e. to protect smoke generators form overheating). = **64, 65, 66**
- = 010001xx as above, but automatic shut-off occurs after 10 min. = **68, 69, 70**
- = 010010xx Speed or last dependent **smoke generation**. for **steam engines** as per CV's #137 - 139 (I.e. preheating during standstill, heavy smoke at high speed or under heavy load.) Smoke turns off as per CV #353; function key has to be pressed to reactivate smoke. = **72, 73, 75**
- = 010100xx Driving state-dependent **smoke generation** for **diesel engines** as per CV#137-139 (preheating during standstill, heavy smoke during motor start-up sound and during acceleration Synchronized control of fan connected to the fan output. Smoke turns off as per CV #353; function key has to be pressed to reactivate smoke. = **80, 81, 82**
- = 100010xx Slow fade in/out of a function output; useful for various lighting effects or motorized equipment (i.e. fan, snow blower). Dimming time is set with CV's #190 and 191. **= 88, 89, 90** (SW version 33.10 and up)

☞ The effect CV's are also suitable **without using a special effect** (with effect code 000000), for *direction dependent function outputs.*

EXAMPLE:

CV #127 = 1, CV #128 = 2, CV #35 = 12 (FO1, FO2 operate directional, ON/OFF with F1 key).

CV	Designation	Range	Default	Description
#125[1]	**Special effects** American lighting effects as well as others such as uncoupler, smoke generator and more on function output F0 (front headlight) Effects can be further adjusted and modified with CV's #62 - 64 and CV #115, #116 (for uncoupler).		0	Bits 1, 0 = 00: bidirectional (active in both directions) = 01: only active in forward direction = 10: only active in reverse direction ATTENTION in case of CV #125 and #126: change CV's #33, 34.... if direction is wrong! Bits 7, 6, 5, 4, 3, 2 = Effect-Code EXAMPLES You want : Program CV #125 to: Mars light forward only - 00000101 = 5 Gyralite independent of direction - 00011100 = 28 Ditch type 1 left, only forward - 00100101 = 37 **Uncoupler - 00110000 = 48** **Soft start of output - 00110100 = 52** **Automatic stop light - 00111000 = 56** Automatic cab light OFF - 00111100 = 60 Auto. smoke OFF after 5 min – 01000000 = 64 Auto. smoke OFF after 10 min – 01000100 = 68 Speed/load depen. smoke - 01001000 = 72 Speed/load depen. diesel smoke - 01010000 = 80
#126	Special effects for rear headlight (default F0 reverse)		0	See CV #125 for details. #125 → Front headlight #126 → Rear headlight
#127 - #132	Special effects for FO1, FO2, FO3, FO4, FO5, FO6		0	see CV #125 for details #127 → FA1 #128 → FA2 #129 → FA3 #130 → FA4 #131 → FA5 #132 → FA6
#159, #160	Special effects for FO7, FO8		0	see CV #125 for details #159 → FA7 #160 → FA8
#62	Effects modifications	0 - 9	0	Change of minimum dimming value
#63	Light effects modification or Stop light OFF delay	0 - 99 0 - 255	51	Tens digit: sets cycle time (0 - 9, default 5), or start-up time during "soft start" with 001101 (0 - 0,9s) Ones digit: extends OFF time For stop light OFF delay (001110xx in CV #125, 126 or 127): Time in tenths of a second the stop lights remain ON after the street car comes to a full stop (range: 0 – 25 sec.).
#64	Effects modifications	0 - 9	5	Ditch light off time modification
#64	Effects modifications	0 - 9	0	Bit 7 - 4: define a ditch light-key (function key+1)*16 consequent: 0=F2, 1=F0, 2=F1,.. 15=F14 Bit 3 - 0: Ditch light OFF time modification [s]~~Ditch light off time modification~~
#393	ZIMO-Config. 5	0 – 255	0	Bit 0 = 1: activate ditch light if bell is played

[1] Special tip for ditch lights: Those are only active if the headlights (F0) are turned on as well as function F2; this is equivalent to the American prototype. The "ditch lights" only function, if the Bits in CV # 33 and # 34 are configured (the definition in CV # 125 - 128 is not sufficient, but additionally required). Example: If ditch lights are defined for FA1 and FA2 , the Bits 2, 3 in CVs # 33, 34 must be on (e.g. CV # 33 = 00001101, CV # 34 = 00001110).

				Bit 1 = 1: activate ditch light if horn is played
#190	Fade-in time for 88, 89, 90 effect with SW version 33.10 or higher (Correction in regards to value 0 with version 34)	0 - 255	0	= 0: illegal value for SW version 33; later 0 sec. = 1: 1 sec fade-in time = (i.e.) 5: @ 4 sec = 255: @ 320 sec ATTENTION: Above values are valid for a "cycle time" 5 (i.e. CV #63 = 50 … 59). About 1/6 of the time with cycle time 0; double time with cycle time 9.
#191	Fade-out time for 88, 89, 90 effect with SW version 33.10 or higher (Correction in regards to value 0 with version 34)	0 - 255	0	= 0: illegal value for SW version 33; later 0 sec. = 1: 1 sec fade-out time = (i.e.) 5: @ 4 sec = 255: @ 320 sec ATTENTION: Above values are valid for a "cycle time" 5 (i.e. CV #63 = 50 … 59). About 1/6 of the time with cycle time 0; double time with cycle time 9.
#353	Automatic smoke generator shut-down	0 - 255 = 0 - 106 min	0	For special effect codes "010010xx" or "010100xx" (smoke generator): Overheat protection: turns OFF after ½ min to about 2 hours. = 0: Won't turn off automatically. = 1 … 255: Switches off autom. after 25 sec./unit.

5.23 Configuration of smoke generators

Smoke generators without fan (Example: „Seuthe" 18 V):

In addition to a simple ON/OFF function via a function output of your choice, the smoke intensity can also be programmed to change between **standstill, cruising** and **acceleration**.

This requires the smoke generator to be connected to one of the function outputs **FO1… FO8** (FO7 and F8 only with SW version 34 or higher) and the selected output must be programmed for the desired effect with the associated "effect CV" (with CV #127 for FO1, CV #128 for FO2 etc.); in this case for load dependent smoke of steam engines (effect code "72") or load dependent smoke of diesels (effect code "80").
The smoke generator characteristic is defined by CV #137, 138 and 139 and must be programmed with appropriate values otherwise the smoke generator will not produce any smoke.

CV	Designation	Range	Default	Description
	Characteristics for smoke generators connected to FO's 1-6			The values in CV #137 – 139 define a smoke characteristic for the function outputs (FO1, FO2, FO3, FO4, FO5 or FO6; referred to below as FOx), provided a "smoke function" for a diesel or steam engine (value 72 or 80) has been selected in the associated CV #127 – 132:
#137	PWM at stand still	0 - 255	0	CV #137: PWM of FOx at standstill
#138	PWM at cruising	0 - 255	0	CV #138: PWM of FOx at cruising speed
#139	PWM during acceleration	0 - 255	0	CV #139: PWM of FOx at acceleration (PWM = Pulse With Modulation)

EXAMPLE: - Typical characteristic for a track voltage set around 20V with above smoke generator:

CV #137 = 70 .. 90: little smoke at standstill.
CV #138 = 200: The smoke intensity is increased to about 80% of its maximum capacity beginning with speed step 1 (at very low speed), which produces relative heavy smoke.
CV #139 = 255: The smoke generator is driven to its maximum under heavy acceleration, which results in thick smoke.

Synchronized steam chuffs or typical diesel smoke (with exhaust fan):

With the built-in fan, synchronized steam chuffs or driving-state dependent diesel smoke can be generated without adding additional electronic components.

The heating element of the smoke generator is connected – as in the example above with the "Seuthe" generator – on **FO1…FO8** and configured with the appropriate CV for the desired effect (i.e. "72" for steam or "80" for diesel).

The fan is connected to the **"fan output"** of the large-scale decoder; see chapter "Installation and wiring", section "Special Connection for Smoke Fan").

CV	Designation	Range	Default	Description
	Definition of smoke generator characteristic, connected to FO1 – 6.			Provided a "smoke function" for a diesel or steam engine (value 72 or 80) has been selected in the associated CV #127 – 132: With the three values in CV #137 – 139 a smoke characteristic for the function outputs (FO1…FO8; referred to below as FOx) is defined and at the same time also – **IMPORTANT** – the maximum permissible voltage!
#137	PWM at stand still	0 - 255	0	CV #137: PWM of FOx at standstill
#138	PWM at steady speed	0 - 255	0	CV #138: PWM of FOx at cruising speed
#139	PWM during acceleration	0 - 255	0	CV #139: PWM of FOx at acceleration (PWM = Pulse With Modulation)
#351	Exhaust fan speed at cruising speed For DIESEL engines	1 - 255	128	The fan speed is adjusted by PWM; the value in CV #351 defines the effect at steady speed. = 128: Fan is driven at half the voltage at cruising speed.
#352	Exhaust fan speed at motor starts and during acceleration For DIESEL engines	1 - 255	255	The exhaust fan is set to a higher speed (usually top speed) for generating the typical exhaust puff during motor starts as well during hard accelertions. = 255: Fan receives maximum voltage at start-up or accelerations.
#353	Automatic smoke generator shutdown For STEAM and DIESEL engines	0 – 255 = 0 - 106 min.	0	If a smoke generator is controlled by one of the effects "010010xx" or „010100xx" in CV's #127 to 132 (for one of the function outputs FO1 to FO6), the output turns itself off automatically after the time defined in this CV, in order to protect the generator against overheating. = 0: no automated turn-off = 1 to 255: automatic turn-off after 25sec/unit, which offers a maximum time of about 6300sec = 105min.
#355	Exhaust fan speed at stand-still	1 – 255	0	Supplement to the settings in CV #133 and the effects with code "72" (steam engines) or "80" (diesel en-

	For STEAM and DIESEL engines			gines), where the fan is only set-up for chuff beats or during start-ups and cruising speeds. With CV # 355, however, the fan speed is adjusted at a standstill, so that even in this state smoke is discharged (to a lesser extent).

Example - The following CV's must (should) be programmed as follows:

"Old" design of the "ZIMO TR92-101" (recognizable by the brass mounting brackets):

CV #137, #138, #139 = 60, 90, 120 respectively: (IMPORTANT) The heating element of the USA Trains smoke generator is designed for maximum 9V, which requires that the voltage of that function output is limited. This is done with suitable values in CV #137, 138 and 139. The above values can be adjusted to some extent according to need and track voltage.

CV #353 = …i.e. 10: shuts the smoke generator off automatically to prevent overheating (In this example "10": after 250 seconds).

CV #351, 352 = ...only for diesel engines when effect code "80" is selected in the applicable CV for FO1…FO6. This defines the fan speed (PWM-voltage) for start-up (default: maximum smoke) and cruising (default: medium smoke); see CV table.

CV #355 = ... for steam and diesel engines. Defines the fan speed (PWM-voltage) at standstill (usually for very little smoke output).

"ZIMO TR92-101" design after September 2015 (without brass mounting brackets):

If the heating element is connected to **24V (Common positive)** and function output (FO1…FO8):

CV #137, #138, #139 = 50, 75, 110 respectively: (IMPORTANT) The heating element of the smoke generator (with the ZIMO added 15 Ohm resistor) is suitable for about 10V maximum, so the voltage has to be limited in all cases through PWM (Pulse With Modulation) with a CV #139 value of "110" and for the other CV's correspondingly lower values (about 40% and 60%, which can of course be varied individually).

If the heating element is connected to **18V (Common positive** with track voltage of 18V or adjustable low-voltage output set to 18 – 19V) and function output (FO1…FO8 as ground):

CV #137, #138, #139 = 65, 100, 150 respectively: (IMPORTANT) The values are set a little higher than in the example above (about 25% higher, since the available 18V is 25% lower than 25V).

All other CV's are the same as in the example for the "old" design; listed here again for the sake of completeness:

CV #353 = …i.e. 10: shuts the smoke generator off automatically to prevent overheating (In this example "10": after 250 seconds).

CV #351, 352 = ...only for diesel engines when effect code "80" is selected in the applicable CV for FO1…FO6. This defines the fan speed (PWM-voltage) for start-up (default: maximum smoke) and cruising (default: medium smoke); see CV table.

CV #355 = ... for steam and diesel engines. Defines the fan speed (PWM-voltage) at standstill (usually for very little smoke output).

Wires: blue (Fan positive, 5 – 6 V, to fan output)
yellow: (Fan ground)
red: (Heating element positive)
green: (to FO1…FO8)

5.24 Configuration of Electric Uncouplers

"System KROIS" and "System ROCO"

When one or two of the function outputs **FO1…FO6** (but not FO7 or FO8) are assigned to the uncoupler function (CV #127 for FO1 etc.), the control of the couplers as well as the entire uncoupling process is defined by the settings in

CV #115 and CV #116.

These CV's limit the pull-in time (to prevent overheating), define a hold-in voltage if required (i.e. System "Roco") as well as the automated coupler unloading and train disengagement.

It is recommended to use the following settings for the **Krois system: CV #115 = 60, 70 or 80;** these settings will limit the pull-in time (full track power) to 2, 3 or 4 seconds respectively. A hold-in voltage is not required for the Krois coupler and the ones digit can therefore remain at "0".

Notes to automated uncoupling (a.k.a. "Coupler waltz)

- The automatic train disengagement is active if the tens digit in CV #116 is other than 0; if desired with prior coupler unloading (when CV #116 > 100).
- The automatic train disengagement (or the preceding coupler unloading) is started at the same time the coupler is activated, but only if the train is standing still (speed 0); if the train is still moving, the uncoupling, unloading and disengagement procedure won't start until the train comes to a full stop.
- The procedure terminates when the "temporary" function key is released (or pressed again if in latched mode), or when the predetermined times (CV #115 for the coupler, CV #116 for the disengagement) have expired.
- The uncoupling and disengagement process is aborted immediately if the speed regulator is operated at the same time.
- The driving direction for the train disengagement is always according to the cab setting; directional settings in the "special effects" definition for uncoupling (Bits 0 and 1 of CV #127, CV #128 etc.) will not be applied.

CV	Designation	Range	Default	Description
#115	Uncoupler control "Pull-in" time and "hold" voltage or use CV # 115 for an alternative second dim value (dimming 0-90% using ones digit; tens digit must be 0)	0 - 99	0	The uncoupler function is only active if "uncoupler" is selected (value 48) in one of the CV's #125…132: Tens digit (0 – 9): Time in seconds the coupler receives full voltage (pull-in time): Value: 0 1 2 3 4 5 6 7 8 9 **seconds: 0 0,1 0,2 0,4 0,8 1 2 3 4** 5 Ones digit (0 to 9): hold-in power in percent of track voltage, 0 - 90%. Applied after the pull-in time elapsed (necessary for ROCO coupler, not needed for KROIS coupler).
#116	Automatic disengagement during uncoupling	0 - 99, 0 - 199	0	Tens digit (0 – 9): Length of time the loco should move away (disengage) from the train; coding as in CV #115. Ones digit (0 – 9) x 4 = Internal speed step applied for disengagement (Momentum per CV #3 etc.) Hundredths digit = 0: No unloading. = 1: Coupler unloading: engine moves toward train in order to relieve coupler tension, before uncoupling and disengaging from the

				train. Example: CV #116 = 61: Loco uncouples and drives away from train for 2 seconds at speed step 4. CV #116 = 155: Loco pushes against train first to unload couplers, uncouples and then drives away from the train for 1 second at speed step 20.

The "Massoth – Coupler" (since Fall 2012)

This coupler comes with a 3 stranded color coded connecting wire:

Red: Connect to a "common positive" pin with full track power

Brown: Connect to any function output

Black: Connect to a "GROUND" pin

The hook of the Massoth coupler is moved by a motor and does not require a time limit as does the Krois coupler for example, and therefore does not need to be programmed with an "uncoupler" function effect nor does it need to be protected with a maximum ON-time through CV #115.

There are however two reasons to use the "uncoupler" function effect anyway (value "48", see description about "System Krois" above):

- To protect the coupler hook from possible damage if inadvertently left in the low position while driving
- If the "coupler waltz" is to be used: in this case, in addition to the effect ("48") assignment for the function output concerned, CV #115 also needs to be set (because the default value "0" would mean a time limit of 0 sec (i.e., set it to "50" for a 5-second time limit or = "99" for 9 seconds with 90% hold voltage; (90% ("9") when the time limit is to be avoided altogether) as well as CV #116 for the desired requirements (see above).

5.25 Servo Configuration

CV	Designation	Range	Default	Description
#161	Servo outputs: Protocol and alternative use of servo outputs 3 & 4 as SUSI	0 - 3 0 Note: CV #161 must be set to "2" for **Smart Servo RC-1!**	0	Bit 0 = 0: Servo protocol with positive pulses. = 1: Servo protocol with negative pulses. Bit 1 = 0: Control wire only active during movement = 1: … always active (consumes power, vibrates at times but holds position even under mechanical load) – this setting is also required for **SmartServo RC-1** (with memory wire)! Bit 2 = 0: For two-key operation, with center position (as per CV #181/182) when both function keys are OFF = 1: For two-key operation (as per CV #181/182), where the servo runs only as long as function keys are active. Bit 3 = 1: Servo outputs 3 and 4 are used for SUSI Data and SUSI clock (only for decoders that actually have 4 servo outputs).
#162	Servo 1 - Left stop	0 - 255	49 = 1 ms pulse	Defines the servo's left stop position. "Left" may become the right stop, depending on values used.
#163	Servo 1 - Right stop	0 - 255	205	Defines the servo's right stop position.
#164	Servo 1 - Center position	0 - 255	127	Defines a center position, if three positions are used.
#165	Servo 1 - Rotating speed	0 - 255	30 = 3 sec	Rotating speed; Time between defined end stops in tenths of a second (total range of 25 sec, default 3 sec.).
#166 - 169	As above but for Servo 2	#166 left stop, #167 right stop, #168 center position, #169 rotating speed.		
#170 - 173	Servo 3	#170 left stop, #171 right stop, #172 center position, #173 rotating speed.		
#174 - 177	Servo 4	#174 left stop, #175 right stop, #176 center position, #177 rotating speed.		
#181 #182 #183 #184	Servo 1 Servo 2 Servo 3 Servo 4 Function assignment	0 - 28 90 - 93 101-114	0 0 0 0	= 0: Servo not in operation = 1: Single-key operation with F1 = 2: Single-key operation with F2 and so on to = 28: Single-key operation with F28 = 90: Servo action depends on loco direction: forward = servo left; reverse = servo right = 91: Servo action depends on loco stop and direction: turns right when stopped and direction is forward, otherwise turns left. = 92: Servo action depends on loco stop and direction: turns right when stopped and direction is reverse, otherwise turns left. = 93: Servo action depends on loco movement: turns right when loco stopped, left when loco moving; direction makes no difference.
				= 101: Two-key operation F1 + F2 = 102: Two-key operation F2 + F3 and so on to =127: Two-key operation F27 + F28 = 111: Two-key operation F11 + F12 = 112: Two-key operation F3 + F6 = 113: Two-key operation F4 + F7 = 114: Two-key operation F5 + F8 (Two-key mode as defined with CV #161, Bit 2)
#185	Special assignment for live steam engines		0	= 1: Steam engine operated with single servo; speed and direction controlled with speed regulator, stop is in center position. = 2: Servo 1 proportional, on speed regulator, Servo 2 for direction. = 3: as in 2, but: direction-servo is automatically in "neutral" if speed is 0 and F1 = ON; If speed step > 0: direction-servo is engaged. NOTE to CV #185 = 2 or 3: Servo 1 is adjustable with CV #162, #163 (end stops); with appropriate values the direction can be reversed as well. Servo 2 is adjustable with CV #166, #167.

6 Feedback – Bidirectional communication

All ZIMO decoder types have been equipped with a type of feedback ever since DCC was formed, which has always been a major difference to competitors' products:

- the ***ZIMO loco number identification*** is part of ZIMO DCC decoders since 1997 and as far back as 1990 with ZIMO's own data format (which is no longer in use today). It can only be used with ZIMO DCC systems (MX1…MX10, MX31ZL, MX32ZL…) and together with ZIMO track section modules (MX9 and successors): After receiving DCC packets, the decoder sends acknowledgment pulses which will be utilized to identify and locate the decoder in the respective section of track.
- all ZIMO decoders are ready for the ***"bidirectional communication"*** according to ***"RailCom"*** since 2004; it is opertional in newer decoders such as the MX695, MX696… series from the beginning (basic functions, ongoing expansion with future software updates).

"Bidirectional" means that the information transfer within the DCC protocol is not only flowing towards the decoder but also in the opposite direction; that is, not just driving, function and switch commands are being sent to decoders but also messages such as acknowledgements, actual speed as well as other status information and CV read-outs are being received from decoders.

The functioning principle of RailCom is based on the introduction of short cut-outs (max. 500 micro seconds) by the command station to the otherwise continuously sent DCC signal. These cut-outs provide the time and opportunity for the decoders to send a few bytes of data to locally mounted detectors.

The relevant CV's for RailCom configuration:

CV	Designation	Range	Default	Description
#28	RailCom Configuration	0 - 3	**3**	Bit 0 - RailCom Channel 1 (Broadcast) 0 = OFF **1 = ON** Bit 1 - RailCom Channel 2 (Data) 0 = OFF **1 = ON**
#29	Grundeinstellungen Configuration data	0 - 63	14 = 0000 **1**110 Which is Bit 3 = 1 ("RailCom" turned on)	Bit 0 - Train direction: 0 = normal, 1 = reversed Bit 1 - Number of speed steps: 0 = 14, 1 = 28 Bit 2 - DC operation (analog): 0 = off 1 = on Bit 3 - RailCom ("bidirectional communication") 0 = deactivated **1 = activated** Bit 4 - Individual speed table: 0 = off, CV # 2, 5, 6, are active. 1 = on, according to CV 's # 67 – 94 Bit 5 - Decoder address: 0 = primary address as per CV #1 1 = ext. address as per CV #17+18
#136	Setting the feedback speed	RailCom display factor	128	Correction factor for the speed feedback via RailCom or (see section 5.8) A value can be read out here after a calibration run has been performed.
#158	Several special bits + RailCom variants	0 - 127	4	Bit 0, Bit 1, Bit 6 various special sound settings Bit 2 = 0: RailCom speed (kph) – feedback using the "old" method (for MX31ZL ! Id 4) = 1: RailCom speed (kph) – feedback using the new STANDARDIZED method (Id 7).

With the help of ***bidirectional communication*** according to RailCom

decoders will acknowledge received commands -

- which increases operational reliability and the bandwidth of DCC systems because already acknowledged commands don't need to be sent repeatedly;

current decoder data is sent to the command station ("global detector") -

- e.g. "real" (measured) train speed, motor load, routing and position codes, "fuel reserves", current CV values on demand from decoders is sent to the command station or more precisely, to a **global detector** in the command station;

decoder addresses are recognized by "local" detectors -

- the actual loco positions are determined by local detectors connected to individual track sections (integrated in future MX9 track section modules), which has been possible with ZIMO's own loco number recognition for a long time, even without bidirectional communication.

RailCom will be further developed over the coming years and new applications added which of course requires new software updates in decoders and other equipment. ZIMO decoders as of 2009 are able to send their own loco address from an isolated section of track (with a so called broadcast method, very fast, although only for one loco inside that section), send CV content on demand along with some decoder data such as actual speed in kph, load and decoder temperature.

On the system side, only one third party product has been available from the beginning – the address display LRC120, which is a "local" RailCom detector displaying the loco address of one track section. In 2007, the ZIMO MX31ZL came to market as the first command station with an integrated "global" RailCom detector.

In 2014 (4. Quarter), ZIMO will deliver the new MX10 command stations with integrated detectors for RailCom. The MX32 cab (released early in 2011) uses feedback functions from the start (speed indicator, CV-reading), but until the appearance of the MX10 it is accessible only in connection with the MX31ZL.

RailCom in ZIMO Decoders is activated with

CV #29, Bit 3 = 1 AND CV #28 = 3

These are usually the default settings on a new decoder, but RailCom is turned off by default in many sound projects or OEM CV sets and must therefore be activated first with above CV's (see table above).

ATTENTION (if the actual speed is not displayed): see CV #158, Bit 2 (in table above).

7 ZIMO SOUND – Selection and Programming

Sound projects, Sound Collections, free and fee-based projects etc.

Specialties of the ZIMO sound organization over the traditional offerings from other manufacturers.

▶ Each sound decoder requires a **sound project in the decoder's flash memory.** The sound project is basically a file, composed of the sound samples of a real locomotive (or several locomotives in the case of the "Sound Collection", see below), as well as playback instructions (in the form of schedules, dependencies on operating condition, speed, acceleration, pitch, etc.) and assignments (to function keys, random generators, switch inputs, etc.).

▶ Each ZIMO decoder comes loaded with a sound project (usually a "sound collection", see below). Different ZIMO sound projects for installation by the user can be downloaded from the ZIMO sound database at www.zimo.at in the form of **"Ready to use" projects** (.zpp file) and often, in addition to that, as **"Full featured" projects** (.zip file):

The "Ready to use" project is a **.zpp file** and can be uploaded to the decoder by the user with the help of decoder update modules such as the MXDECUP, MXULF, MX31ZL or MX10 command station. The file is placed on an USB stick and the stick plugged into the USB host socket of the mentioned modules or sent from a computer (connected to the USB client socket with the software **ZSP** or **ZIRC** installed on the PC) to the decoder. After the sound is uploaded to the decoder, many assignments and settings can be changed to suit individual tastes (even though it is a "ready-to-use" project), using the procedures and CV's described in the decoder manual.

The "Full featured" project on the other hand is downloaded as a **.zip file** from the sound database; it cannot be uploaded to the decoder directly but can be unzipped and edited with the help of the **"ZIMO sound program" ZSP.** Assignments and settings can be determined within ZSP and it is also possible to remove sound samples for external processing or exchange them with others; it is therefore possible to create your own or highly indiviualized sound projects. The result is again a **.zpp** file that can be uploaded to the decoder.

▶ ZIMO sound decoders come preferably with a **"Sound collection";** this is a special type of a sound project: sound samples and CV parameters for several engines (i.e. for 5 engines) are stored in the decoder's memory. The preferred sound for a given locomotive can be selected with the cab (no need to load a different sound sample from the computer).

The user is free to change acoustics of a locomotive to his/her own taste by combining, for example, a chuff sound from 5 different chuff samples and one or several whistles (selection is made using the "CV #300 procedure); other sounds are selected the same way, such as bells, compressors, steam shovels, oil burners, break squeals etc.

Note: Even normal sound projects ("normal" = for a specific locomotive) comprise the characteristics of a "sound collection", by containing several whistles for example from which one can be selected using the "CV #300 procedure".

▶ Among the sound projects available from the ZIMO sound database it must be distinguished between the

- "Free D'load" (= no charge) sound projects, often produced by ZIMO and the
- "Coded" (= purchased) sound projects, from external sound providers.

The "Coded sound projects" are contributed by external ZIMO partners (= providers, for example by Heinz Däppen for the Rhaetian Railway and American steam locomotives), who get reimbursed by the sale of "load codes". These fee-based projects can be downloaded for free from the ZIMO Sound Database, but can only be used in **"coded" decoders**, i.e. those in which the appropriate **"load code"** has been programmed beforehand. "Encoded decoders" can be purchased with the "load code" pre-installed (subject to a charge, see price list) or the load code is purchased later and entered to the appropriate decoder CV's (# 260, 261, 262, 263). The "load code", which authorizes the use of sound projects of a specific sound supplier (i.e. the sound projects of Heinz Däppen) applies to one specific decoder which is identified by its **decoder ID** (CV 250, 251, 252, 253).

▶ In addition to the "Free D'load" and "Coded" projects, both of which are ready for download on the ZIMOSound Database (see above), there are also the

- "Preloaded" sound projects; these are available exclusively as pre-programmed decoders and this in turn often only installed in new locomotives. "Preloaded" sound decoders are not usually provided by Zimo, but by model railroad manufacturers and distributors, who are also responsible for setting the prices. These sound projects are merely listed in the ZIMO Sound Database as reference.

Decoders with sound collection – Selecting a loco type using CV #265

i.e.the "European steam/diesel collection":

CV	Designation	Range	Default	Description
#265	Loco type selection	1 2 … 101 102 …	1 or 101 Steam = 1 Diesel = 101	= 0, 100, 200: Reserved for future applications = 1, 2 … 32: Select among various steam sounds stored in the decoder, i.e. for loco BR01, BR28, BR50, etc... Chuff sounds as well as other sounds (whistle, compressor, bell…) will be matched. = 101, 102 … 132: Select among various diesel engines (if several diesel sounds are in the collection).

Operating the sound decoder for the first time

with "Euro steam/diesel" sound collection:

As delivered, the decoder comes with a typical engine sound activated and function-sounds allocated to function keys:

Function F8 – Sound ON/OFF

sounds played back with a function key remain active regardless whether F8 is on or off (a separate function key can be assigned with CV #311 to turn the function sound ON/OFF, which could of course also be F8)!

In the case of a decoder with **"European steam collection"** the sound is of a 2-cylinder engine (the chuff rate can only be approximate without further tuning) with automated water drainage and brake squeal as well as some randomly played stationary sound.

The following sounds are allocated to these **function keys:**

F2 – short whistle
F4 – water drain (blow off…)
F5 – long whistle (playable)
F6 – bell
F7 – coal shoveling or oil burner
F9 – compressor
F10 – generator
F11 – injector

F1 and F3 are not allocated for sound by default since they are usually required for other tasks.

The following stationary sounds are allocated to the **random sound generator:**

Z1 – compressor Z2 – coal shoveling Z3 – injector

The **switch inputs** are allocated to the following by default:

S1 – long whistle S2 – nothing S3 – cam sensor

A sound project is composed of…

... sound samples, schedules and CV settings.

To produce the sound of a locomotive, the sound sample contains the following components:

1) the **"main engine"** or **"driving sound"**: this is the central sound, such as the chuff or diesel engine sound, or the cooling fan (which is the key sound in electric locomotive projects).
   This "main engine" sound is the only sound component associated with a **schedule**, which defines important properties, especially the transitions between different sound samples in various speed, acceleration and load situations.
   This schedule can only be changed in the "ZIMO Sound Programmer" ZSP, not by CV's. However, there are numerous possibilities for **fine-tuning** the main engine sound **through CV's** (eg relation between chuff frequency and speed, lead-chuff accentuation, coasting/notching functions, etc.)
2) **Other scheduled sounds** (often inaccurately called background sounds): these are boiling, draining, turbocharger or brake squealing sounds and many others; also in the case of electric locomotives the actual primary sounds of the thyristor unit and the electric motor.
   "Scheduled" sounds - both the "main engine" and "other" - are characterized in that the decoder plays them back automatically based on the driving situation, while the "function sounds" (see below) are activated with the cabs function keys.
   These "other" -sounds (ie all except the "main engine" sound, see above) are NOT played back according to a schedule; they are **fully defined by CVs**, **and can be modified** directly by these CV's or CV # 300 - procedures, even during operation (speed, load dependence, etc.). Only the underlying original recordings, that is the sound sample or a selection of samples, is stored in the sound project (or in the sound collection).
3) The **function sounds**, which are played back by pressing the corresponding function keys includes acoustic signals such a whistles, horns, bells but also other sounds like coal shoveling, coupler clank, lowering of pantographs as well as station announcements.
   The volume of each sound and whether it is "looped" (for continuous playback as long as the function key is pressed) is **defined by CV's** and can be **modified by these CV's** or with the CV #300 procedure. Here too, only the sound samples of the project or selections of several projects are predefined.

4) and 5) the **switch input** and **random sounds** are normally sounds that can also be used as function sounds but are triggered by switch inputs or random generators.

The occasionally used term "driving sound" refers to a subset of all the sounds, namely the "main engine" sound and most of the "other" sounds; the "departure whistle" sound for example is not included because it is not dependent on driving data.

7.1 The "CV #300 procedures"

The term "CV # 300 - procedure" means the "pseudo-programming" of CV # 300, which allows the modification of the currently loaded sound projects during normal operation, in relation to:

- the **selection** of sound samples within sound groups (i.e. " short whistle") of a "sound collection" (which has several sound samples in some of its sound groups) or a "normal" sound project with several sound samples in specific groups.
- the **volume** and the sound **loop** behavior for individual sounds; for example, how loud the whislte blows in relation to the driving sound volume (i.e. chuff beats).

NOTE: If setting the volume of individual sounds is the main concern, it is more convenient to use the direct CVs, see chapter "Drive-independent basic settings"; in many applications the CV #300 procedure is therefore NOT needed.

The following procedures are always used in the same way in spite of the flexible decoder layout and different sound sample compilations. It is also worth mentioning that the sound samples can be listened to and evaluated under actual operating conditions (with the engine running), not just on the computer.

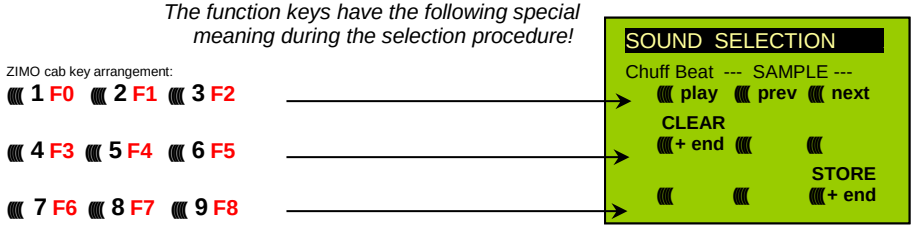
The **selection procedure** is started with a "Pseudo-Programming" in operations mode ("on-the-main"):

CV #300 = 100 (only for steam / not possible with DIESEL engines!).

The "Pseudo-Programming" (meaning that the entered value is not really stored in memory) has the effect that the **function keys F0 to F8** no longer actuate function outputs but instead are now available for **special tasks** within the sound selection procedure. The function keys should be set to momentary, if possible, which would facilitate the procedure. ***CV #300 procedures must be done in operations mode (on the main), NOT in service mode!***

The function key identifications (and the MX31/MX32 cab displays) shown are typical for a ZIMO cab during the selection procedures (and for other sound adjustment procedures) but **is analogous to the function keys of third party cabs,** although the layout may be different.

The function keys have the following special meaning during the selection procedure!



F0 = play : plays back the current chuff sound for evaluation; only possible with the engine at standstill; the chuff sounds are played back automatically when the engine is moving.

F1, F2 = prev, next : plays back the previous or next recording stored in the decoder; the sound file can immediately be evaluated with the engine stopped, with the engine running the selected file replaces the currently active.

F3 = CLEAR + end : The **selection procedure** is stopped and the selection is cleared, that is no chuff sound will be stored (boiling and blow-off sound remains).

F8 = STORE + end : The **selection procedure** is stopped with the last selected chuff set replacing the current set.

The **selection procedure** is also stopped when programming anything else (e.g. **CV #300 = 0** or any other value or any other CV) or by interrupting power. In these cases, the **current chuff set remains.** Such "forced endings" are also useful when the "old" sound should remain as the current sound without first having to locate it again.

The selection procedure is supported with **acoustic signals**:
The **"cuckoo jingle"** (confirmation jingle) sounds when:

- the last stored chuff sound is reached; use the key to scroll in the opposite direction (F1, F2) to listen to the other stored chuff sounds,
- play-back is tried (F0) but no sound sample is assigned,

- a wrong key is pressed (F4, F5 etc.)

The **"confirmation jingle"** is played after ending the selection procedure with F3 or F8.

The engines can be **operated normally** during the selection procedure: with speed regulator, direction key and MAN key (the latter only with ZIMO cabs); functions cannot be actuated until the selection procedure is terminated with F3, F8 or by other programming steps, see above.

Selecting boiling, whistle, blow-off, brake squeal sounds…

within a sound collection or a sound project containing several samples per group:

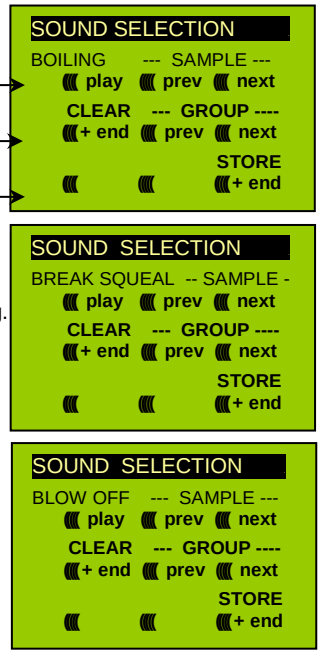
The **selection procedures** for these "automated background sounds" are initiated with a "Pseudo-Programming" in operations mode programming

CV #300 = 128 for the boiling sound (steam only) .
CV #300 = 129 for direction-change sound .
CV #300 = 130 for the brake squeal .
CV #300 = 131 thyristor-control sound (electric engine) .
CV #300 = 132 for the "start" whistle or horn .
CV #300 = 133 for blow-off sound =cylinder valves (STEAM only) .
NOTE: the blow-off selection (CV #300 = 133) is also valid for function key playback (CV #312).
CV #300 = 134 for the driving sound of ELECTRIC engines .
CV #300 = 135 for rolling noise .
CV #300 = 136 for the switchgear sound of ELECTRIC engines .
CV #300 = 137 for a second Thyristor sound (ELEKTRIC engines) .
CV #300 = 141 for the turbo charger (DIESEL engine) .
CV #300 = 142 for the „dynamic brake" (Electric brake, ELEKTRIC engines) .

The selection procedure for background sounds is the same as for the selection of chuff sounds. EXCEPT: the engine should be at a **standstill** because the **speed regulator** is used **for setting the volume** of the relevant sound file!
Note: these sound files can also be used as function sounds, allocated to function keys (see next page); the automated back-ground sounds can then be cancelled with the function keys.

The function keys have the following special meaning during the selection procedure; speed regulator is used for volume setting!

ZIMO cab key arrangement
1 F0 2 F1 3 F2
4 F3 5 F4 6 F5
7 F6 8 F7 9 F8



Function keys are used as with chuff selections:

F0 = play: plays back the currently selected sound
F1, F2 = prev., next: plays back the previous or next recording.
F4, F5 = prev., next: switches between sound groups.
The **speed regulator** acts as volume control for the background sound during the selection procedure.
F3 = CLEAR + end: **Selection procedure** is **stopped** and the current sample removed.
F8 = STORE + end : **Selection procedure** is **stopped** and the new selection activated.

The **selection procedure** can also be **ended** by any other programming procedure or by removing power.

Normal function outputs cannot be activated as long as the selection procedure is active.

Allocating sound samples to function keys F1 … F19:

within a sound collection or a sound project containing several samples per group:

A sound sample can be allocated to each function key F1…F19 from the sound samples stored in the decoder. It is absolutely permissible to have a function key assigned for a function output (FO1, FO2 etc.) as well as for a sound function, both of which will be activated when the key is pressed.

The **allocation procedure** for function sounds are initiated with a "Pseudo-Programming" in operations mode programming:

CV # 300 = 1 for function F1
CV # 300 = 2 for function F2
etc. until F19
CV # 300 = 20 for function F0 (!)

Note: Function F4 is by default used for water drainage sound (with CV #312); if F4 is to be used for something different, CV #312 must be set to zero (CV #312 = 0).

The allocation procedure is very similar to the selection procedures for driving and background sounds, with the difference that sound allocation is not limited to sound samples of a certain group but also allows switching between groups to find the desired sample.

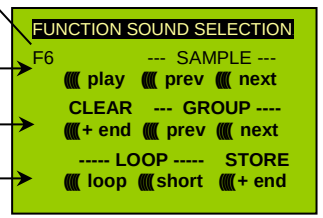
*Sound samples are organized in **groups** for easier location; i.e. groups like "short whistle" / "long whistle" / "horn" / "bell" / "shoveling coal / "announcements" and much more.*

The engine should remain **stationary** though since the **speed regulator** is used **for volume settings** during the allocation procedure!

Depends on entry: F1 . . . F19

The function keys have the following special meaning during the selection procedure!

ZIMO cab key arrangement:
1 F0 2 F1 3 F2
4 F3 5 F4 6 F5
7 F6 8 F7 9 F8



F0 = play : plays back the current chuff sound for evaluation.
F1, F2 = prev, next : plays back the previous or next recording stored in the decoder.
F4, F5 = prev, next : switches between sound groups (e.g. whistles, bells etc.); starts play back the with the first sample of this group.

The **speed regulator** acts as volume control for the selected sound during allocation procedure.

F6 = loop : If F6 is "on" when exiting the allocation procedures, the sound sample is stored and played back as long as the relevant function key is pressed by repeating the sound between the loop markers (the loop marks are part of the sound file).

Playable whistle!

F7 = short : If F7 is "on" when exiting the allocation procedures, the sound sample is

shortened and played back only as long as the function key is pressed, by omitting the center portion.

Note: F6 and F7 are only effective provided the loop markers are included in the sample; basic settings are also saved; changes take effect only if F6/F7 is actuated.

Note: If F6 and F7 are not actuated, the sound sample will always be played back in the same length it was saved, regardless how long the function key is pressed.

F3 = CLEAR + end : The **allocation procedure** is **stopped** and the current sound removed. There will be no sound allocated to this function key.

F8 = STORE + end : The **allocation procedure** is **stopped** and the last selected function sound is stored and ready for playback when this function key is pressed.

The **allocation procedure** can also be **ended** by any other programming procedure (e.g. CV #300 = 0 or any other value or CV) or by removing power from the decoder. The "old" allocations remain active in such cases; such "forced endings" are also useful when the "old" sound should remain as the current sound without first having to locate it again.

The selection procedure is supported with **sound signals**:

The **"cuckoo jingle"** sounds when:

- the last stored sound sample of that group is reached; use the key to scroll in the opposite direction (F1, F2) to listen to the other stored sounds,
- the last stored sound group is reached (with F4 or F5); use the other key (F4 or F5) to scroll in the opposite direction.
- play-back is attempted (with F0) but no sound sample is available,
- a wrong key is pressed.

The **"confirmations jingle"** is played after ending the allocation procedure with F3 or F8.

Allocation of sound samples to the random generators Z1…Z8:

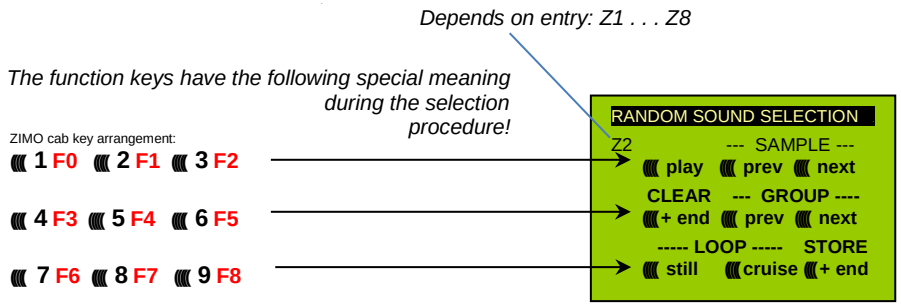
The MX690 decoders provide 8 simultaneously playing random generators who's timing is determined by CV's; see "CV table" from CV #315.

A sound sample can be added to each random generator from the pool of samples in the decoder.

The **allocation procedure** for random sound is initiated with a "Pseudo-Programming" in operations mode (on-the-main):

CV # 300 = 101 for random generator Z1
(Z1 has special logic incorporated for the compressor and should therefore always be used for that)

CV # 300 = 102 for random generator Z2
CV # 300 = 103 for random generator Z3
etc.



The meaning and action of the function keys is the same as for function sounds (see above):

F0 = play: playback
F1, F2 = prev, next: playback of previous or next sound sample
etc.

but

F6 = still: If F6 is active when ending the allocation procedure, the sound sample is played as random sound at standstill only (default).

F7 = cruise: If F7 is active when ending the allocation procedure, the sound sample is played as random sound when the locomotive is moving.

The allocation procedure for random sound is the same as for function sound!

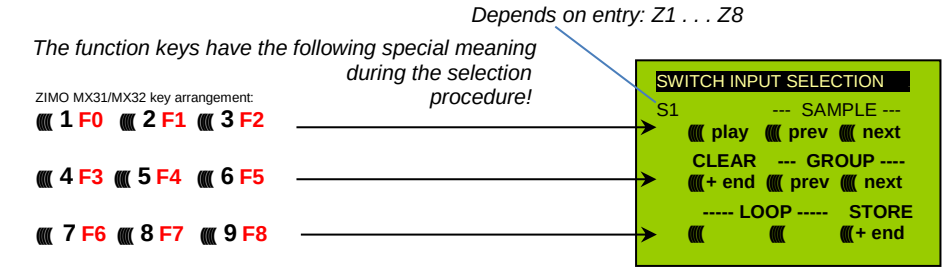
Allocation sound samples to switch inputs S1, S2, S3:

The MX690 has 3 switch inputs available, of which two ("1" & "2") are freely available to the user while one ("3") is usually reserved for a cam sensor input; which can also be used for other inputs if not used for a cam sensor (i.e. the virtual cam sensor is used instead). These inputs can accept reed switches, optical or hall-effect sensors and similar; see chapter 8: "Connecting speaker, cam sensor".

A sound sample can be allocated to each switch input, from the pool of stored samples in the decoder; playback times can be set with the help of CV's #341, 342 and 343, see CV table.

The switch input **allocation procedure** is initiated with the operations mode Pseudo-Programming

CV #300 = 111 for switch input S1
CV #300 = 112 for switch input S2
CV #300 = 113 for switch input S3
and so on…



The meaning and action of the function keys is the same as for function sounds (see above):

F0 = play : play back
F1, F2 = prev, next : play back of previous or next sound sample
and so on.

7.2 *"Incremental Programming" of sound CV's, an alternative to "normal" programming*

Configuration variables (CV's) for optimizing sound effects can of course be programmed in the conventional manner by changing CV values using the cab in service mode (on the programming track) or in operations mode (on the main track), but many can alternatively also be programmed by

"Incremental" programming.

This method is not suitable for CVs where individual bits need to be set independently.

The "incremental programming" is a special process of the "operations mode" programming with the following fundamental principle: the CV's are not programmed with an absolute value (as is normally the case) but rather the current value of a CV is being incremented or decremented by a fixed value (defined in the decoder for each CV).

The function keys of the cab temporarily serve as instruments for the incremental programming, which means they cannot be used for function output actuations during that time. The function keys are temporarily assigned for this task with the "Pseudo-Programming"

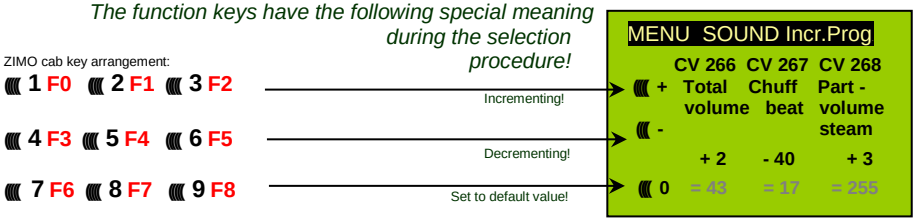
CV #301 = 66,

which changes the function keys to INC and DEC keys, first for CV #266 (that is the CV number derived from the value + 200).

Several CV's are grouped together in one procedure for an easier and better handling. In the case of CV #301 = 66, not only the leading CV #266 ("Lead-CV") is assigned for incremental programming but also CV #267 and #268.

This is again shown here by means of the ZIMO cab with the special MX31 display, but is valid analogous for the function keys of other cabs.

The function keys have the following special meaning during the selection procedure!



Drawing of an MX31 display, not a photo!

The last line shown in gray (absolute CV values) will not be available until bidirectional communication is being implemented!

F0, F3, F6 Incrementing, decrementing and default setting of the lead CV number that was entered during the "Pseudo-Programming" initiation CV #301 = … (or via menu with the MX31).

F1, F4, F7 Incrementing, decrementing and default setting of the second CV number of that group; which CV's that are part of a group is shown in the CV table or is indicated in the ZIMO MX31 cab display.

F2, F5, F8 Incrementing, decrementing and default setting of the third CV number of that group (if the group includes 3 CV's).

The incrementing and decrementing of CV values (usually in the 0…255 range) takes place in steps of 1, 5, 10 or 15; this is predefined by the decoder software and cannot be changed. Intermediate values can be entered by direct CV programming, which in reality is hardly necessary.

The **"cuckoo jingle"** sounds when….

…. the upper or lower end of a CV value range is reached!

If RailCom is not available (because the system used is not equipped with RailCom), the value of a particular CV can only be determined by reading it out on the programming track. Although, most of the time this is not necessary since the reaction to a changed CV value can immediately be heard by the changing sound.

Note: With the MXDECUP update module it is possible to read-out and write complete CV and parameter sets and if necessary edit them on a computer!

7.3 The test-run for determining the motor's basic load

The following procedure enables the (subsequent) adjustment of driving sound to engine load (i.e. inclines, pulling weight…), such as steam chuffs (volume and sound) with the CV's #275, 276…

Technical background:
The load dependent sound is based on EMF (Electro Motive Force) measurements inside the decoder, which is primarily used for keeping the motor speed constant during load changes. Before the decoder can produce the correct sound for the respective driving conditions it has to know first what these measurements are at normal "no-load" cruising speed (smooth rolling of the engine or train on straight level track). This "basic load" of an engine or train is often considerably higher on model trains than on the real railroad, which is due to gearbox losses, power pick-ups etc. Deviations from this "basic load" will then be interpreted as inclines or declines, which triggers appropriately modified chuff sounds.

Initiated with "Pseudo-Programming"

CV #302 = 75

an automated test run is performed to record the "basic load" factor in forward direction;

ATTENTION: the engine (or train) is **driven automatically** in forward direction for which unoccupied track must be available of **at least 5 meters (15 feet),** with absolutely no inclines or declines and without any (tight) curves.

With **CV #302 = 76**

an automated recording run can be performed in reverse direction, for locomotives that have different "basic loads" in this direction (otherwise, the basic load in reverse is considered identical to forward).

The measured results are stored in **CV's #777 and 778** (slow/fast PWM values, forward) and **#779 and 780** (PWM values in reverse direction); these CV's can be read out and used as needed for other vehicles, or used as base for further tests.

Note: A "heavy" train (a train with higher rolling resistance due to power pickups of lighted coaches for example) may have a different "basic load" than an engine with nothing on the hook. A separate recording run may be required for such situation in order to obtain the best load dependent sound.

7.4 Basic settings independent of powertrain

The CV's in the following table have the same meaning for all types of power (Steam, diesel, electric):

NOTE: The **default values** of individual CV's are **NOT decoder-specific,** but rather depend on the decoder's **sound project.** This means that a HARD RESET with CV #8 = 8 returns the decoder to the state defined by the sound project. The default values listed below are values often used in sound projects, but not necessarily the correct values in all cases.

CV	Designation	Range	Default	Description
#265	Select loco type			For sound collections; see first page of this chapter (5.)
#266	Total volume	0-255 = 0-400%	64 = 100%	The value "65" results (mathematically) in the highest possible distortion-free playback volume; but values of up to 100 can be perfectly suitable. **Recommended: #266 = 40…90**
#395				Maximum volume the sound can be raised to (does not have to be the same value as in CV #266
#396				Defines function key for volume decrease; lowers volume as long as key is pressed; about 10 steps/sec, down to 0. ATTENTION: This changes CV #266.
#397				Defines function key for volume increase; raises volume as long as key is pressed; about 10 steps/sec, to the maximum defined in CV #395. ATTENTION: This changes CV #266; can be used as a substitute for a mute key.
#310	ON/OFF key for engine and random sound	0 - 28, 255	8	Defines the function key (by default F8) that turns the engine sound (chuffs, boiling, blow-offs, brake squeals...) as well as the random sound (compressor, coal shoveling...) ON or OFF. = 8: F8 key switches driving sound ON or OFF. Note: this is the default key for ZIMO original sound projects; OEM prjects (i.e. ROCO) often use other settings. Most often 1 for the F1 key. = 1…28: ON/OFF key for F1…F28. = 255: engine and random sounds are always ON.
#311	ON/OFF key for function sound	0 - 28	0	Function key assigned as ON/OFF key of function sounds (i.e. F2 – whistle, F6 – bell etc.). = 0: does not mean that F0 is assigned for this task but rather that the function sounds are always active. = (#310), if the same value is entered here as in CV #310, the key defined in #310 turns all sound ON/OFF. = 1 ... 28: Separate ON/OFF key for function sound.
#312	Blow-off key			See chapter 5.5 "Basic steam engine settings". (does not belong in this chapter, despite the correct number sequence)
#313	Mute key,	0 - 28 101 - 128	8	This CV assigns a function key with which the driving sounds can be faded in and out, i.e. when the train disappears behind scenery. F8 is used by default, which is already the sound
#314				on/off key but now does so softly. = 0: No mute key or mute function. = 1…28: Selected function key F1…F28 as mute key. = 101…128: Assigned function key with inverted action.
#376	Mute – fade in/out time	0 – 255 = 0 – 25 sec	0	Time in tenths of a second for sound fading in/out when mute button is pressed. Total range is 25 seconds. = 0 (to 10): minimum time setting of 1 sec. = 11…255: longer "fade" times
	Driving sound volume (Multiplier)	0 – 255 = 0 - 100 %	255 = 100 %	To reduce the driving sound volume (E.g . Diesel motor with related sounds such as turbo charger) compared to the function sounds.

The following CV's can be programmed both **"normal"** (i.e. CV #... = ...) and **"incremental".** "Incremental programming" is especially useful when the proper value cannot be calculated in advance and must be determined by trial, which is often the case with many sound parameters.

The "Lead CV" in each case is the first of 3 consequential CV's that are edited and shown on the same screen of a ZIMO MX31/MX32 cab during the "incremental programming" procedure.

CV	Designation	Range	INC-Step	Default	Description
LEAD - CV **#287**	Brake squeal threshold	0 – 255	10	20	The brake squeal should start when the speed drops below a specific speed step. It will be automatically stopped at speed 0 (based on back-EMF results).
#288	Minimum driving time before brake squeals	0 - 255 = 0 - 25 sec	10	50	The brake squeal is to be suppressed when an engine is driven for a short time only, which is usually a shunting run and often without any cars (in reality it is mostly the cars that are squealing not the engine itself!). Note: Brake squeal sounds can also be assigned to a function key (see allocation procedure CV #300 = …), with which the brake squeal can be started or stopped manually!

Coasting and **Notching** functions are required for driving situtations where the engine sound cannot be derived from speed, acceleration and load only.
Primarily in diesel locomotives (but not necessarily limited to diesels), the motor's idle sound or a certain specified speed step sound is enforced by keystroke.

This method can be used for "downshifting" (often to neutral) as well as "upshifting" (i.e. elevated idle for heating). Future software versions will expand this function to a fully independent sound effect.

CV	Bezeichnung	Werte-Bereich	Default	Beschreibung
#374	Coasting-Key (or Notching)	0 - 28	0	Function key that activates "Coasting", which forces the motor sound to a specified speed independent of the driving

CV	Bezeichnung	Werte-Bereich	Default	Beschreibung
				situation. Define the (sound) speed in CV #375 (often used for idle sound while coasting). = 0: does NOT mean F0, but rather that NO key is assigned for coasting. = 1 ... 28: One of the function keys F1 … F28 for "Coasting"
# 375	Coasting-Step (or Notching)	0 - 10	0	Motor speed (sound) to be activated with coasting key (as per CV #374), independent of driving situation. = 0: Idle sound (typical coasting situations) = 1 … 10: Sound speed (Diesel engines typically have 5 to 10 notches, which can be activated with the coasting key.

NOTE: If a decoder comes with a **potentiometer for volume control** (mostly on large-scale decoders), the pot meter should NOT be fully opened if full volume is not really desired (Loss of sound quality if pot meter is fully open and at the same time the volume is heavily reduced by CV's!).

The volume for "background" sounds (boiling, brake squealing etc.), function sounds, random sounds and switch input sounds can be set within the sound selection proccedures (see the "CV #300 procedures" above).

More convenient however is the direct volume adjustment by CV's (especially when no sound selection is necessary, which is often the case). Of course, not all sounds listed below are part of every sound project. Changing sound CV values of sound files that are not part of the relevant sound project have no effect.

Background sounds - Volume adjustments:

#574	Boiling	0 - 255	0	Boiling volume
#576	Directions change	0 - 255	0	Directions change volume
#578	Brake squeal	0 - 255	0	Brake squeal volume
#580	Thyristor sound	0 - 255	0	Thyristor sound volume (ELECTRIC engine)
#582	Start whistle/horn	0 - 255	0	Start whistle/horn volume
#584	Blow-off	0 - 255	0	Blow-off volume (STEAM engine)
#586	Electric motor	0 - 255	0	Electric motor volume (ELECTRIC engine)
#588	Driving sounds	0 - 255	0	Driving sounds volume
#590	Switch gear	0 - 255	0	Switch gear volume (ELECTRIC engine)
#592	Second Thyristor	0 - 255	0	Second Thyristor volume (ELECTRIC engine)
#594	Panto up	0 – 255	0	Pantograph up volume (ELECTRIC engine)
#596	Panto down	0 – 255	0	Pantograph down volume (ELECTRIC engine)
#598	Panto stop (down)	0 – 255	0	Pantograph stop (down) (ELECTRIC engine)
#600	Turbo	0 - 255	0	Turbocharger volume (DIESEL engine)
#602	Dynamic brakes	0 - 255	0	Dynamic brake volume (ELECTRIC engine)

Note: The CV ahead of the CV's listed (#573, 575 etc.) contain the sound sample numbers to be played.

Function sounds - Volume adjustments:

CV	Designation	Range	De-fault	Description
#571	Function sound F0	0 - 255 = 100, 1-100 %	0	Sound volume operated with function key F0 = 0: full volume, original sound sample volume (same as 255) = 1 .. 254: reduced volume 1 - 99,5 % = 255: full volume
#514	Function sound F1	0 - 255	0	Volume for function sound F1
#517	Function sound F2	0 - 255	0	Volume for function sound F2
#520	Function sound F3	0 - 255	0	Volume for function sound F3
#523	Function sound F4	0 - 255	0	Volume for function sound F4
#526	Function sound F5	0 - 255	0	Volume for function sound F5
#529	Function sound F6	0 - 255	0	Volume for function sound F6
#532	Function sound F7	0 - 255	0	Volume for function sound F7
#535	Function sound F8	0 - 255	0	Volume for function sound F8
#538	Function sound F9	0 - 255	0	Volume for function sound F9
#541	Function sound F10	0 - 255	0	Volume for function sound F10
#544	Function sound F11	0 - 255	0	Volume for function sound F11
#547	Function sound F12	0 - 255	0	Volume for function sound F12
#550	Function sound F13	0 - 255	0	Volume for function sound F13
#553	Function sound F14	0 - 255	0	Volume for function sound F14
#556	Function sound F15	0 - 255	0	Volume for function sound F15
#559	Funktions-Sound F16	0 - 255	0	Volume for function sound F16
#562	Function sound F17	0 - 255	0	Volume for function sound F17
#565	Function sound F18	0 - 255	0	Volume for function sound F18
#568	Function sound F19	0 - 255	0	Volume for function sound F19

#674, #677…#698 = volume for sounds on F20, F21…F28.

Note: The in-between CV's above (#570, 572, #513, 515, 516, 518 etc.) hold information for the relevant sound samples (sample numbers, loop parameters etc.), which can also be modified if needed, usually with the CV #300 procedures.

Switch input sounds - Volume adjustments:

#739	Switch input sound S1	0 - 255 = 100, 1-100 %	0	Volume setting for the sound activated by switch input S1. = 0: full volume, original sample volume (same as 255) = 1 .. 254: reduced volume 1 - 99,5 % = 255: full volume
#741	Switch input sound S2	0 - 255	0	Volume setting for the sound activated with switch input S2
#743	Switch input sound S3	0 - 255	0	Volume setting for the sound activated with switch input S3

Note: The CV immediately ahead of the CV's listed (# 740, 742) contain the sound sample numbers to be played.

Random sounds - Volume adjustments:

#745	Random sound Z1			Volume setting for sound activated by random generator Z1
#748	Random sound Z2			Volume setting for sound activated by random generator Z2
#751	Random sound Z3			Volume setting for sound activated by random generator Z3
#754	Random sound Z4			Volume setting for sound activated by random generator Z4
#757	Random sound Z5			Volume setting for sound activated by random generator Z5
#760	Random sound Z6			Volume setting for sound activated by random generator Z6
#763	Random sound Z7			Volume setting for sound activated by random generator Z7
#766	Random sound Z8			Volume setting for sound activated by random generator Z8

Note: The CV immediately ahead of the CV's listed (#744, 747 etc.) contain the sound sample numbers to be played.

7.5 Steam engine → Basic sound settings

The following CV's can be programmed both **"normal"** (i.e. CV #... = ...) and **"incremental".** "Incremental programming" is especially useful when the proper value cannot be calculated in advance and must be determined by trial, which is often the case with many sound parameters.

The "Lead CV" in each case is the first of 3 consequential CV's that are edited and shown on the same screen of a ZIMO MX31/MX32 cab during the "incremental programming" procedure.

CV	Designation	Range	INC-step	De-fault	Description
LEAD - CV **#266**	Total volume	0 - 255	5	64	See chapter 5.4 "Basic settings independent of powertrain"
#267	Chuff sound frequency with "virtual cam sensor" also see CV #354 in this table (chuff frequency at speed step 1)	0 - 255	1	70	CV #267 is only active if **CV #268 = 0:** Chuff beats follow the "virtual cam sensor"; an actual cam sensor is not needed in this case. The default setting "70" results in about 4, 6 or 8 chuffs per wheel revolution, depending on the chuff set selected; because it also depends in large part on the motor and gearbox used, an individual adjustment is necessary in most cases in order to achieve the exact chuff frequency. This is the purpose for CV #267: The lower the value the higher the chuff frequency and vice versa. The setting should be performed at a low speed (around speed step 10), but not at the lowest speed step 1.
#268	Switching to real cam sensor and trigger count for chuff rate and Special function for "Simple articulated" steam engines	0 - 255	1	0	= 0: "Virtual" cam sensor is active (to be adjusted with CV #267, see above). = 1: real cam sensor is active (connected to switch input 2 of the MX640, see chapter 6); each negative spike results in a chuff beat. = 2, 3, 4 … real cam sensor, several triggers in sequence (2, 3, 4 …) result in one chuff beat. = 128 (Bit 7=1 with "virtual" cam sensor): second driver is a bit slower; only meaningful if a second sound sample is available in the sound project. (Bit 7 = 1 with real cam sensor, see above for values): Cam sensor for driver 1 on IN3 (as usual), Cam sensor for driver 2 on IN2 (only possible if decoder has 2 inputs). = 192 (Bit 6 and 7 = 1): When no separate sound sample is available for the second driver, the same sample is played back for the second driver albeit a bit slower.
LEAD - CV **#269**	Accentuated lead-chuff	0 - 255	10	0	A typical sound signature of a passing steam engine is that one chuff out of a group of 4 or 6 chuffs is louder in volume than the rest; this effect is already part of the chuff set but can be further amplified with the help of CV #269.
#270	PROJECT not functional yet: Longer chuff length at very low speeds	0 - 255	10	?	PROJECT (not yet implemented): The chuff sounds of a real engine are extended when driving at very low speeds due to the mechanical valve control. This effect can be more or less accentuated with CV #270.
#271	Overlapping effect at high speed	0 – 255 (useful up to @ 30)	1	16	The individual steam chuffs of a real engine overlap each other at high speed. Because the frequency of the chuffs increases but won't shorten to the same extend they will eventually blend in to a weakly modulated swoosh. This is not always desired in model railroading because it doesn't sound that attractive, hence CV #271, with which an adjustment is possible to have the chuff beats accentuated at high speed or rather fade away.
LEAD - CV **#272**	Blow-off duration also see CV #312 (blow-off key)	0 - 255 = 0 - 25 sec	10	50 = 5 sec	Opening the cylinder valves on a prototype steam engine for the purpose of water drainage is entirely up to the engineer. An automated draining at start-up is more suitable in model railroading; CV #272 defines how long after start-up the blow-off sound should play. Value in CV #272 = time in tenth of a second! Note: If the blow-off sound is also allocated to a function key (as delivered on F4, see CV #312), the automated blow-off sound can be shortened or extended with the relevant function key. Automated blow-off and function key blow-off are inevitably the

CV	Designation	Range	INC-step	De-fault	Description
					same (as per selection/allocation). **= 0**: no blow-off sound played back
#273	Start-up delay during blow-off	0 - 255 = 0 - 25 sec	1	0	Opening the cylinder valves and with it the related blow-off sound on a real steam engine starts most often before the engine even starts to move. This can be imitated with CV #273 by automatically delaying the start of the locomotive. This effect is cancelled when a shunting function with momentum deactivation is being activated (see allocation of F3 or F4 in CV #124!) = 0: no delayed start = 1: Special setting for blow-off via speed regulator; no start-up delay, but setting the speed to the lowest speed step causes the blow-off sound to be played without powering the motor (only with 128 speed steps). = 2: Start-up delay in tenths of a second, Recommendation: no value > 20 (> 2 sec)
#274	Blow-off schedule, start-up whistle schedule	0 - 255 = 0 - 25 sec	10	30	Constant opening and closing of the cylinder valves in real shunting operations, that often requires many short trips with associated idle times, is usually ommited. CV #274 causes the blow-off sound to be suppressed if the engine wasn't standing still for the time defined here. Value in CV #274 = time in tenth of a second! The same stop-time is also used for the start-up whistle!
#312	Blow-off key	0 - 19	-	4 = F4	Defines a function key to playback the blow-off sound manually, for shunting with open cylinder valves for example (that is the same sound programmed with CV #300 = 133 for automated playback). = 4: usual blow-off key = 0: no key assigned (use this setting if keys are needed for other purposes).
#354	Steam chuff frequency at speed step 1 also see CV #267 in this table	1 - 255	-	0	CV #354 works only if used together with CV #267! CV #354 compensates for the non-linear speed measurements of the "virtual cam sensor": While the adjustment of CV #267 is done in the vicinity of speed step 10 (slow but not very slow), a correction for speed step 1 can be performed with CV #354 (extremely slow). = 0: no effect = 1…127: more chuff beats in relation to CV #267, = 255…128: less chuff beats.

CV	Designation	Range	INC-step	De-fault	Description
#154	Various special bits		-	0	Bit 1 = 1: DIESEL, ELECTRO: Start immediately even if idle sound playback is not finished. Bit 2 = 1: DIESEL, ELECTRO: Wait for idle sound at short stops before departure. Bit 4 = 1: STEAM: Two stage compressor (Z1 for fast refill after coming to a stop, Z2 for slow pressure loss compensation during longer stops). Bit 7 = 1: STEAM: Delay departure until start whistle has finished playback. Other Bits: OEM special applications (Pantos)
#158	Various special bits		-	0	Bit 0 = 1: SPECIAL MX648: Function output FO1 is used for an automatic control line of an external energy storage. Bit 1 = 1: DIESEL-MECHANICAL: No RPM increase when braking (see CV #364). Bit 2 = 0: RailCom actual speed (kph) feedback in "old" format (for MX31ZL, RailCom ID 4). = 1: RailCom actual speed (kph) feedback in current format (RailCom ID 7). Bit 3 = 1: "Looped" driving sounds will be faded out when switching to a different speed step in order to shorten the sounds. Bit 4 = 1: Steam chuff frequency increases slower at high speed (non-proprotional) Bit 5 = 1: Braking (even by one speed step) causes the motor and turbo sounds to decrease by on sound step. Bit 6 = 1: Thyristor sound may be louder when braking (even if the volume is supposed to decrease according to CV #357); see CV #357. Bit 7 = 1: SPECIAL MX645: ELECTRIC: Flashes of light (approx. 0.1 sec) on FO7 when switch gear sound is played.
#394	Sample crossfading	0 - 255	-	0	Bit 0 = 1: SPECIAL MX645: ELECTRIC: Flashes of light (approx. 0.1 sec) on FO6 when switch gear sound is played. Bit 4 = 1: Faster acceleration when speed regulator fully opened. Bit 5 = 1: Crossfading of chuff samples

7.6 Steam engine → Load and acceleration dependency

The load dependency of the sound is based on the current engine load and the acceleration / deceleration settings. The results of the "basic" load test serve as reference for the current motor load, see section 7.3 "The test run for determining the motor's basic load".

NOTE: ZIMO large-scale decoders MX695 and up, and possibly some of the smaller decoders (but not the current MX640 – MX648's) contain a position and acceleration sensor that will improve the function of load dependency dramatically, once it is activated with future software versions.

To set up load dependent sound, follow the **instructions in this order:**

+ Perform "The test run for determining the motor's basic load"; see chapter 5.3

+ Adjust CV's #275 and #276 **+** Adjust CV #277 **+** If needed CV #278 and #279

NOTE: The CV's in this chapter affect the volume's load dependency of the relevant sound (that is, by how much the volume should increase at higher loads or decrease by lesser loads, all the way down to mute if necessary). A possible exchange of sound samples at load increase or decrease is however a matter of the sound project program.

There are however special exceptions to this rule...

NOTE: The **default values** listed in the individual CV's are guidelines only, as actual values in reality may be determined by the loaded **sound project;** this also means that a HARD RESET with CV #8 = 8 restores the CV's back to the sound project values.

CV	Designation	Range	INC-Step	Default	Description
LEAD - CV **#275**	Chuff sound volume at low speed and no-load	0 - 255	10	60	With this CV the chuff volume can be adjusted for low speed and "basic load" (same conditions as during the "automated recording run"). Here, the engine is driven by about 1/10 of its full speed, adhering to the exact speed is however not important. During this adjustment CV #277 is to be left at "0" (default), so that the setting for "no-load driving" is not influenced by load factors.
#276	Volume at high speed and no-load	0 - 255	10	80	Same procedure as in CV #275 above, but for high speed. CV #276 defines the "basic-load" chuff sound volume at full speed. Set the speed regulator to maximum during this set-up.
#277	Chuff volume changes according to load	0 - 255	10	0 = no reaction	When deviating from the basic load (as determined by the "Automated recording of the motor's "basic load" factor", see above), the chuff beat volume should be increasing (on inclines) or decreasing on declines (even muted).
					CV #277 defines the degree of change, which must be set to the proper value by trial.
LEAD - CV #278	Load change threshold	0 - 255	10	0	With this CV, a change in volume to small load changes can be suppressed (i.e. in curves) in order to prevent chaotic sound impressions. Suitable settings can only be determined by trial.
#279	Reaction time to load change	0 - 255	1	0	This CV determines how quick the sound reacts to load changes, whereas the factor is not just time but rather "load-change dependent time" (= the bigger the change the faster the effect). This CV is also used to suppress chaotic sound changes. Suitable settings can only be determined by trial.
LEAD - CV **#281**	Chuff volume - Acceleration threshold for full load sound	0 – 255 (internal speed steps)	1	1	More powerful and louder chuff sounds should be played back indicating increased power requirements during accelerations, compared to "basic load". As is the case with the prototype, the increased sound should be noticeable before the increase in speed becomes visible, since the latter is a result of the increased steam volume supplied to the pistons. It is therefore practical that the heavy acceleration sound is played back when the speed has increased by just one speed step (when no real speed change is noticed), to be able to control the proper sound sequence with the speed regulator. The "engineer" can in this fashion adjust the sound (by increasing the speed by 1 step) in anticipation of an imminent incline. =1: Acceleration sound played back (at full volume) if speed has increased by just one speed step. = 2, 3…. Acceleration sound played back at full volume only after increasing speed by this number of speed steps; before that: proportional volume.
#282	Duration of acceleration sound	0 - 255 = 0 - 25 sec	10	30 = 3 sec	The acceleration sound should remain for a certain length of time after the speed increased (otherwise each single speed step would be audible, which is unrealistic).

					Value in CV #282 = time in tenth of a second!
#283	Chuff sound volume during full acceleration	0 - 255	10	255	The volume of steam chuffs at maximum acceleration is set with CV #283 (default: 255 = full volume). If CV #281 = 1 (acceleration threshold set to 1 speed step), the volume defined here is applied with each speed increase, even if it's just 1 step.
LEAD - CV **#284**	Threshold for deceleration sound	0 -255 (internal speed steps)	1	1	Steam chuffs should be played back at less volume (or muted) signifying the reduced power requirement during deceleration. The sound reduction logic is analog to a reversed acceleration (per CV #281 to #283). = 1: Reduces sound to a minimum (as per CV #286) when speed is reduced by just 1 step. = 2, 3 ... sound reduced to minimum after lowering speed by this number of steps.
#285	Duration of reduced volume during deceleration	0 - 255 = 0 - 25 sec	10	30 = 3 sec	After the speed has been reduced, the sound should remain quieter for a specific time (analog to the acceleration case). Value in CV #285 = time in tenth of a second!
#286	Volume level during deceleration	0 - 255	10	20	CV #286 is used to define the chuff volume during deceleration (Default: 20 = pretty quiet but not muted). If CV #284 = 1 (deceleration threshold set to 1 speed step), the volume defined here is applied with every reduction in speed (even if decreased by just 1 step).

7.7 Diesel and Electric engines → Diesel motor sound
Turbocharger sound
Thyristor sound
Electric motor sound
Switchgear sound

Diesel and Electric engines have certain commonalities and are therefore described in the same chapter: Diesel-electric propulsion systems have sound components (sound sequences) from both areas. On the other hand, the separation of "Basic settings" and "Load dependence" (as with the steam engines in the previous chapters) is not practical.

CV	Designation	Range	INC-step	De-fault	Description
#266	Total volume	0 - 255	5	64	See chapter 7.4 “Basic settings independent of powertrain”
#280	Diesel engine - Load influence	0 - 255	10	0	This CV determines the reaction of the diesel sound to load: Diesel-hydraulic engines – higher and lower rpm’s and notches Diesel-electric engines – cruise/idle rpm Diesel-mechanical – shift points. = 0: no influence, motor rpm changes with speed = 1 to 255: minimum to maximum influence. NOTE: It is highly recommended to perform the **automated test run** with CV #302 = 75 first (see chapter 7.3).
#154	Various Special Bits		-	0	Bit 1 = 1: DIESEL, ELECTRO: Start immediately even if idle sound playback is not finished. Bit 2 = 1: DIESEL, ELECTRO: Wait for idle sound at short stops before departure. Bit 4 = 1, Bit 7 = 1: see STEAM
#158	Various special bits (mostly in connection with functions de-fined in various other CV’s)				Bit 0 = 1: SPECIAL MX648: Function output FO1 is used for an automatic control line of an external energy storage. Bit 1 = 1: DIESEL-MECHANICAL: No RPM increase when braking (see CV #364). Bit 2 = 0: RailCom actual speed (kph) feedback in “old” format (for MX31ZL, RailCom ID 4). = 1: RailCom actual speed (kph) feedback in current format (RailCom ID 7). Bit 3 = 1: “Looped” driving sounds will be faded out when switching to a different speed step in order to shorten the sounds. Bit 4 = 1: Steam chuff frequency increases slower at high speed (non-proportional) Bit 5 = 1: Braking (even by one speed step) causes the motor and turbo sounds to decrease by on sound step. Bit 6 = 1: Thyristor sound may be louder when braking (even if the volume is supposed to decrease according to CV #357); see CV #357. Bit 7 = 1: SPECIAL MX645: ELECTRIC: Flashes of light (approx. 0.1 sec) on FO7 when switch gear sound is played.
#344	Run-on time of motor sounds (Cooling fan etc.) after stops	0 - 255 = 0 - 25 sec	-	0	After the engine comes to a stop some accesso-ries are supposed to remain operating (i.e. cool-ing fans) and automatically stop after the time de-fined here, provided the engine didn’t start up again. = 0: Won’t run after stop = 1 … 255: Runs for another 1 to 25 seconds.
#345	SHIFT key to switch between two sound variations within a sound collection: for different operating modes of a locomotive or between the sounds of a MULTI-SYSTEM engine	1 - 28		0	Defines a function key (F1 – F28) which switches between two sound types (i.e. between an electro and diesel sound of a multi-system engine) that is, between the sound in CV #265 and the next one in the list. For example Switch between two modes of operation (light train / heavy train) or Switch between en electric or diesel propul-sion of a multi-system engine; typical case: Sound project for RhB Gem.
#346	Prerequisite for switching between collections, as per CV #345	0, 1, 2		0	Bit 0 = 1: Switches between sound collections at stand-still even with sound ON. Bit 1 = 1: Switching is also possible while driving.
#347	Key for switch-over to solo driving and sound performance	0 - 28		0	= 0: No key, no switch-over possible. = 1…28: One of these function keys (F1 – F28) acts as the switch-over key for driving a heavy train or a single locomotive. Parameters are selected with CV #348.
#348	Switch-over parame-ters for key selected with CV #347	0 - 7		0	When driving solo (Function key as per CV #347 is ON), the… Bit 0 = 1:…Diesel sound should rev up unhindered to maximum rpm (or limited in relation to speed step as per CV #389). Bit 1 = 1: acceleration and deceleration times in CV #3 and 4 should be reduced, wherein the amount of reduction is set in CV #390. Bit 2 = 1: motor’s idle sound should be played-back when driving at low speeds, wherein the highest speed step is set in CV #391.
#387	Influence of accel-eration to diesel sound steps	0 - 255		0	In addition to the speed step (as defined in the ZSP flow diagram), the current change of speed (accel-eration, deceleration) should also have an influ-ence on sound due to the associated increase or decrease in load.

CV	Designation	Range	INC-step	De-fault	Description
					= 0: No influence (sound depends on speed step only) = 64: experience has shown this to be a practical value = 255: maximum acceleration response (highest sound step during acceleration)
#388	Influence of deceler-ation to diesel sound steps	0 - 255		0	Same as CV #387 but used during decelerations. = 0: No influence (sound depends on speed step only) = 64: experience has shown this to be a practical value = 255: maximum deceleration response
#389	Limitation of the ac-celeration influence over diesel sound steps	0 - 255		0	This CV determines how far the sound step may deviate during accelerations (= difference between target speed from the cab and actual speed) from a direct depedence on speed step (as per schedule). = 0: No deviation; motor sounds according to schedule, sound does not depend on acceleration. = 1…254: Dependence increases with value. = 255: fully dependend on target speed.
#390	Momentum reduction when driving solo (engine only)	0 - 255		0	When switching to solo driving (or lighter train) with key defined in CV #347 the momentum is reduced (if so selected with CV #348, Bit 1): = 0 or 255: No reduction = 128: Momentum reduced by half = 64: Reduced to ¼ = 1: virtually cancels all momentum.
#391	Driving with idle sound, when driving solo	0 - 255		0	The diesel motor sound should remain at idle when driving solo (with function key defined in CV #347), until the speed step defined in CV #391 is reached.
#348	Sparks with switch-gear sound	0 - 255	MX645 only!	0	Bit 0 = 1: Sparks at function output FO6 when switchgear sound is played back
#378	Likelihood of switch-gear sparks during acceleration	0 - 255	MX645 only!	0	Likelihood for sparks when accelerating = 0: always = 1: very rarely = 254: very often (almost always)
#379	Likelihood of switch-gear sparks during deceleration	0 – 255	MX645 only!	0	Likelihood for sparks when decelerating = 0: always = 1: very rarely = 254: very often (almost always)
#364	Speed drop during upshifts			0	This special CV applies only to diesel-mechanical engines and defines the typical drop in speed when

CV	Designation	Range	INC-step	De-fault	Description
	for DIESEL engines with mechanical transmission.				shifting up. See sound projects (i.e. VT 61)
#365	Upshift rpm for DIESEL engines with mech. transmis-sion.			0	This special CV applies only to diesel-mechanical engines and defines the highest rpm before shifting up. See sound projects (i.e. VT 61)
#366	Maximum turbo sound volume for DIESEL engines	0 - 255		48	
#367	Turbo rpm depend-ency on speed for DIESEL engines	0 - 255		150	Turbo playback frequency depending on engine speed.
#368	Turbo rpm depend-ency on acceleration for DIESEL engines	0 - 255		100	Playback frequency depends on the difference of set speed to actual speed (= acceleration).
#369	Minimum load for turbo for DIESEL engines	0 - 255		30	Audibility threshold for turbochargers; the load is derived from CV #367 and 368.
#370	Frequency increase of turbo for DIESEL engines	0 - 255		25	Speed of frequency increase of the turbocharger.
#371	Frequency decrease of turbo for DIESEL engines	0 - 255		15	Speed of frequency decrease of the turbocharger.
#289	Thyristor control Stepping effect ELECTRIC engines	0 - 255			The pitch of the thyristor sound of many engines (typical example: Taurus) should not ascend even-ly but rather in steps (scale). = 1 - 255: ascending scale according to the corre-sponding speed step interval.
#290	Thyristor sound at “slow” speeds for ELECTRIC engines	0 - 255			Sound pitch for speed defined in CV #292.
#291	Thyristor control Sound pitch at max-imum speed for ELECTRIC engines	0 - 255			Sound pitch at top speed.
#292	Thyristor low speed for ELECTRIC engines	0 - 255			Speed for sound pitch per CV #290.

CV	Designation	Range	INC-step	De-fault	Description
#293	Thyristor control Volume at steady speed for ELECTRIC engines	0 - 255			Thyristor sound volume at steady speed (no acceleration or deceleration in process).
#294	Thyristor control Volume during acceleration for ELECTRIC engines	0 - 255			Volume during accelerations; the value in CV #294 should be larger than in CV #293 to be useful (so that the volume increases when the engine accelerates).
#295	Thyristor control Volume during deceleration Motor sound of ELECTRIC engines	0 - 255			Volume during heavier decelerations (braking)
#357	Thyristor control Lowering the volume at higher speeds for ELECTRIC engines	0 - 255		0	Internal speed step at which the thyristor sound volume should be reduced. The volume stays at this reduced level while braking. By changing CV #158 Bit 6 = 1, the volume will be raised while braking.
#358	Thyristor control Volume reduction curve at higher speeds for ELECTRIC engines	0 - 255		0	Defines a curve as to how the thyristor sound should be lowered at the speed step in CV #357. = 0: no reduction. = 10: reduced by about 3% per speed step. = 255: aborts the sound when the speed step defined in CV #357 is reached.
#362	Thyristor control Switchover threshold for second thyristor sound for ELECTRIC engines	0 - 255	0		Defines a speed step at which a second thyristor sound for higher speeds is played back; this was introduced for the sound project “ICN” (Roco OEM sound) = 0: no second thyristor sound.
#296	Electric motor sound, maximum volume for ELECTRIC engines	0 -255		0	Maximum volume of motor sound.
#297	Electric motor sound, when sound becomes audible for ELECTRIC engines	0 -255		0	Internal speed step at which the motor sound becomes audible. Part of a charachteristic curve with CV’s #298/299.
#298	Electric motor sound, volume dependent on speed for ELECTRIC engines	0 -255		0	Slope of the characteristic curve for speed dependent volume. (curve starts with #297) See ZSP manual!
#299	Electric motor sound, Sound pitch dependent on speed for ELECTRIC engines	0 -255		0	Slope of the characteristic curve for speed dependent volume. (curve starts with #297) See ZSP manual!
#372	Electric motor sound, Volume dependent on speed for ELECTRIC engines	0 – 255		0	= 0: No function = 1…255: minimal to maximum effect
#373	Electric motor sound, Volume dependent on braking for ELECTRIC engines	0 – 255		0	= 0: No function = 1…255: minimal to maximum effect
#350	Switchgear sound, lock-out after start up for ELECTRIC engines.	0 - 255	0		Time in tenths of a second (0 – 25 sec.) the switch gear sound should be delayed after departure; useful when the first switching step is already part of the sound sample “idle -> F1”. The switchgear on some engines (i.e. E10) should not be heard immediately after start-up but rather after some time defined here. = 0: Switchgear is heard immediately at departure.
#359	Electric switch gear sound Playback duration for the switch gear sound during speed changes for ELECTRIC engines	0 - 255		30	Time in tenth of a second the switch gear should be heard during speed changes (adjustable from 0 – 25 sec.). Effective only if switch gear sound is part of the sound project.
#360	Electric switch gear sound Playback duration for the switch gear sound after coming to a stop for ELECTRIC engines	0 - 255		0	Time in tenth of a second the switch gear should be heard after the engine comes to a full stop (adjustable from 0 – 25 sec.). = 0: no sound after stop.
#361	Switch gear sound Playback delay	0 – 255		20	During rapid successions in speed changes the switch gear sound would be played back too often. CV #361: Time in tenths of a second (0 – 25 sec.)

CV	Designation	Range	INC-step	De-fault	Description
	for ELECTRIC engines				defines minimum delay between multiple play-backs.
#363	Switch gear sound Dividing the speed into shift steps for ELECTRIC engines	0 - 255		0	Number of shift steps to cover the whole speed range; i.e. if 10 shift steps are programmed, the switch gear sound is played back at internal speed step 25, 50, 75… (a total of 10 times) = 0: synonymous with 5 (5 switch steps over the whole speed range).
#380	Manual electric brake key	1 – 28		0	Defines a function key to manually control the sound of a “dynamic” or “electric” brake.
#381	Electric brake - minimum speed	0 – 255		0	The electric brake shall only be heard between the value defind in CV #381…
#382	Electric brake - maximum speed	0 – 255		0	…and the value in CV #382
#383	Electric brake - Pitch	0 – 255		0	= 0: Pitch independent of speed = 1…255: …depends increasingly on speed.
#384	Electric brake – Deceleration threshold	0 – 255		0	The number of speed steps lowered during decel-eration before the electric brake sound is played back.
#385	Electric brake – Downhill	0 – 255		0	= 0: no effect at “negative” load = 1 – 255: Sound triggered at “negative” load.
#386	Electric brake – Loops	0 – 255		0	Bit 3 = 0: Sound fades out at sample end = 1: Sound ends at with sample end Bit 2…0: Increases minimum playback time by 0 … 7 seconds, to prevent an interruption in break sound between speed steps.

Coasting and **Notching** functions are required for driving situtations where the engine sound cannot be derived from speed, acceleration and load only.
Primarily in diesel locomotives (but not necessarily limited to diesels), the motor’s idle sound or a certain specified speed step sound is enforced by keystroke.

This method can be used for “downshifting” (often to neutral) as well as “upshifting” (i.e. elevated idle for heating). Future software versions will expand this function to a fully independent sound effect.

CV	Designation	Range	Default	Description
#374	Coasting-Key (or Notching)	0 - 28	0	Function key that activates “Coasting“, which forces the motor sound to a specified speed independent of the driving situation. Define the (sound) speed in CV #375 (often used for idle sound while coasting). = 0: does NOT mean F0, but rather that NO key is assigned for coasting. = 1 ... 28: One of the function keys F1 … F28 for “Coasting“
# 375	Coasting-Step (or Notching)	0 - 10	0	Motor speed (sound) to be activated with coasting key (as per CV #374), independent of driving situation. = 0: Idle sound (typical coasting situations) = 1 … 10: Sound speed (Diesel engines typically have 5 to 10 notches, which can be activated with the coasting key.
#398	Automatic Coasting	0 – 255	0	The number of speed steps the train’s speed has to be re-duced within 0.5 seconds in order for the automatic coasting effect to set the motor sound to idle (without assigning a coasting key above). The motor sound will not return to idle if the speed is reduced at a slower rate.

It is especially convenient if the ***sound step can be raised manually*** with a function key when operating diesel engines.

CV	Designation	Range	Default	Description
#339	Key assignment for raising diesel step	0 - 28	0	Define a function key that raises the diesel motor to the min-imum step defined in CV #340. See below if more function keys are needed to raise the sound further.
#340	Define diesel step and possibly more key assignments	0 - 10	0	Minimum step the sound of the diesel motor should increase to with the key defined in CV #339. These steps are not mo-tor speed steps but rather sound steps. A sound library can have 1 to 10 speed (sound) steps (i.e. “1” forces the sound to sound step 1, “2” to sound step 2 etc.). The sound can only be increased with these keys. For sound decrease, use the coasting functions in the table above. To add more function keys for more speed increases use this calculation: Lowest speed (sound) step for the first key defined in CV #339 + (16 * (number of keys – 1)). Example: F4 is defined as the first key in CV #339, which is supposed to raise the speed from idle to the first cruise step. To add 3 more keys (F5 to 2nd cruise step, F6 to 3rd , F7 to 4th): 1 (first cruise step above idle) + 63 (4 * 16 – 1) = 64.

7.8 Random and Switch input sounds

#315	Minimum interval for random generator Z1	0 - 255 = 0 - 255 sec	1	The random generator generates internal pulses in irregular intervals that are used to playback a sound file assigned to the random generator. CV #315 defines the shortest possible interval between two consecutive pulses. Sound samples are assigned to the random generator Z1 with the help of the procedure CV #300 = 101, see above! By default, the compressor is assigned to Z1.
				Special note to random generator Z1: The random generator Z1 is optimized for the compressor (which should be played back shortly after the train has stopped); therefore the default assignment should be retained or at the most be used for a different compressor. CV #315 also determines the proper time the compressor is started after coming to a stop!
#316	Maximum interval for random generator Z1	0 - 255 = 0 - 255 sec	60	CV #316 defines the maximum time interval between two consecutive pulses of the random generator Z1 (that is most often the start of the compressor after coming to a stop); the actually occurring pulses between the values in CV #315 and #316 are equally distributed.
#317	Playback length for random generator Z1	0 - 255 = 0 - 255 sec	5	The sound sample assigned to the random generator Z1 (most often the compressor) is played back for the number of times defined in CV #317. = 0: Sample plays once (in the defined duration)
#318 #319 #320	As above but for sound generator Z2	0 - 255 0 - 255 0 - 255	20 80 5	By default, Z2 is assigned for coal shoveling at stand-still.
#321 #320 #323	As above but for sound generator Z3	0 - 255 0 - 255 0 - 255	30 90 3	By default, Z3 is assigned for the injector at stand-still.
#324 #325 #326	As above but for sound generator Z4	0 - 255 0 - 255 0 - 255		As delivered, this random generator is not assigned to any sound.
#327 #328 #329	As above but for sound generator Z5	0 - 255 0 - 255 0 - 255		As delivered, this random generator is not assigned to any sound.
#330 #331 #332	As above but for sound generator Z6	0 - 255 0 - 255 0 - 255		As delivered, this random generator is not assigned to any sound.
#333 #334 #335	As above but for sound generator Z7	0 - 255 0 - 255 0 - 255		As delivered, this random generator is not assigned to any sound.
#336 #337 #338	As above but for sound generator Z8	0 - 255 0 - 255 0 - 255		As delivered, this random generator is not assigned to any sound.
#341	Switch input 1	0 - 255	0	The sound sample allocated to switch input 1 is played back
	Playback duration	= 0 - 255 sec		for the duration defined with this CV. = 0: Play back once (duration as recorded)
#342	Switch input 2 Playback duration	0 - 255 = 0 - 255 sec	0	The sound sample allocated to switch input 2 is played back for the duration defined with this CV. = 0: Play back once (duration as recorded)
#343	Switch input 3 (if not used for the cam sensor) Playback time	0 - 255 = 0 - 255 sec	0	The sound sample allocated to switch input 3 is played back for the duration defined with this CV. = 0: Play back once (duration as recorded)

8 CV – Summery List

This list summarizes all CV's in numerical order, with very short descriptions (as a reminder).
Detailed information can be found in the **preceding chapters** ("Configure", "ZIMO Sound").
The "red" column: Denotes the subchapter in chapter 3 "Addressing, Programming" or another main chapter.

	CV	Designation	Range	Default	Description
4	#1	Short address	1 – 127	3	The "short" address; active when Bit 5 in CV #29 is 0.
6	#2	Start voltage	1 - 255	1	Internal speed step for **lowest** external speed step.
7	#3	Acceleration rate	0 - 255	(2)	Multiplied by 0.9 equals' acceleration time.
7	#4	Deceleration rate	0 - 255	(1)	Multiplied by 0.9 equals' deceleration time.
6	#5	Top speed	0 - 255	1 (=255)	Internal speed step for **highest** external speed step.
6	#6	Medium speed	32 - 128	1 (=1/3 # 5)	Internal speed step for **medium** external speed step.
3	#7	SW-Version number	Read-only	-	The current SW number; for subversion see CV #65.
3	#8	Manuf.-ID, Reset, Set	0, 8, Set #	145 (ZIMO)	given by the NMRA; CV #8 = 8 → Hard Reset.
6	#9	Motor regulation.	1 - 255	55	Sample time (tens digit), sample rate (ones digit)
6	#10	Compensation-Cutoff	0 - 252	0	Internal speed step, where BEMF intensity per CV#113.
-	#11	------			
-	#12	------			
5	#13	Analog functions F1 - F8	0 - 255	0	Select analog functions F1 (Bit 0), F2 (Bit 1)...
5	#14	Analog funct. F0, F9 …	0 - 255	0	Select analog functions, F0 forw (Bit 0), rev (Bit 1)...
-	#15	------			
-	#16	------			
4	#17,18	Extended address	128 - 10239	0	The long address. Active when CV #29, Bit 5 = 1.
4	#19	Consist address	0 - 127	0	Consist address active when > 0.
4	#21	Consist function F1 - F8	0 - 255	0	Select consist functions F1 (Bit 0), F2 (Bit 1)….
4	#22	Consist function F0	0 - 3	0	Select consist function F0 forw (Bit 0), rev (Bit 1).
7	#23	Acceleration variation	0 - 255	0	For temporary adjustment to CV #3
7	#24	Deceleration variation	0 - 255	0	For temporary adjustment to CV #4
-	#25	------			
-	#26	------			
10	#27	Asym. Stop (ABC)	0, 1, 2, 3	0	Bit 0 = 1: Stop, with right rail Bit 1: left rail
2	#28	RailCom Configuration	0, 1, 2, 3	3	Bit 0 = 1: RailCom (Broadcast) Bit 1 = 1: Data
2	#29	DCC Basic Settings	0 - 63	14 = 0000 1110 with Bits 1, 2, 3 (28 SS, Analog, RailCom)	Bit 0 – Direction: 0 = normal, 1 = reversed Bit 1 – Speed step system: 0 = 14, 1 = 28, 128 Bit 2 – Automatic analog operation Bit 3 – RailCom: 0 = OFF, 1 = ON Bit 4 – Speed curve: 0 = 3-point, 1 = free definition Bit 5 – Short/long address: 0 = CV #1, 1 = CV's #17,18
14	#33	NMRA Function map F0	0 - 255	1	Function mapping for F0 forward
14	#34	NMRA Function map F0	0 - 255	2	Function mapping for F0 reverse
14	#35-46	Function mapp. F1 - F12	0 - 255	4,8,2,4,8,...	Function mapping for F1 ... F12
-	#47	------			
-	#48	------			
9	#49	HLU Acceleration	0 - 255	0	Multiplied by 0.4 = signal controlled acceleration
9	#50	HLU Deceleration	0 - 255	0	Multiplied by 0.4 = signal controlled deceleration
9	#51-55	HLU Limits	0 - 255	20,40,…	Speed step for each of the 5 HLU speed limits
6	#56	Motor regulation	1 - 255	55	PID regulation: P-Value (tens digit), I-Value (Ones digit)
6	#57	Voltage reference	0 - 255	0	Value = 1/10 of fixed voltage. "0" = track voltage.
6	#58	BEMF intensity	0 - 255	255	Load compensation at low speeds
9	#59	HLU Reaction time	0 - 255	5	Delay for HLU changes, in tenth of a second
18	#60	Dimming	0 - 255	0	Reduction of function output voltage through PWM.
14	#61	ZIMO ext. mapping	1,2...97, 98	0	Configurations not covered by NMRA mapping
21	#62	Light effects mod.	0 - 9	0	Adjusts minimum dim value
21	#63	Light effects mod.	0 - 99	51	Cycle time (tens digit), Off-time extension (ones dig-it)
21	#64	Light effects mod.	0 - 9	5	Ditch light off-time modification
3	#65	SW-Subversion #	0 - 255	-	Completes the version number in CV #7.
6	#66	Forward trimming	0 - 255	0	Multiplies speed step by trim value/128
6	#67-94	Free speed table	0 - 255	0	Internal speed step for each of the 28 external steps
6	#95	Reverse trimming	0 - 255	0	Multiplies speed step by trim value/128
-	#96 ...	------			
-	105, 6	User data	0 - 255	0	Free memory space for user data
16	#107	Light suppression	0 - 255	0	Light suppression for cab 1 (forward)
16	#108	Light suppression	0 - 255	0	Light suppression for cab 2 (rear)

	CV	Designation	Range	Default	Description
-	109 …	------			
1, 6, 20 …	#112	Special ZIMO configuration bits	0 - 255	4 = 00000100 also Bit 2 = 1 (Loco ID puls-es ON, 20 kHz)	Bit 1 = 1: High frequency acknowledgements Bit 2 = 0 / 1: ZIMO loco ID ON/OFF Bit 3 = 1: 8 Functions-Mode (for old ZIMO systems) Bit 4 = 1: Pulse chain recognition (for old LGB-System) Bit 5 = 0 / 1: Motor control at 20 kHz or 40 kHz Bit 6 = 1: „Märklin"-Braking (+ CV # 29, Bit 2, # 124, 5)
6	#113	BEMF reduction	0 - 255	0	Intensity reduced at speed step defined in CV #10.
18	#114	Dim Mask 1	Bits 0 - 7	0	Individual outputs exempted from dimming per CV #60
23	#115	Uncoupler control	0 - 99	0	Eff 48: Pull-in V. (tens digit), Hold voltage (ones digit)
23	#116	Autom. uncoupling	0 - 199	0	Unload (Hundredth) Separat.(Tens), speed (Ones digit)
19	#117	Flasher	0 - 99	0	ON time (Tens digit), OFF time (Ones digit)
19	#118	Flasher mask	Bits 0 - 7	0	Function outputs included for flashing as per CV #117.
18	#119	F6 low beam mask	Bits 0 - 7	0	Enter FO for low-beam switching with F6 as per CV #60
18	#120	F7 low beam mask	Bits 0 - 7	0	Enter FO for low-beam switching with F7 as per CV #60
7	#121	Expon. acceleration	0 - 99	0	Speed range included (Tens digit), curve (Ones digit)
7	#122	Expon. deceleration	0 - 99	0	Speed range included (Tens digit), curve (Ones digit)
7	#123	Adapt. accel./decel.	0 - 99	0	Accel. Convergence (Tens dig.), Decel. Conv. (Ones…)
13	#124	Shunting keys, Out-puts instead of SUSI	Bits 0-4, 6	0	Shunting key (for half speed, accel. deactivation), Switch between SUSI – Logic level outputs
21	#125 #126 #127 #128 #129 #130 #131 #132	Effects F0 front F0 rear F1 F2 F3 F4 F5 F6	0 - 255	0	Bits 1, 0 = 00: directional (active in both directions) = 01: only forward = 10: only reverse Bits 7, 6, 5, 4, 3, 2 = Effect-Code, i.e.: Uncoupler - 00110000 = "48" Soft-Start for function output - 00110100 = "52" Autom. Brake light - 00111000 = „56" and so on.
23	#133	------			
10	#134	Asymm. stops (ABC)	1-14,101,,	106	Sensitivity (Hundredth), Threshold (Tens, ones digit).
8	#135	km/h - Control	2 - 20	0	= 1 → Calibration run; 5, 10, 20: Relation km/ spd. step
8	#136	km/h - Control	or:	RailCom	Contr. value after cal-run; or correct. value for Rail-Com
22	#137 #138 #139	Smoke generator characteristics	0 - 255 0 - 255 0 - 255	0 0 0	Eff 72,80: CV #137: PWM of FOx at stand still CV #138: PWM of FOx at cruising speed CV #139: PWM of FOx during acceleration

	CV	Designation	Range	Default	Description
12	#140	Distance controlled stopping	0-3,11-13	0	= 1: HLU or ABC = 2: manual = 3: both
12	#141	Distance controlled stopping	0 - 255	0	"Constant distance": Stop point = 155: 500 m
12	#142	Distance controlled stopping	0 - 255	12	High speed correction for ABC
12	#143	Distance controlled stopping	0 - 255	0	High speed correction for HLU
1	#144	Prog,/ Update Lock	Bits 6, 7	0	Bit 6 = 1: „Service mode"-Lock, Bit 7 = 1: Update-Lock
15	#145	------			
7	#146	Gear backlash compen.	0 - 255	0	Hundredth' of a second at min. speed after dir.-change
6	147,…	Experimental-CV's	0 - 255	0	Special motor regulation settings
5	#151	Motor brake	0 - 9	0	= 1 … 9: Force and speed of application
18	#152	Dim Mask 2	Bits 0 - 7	0	Individual outputs exempted from dimming per CV #60
-	#153	Continue w/o signal	0 - 255	0	Tenth of seconds: stop after losing DCC signal
-	#154	Special OEM-Bits			
13	#155	Half-speed key	0 - 19	0	Function key selection (instead of CV #124)
13	#156	Momentum deact.	0 - 19	0	Function key selection (instead of CV #124)
13	#157	MAN key	0 - 19	0	Function key selection
4.	#158	Several sound bits + RailCom variants	0 - 127	0	Bit 2 = 0: RailCom speed (kph) – feedback using ID 4 = 1: Standardized feedback method using ID 7.
21	#159 #160	Effects on F7 F8	0 - 255	0	Same as CV"s #125 – 132 but for F7 and F8
25	#161	Servo Protocol	0 - 3	0	Bit 0 = 0: positive pulses , = 1: negative pulses Bit 1 = 0: active only w. moving, = 1: always active
25	#162 #163 #164 #165	Servo 1 left stop Servo 1 right stop Servo 1 center stop Servo 1 speed	0 - 255	49 205 127 30	Defines left stop position Defines right stop position for 3-position control Time in tenth of seconds between left and right stop
25	#166 #167 #168 #169	Servo 2 left stop Servo 2 right stop Servo 2 center stop Servo 2 speed	0 - 255	49 205 127 30	Defines left stop position Defines right stop position for 3-position control Time in tenth of seconds between left and right stop
25	#170 #171 #172 #173	Servo 3 left stop Servo 3 right stop Servo 3 center stop Servo 3 speed	0 - 255	49 205 127 30	Defines left stop position Defines right stop position for 3-position control Time in tenth of seconds between left and right stop
25	#174 #175 #176 #177	Servo 4 left stop Servo 4 right stop Servo 4 center stop Servo 4 speed	0 - 255	49 205 127 30	Defines left stop position Defines right stop position for 3-position control Time in tenth of seconds between left and right stop

	CV	Designation	Range	Default	Description
25	#181 #182 #183 #184	Servo 1 Servo 2 Servo 3 Servo 4	0 - 114	0 0 0 0	Operating modes (One key, two keys …)
25	#185	Special live steam	1 - 3	0	Operating settings for live steam engines
--	#186-189	Special pantograph configurations	-	0	Pantograph settings for special projects
5	#190 - 191	Dimming times with effect 88	0-255		Turn-ON/OFF times for effects 88, 89 and 90
3	#250, 251, 252, 253	Decoder-ID	Read-only	-	Decoder's serial number
3	#260, 261, 262, 263	Lade-Code	-	-	for authorization of "coded" sound-projects
-	#264	------			
4 -	#265	Select sound-collection	1, 2, 3, …	1	= 1, 2, … 32: Select among the stored sounds
5 -	#266	Total volume	0 - 65 (255)	65	!!: >65: Over modulated, may damage speaker
5. 4	#395 – 397	Volume Keys	-	0	Volume adjustments with function keys
5. 4	#376	Volume driving sound	0 – 255	255	Reduction of motor sound compared to total volume
5 -	#267 - 766	Sound-Parameter	-	-	Sound generation settings (see sound CV table above)
18	#400 #401 ….. #428	Input-Mapping	0 - 255	0	External function (Function key) for internal F0 External function (Function key) for internal F1 …… External function (Function key) for internal F28

9 Service Instructions

Even Zimo decoders can break down ... sometimes "for no reason", sometimes due to short circuits in the wiring, sometimes by a failed update ...
These defective decoder can of course sent to Zimo for repair or replacement. Whether this is covered by warranty or a payable service, the submitter should expect a decoder back that is not only functional, but is also configured similarly as the original (i.e. the same CV values and the same sound project). However, this is not possible if the decoder is damaged so badly that it cannot be read-out anymore.

THEREFORE ... is it **recommended** to READ OUT IMPORTANT DATA from the decoder before it is defective and to send this information along with the decoder to ZIMO for repair.

Other information required:

Address
Loaded SW version (CV #7, 65)
Possibly activated CV Set (activation code for CV #8, concerns non-sound decoder)
Decoder ID (CV #250 ... 253, if available)
Possibly load code (CV #260 ... 263, relates to sound decoder)
Loaded sound project.

It would also be **very useful** (but relatively complex) to read out the entire CV list and keep it in a safe place, so it can later be programmed to a repaired decoder (which sometimes requires a hard-reset) or a replacement. Reading out and reprogramming decoders is easy with the help of

the program "ADaPT" (from E.Sperrer, works with Zimo and some other DCC systems),
or ZSP (works with MX31ZL MXDECUP or, in the future, with MXULF or MX10)
or with ZSC (works with MXULF in the future or MX10).

NOTE: Future Zimo command stations will read decoder configurations automatically (in the background) and make it available when needed. But is at the time of this writing (May 2013) still future...

ADDITIONAL INFORMATION relating to submission of defective decoders:

- To avoid unnecessary repair shipments it should be verified beforehand whether a defect is in fact present. Quite a few of the submitted decoders are only configured wrongly and all that was needed was a "hard reset" (CV #8 = 8) to get the decoder CV's back to the default values or the default values of a sound project.
- WARNING: Sometimes defects are simulated when a loaded sound project or its integrated CV table expects a specific loco model (e.g., certain types of lighting equipment), but the equipment is missing or not wired appropriately. Typical cases: The light is no longer working with F0 (because the sound project has redirected the light to another function key), or locomotive will "drive off unchecked" (because the sound project activated a servo with a corresponding uncoupling procedure).
  Note: for the individual sound projects in the Zimo sound database, there is usually also a version that contains only the sound and no specially prepared vehicle is required.
- If the problem is "only" very poor drivability, it would be of advantage to contact service@zimo.at before sending the decoder back. Often a simple remedy can be found without sending the decoder back.
- ZIMO can only accept decoders for repair, BUT NOT complete engines or engine parts with a decoder installed. There are of course exceptions in problematic cases that have to do with the interaction between the locomotive and decoder, but only after prior agreement.
- The defect (or reason for return) should be described with as much detail as possible in addition to the above mentioned information required.
- So called OEM decoder, such as have been installed by a loco manufacturer, should be taken care of by them. However, ZIMO will repair these as well when sent to the ZIMO service department. The warranty and repair conditions may of course differ from those of the vehicle manufacturer (whether this is "better" or "worse" is rather coincidence). Even in these cases: submit only the Zimo decoder, not complete engines!

If a decoder gets exchanged, the original OEM sound project can in most cases be used in the replacement decoder as well (if the necessary information has been submitted to us). This applies to vehicle manufacturers like Roco, Fleischmann, Wunder, Demko and many others, but it is also possible that ZIMO does not have the sound from manufacturers that provided the sound themselves.

- "Preloaded" sound projects (see Sound Database), however, are usually NOT available from Zimo, but only the author / company who usually provides the sound only preloaded in a decoder. Such sound decoders are therefore better sent directly to the original supplier. Naturally if the problem is a pure hardware issue, such as a defective motor or function output, it can be dealt easily at ZIMO.

Please fill out and accompany a ZIMO repair form with your shipment. Such forms can be downloaded here:

http://www.zimo.at/web2010/sales/Reparatur-Formular_en.pdf