INSTRUCTION MANUAL

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.
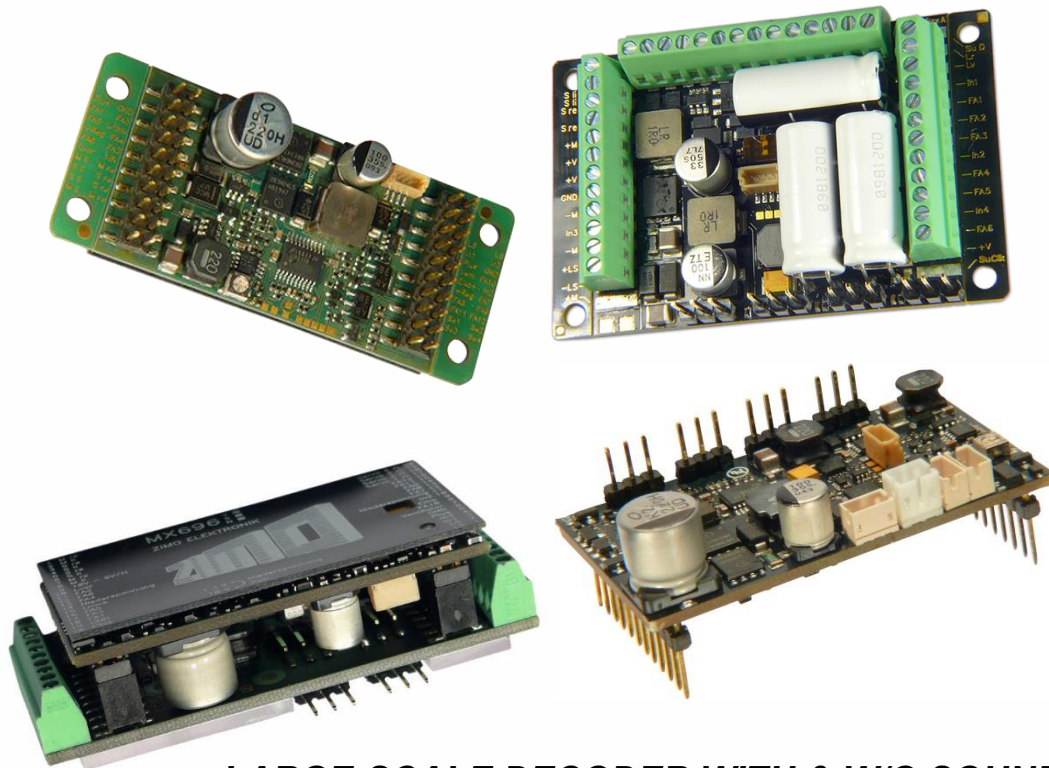
LARGE-SCALE DECODER WITH & W/O SOUND

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

Decoder versions listed in gray are no longer in production

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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 28 Screw terminals (2 x 12 and 1 x 4)
	version: 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: 5 V, 10 V, 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: 2 Pin connectors, 12-pins ea. (matching ESU-interface)
	Version 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 15 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: 10 V 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: 10 V
	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 5 V output (as does the MX695KV/MX695LV), but the variable output can be set between 5 – 6 V to supply servos with power…
OR: Use the MX696KV (MX696V combined with LOKPL96KV board), which does have a fixed 5 V output.

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68 x 29 x 20 mm

MX696K…	**Narrow large-scale sound decoder with screw terminals** *(Decoder and loco board combinations)*

| **MX696KV** **MX696KS** | 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)

Reduced　　　20 Screw terminals
Version:　　　　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 Adapter Boards for Large-Scale Decoder** *for more information about these boards.*

60 x 32 x 21mm

MX697	**Large-scale sound decoder for US interfaces** **(Bachmann, Aristocraft)**

| **MX697V** **MX697S** | Full Version:　2　12-pin connectors
　　　　　　　10　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　Connection for external capacitor
　　　　　　　　1　Speaker connection (4 or 8 Ohm at 10 Watt)

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

50 x 40 x 13 mm

MX699K …	**Large-scale sound decoder with screw terminals**

| **MX699KV** **MX699KS** | Full Version:　38 Screw terminals (2x12 and 1x14)
　　　　　　　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/8 V)
　　　　　　　　1 Additional connection for external capacitor module

Reduced　　　30 Screw terminals (2x12 and 1x6)
Version:　　　　8　Function outputs (including headlights)
　　　　　　　　1　Special smoke fan output
　　　　　　　　3　Low-voltage outputs: 5 V, 10 V
　　　　　　　　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/8 V)
　　　　　　　　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* **MX699LS** *-LS: Direct fit for the 2 x 14 – pin Märklin interface* | Full Version:　3　14-pin connectors
　　　　　　　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/8 V)
　　　　　　　　1　Additional connection for external capacitor module

Reduced　　　2　14-pin connectors
Version:　　　　8　Function outputs (including headlights)
　　　　　　　　1　Special smoke fan output
　　　　　　　　3　Low-voltage outputs: 5 V, 10 V
　　　　　　　　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/8 V)
　　　　　　　　1　Additional connection for external capacitor module |

NOTE to the Märklin interface on MX699LM and -LS:
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 - 24 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 (= 180 sec at 22 kHz)
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 ºC
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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The decoder type can be read out in CV #250

130=MX630 (2022) (*)	131=MX630 RevE (*)	132=MX623 (2022) (*)	133=MX633 (2020) (*)	134=MX634 (2020) (*)
135=MX635 (*)	136=MX636 (*)	137=MX637 (*)	138=MX622 (*)	142=MDS442 (*)
152= MX152 Roco	158=MX685 RevE (*)	160=MX660	165=REE_DU65	166=MX600 (2021) (*)
171=MX671	173=MX673 (*)	174=MX675 (*)	175=MX675 (*)	176=R72016
177=MX617 (*)	178=MX676 (*)	179=MXLIPL3 (380mm)	180=MX688 (2022) (*)	181=MX618 (*)
182=MX682 (*)	183=MX689	184=MXLIPL1 (160mm)	185=MX685 (2020) (*)	186=MX605N (*)
187=MX605FL	188=MX605SL	189=MX605	190=MX659	192=MX622 (2020) (*)
193=MX638 (*)	194=MX615	195=MX616	196=MXKISS	197=MX617 (*)
198=FLM_E69	199=MX600	200=MX82	201=MX620	202=MX62
203=MX63	204=MX64	205=MX64H	206=MX64D	207=MX680
208=MX690	209=MX69	210=MX640	211=MX630-P2520	212=MX632
213=MX631	214=MX642	215=MX643	216=MX647	217=MX646
218=MX630 (2011)	219=MX631 (2011)	220=MX632 (2011)	221=MX645	222=MX644
223=MX621	224=MX695 RevB	225=MX648	226=MX685	227=MX695 RevC
228=MX681	229=MX695N	230=MX696	231=MX696N	232=MX686
233=MX622	234=MX623	235=MX687	236=MX621-FLM	237=MX633
238=MX820 RevA	240=MX634	241=MX686B	242=MX820 RevB	243=MX618 (*)
244=Roco NextG (*)	245=MX697 RevA	246=MX658	247=MX688	248=MX821
249=MX648 RevC,D	250=MX699	251=Roco 2067	252=Roco ICE	253=MX649
254=MX697 RevB	(*) Diese Nichtsound- bzw. Funktionsdecoder haben ein größeres EPROM (1k EEPROM), unterstützen daher auch die höheren CVs			

ab CV#255, sofern diese nichts mit Sound (direkt/indirekt) zu tun haben.

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. (Automatic reboot attempts may result in flashing lights).

These safety precautions do not mean 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 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 ºC 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 ºC, typically after 30 to 60 sec.

SOFTWARE UPDATE

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

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.

ZIMO ELEKTRONIK

3 Installation and Wiring of the MX695 - MX69

MX695

Full track voltage for function outputs
optional: + 10 V for function outputs
optional: + 5 V for function outputs
optional: variable low-voltage for function outputs

External energy source choose from
- Electrolytic capacitor (rated at 20 V),
- Gold-Cap-Series
  (Total voltage > 17 V),
- Battery (14.4 V pack,
  requires special circuitry)

4700 uF 25 V oder mehr

Function element on FO12
Function element on FO11
Function element on FO10
Function element on FO9
Function element on FO8
Function element on FO7

Regulator for low-voltage output

Solder pads for optional external voltage regulator

100 K lin

Capacitor Positive
GROUND

+ 10 V
+ 5 V
FO7
FO8
FO9
FO10
FO11
FO12
Variable low voltage

Smoke Fan (5 V - Motor)
Special fan connection

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

Left rail
Right rail

S ii
S na
S na

Lr — FLr
Lv — FLf
In1 — IN1
FA1 — FO1
FA2 — FO2
FA3 — FO3
In2 — IN2
FA4 — FO4
FA5 — FO5
GND — GROUND
FA6 — FO6
POSITIVE

Motor right
Common positive

+M
+V
+V

GROUND
GND

Switch input
In3

-M
-M

SUSI

LS
LS
+LS
-LS

Volume control

100 K log

Solder pads for optional external volume control

4 Ohm or 8 Ohm speaker (or 2 x 8 Ohm)

Cam sensor for chuff synch, mechanical, Reed switch or Opto-Sensor

Control lead
+ 5 V
GROUND

Servo 1
Servo 2
Servo 3
Servo 4

More switches

GROUND
SUSI Data
SUSI Clock
Positive

Robbe: white · red · black
Graupner: orange · red · brown
           (Control · +5V · GROUND)

right   left
Motor(s)

left   right
Rail

optional: var. low-voltage for function outputs
optional: + 5 V fixed for function outputs
optional: + 5 V fixed for function outputs
optional: + 10 V fixed for function outputs
Full track voltage for function outputs

MX696

Drawing valid for
MX696S, MX696V

(—— —— = applies only to MX696V)

Reed switch at input 2

Reed switch at input 1

Mechanical switch, read switch
or Opto sensor at input 3
as cam sensor

Smoke fan
(5 V - Motor)

External electrolytic capacitor
(Rated at > 20 V)
or Goldcap-Module (> 17 V)

+ 4700 uF
25 V
—　or higher

GROUND
SUSI Data
SUSI Clock
Positive

4 Ohm
or 8 Ohm
speaker
(or 2 x 8 Ohm parallel)

20-conductor ribbon cable

20-pin plug

20-pin plug
10-pin plug at MX696S
20-pin plug at MX696V

20-cond. ribbon cable
10-cond. for MX696S
20-cond. for MX696V

Potentiometer for
low-voltage settings

Low voltage for servos set to 5-6 V
GROUND (neg. Servo-supply)
Control wire 1
Control wire 2
Control wire 3
Control wire 4

Servo 1　Servo 2　Servo 3　Servo 4

Robbe:　white · red · black
Graupner:　orange · red · brown
(Control - Ground - + 5 V)

left　right
Motor(s)

left　right
Track

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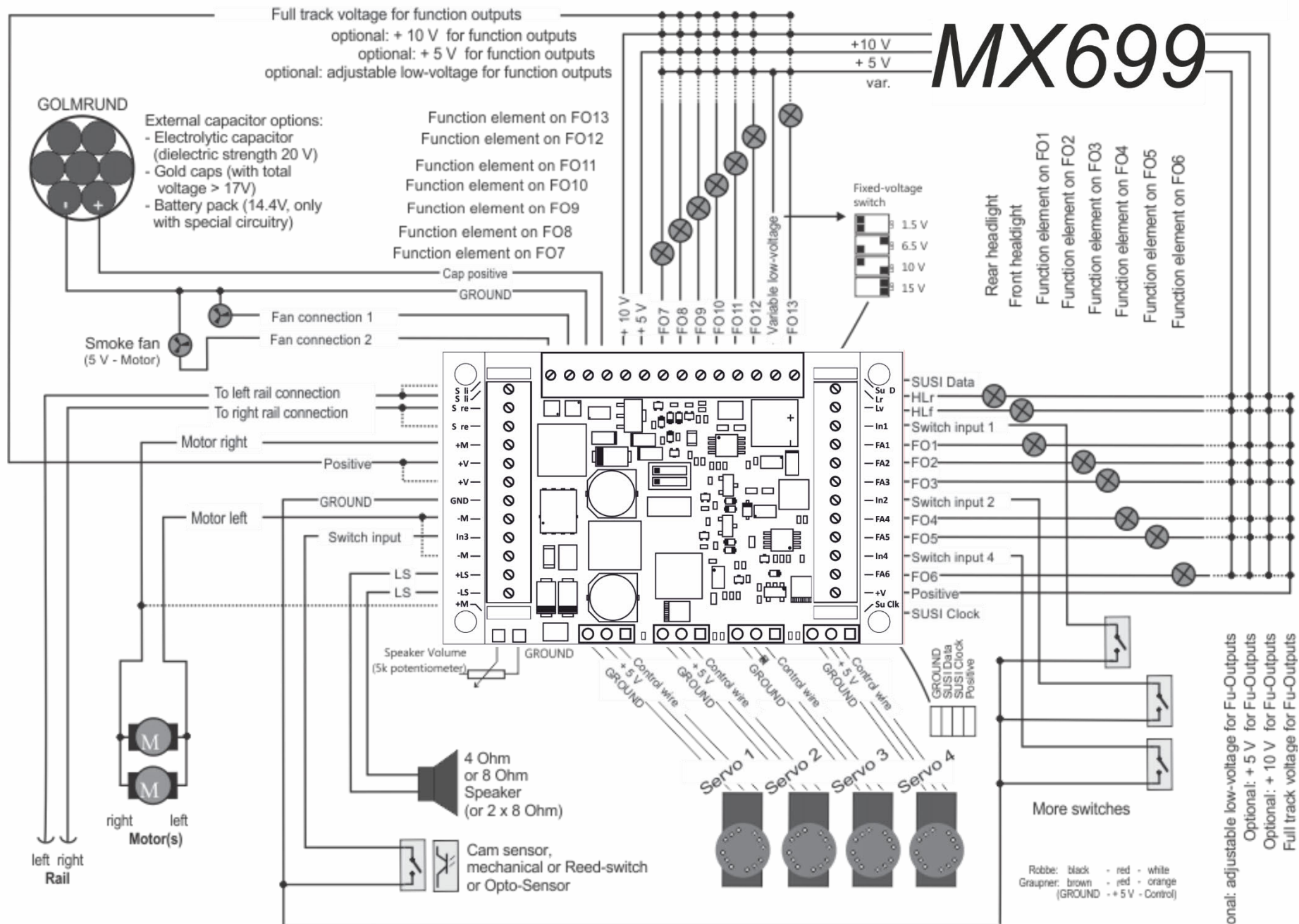(These pins are mounted in parallel on the MX690)

ZIMO ELEKTRONIK

MX697

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

Cap positive
GROUND

Fixed-voltage switch
1.5 V
6.5 V
10 V
15 V

+ 10 V
+ 5 V
FO7
FO8
FO9
FO10
FO11
FO12
Variable low-voltage
FO13

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

Smoke fan
(5 V - Motor)

Fan connection 1
Fan connection 2

To left rail connection
To right rail connection

Motor right
Positive

Motor left

GROUND

Switch input

LS
LS

S li
S li
S re
S re
+M
+V
+V
GND
-M
In3
-M
+LS
-LS
+M

Su D
Lr
Lv
In1
FA1
FA2
FA3
In2
FA4
FA5
In4
FA6
+V
Su Clk

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

4 Ohm
or 8 Ohm
Speaker
(or 2 x 8 Ohm)

GROUND
+ 5 V
Control wire
GROUND

GROUND
+ 5 V
Control wire
GROUND

GROUND
+ 5 V
Control wire
GROUND

GROUND
+ 5 V
Control wire
GROUND

Servo 1   Servo 2   Servo 3   Servo 4

GROUND
SUSI Data
SUSI Clock
Positive

right   left
Motor(s)

left right
Rail

Cam sensor,
mechanical or Reed-switch
or Opto-Sensor

More switches

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

Image showing vertical connections with screw terminals (12 plugs) plus 2 solder pads, like on K-types. L-types have 14 pins.

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The following connection diagrams are based on the MX699.
The connections on the MX696 and MX697 are placed differently, but functionally similar

3.1 Tracks and motor(s)

The loco must provide enough space in-side, so the decoder can be mounted without exerting mechanical stress.

All direct connections that are pre-sent in the original wiring configu-ration between the power pick-ups (wheels and wipers) and the motor must be insulated.

The same is important for the headlights and other additional ac-cessories, which must be com-pletely insulated.

Tracks (wheels, wipers) and motor are connected to the correspond-ing positions on the screw termi-nals (pins) according to the picture. The second connection points (on-ly partly available) can, but do not have to, be used additionally.

Generally, all DC motors used in model railways can be used.

In case, there is more than one motor in the loco, those are con-nected in parallel and combined with each other to the decoder. A parallel connection like this ensures an automatic alignment, pro-vided it is an identical motor- and transmission arrangement. The MX699 usually is always strong enough to handle two or more motors.

See configuration (CVs) for motor regulation!

The connection pins for tracks and motor are available twice on the decoder, to enable sending the full voltage through the relatively thin cables. For a use of up to 2 A, it is, however, sufficient to use only one pin.
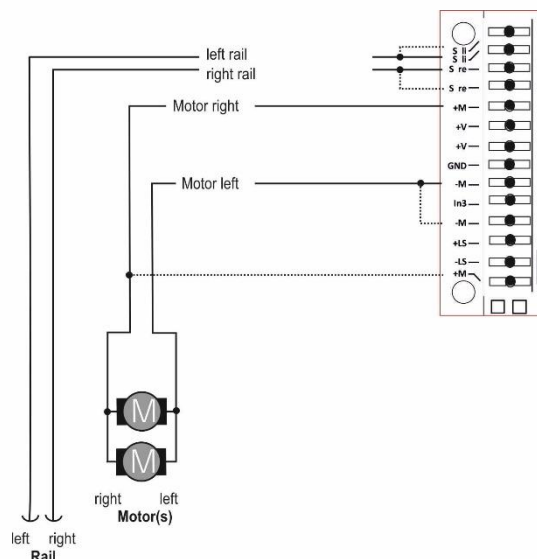
3.2 Speaker, cam sensor and volume regulation

All 4 Ohm or 8 Ohm speakers can be used, or even some speakers connected in parallel, so there is a total impedance of not more than 4 Ohm.

The sound amplifier of the MX699 works with 10.8 V and therefore presents a sinus power of 12 Watt onto a 4 Ohm speaker; onto an 8 Ohm corre-spondingly less, i.e. about 5 Watt.

In case, tweeters are used, they are connected in parallel to the main speaker via a frequency crossover (e.g.: a capacitor of 10 µF).

> **ATTENTION**: for speakers with lower specifica-tions the volume has to be adjusted to the pro-cessable track power.

A cam sensor (to synchronize steam chuffs with wheel rotation) is usually not necessary, because the software-provided "virtual cam sensor" is suffi-cient.

In case there is a real cam sensor, a mechanical contact or a photo transistor, as well as a Hall sensor can be connected to the switch input "IN3". The corresponding element has to produce a low-resistance (i.e. <10K) connection between switch input and GROUND in the desired rotation-dependent cycle.

The volume can be controlled alternatively or additionally to the CV-configuration (see CV #266) via the connections to an external regulator in the loco.

ONLY MX695: If such a regulator is used (100K, preferably logarithmic), the regulator on the PCB shall be set to the highest possible volume (left limit stop), unless it is used to limit the maximum volume to protect a lower-power speaker.

> **NOTE** to the decoder MX696, MX697, MX699:
> These large-scale decoders (i.e. all except the MX695) do NOT have a volume regulator on the PCB. Nevertheless, external volume control units (potentiometers, 10K for MX697, 5K for MX699) can be connected. This is NOT possible with MX696-Series!

> **NOTE:** if a decoder has a mechanical volume control (MX695), this should NOT be turned to "full" unless a really high volume is desired (loss of quality if the control is set to "full" and the volume is greatly reduced by CVs at the same time)!
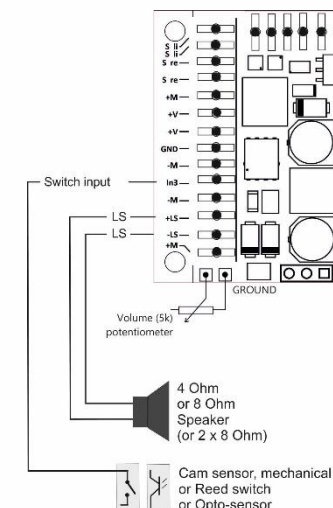
3.3 Consumers and low voltage outputs

"Consumers" (or function elements) is all equipment connected to the function outputs Flf, Flr, FO1-FO13. Mostly, this is lighting equipment (light bulbs and LEDs), but also positioning magnets, small motors, relays, etc.
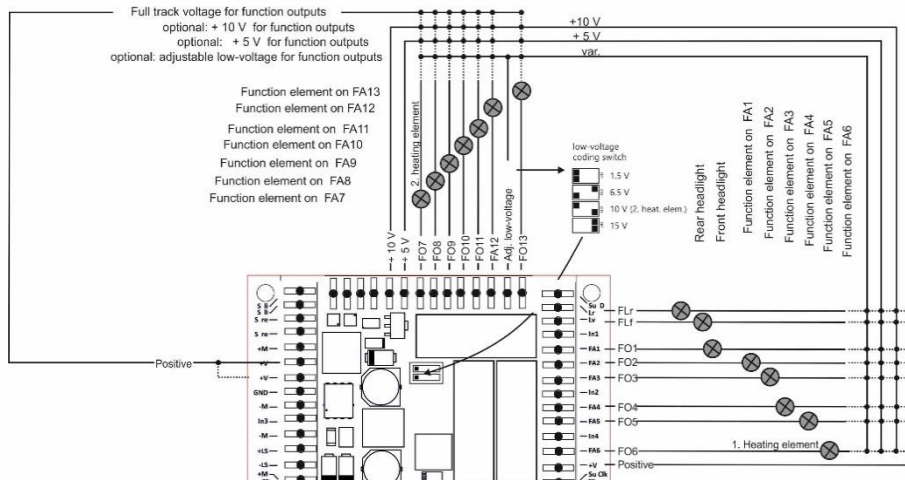
Each consumer (light bulbs, groups of light bulbs or other) is always connected to the corresponding function output (negative) and to one of the up to 4 positive poles (positive):

- Positive pole - full track voltage: the directly commutated driving voltage; depending on the stabilization of the digital command station and track voltage, this is relatively unstable, i.e. oscillates with the driving voltage.

- Low voltage – 10 V: this is the voltage mostly used within the decoder to produce sound.

> **ATTENTION**: too much or volatile consumption by the consumers at the 10 V source can impair the sound quality. A short circuit on the 10 V output can damage the decoder. Therefore, only use it, if there is no other possibility (i.e. the adjustable low-voltage output is already in use).

- Low-voltage - 5 V: this voltage is provided for servos and consumers, e.g. also for common 5 V light bulbs.
  Only in V-types!

- the adjustable (= variable) low-voltage: via a coding switch on the decoder PCB, which leads to the space between FO12 and FO13, the low-voltage can be adjusted in the following steps: 1.5 V, 6.5 V, 10 V, 15 V.
  Only in V-types!

> **NOTE**: Rather use a low-voltage source than reducing the voltage per software (dimming with CV #60), because dimming uses PWM reduction (full voltage impulses with a corresponding duty cycle), which can damage light bulbs (not LEDs).

See chapters concerning decoder configuration (CVs) for function mapping, function effects, electrical couplers (systems by Krois, Heyn), etc.

Note to decoders MX696:

The MX696 does NOT have the (definite) 5 V low-voltage. If needed (e.g. for servos) the adjustable low-voltage (only MX696V) has to be used.

Note to decoders MX696N (non-sound version):

Those provide a 6 V low voltage output (instead of the 10 V low voltage of the sound decoders). Due to this, servos can be supplied directly by the decoder.

3.4 Special connections for smoke-fans
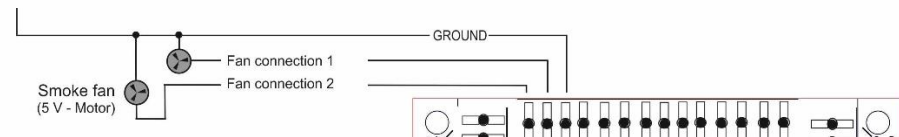
Those outputs are used to control fan motors of clocked smoke generators, as they are used in many modern locos.

The special feature of these outputs (in contrast to the "normal" function outputs) is the possibility to brake the motor. This inhibits the motor from rotating after a current impulse, whereby the steam-clocking gets stronger and more accentuated. The outputs are designed for a 5 V motor and for a load capacity of up to 100 mA continuous current (the start-up current may be higher).

The decoders MX695, MX696 and MX697 only have one fan output.

3.5 Servos

The MX699 provides 4 connections for common servos, which can be used for couplers, pantographs, and other mechanical equipment.
Each servo connection has its own control line, while the supply (+ 5 V, GROUND) is shared by all.
See chapter concerning decoder configuration regarding allocation and setting of the servos.

> **ATTENTION**: Servos of different manufacturers all have three wires, but the order and colors of the wires differ.

5 V supply for servos is only available in V-types. The control wires on the other hand can be used in all types of the MX695; if needed, the 5 V supply must be provided externally.

The control wires though are usable with all sound decoder versions; if necessary, use an external 5 V power source to power the servo.
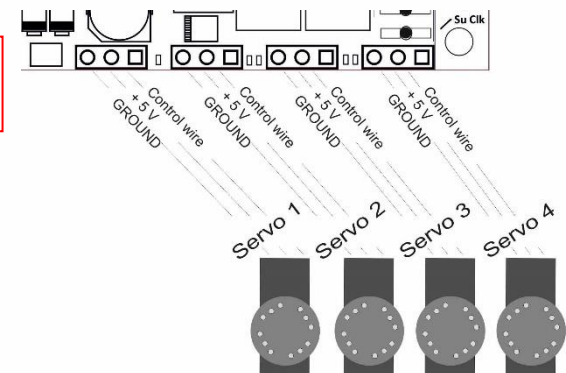
3.6 Switch inputs

Additionally, to the switch input "IN 3" (see chapter 3.2 Speaker, cam sensor and volume regulation) there are 3 further inputs ("IN 1", "IN 2" and "IN 4"). These can be used to connect reed contacts to trigger sounds, etc. Electrically, those switch inputs behave very similar.

See chapter concerning decoder configuration (CVs), especially regarding sound.
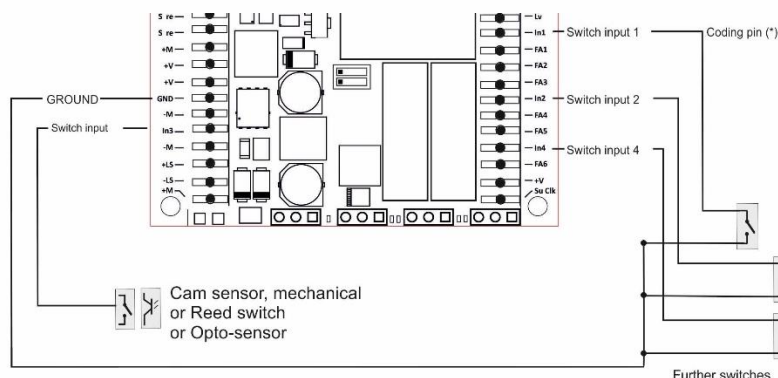
3.7   External stay-alive capacitor

A stay-alive capacitor (a bigger electrolytic capacitor, a "Goldcap", etc. or a battery)

- improves the driving behavior on dirty tracks (or wheels),

- reduces flickering lights caused by interrupted contact (e.g. frogs),

- Prevents the train from getting stuck when driving slowly, especially in combination with the ZIMO software feature "prevent stopping on tracks without current" *),

- compensates energy loss produced by RailCom and HLU cut-outs and the corresponding motor sound, additionally improves the quality of the RailCom signal.
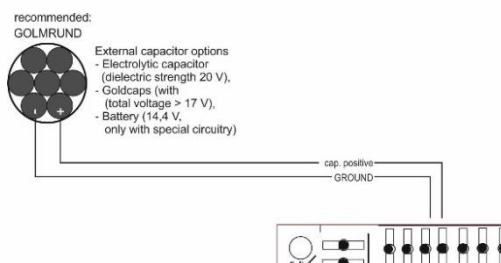
*) In case, the current supply is interrupted (due to dirty rails or frogs), the decoder automatically provides enough energy to move the train forward, even if it was currently in a braking procedure and was supposed to stop. The train is stopped as soon as the wheel-track-contact is reestablished. After the train stopped, the decoder tests again for track power (if there is none, the engine moves the train a little forward until power is restored).

← the Goldcap module **GOLMRUND**, often used as stay-alive capacitor
it consists of 7 Goldcaps, i.e. 7 x 1F, in total **140000 µF / 17.5 V.**

Generally, the efficiency of energy storage modules increases with the capacity; starting with 1000 µF (µF = Micro Farad) you can see an effect, about 100,000 µF are recommended for large-scale locos, as far as there is enough space in the loco. Goldcap modules with a capacity of 1 F do have a bigger effect. Too big capacities have the disadvantage of very long charging times; therefore ZIMO recommends not more than 0.5 F for Goldcap modules (related to full voltage of about 15 V to 25 V from a series connection of 6-10 elements with 2.5 V each; a single Goldcap therefore has a capacity of up to about 3 F.

Proper preparations in ZIMO large-scale locos (capacitor+ connection) ensure that external capacitors do not cause problems when programming decoders or updating the software (referring to ZIMO loco number recognition via RailCom).

The charging current for the stay-alive capacitor on the positive connection is about 100 mA, i.e. fully charging a 10,000 µF capacitor takes about 5 seconds, a 0.5 F Goldcap takes about 3 minutes.

The ZIMO Goldcap most used is the **GOLMRUND** (and the GOLMLANG), which consists of 7 Goldcaps, 1F / 2.5 V each, ergo **140.000 µF / 17.5 V** in total. The capacitor+ connection on the decoder ensures that the charging voltage does not get too high.

Using a battery instead of a capacitor can only be recommended for experts (engineering specialists); it is very important that the battery is completely discharged after taking the loco off the supply of the tracks. Tip: a relay, supplied by the running voltage, with a capacitor hold circuit, which interrupts the connection to the battery after about 1 minute of lost supply.


Note to decoders MX699:

Contrary to other types, the MX699 also have an internal stay-alive capacitor, which consists of 3 Supercaps in series, each with 3 F / 2.7 V, i.e. 1 F and 8 V in total. This capacitor ensures securely passing parts without current, possibly with reduced speed. The sound supply is guaranteed by transforming 8 V to 10 V, so the sound is fully preserved.
Nevertheless, it may be useful to connect an external stay-alive capacitor, like a *GOLMRUND*, because it is charged to higher voltage (17.5 V instead of 8 V). This provides more voltage and energy for motor and functions.

3.8 SUSI interface

The "SUSI" interface was developed by Fa. Dietz and defines the connection of additional modules to the decoder. Usually these are sound modules, which are used in combination with non-sound decoders, i.e. *MX695KN* and *MX696N*.

Additional to the sound modules, the market also provides digital couplers with a SUSI interface. Some locos have PCBs for pantographs with SUSI interface integrated, wherefore they can use the interface on the decoder.

Furthermore, the SUSI interface is used for loading a sound project or update fast (with the decoder updating and testing device MXULF/A); however, this uses faster communication instead of the SUSI protocol.
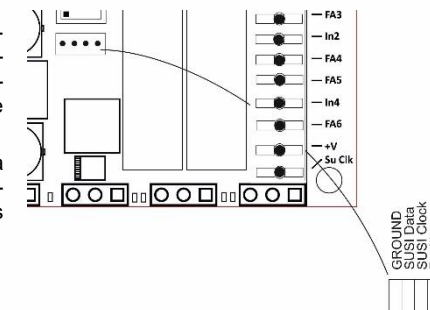
4   *Loco Adapter Boards for Large-Scale Decoder*

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 LOKPL95BS, -BV with solder pads,
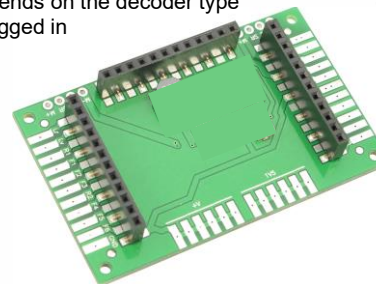### *designed for the large-scale decoders MX695LS and MX695LV*

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):

Connection diagram for adaptor board **LOKPL95BS** (solder pads) and **LOKPL95BV**

NOTE: The servos are to be connected directly to the Mx695 decoder even if an adapter board is used.
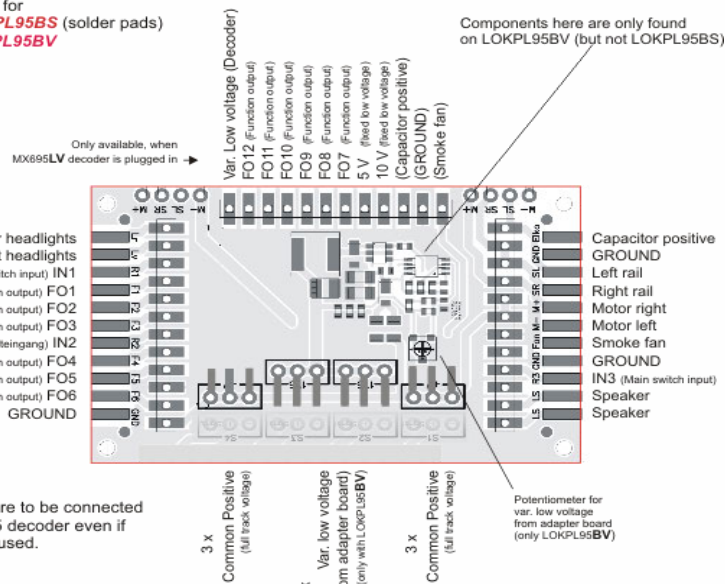
LOKPL95BS
circuit board with solder pads, usabilty of upper connector row depends on the decoder type plugged in

LOKPL95BV15, LOKPL95BV50
with additional variable low voltage (fixed set to either 1.5 V or 5 V), otherwise identical
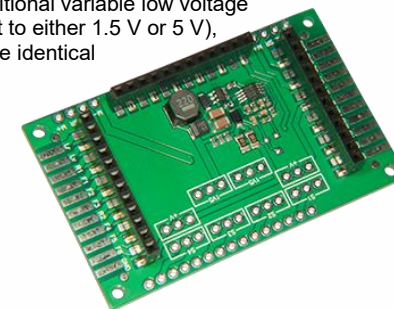
Loco board LOKPL95BV with decoder MX695 plugged in →

> **NOTE**: The servo connections are NOT accessible on the loco board. They are therefore directly plugged into 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 LOKPL96...
designed for large-scale decoders MX696S and MX696V

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
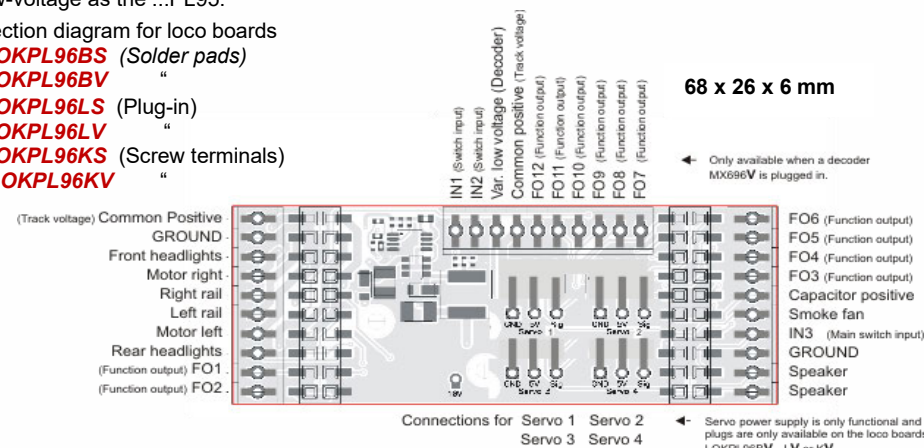**LOKPL96BS** (Solder pads)
and **LOKPL96BV**   "
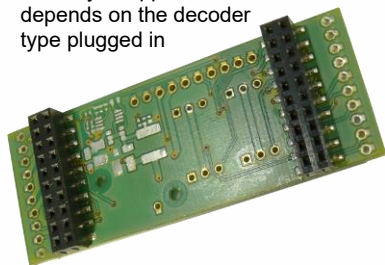**LOKPL96LS** (Plug-in)
and **LOKPL96LV**   "
LOKPL96KS (Screw terminals)
and **LOKPL96KV**   "
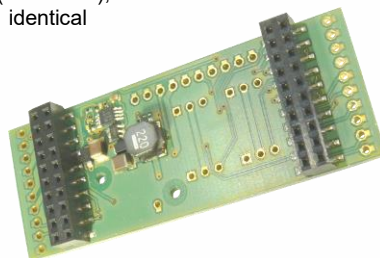
68 x 26 x 6 mm
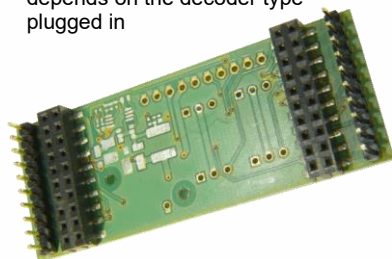
LOKPL96BS

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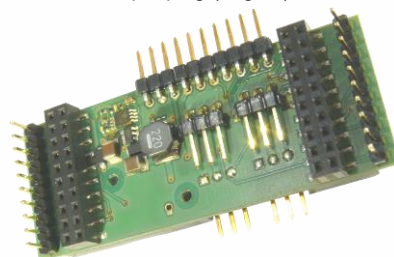   type plugged in

LOKPL96BV

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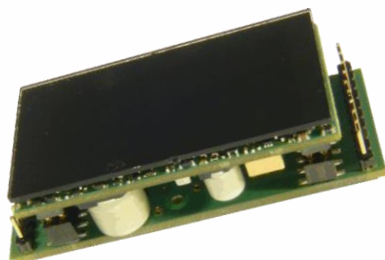   identical

LOKPL96LS

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

LOKPL96LV

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

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

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 – 5 V - 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

LOKPL96KV

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

This version (-KS) is designed to combine with the MX696S decoder.
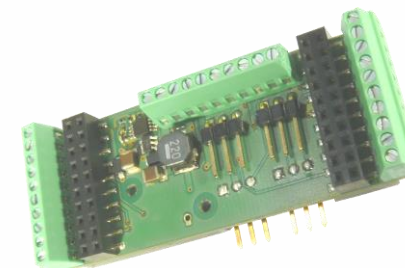
This version (-KV) is designed to combine with the MX696V decoder. The angled servo pins must be bent or cut off if space is limited.

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 MX695KS in terms of functions and connectivity (Screw terminals) but is much narrower (29 instead of 40 mm).

LOKPL96KV + MX696V = MX696KV

This decoder combination is similar to the type MX695KV in terms of functions and connectivity (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

8 Function Outputs +

5V Low-voltage +

4 complete (0V, 5V, Control)
Servo Connections

MX695LS + LOKPL95BV

MX696S + LOKPL96BV

MX696V + LOKPL96BS

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

14 Function Outputs

14 Function Outputs +

5V Low-voltage +

4 complete
Servo Connections

MX695LV + LOKPL95BS

MX695LV

Decoder w/o loco board

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

MX695LV + LOKPL95BV

MX696V + LOKPL96BV

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

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!

MX696S +
LOKPL96KS

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

MX696S +
LOKPL96KV

MX696V +
LOKPL96KS
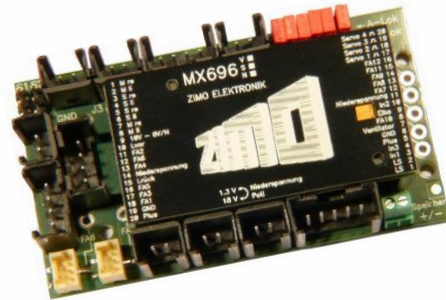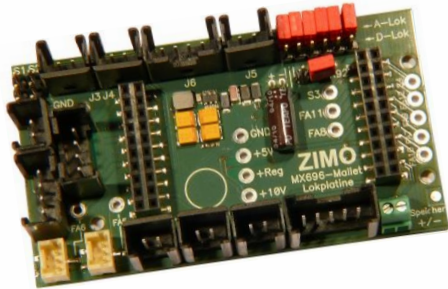
MX696V +
LOKPL96KV

ZIMO ELEKTRONIK

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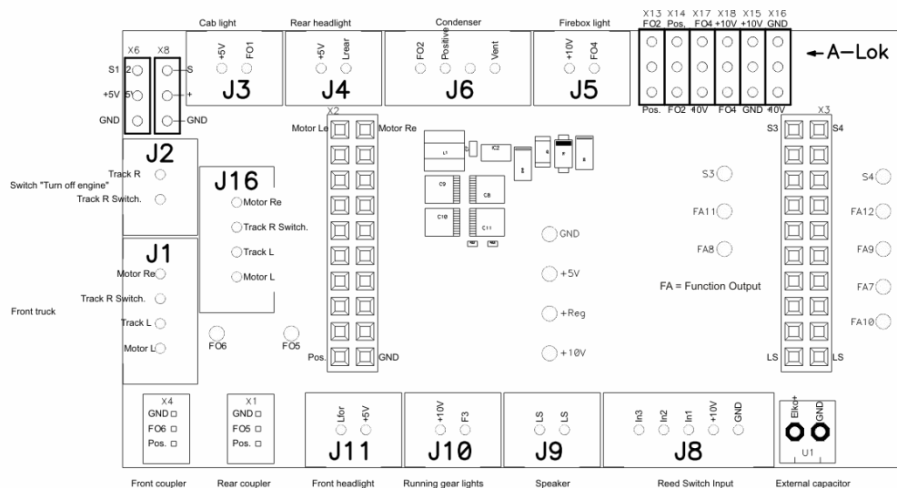### as carrier of the large-scale decoders MX6**96**S or MX6**96**V

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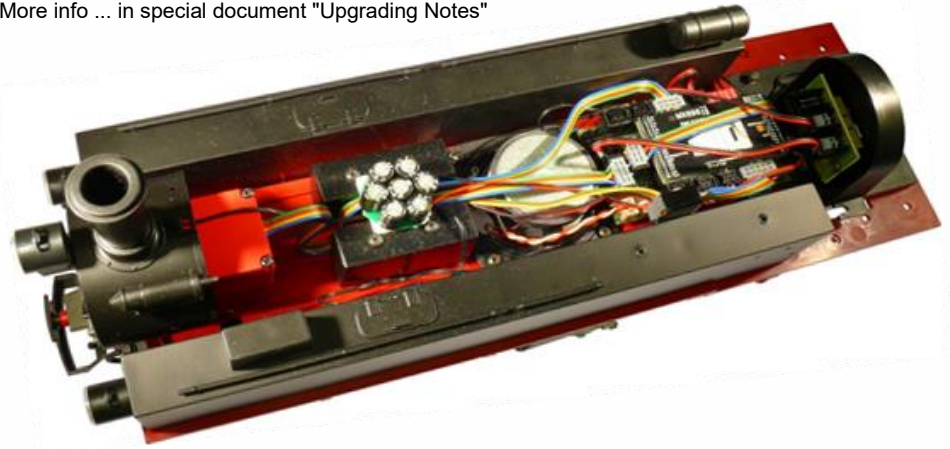
The upgraded locomotive: Goldcap-Module on the left, decoder on the right.

*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 appropriate decoder is plugged in.

Connection diagram for
loco board **LOKPL99** (with solder pads)
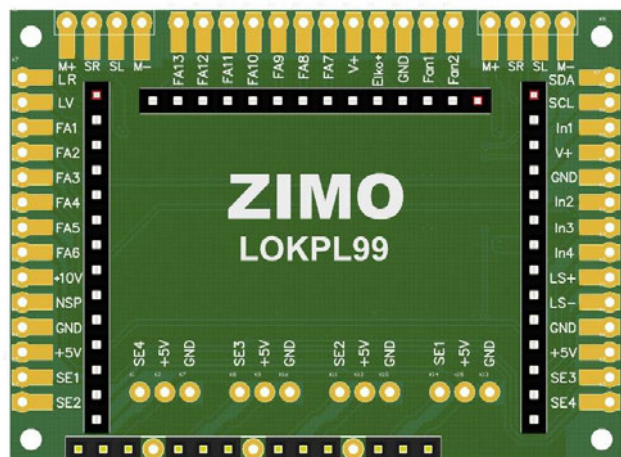
62 x 40 x 10 mm

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

LOKPL99 →

← *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 CVs "on the main" is always possible in operations mode. However, an acknowledgement of successful programming steps or when reading out CVs 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

<center>CV #144 = 0 or = 128</center>

<center>(the latter allows programming but prevents decoder updating).</center>

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 <u>no effect</u> on CV #144, which is therefore always accessible for unlocking.	Bits 3, 4, 5, 6, 7	0 or 255	= 0: Update and programming lock not active Bit 3 = 1: CV-write lock for POM (=OP PROG mode), except CV #144 itself Bit 4 = 1: ACK sound at CV programming Bit 5 = 1: CV-read lock in "Service Mode" 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	0	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 CVs 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 CVs (from CV #265) and (less frequently) all other CVs.

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

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

<center>"Programming-on-the-fly".</center>

According to the current NMRA DCC standards it should only be possible to program and read CVs 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 CVs are set as:

<center>CV #29, Bit 3 = 1   AND   CV #28 = 3</center>

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 – 15 64 - 79	3	Bit 0 - RailCom Channel 1 (broadcast) 0 = off <u>1</u> = on Bit 1 - RailCom Channel 2 (Data) 0 = off <u>1</u> = on Bit 2 - deactivates OW reception <u>0</u> = off 1 = on (since SW 40.5) Bit 3 - deactivates OW transmission via Railcom <u>0</u> = off 1 = on (since SW 40.5) Bit 6 - High current RailCom (MX699 series only) <u>0</u> = off 1 = on

CV	Designation	Range	Default	Description

#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 CVs #67 – #94
				Bit 5 – Decoder address (DCC)
				    0 = primary address as per CV #1
				    1 = ext. address as per CVs #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 CVs 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 CVs #17 / #18.

- Most digital systems (apart from very old or simple products) automatically calculate the value for the CVs 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	128	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 CVs #67 – #94 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 CVs) or
- by programming the following decoder CVs 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 CVs #21 + #22. Bit 7 = 1: Driving direction reversed
#20	Extended consist address From SW version 36.6	0 - 102	0	The value of CV #20 multiplied with 100 added together with the value of CV #19 which result is the address at consist. e.g. CV #20= 12, CV #19=34 is address. 1234 CV #20=100, CV #19=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 - 255	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 controlled by individual address = 1: …. by consist address Bit 3 = 0: F10 controlled by individual address = 1: …. by consist address Bit 4 = 0: F11 controlled by individual address = 1: …. by consist address Bit 5 = 0: F12 controlled by individual address = 1: …. by consist address Bit 7 = 1: F13 – F27 (all!) …. by consist address Bit 6 = 1: From SW version 37.0! Auto-Consist: It is changed automatically between single and consist address, in each case to that address, whose speed is > 0, if the other speed = 0.
#97	Change between single and consist address by means of the Function key	0 – 28	0	Using this key (only on the main address), you can switch between the main address of the decoder (on CV #1 or CVs #17, #18) or the consist address. But for this CV #21 and CV #22 must be set to CV value 0 and it replaces the command CV #22, Bit 6=1. = 1 - 28: Pressing the defined function key (1 - 28) switches to driving with the main address of the decoder (i.e. CV #1 or CVs #17, #18) despite the presence of a consist address (CV #19 > 0, and/or CV #20). ATTENTION: Defines an F button (0=none, 1=F1, 2=F2; 28=F28) which switches to the composite address (CV#19 or CV#19/20) when the first address (CV#1 or CV#17/18) is active. To do this, CV#21 and CV#22 must each be set to the CV value 0 (this is why the command CV#22,Bit6=1 is also replaced).

CV	Designation	Range	Default	Description
#151	Reduction of the motor control in Consist.	Tens digits 1 - 9	0	The tens digit 1 - 9 reduces the regulation of the motor to 10 - 90 % of the value according to CV #58.
#109 #110	Automatic one-sided light suppression	Bit 7 = 0,1 Bit 7 = 0,1		If CV #109, bit 7 = 1 and CV #110, bit 7 = 1, the driver's cab light suppression in the consist is automatically activated.

5.5 Analog operation

All ZIMO decoders can operate 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 CVs can of course be read-out or programmed only with a DCC system or other program. devices.

CV	Designation	Range	Default	Description
#13	**Analog Functions F1-F8**	0 - 255	0	Defines FU 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	67 therefore Bit0 = 1 Bit1 = 1 Bit 6 = 1:	Defines FU 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

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.

CV	Designation	Range	Default	Description
				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. Bit 7 = 0: unregulated DC operation = 1: regulated DC operation
#29	**Base Configuration**	0 - 63	14 = 0000 11**1**0 so Bit 2 = 1 (analog mode possible)	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
#840 #841	Functions F13 - F20 or F21 - F28	0 - 255	0	Other functions switched on in analog mode

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 CVs)

… = 1: 28-step curve (defined by 28 CVs)

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 CVs #67 - #94, all 28 external speed steps can be freely assigned to the 128 internal speed steps. These 28 CVs 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.
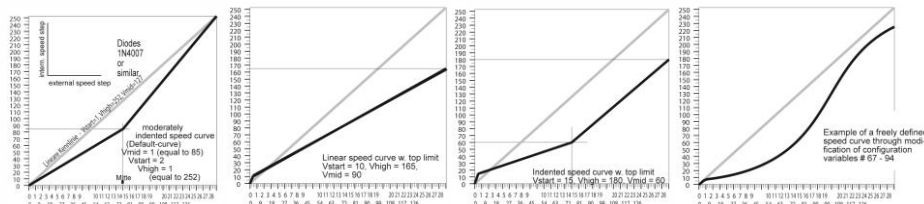
CV	Designation	Range	Default	Description
#2	**Vstart** (Lowest speed)	1 - 255	1	Internal speed step (1 - 255) applied as **lowest** external speed step (= speed step 1)

CV	Designation	Range	Default	Description
	three step curve if CV #29, Bit 4 = 0			(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 CVs #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 - 127 (129-255)	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 14 V 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 2 V lower) doesn't fall below the absolute reference voltage.

ZIMO ELEKTRONIK

- 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 always keep the track voltage constant (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 do not keep track voltage stabilized. Instead set this CV about 2 V below track voltage (i.e. 140 for 16 V).

- 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 22 V at idle but drops to 16 V 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 CVs:

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 Proportional-Integral-Differential values. 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)	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 $(131+ \text{mantissa}*4) *2^{\exp}$. 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	0	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...
#147	EMF - measurement gap extended range	0 – 255	0	Useful initial value for testing: 20 for Fleischmann. To avoid the jerking (of buck jumps); if the value is too large, the control may become worse. Increase value slowly until jerking is gone.

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 CVs

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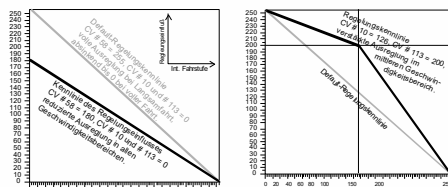
The overall intensity of load compensation can be defined with *CV #58* from no compensation (value 0) to full compensation (value 255). Useful values range from 100 to 200.

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 CVs #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 CVs** for test purposes, to find out whether certain automatic settings have a negative effect on motor regulation. Using these experimental CVs will deactivate the automatic settings. CVs #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. Tens digit: 1-9: Reduction of the motor regulation if consist-key is active. The values 1-9 reduce the control to 10 % - 90 % of the value set in CV #58.

5.7 Acceleration and Deceleration:

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

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

- A sound project in sound decoders always comes with different values in CVs #3 and #4 (as well as many other CVs) 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.

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 does not 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.
#111	Emergency Delay time	0 – 255	0	This CV value is valid for Emergency Stop instead of CV #4, i.e. for single stop and collective stop emerg.
#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 De-celeration	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 accel-eration	0 - 255	-	Bit 0 = 1: Light flashes at switch gear sound. Bit 4 = 1: Quicker acceleration with sound playing

CV	Designation	Range	Default	Description
	From SW-Version 33.25			back "heavy load when speed regulator is moved rapidly to full speed. Bit 5 = 1: Overlapping of chuff beats
#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.
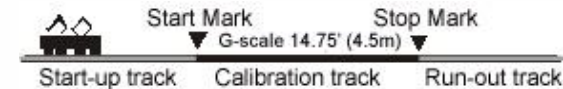
Step 1. Set the engine on the track, with the proper travel direction selected, about 1 to 2 meters (3 – 6 ft) before the start marker and the function F0 (headlights) <u>turned off.</u> Acceleration times (in CV #3 of the decoder as well as settings in the cab) should be set to 0 or a very small value.
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" (CVs #51 – #55). The values entered to those CVs 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 confirmation	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 CVs #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.
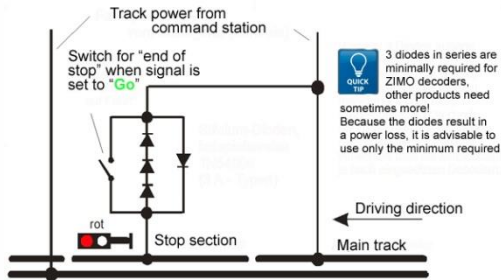
The deceleration (often CV #52 for "U" limit) and brake (CV #4 and #50) characteristics should be set so that all locos come to a complete stop within about 2/3 of the stop section, which in large-scale is typically 2' - 2 ½' before the end of a stop section. Setting the loco up to stop precisely within 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 From SW V 38.10 >	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. If CV #135 > 0 (i.e. km/h - regulation in force): The HLU limits are to be understood as km/h!
#59	**Signal dependent reaction time** (HLU, ABC, Märklin braking distance)	0 - 255	5	ZIMO signal-controlled speed influence ("HLU") with track section module MX9 or StEin, with signal stop by "asymmetric DCC signal" or Märklin brake section Time in tenths of a second in which an acceleration process is initiated after receiving a higher signal-controlled limit than the one valid so far. With CV #59 > 0 this also cancels any interruption of the constant braking distance (CV #141 or CV #830 - #833) by a second slider in case of Märklin braking distance.

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

As of SW version 36.1: ABC slow speed step also functional (e.g. Lenz modules BM2)

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.

Track power from command station

Switch for "end of stop" when signal is set to "Go"

3 diodes in series are minimally required for ZIMO decoders, other products need sometimes more! Because the diodes result in a power loss, it is advisable to use only the minimum required

rot

Stop section

Driving direction

Main track

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 2 V. 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 decoder 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 (0.4 V 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).

The ABC slow speed step, which is common for Lenz decoders, is supported by ZIMO decoders since SW version 36.1 (fall 2016). The speed for the ABC slow speed step can be set via CV #53.

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.
#49 #50	**Acceleration, Deceleration rate**	0 - 255	0	Effect in ABC as in HLU! Therefore, see description in chapter "ZIMO signal-controlled speed influence"!
#53	**Slow speed section**	0 - 255	70	The internal speed step in the ABC - slow speed section
#100	Current asymmetry voltage	0 - 255		Currently measured absolute asymmetry of the rail voltage [0.1V] (to find problems with ABC detection) The CV #100 delivers when read out via PoM (=Prog On the Main, =OP Prog Mode) the asymmetry voltage measured AT THE TIME in tenths of a volt. For the read CV values of CV #100 the following applies:

CV	Designation	Range	Default	Description
				[…] 2 = 0.2 V Asymmetry right track higher voltage 1 = 0.1 V Asymmetry right track higher voltage 0 = perfectly symmetrical signal 255= 0.1 V Asymmetry left track higher voltage 254= 0.2 V Asymmetry left track higher voltage […] The result is rounded to tenths of a volt, therefore the last bit may "flicker" a bit (e.g. with a measured rail voltage asymmetry of e.g. 1.44 V the CV sometimes returns 14 and sometimes 15 as CV value).
#101	Correction factor for CV #100	0 - 255	0	CV #101 can be used to define a correction factor in one of the two directions (only necessary for models with 6pol NEM 651 interface, where the consumers load one of the two rails). Offset adjustment of the asymmetry (signed: 128=-128 ... 127=+127) to compensate for resistance tolerances of the rail voltage measurement
#134	**Asymmetrical threshold** for stopping with asymmetrical DCC signal (Lenz ABC method)	1 - 14, 101 - 114, 201 - 214 = 0,1 - 1,4 V	106 = 0.4 V	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	5	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. = 5: Default. This setting usually works fine if CV #134 is also set to default.
#192 PROV #59	ABC - Shuttle Retention time	0 - 255	0	= 0: no ABC - shuttle operation = 1 - 255: stay time (in sec) in the ABC stopping (=reversal) sections at ends of shuttle section. **ATTENTION** (PROVISORY in SW version 38.00): CV #59 contains stay time (only with CV #27 bit 6).

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 CVs.

CV	Designation	Range	Default	Description
#29, #124, #112	Single Bits in each of these CVs 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, 1, 2, 3, 11, 12, 13	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)	0 - 255	0	This CV defines the "constant stopping" distance. The right value for the existing stop sections has to be determined by trial.

	Setting the distance			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	5	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. = 5: 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.
#830	**Braking distance forward High Byte**	0 - 255	0	Extended definition of the constant braking distance: With CVs #830 - #833 a more precise and direction dependent braking distance can now be set. The factor compared to CV #141 is 1 to 16.
#831	**Braking distance forward Low Byte**	0 - 255	0	
#832	**Braking distance reverse high byte**	0 - 255	0	The braking distance to be defined is calculated from: (256 * High Byte) + Low Byte.
#833	**Braking distance reverse low byte**	0 - 255	0	CVs #830 - #833 are only effective when CV #141= 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 un-prototypical 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.
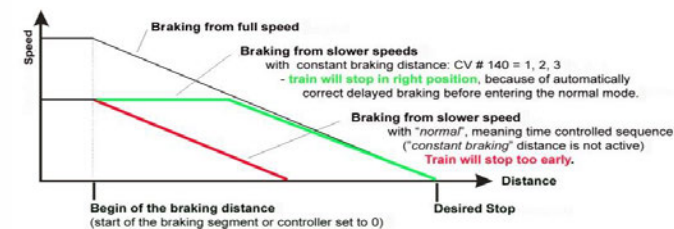
First method for a constant stopping distance
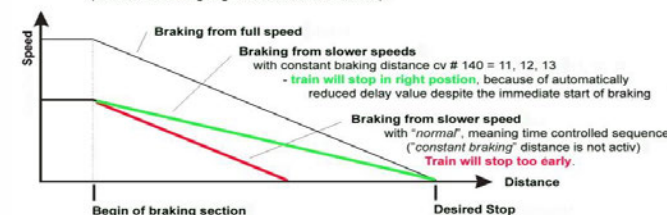
Second method for a constant stopping distance

⚠️ "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, CVs #155, #156 and #157 are the preferred CVs 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 CVs #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 CVs #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 com-

CV	Designation	Range	Default	Description
				pletely: Bits 0, 1, 2 & 4 = 1; that is CV #124 =23. F3 for half-speed key <u>and</u> removing momentum: Bits 0, 1, 4 &6 = 1; that is CV #124 = 83. **Bit 5 = 1:** "DC stopping"
#155	Half-speed key selection	0, 1 - 28, 29, 30	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. If CV #155 = = 0: not CV #155 but CV #124 is active = 1 -28: Function key F1 - F28 = 29: Function key F0 = 30: MAN key Additionally the half-speed can be set via Bit7-5. Bit 7-5 = 000 = 0.625; Bit 7-5 = 001 = 0.125; ... Bit7-5 = 100 = 0.5; ...Bit7-5 = 111 = 0.875

#156	Momentum-deactivation key selection	0, 1 - 28, 29, 30, 129 -156, 157, 158	0	This CV overwrites the setting of the F-keys in CV #124 (bits 2&6) in case it is not satisfactory. The set effective range (bits 0&1) of the acceleration behaviour does not change.
				If CV #156 > 0 (i.e. a key is set), any assignment in CV #124 is ineffective.
				If CV #155 =
				= 0 means CV #155 not active, so CV #124 is valid.
				= 1 - 28: Function key F1 - F28
				= 29: Function key F0
				= 30: MAN key
				Bit 7 = 1: Suppressing the switching of the light on reversal of direction.
				The settings of CV #124 regarding the type of deactivation or reduction still apply, that is:
				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).

#157	Selects a function key for the MAN function Only needed for non-ZIMO cabs that don't have the MN key.	0, 1 - 28, 29, 30	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

CVs #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	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

							FO6	FO5	FO4	FO3	FO2	FO1		
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 CVs (#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 CVs:

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 CVs #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 CVs, 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 the coupled end).

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 (= no effect)	The value of this CV is calculated as follows: The number of a function output (FO1 – FO7) **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	Bit 0 - 5	0	Bit 0-2: 3rd Fu output is switched off together with CV#107 (FA1 - FA7) Bit 3-5: 4th Fu output is switched off together with CV#107 (FA1 - FA7). 7 = 1, the driver's cab light suppression is automatically activated in the Consist.
#110	Additional FU-output, cab side 2	Bit 0 - 5	0	Like CV #109 but together with CV #108.

5.17 The "Swiss Mapping"
(from SW version 32, extended with 34.0 and 35.27)

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 LEDs) and the decoder offers as many function outputs, at least 6. ZIMO decoders offer indeed between 6 and 10 function outputs (except for a few miniature decoders), large-scale decoders even more.

The desired lighting states are defined by **a total of 17 CV groups**, each group **containing 6 CVs** (= 102 CVs; CV #430 - #507 + #800 - #823). The principle is simple, 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) 129 – 157	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. Bit 7 = 1: Invert function of F key
#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. Bit 6 = 1: In forward direction, the outputs of the M key are not switched off when the F key is on. (from SW version 35)

CV	Name	Range	Default	Description
				Bit 5 = 1: In reverse direction, the outputs of the M button are not switched off when the F button is on. *(from SW version 35)* = 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 tail-light 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	Bits 0 - 3: 1 - 12 14 (FO0f) 15 (FO0r) Bits 5 - 7: 0 - 7	0	Bits 0 – 3: Function output to be turned ON in forward direction under the conditions set out for the "F" and "M" keys. Bits 7,6,5 (with 7 possible values and zero): Number of the "dimming CV" to be applied, i.e. "1" (bit 5 = 1) means dimming according to CV #508, etc.
#433	Swiss Mapping Group 1 "A1" forward	Bits 0 - 3: 1 - 12 14 (FO0f) 15 (FO0r) Bits 5 - 7: 0 - 7	0	Bits 0 – 3: Additional function output to be switched ON in forward direction under the conditions set out for the "F" and "M" keys. Bits 7,6,5 (with 7 possible values and zero): Number of the "dimming CV" to be applied, i.e. "1" (bit 5 = 1) means dimming according to CV #508, etc.
#434	Swiss Mapping Group 1 "A2" reverse	Bits 0 - 3: 1 - 12 14 (FO0f) 15 (FO0r) Bits 5 - 7: 0 - 7	0	Bits 0 – 3: Function output to be turned ON in reverse direction under the conditions set out for the "F" and "M" keys. Bits 7,6,5 (with 7 possible values and zero): Number of the "dimming CV" to be applied, i.e. "1" (bit 5 = 1) means dimming according to CV #508, etc.
#435	Swiss Mapping Group 1 "A2" reverse	Bits 0 - 3: 1 - 12 14 (FO0f) 15 (FO0r) Bits 5 - 7: 0 - 7	0	Bits 0 – 3: Additional function output to be switched ON in reverse direction under the conditions set out for the "F" and "M" keys. Bits 7,6,5 (with 7 possible values and zero): Number of the "dimming CV" to be applied, i.e. "1" (bit 5 = 1) means dimming according to CV #508, etc.
#436 - #441	. . .　Group 2.	. . .	0	All 6 CVs of Group 2 are defined the same way is the 6 CVs in group 1.
#442 - #447	. . .　Group 3	. . .	0	All 6 CVs of Group 2 are defined the same way is the 6 CVs in group 1.
#448 - #453	. . .　Group 4	. . .	0	. . .
#454 - #459	. . .　Group 5	. . .	0	. . .
#460 - #465	. . .　Group 6	. . .	0	. . .

CV	Name	Range	Default	Description
#466 - #471	. . .　Group 7	. . .	0	. . .
#472 - #477	. . .　Group 8	. . .	0	. . .
#478 - #483	. . .　Group 9	. . .	0	. . .
#484 - #489	10　. . .　Group	. . .	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	. . .
#800 - #805	. . .　Group 14		0	*. . . (Groups 14, 15, 16 and 17 only as of SW version 35.27)*
#806 - #811	. . .　Group 15		0	
#812 - #817	. . .　Group 16		0	
#818 - #823	. . .　Group 17		0	
#508 #509 #510 #511 #512	values for "Swiss mapping" Spezial Einstellungen	(0- 31)*8 (only Bits 7 – 3 used) Bits 2 - 0	248	One of these five CVs, i.e. the five dimming values it contains, can be linked to in any of the group CVs (e.g. #432, #433, #434, #435). This means that the function outputs to be switched on are to be dimmed accordingly. Can be used with function outputs FO0 to FO13. Bit 0 = 1: suppresses the light effect *(from SW version 36.1)* Bit 1 = 1: blinking effect *(from SW version 37.0)* Bit 2 = 1: inverse blinking effect *(from SW version 37.0)*
#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 17 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 (see CV #155).

	Front	Rear
Lfor		
Lrev		
FO1		
FO2		
FO3		
FO4		
FO5		
FO6		

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 CVs 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 = 3	#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 CVs 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 <u>and</u> M key is ON.

The third to sixth CVs 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:　*CVs #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 for example: CV #403 = 1: Key F1 to internal F3 　　　= 9: Key F9 to internal F3 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 18 V bulbs and a track voltage of 24 V (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 12 V 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 5 V or 1.2 V 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").

- LEDs, 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 25 V (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 CVs (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 CVs #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. UNDERLINE 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 <u>and</u> 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 CVs #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 CVs #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 CVs starting with #125; but for historical reasons, CVs #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	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

CVs #125,   #126,   #127 … #132,   #159,   #160

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

The values that can be programmed into the effect CVs consist of

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

<table>
<tr><td></td><td>Bits 1,0 = 00: bidirectional (active in both directions)</td></tr>
<tr><td></td><td>= 01: active in forward direction only   (+ 1)</td></tr>
<tr><td></td><td>= 10: active in reverse direction only   (+ 2)</td></tr>
</table>

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,   = **48, 49, 50**
        automatic disengagement in CV #116
= 001101xx "Soft start" = slow power-up of function output   = **52, 53, 54**
= 001110xx Automatic stoplights for street cars,   = **56, 57, 58**
        stoplight-off delay, see CV #63.
= 001111xx Function output turns itself off at speed >0   = **60, 61, 62**
        (i.e. turns off cab light when driving).
= 010000xx Function output turns itself off after 5 minutes   = **64, 65, 66**
        (i.e. to protect smoke generators form overheating).
= 010001xx as above, but automatic shut-off occurs after 10 min.   = **68, 69, 70**
= 010010xx Speed or last dependent **smoke generation**.   = **72, 73, 75**
        for **steam engines** as per CVs #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.
= 010100xx Driving state-dependent **smoke generation** for **diesel engines**   = **80, 81, 82**
        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.
= 010110xx Slow fade in/out of a function output; useful for various   = **88, 89, 90**
        lighting effects or motorized equipment (i.e. fan, snow blower).   *(SW version*
        Dimming time is set with CVs #190 and #191.   *33.10 and up)*
= 010111xx Fluorescent tube effect *(from SW version 36.7)*   = **92, 93, 94**
= 011000xx Brake spark during heavy braking *(from SW-Version 37.0)*   = **96, 97, 98**

- The effect CVs are also suitable **without using a special effect** (with effect code 000000), for

direction dependent function outputs.

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 CVs #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 CVs #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 **ATTENTION**: Effects "Clutch" and "Smoke" have moved from F0 - F6 to F1 - F8 with SW version 34!
#62	Effects modifications	0 - 9	0	Change of minimum dimming value (0 - 90 %)
#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.).

[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).

#64	Ditchlight modification	0 - 255	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]
#393	ZIMO-Config. 5	0 – 255	0	Bit 0 = 1: activate ditch light if bell is played 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 FO8 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 <u>must</u> be programmed with appropriate values otherwise the smoke generator will not produce any smoke.

CV	Designation	Range	Default	Description
#137 #138 #139	Characteristics for smoke generators connected to FOs 1-6 PWM at stand still PWM at cruising PWM during acceleration	0 - 255 0 - 255 0 - 255	0 0 0	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), <u>provided</u> a "smoke function" for a diesel or steam engine (value 72 or 80) has been selected in the associated CV #127 – #132: CV #137: PWM of FOx at standstill CV #138: PWM of FOx at cruising speed CV #139: PWM of FOx at acceleration (PWM = Pulse With Modulation)

EXAMPLE: - Typical characteristic for a track voltage set around 20 V 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 <u>without</u> 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
#137 #138 #139	Definition of smoke generator characteristic, connected to FO1 – 6. PWM at stand still PWM at steady speed PWM during acceleration	0 - 255 0 - 255 0 - 255	0 0 0	<u>Provided</u> 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! CV #137: PWM of FOx at standstill CV #138: PWM of FOx at cruising speed 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 CVs #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 For STEAM and DIESEL engines	1 – 255	0	Supplement to the settings in CV #133 and the effects with code "72" (steam engines) or "80" (diesel engines), 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 CVs 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 9 V, 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 **24 V (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 10 V 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 CVs correspondingly lower values (about 40 % and 60 %, which can of course be varied individually).

If the heating element is connected to **18 V (Common positive** with track voltage of 18 V or adjustable low-voltage output set to 18 – 19 V) 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 18 V is 25 % lower than 25 V).

All other CVs 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 – FO8** (from SW Version 34.0, before only up to FO6) 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 CVs 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 - 255	0	The uncoupler function is only active if "uncoupler" is selected (value 48) in one of the CVs #125 - #132: Hundreds digit (from SW.Vers. 40.18): defines waiting time between coupling opening and driving away (CV value 0= 0,3 sec.; 1= 2,5 sec.; 2= 1,0 sec.)" when Coupler waltz (CV #116) is activated. 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 = Coupler waltz	0 - 99, 0 - 199	0	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. 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.) 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 <u>must</u> be set to "2" for **Smart Servo RC-1!**
			0	Bit 0 = <u>0</u>: Servo protocol with positive pulses.
				    = 1: Servo protocol with negative pulses.
				Bit 1 = <u>0</u>: 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 #170 - #173 #174 - #177	As above but for Servo 2 Servo 3 Servo 4	#166 left stop, #167 right stop, #168 center position, #169 rotating speed. #170 left stop, #171 right stop, #172 center position, #173 rotating speed. #174 left stop, #175 right stop, #176 center position, #177 rotating speed.		
#181	Servo 1	0 - 28	0	= 0: Servo not in operation

#182 #183 #184	Servo 2 Servo 3 Servo 4 Function assignment	90 - 93 101-114	0 0 0	= 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. = 94: refers to the function "Panto1" which is configured in CV #186 is configured = 95: ... "Panto2" which is configured in CV #187 = 96: ... "Panto3" which is configured in CV #188 = 97: ... "Panto4" which is configured in CV #189 = 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.

#186
#187
#188
#189
	"Panto1"
	"Panto2"
	"Panto3"
	"Panto4"
			0	Bit 7 = 0: Not sound dependent
				    = 1: Sound Dependent
				Bit 6 - 5 = 00: direction independent,
				    = 01: only for forward drive
				    = 10: only for reverse drive
				    = 11: only when function key is switched off
				Bit 4 - 0: Key to activate (00001=F1, 00010=F2, 00011=F3, …)

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 CVs for RailCom configuration:

CV	Designation	Range	Default	Description

#28	RailCom Configuration	0 – 15
		64 - 67
			3	Bit 0 - RailCom Channel 1 (broadcast)
				          0 = off 1 = on
				Bit 1 - RailCom Channel 2 (Data)
				          0 = off 1 = on
				Bit 2 - deactivates OW reception
				          0 = off 1 = on (since SW 40.5)
				Bit 3 - deactivates OW transmission via Railcom
				          0 = off 1 = on (since SW 40.5)
				Bit 6 - High current RailCom (MX699 series only)
				          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 CVs #67 – #94
				Bit 5 - Decoder address:
				          0 = primary address as per CV #1
				          1 = ext. address as per CV #17 + #18

#135	Addition to CV #136	Bit 6	0	Bit 6 of CV #135 is the "9th bit" for the speed feedback in CV #136 (see next line)
#136	Setting the feedback	RailCom	128	Correction factor for the speed feedback

CV	Designation	Range	Default	Description
	speed	display factor		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.

RailCom in ZIMO Decoders is activated with

$$CV \#29, Bit\ 3 = 1 \quad AND \quad CV \#28 = 3$$

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 CVs (see table above).

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

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ZIMO ELEKTRONIK

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 CVs 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 (CV #265, 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 CVs (#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).

Note: CV#265=1 -> Dampflok BR 01 (default)
CV#265=2 -> Steam BR 01.10   CV#265=3 -> Steam BR 44
CV#265=4 -> Steam BR 50   CV#265=5 -> Steam BR 52
CV#265=6 -> Steam BR 298   und   CV#265=101 -> Diesel BR 218

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	F7 – coal shoveling or oil burner
F4 – water drain (blow off…)	F9 – compressor
F5 – long whistle (playable)	F10 – generator
F6 – bell	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 CVs. However, there are numerous possibilities for **fine-tuning** the main engine sound **through CVs** (e.g. 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 CVs 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 CVs** and can be **modified by these CVs** 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"

A convenient procedure (w/o the use of CV #300) is available with ZIMO MX31/MX32 cabs

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.

Selecting another chuff set (if several sets are present in a sound collection):

(only possible for steam projects, not for diesel or electrics)

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"):

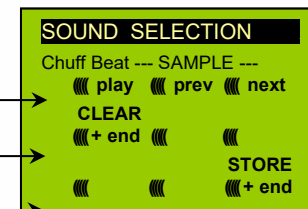**CV #300 = 100 (only for steam / not possible with DIESEL engines!).**

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!

ZIMO cab key arrangement:

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

```
SOUND  SELECTION
Chuff Beat --- SAMPLE ---
   play    prev    next
    CLEAR
  + end
                  STORE
                  + end
```

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**
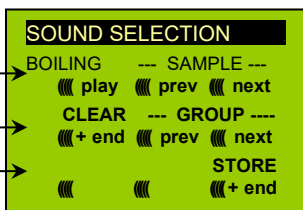
《 **7 F6** 《 **8 F7** 《 **9 F8**

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.

```
SOUND SELECTION
BOILING     --- SAMPLE ---
   《 play  《 prev 《 next
   CLEAR   --- GROUP ----
   《+ end 《 prev 《 next
                    STORE
   《        《         《+ end
```

```
SOUND  SELECTION
BREAK SQUEAL  -- SAMPLE -
   《 play  《 prev 《 next
   CLEAR   --- GROUP ----
   《+ end 《 prev 《 next
                    STORE
   《        《         《+ end
```

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.

```
SOUND  SELECTION
BLOW OFF    --- SAMPLE ---
   《 play  《 prev 《 next
   CLEAR   --- GROUP ----
   《+ end 《 prev 《 next
                    STORE
   《        《         《+ end
```

Allocating sound samples to function keys F1 - F
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 is 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!
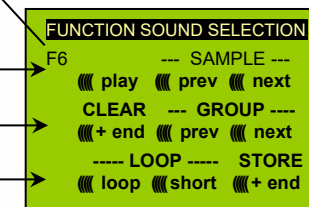
Depends on entry: F1 - F19

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**

```
FUNCTION SOUND SELECTION
F6            --- SAMPLE ---
   《 play  《 prev 《 next
   CLEAR   --- GROUP ----
   《+ end 《 prev 《 next
   ----- LOOP -----  STORE
   《 loop 《short 《+ end
```

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 CVs; 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 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

Depends on entry: Z1 . . . Z8

RANDOM SOUND SELECTION
Z2   --- SAMPLE ---
(((play   (((prev (((next
   CLEAR   --- GROUP ----
(((+ end (((prev (((next
----- LOOP -----   STORE
(((still   (((cruise (((+ end

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 CVs #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…

Depends on entry: Z1 - Z8

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

ZIMO MX31/MX32 key arrangement:

(((1 F0   (((2 F1   (((3 F2
(((4 F3   (((5 F4   (((6 F5
(((7 F6   (((8 F7   (((9 F8

SWITCH INPUT SELECTION
S1   --- SAMPLE ---
(((play   (((prev (((next
   CLEAR   --- GROUP ----
(((+ end (((prev (((next
----- LOOP -----   STORE
(((((((((+ end

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 CVs,*
an alternative to "normal" programming

Configuration variables (CVs) 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 CVs 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 CVs 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!

ZIMO cab key arrangement:

《 1 F0   **《 2 F1**   **《 3 F2**
《 4 F3   **《 5 F4**   **《 6 F5**
《 7 F6   **《 8 F7**   **《 9 F8**

Incrementing!
Decrementing!
Set to default value!

MENU SOUND Incr.Prog		
CV 266	CV 267	CV 268
《 + Total volume	Chuff beat	Part - volume steam
《 -		
+ 2	- 40	+ 3
《 0 = 43	= 17	= 255

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 CVs 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 CVs).

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 CVs #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 **CVs #777 and #778** (slow/fast PWM values, forward) and **#779 and #780** (PWM values in reverse direction); these CVs 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.

If you start the measurement run in SERV Prog, you must exit SERV Prog immediately after the CV write command on CV #302 (press E on ZIMO consoles or E twice on MX32/FU to start the motor). Please do not carry out the test run on a roller test bench, because here short voltage interruptions (contact rail - roller test bench) can occur at higher speeds.

7.4 Basic settings independent of powertrain

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

> **NOTE**: The **default values** of individual CVs 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	De-fault	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 also for non-sound decoders (only types with 1K EEPROM) for key with which start-up delay is activated (1-28 for F1-F28)	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. = 0 - 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 0 **Link between sounds and function output:** | #726	Link 1 Sound			Sound nu
#727	Link 1 FO			Function o 1=FO0v,
#728	Link 2 Sound			Soundnum	

CV	Designation	Range	De-fault	Description
					#729	Link 2 FO			Function output which 1=FO0v, 2=FO0r, 3=FO
#730 … #735	…			…
#736	Link 6 Sound			Sound number which s
#737	Link 6 FO			Function output which 1=FO0v, 2=FO0r, 3=FO	
				Steam engine → Basic sound 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 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.
#314	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
#376	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 CVs 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 CVs 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!
#303 - #306	Reed 1 - 4 Sound configuration	0 - 255			Bit 0-4: Button to activate or deactivate reed input: 1-28 = F1-F28, 29 = F0, 30 = MAN button Bit 5: Button for reed input inverted function 0=sound active when button on, 1=when button off Bit 6: Loop active as long as reed is active Bit 7: Shorten active when reed becomes inactive Several reed sounds are possible at the same time.
#307	Cornering squeal sequence Reed configuration			0	Bit0 - Reed1 triggers Cornering squeal Bit1 - Reed2 triggers Cornering squeal Bit2 - Reed3 triggers Cornering squeal Bit3 - Reed4 triggers Cornering squeal Bit7 - 0 = Key off CV #308 suppresses Cornering squeal of reed inputs when key on 1 = key off CV #308 activates Cornering squeal independent of reed inputs
#308	Cornering squeal key	0 - 28		0	0 = No key defined. Reed inputs always active. 1-28 = F1 to F28 key.
#133	Reed Config.			0	Bit 4 - inverts the polarity of Reed1 input Bit 3 - inverts the polarity of Reed2 input Bit 2 - inverts the polarity of Reed3 input Bit 5 - inverts the polarity of Reed4 input

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 desired (Loss of sound quality if pot meter is fully open and at the same time the volume is heavily reduced by CVs!).

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 CVs (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)

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 #517 #520 #523 …. #565 #568	Function sound F1 Function sound F2 Function sound F3 Function sound F4 … Function sound F18 Function sound F19	0 - 255	0	Volume for function sound F1 Volume for function sound F2 Volume for function sound F3 Volume for function sound F4 …. Volume for function sound F18 Volume for function sound F19
#674 … #698	Function sound F20 … Function sound F28	0 - 255	0	Volume for function sound F20 … Volume for function sound F28

Switch input sounds - Volume adjustments:

NOTE: The in-between CVs 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.

#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
#671	Switch input sound S4	0 - 255	0	Sound sample number for switching input S4
#672	Switch input sound S4	0 - 255	0	Volume setting for the sound activated with switch input S4

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

Link between sounds and function output:

#726	Link 1 Sound			Sound number which should be valid for link 1
#727	Link 1 FO			Function output which is to be valid for link 1. 1=FO0v, 2=FO0r, 3=FO1, ...
#728	Link 2 Sound			Soundnummer welche für die Verknüpfung 2 gelten soll
#729	Link 2 FO			Function output which is to be valid for link 2. 1=FO0v, 2=FO0r, 3=FO1, ...
#730 … #735	…			…
#736	Link 6 Sound			Sound number which should be valid for link 6.
#737	Link 6 FO			Function output which is to be valid for link 6. 1=FO0v, 2=FO0r, 3=FO1, ...

7.5 Steam engine → Basic sound settings

The following CVs 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 CVs 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 7.4 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:

CV	Designation	Range	INC-step	De-fault	Description
					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	0,1 – 63 And Bits 6, 7 (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 …, 63 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 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 does not 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

CV	Designation	Range	INC-step	De-fault	Description
					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 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 was not 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

CV	Designation	Range	INC-step	De-fault	Description
					= 1 - 127: more chuff beats in relation to CV #267, = 255 - 128: less chuff beats.
#154	Various special bits	-	0	Bit0: Panto-Motors on FO4 to FO7 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 3). = 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 7.3

+ Adjust CVs #275 and #276   + Adjust CV #277   + If needed CV #278 and #279

> **NOTE**: The CVs 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 CVs 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 CVs 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	Designation	Range	INC-Step	Default	Description
					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. =<u>1</u>: 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	Threshold for	0 -255 (internal	1	1	Steam chuffs should be played back at less volume (or muted) signifying the reduced power requirement during deceleration. The sound re-

CV	Designation	Range		Default	Description
#284	deceleration sound	speed steps)			duction 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	Default	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 rpms and notches Diesel-electric engines – cruise/idle rpm

CV	Designation	Range	INC-step	Default	Description
					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	Bit0: Panto-Motors on FO4 to FO7 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 defined in various other CVs)				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 3). = 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 accessories are supposed to remain operating (i.e. cooling fans) and automatically stop after the time defined 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	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-

ZIMO ELEKTRONIK

CV	Designation	Range	INC-step	De-fault	Description
	between the sounds of a MULTI-SYSTEM engine				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.
#835	More set-switching keys	0 - 32		0	Extension of CV #345. Here the number of consecutive keys can be defined, which then switch to Set2, Set3, Set4, ... The first key is still defined in CV #345
#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 parameters for key selected with CV #347	0 - 31		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. Bit 3 = 1: Deactivate second smoke generator fan pulse output (Vent 2) and the higher FO, the one where the second heating element resistor is connected, by the Loco drive key. Bit 4 = 1: Brake squeal is suppressed with Loco drive key.
#387	Influence of acceleration 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 (acceleration, deceleration) should also have an influence on sound due to the associated increase or decrease in load. = 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 deceleration to diesel sound steps	0 - 255		0	Same as CV #387 but used during decelerations. = 0: No influence (sound depends on speed step only)

CV	Designation	Range	INC-step	De-fault	Description
					= 64: experience has shown this to be a practical value = 255: maximum deceleration response
#389	Limitation of the acceleration 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.
#836	Motor Start Sound	Bit 0		0	Bit 0 = 1: Loco should not start as long as the motor start sound has not finished playing.
#378	Probability Light flashing during Acceleration	0 - 255		0	Probability for light flashes (according to CV #158, bit 7 for FO7 or #394 for FO6) during acceleration. = 0: always = 1: very rarely = 255: very often (almost always)
#379	Probability Light flashing at Delay	0 - 255		0	Probability for light flashes (according to CV #158, bit 7 for FO7 or #394 for FO6) during delay. = 0: always = 1: very rarely = 255: very often (almost always)
#364	Speed drop during upshifts for DIESEL engines with mechanical transmission.			0	This special CV applies only to diesel-mechanical engines and defines the typical drop in speed when shifting up. See sound projects (i.e. VT 61)
#365	Upshift rpm for DIESEL engines with mech. transmission.			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)

CV	Designation	Range	INC-step	De-fault	Description
#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.
#829	Turbocharger Minimum diesel step	0 - 255		0	The minimum diesel step from which the turbo-charger should start. 0 = from speed step 1 1 = speed step 2, etc.
#834	Turbocharger Acceleration de-pendence	0 - 255		0	Reduction of the acceleration dependency, if "Loco drive key" (CV #368) is switched on.
#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.
#293	Thyristor control Volume at steady	0 - 255			Thyristor sound volume at steady speed (no accel-eration or deceleration in process).

CV	Designation	Range	INC-step	De-fault	Description
	speed for ELECTRIC engines				
#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 accel-erates).
#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.
#394	ZIMO Config. 4	Bit 7		0	Thyristor sound comes before driving away
#296	Electric motor sound, maximum volume for ELECTRIC engines	0 -255		0	Maximum volume of motor sound.
#297	E-motor Minimum load	0 -255		0	Internal speed step at which engine noise becomes audible for the first time; at this speed it starts qui-etly and reaches the maximum volume at the speed according to CV #298 / #299 according to CV #296
#298	Electric motor sound, volume dependent on speed for ELECTRIC engines	0 - 255		0	Slope of the characteristic curve for speed de-pendent volume. (curve starts with #297) See ZSP manual!
#299	Electric motor sound, Sound pitch	0 - 100		0	Slope of the characteristic curve for speed de-pendent volume. (curve starts with #297)

CV	Designation	Range	INC-step	De-fault	Description
	dependent on speed for ELECTRIC engines				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			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 for ELECTRIC engines	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.) 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).
#393	ZIMO Config. 5	Bit 2,		0	

CV	Designation	Range	INC-step	De-fault	Description
		Bit 3			
#380	Manual electric brake key	0, 1 - 29		0 (S/D) 1 (E)	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 deceleration 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 – 15		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.
#356	Speedlock-Key	0 - 28		0	When the key is activated, the driving sound can be changed with the speed controller without changing the speed.
#837	Script sequences	Bi 0 - 7		0	Bit 0 - 7 = 1: Deactivate script 1 - 8

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 - 29	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"

CV	Designation	Range	Default	Description
#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 reduced 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 minimum 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 motor 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

CV	Designation	Range	Default	Description
#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.

CV	Designation	Range	Default	Description
				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 Playback duration	0 - 255 = 0 - 255 sec	0	The sound sample allocated to switch input 1 is played back 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	0 - 255 =	0	The sound sample allocated to switch input 3 is played back for the duration defined with this CV.

	cam sensor) Playback time	0 - 255 sec		= 0: Play back once (duration as recorded)
#392	Switching input 4 Playback duration	0 - 255 = 0 - 255 sec	0	The sound sample assigned to the switching input S4 is to be played for the duration defined here. = 0: Play sample once (in the saved duration)

8   CV – Summery List

This list summarizes all CVs 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: Reference to chapters in these operating instructions with detailed description, click to go to the respective chapter

	CV	Designation	Range	Default	Description
5.4	#1	Short address	1 – 127	3	The "short" address; active when Bit 5 in CV #29 is 0.
5.6	#2	Start voltage	1 - 255	1	Internal speed step for **lowest** external speed step.
5.7	#3	Acceleration rate	0 - 255	(2)	Multiplied by 0.9 equals' acceleration time.
5.7	#4	Deceleration rate	0 - 255	(1)	Multiplied by 0.9 equals' deceleration time.
5.6	#5	Top speed	0 - 255	1 (=255)	Internal speed step for **highest** external speed step.
5.6	#6	Medium speed	⅓ to ½ #5	1 (=1/3 #5)	Internal speed step for **medium** external speed step.
5.3	#7	SW-Version number	Read-only	-	The current SW number; for subversion see CV #65.
5.3	#8	Manuf.-ID, Reset, Set	0, 8, Set #	145 (ZIMO)	given by the NMRA; CV #8 = 8 → Hard Reset.
5.6	#9	Motor regulation.	1 - 255	55	Sample time (tens digit), sample rate (ones digit)
5.6	#10	Compensation-Cutoff	0 - 252	0	Internal speed step, where BEMF intensity per CV #113.
-	#11	------			
-	#12	------			
5.5	#13	Analog functions F1 - F8	0 - 255	0	Select analog functions F1 (Bit 0), F2 (Bit 1)...
5.5	#14	Analog funct. F0, F9 …	0 - 255	(CV #14) 67 therefore Bit 6 = 1:	Select analog functions, F0 forw (Bit 0), rev (Bit 1)...
-	#15	------			
-	#16	------			
5.4	#17, #18	Extended address	128 -10239	128	The long address. Active when CV #29, Bit 5 = 1.
5.4	#19	Consist address	0 – 127, 128-255	0	Short address for consist function 1 – 127, Bit 7 = 1: direction inversed
5.4	#20	Extended consist address From SW version 36.6	0 - 102	0	The value of CV #20 multiplied with 100 added together with the value of CV #19 which result is the address at consist. e.g. CV #20= 12, CV #19=34 is address. 1234 CV #20=100, CV #19=00 is address 10000
5.4	#21	Consist function F1 - F8	0 - 255	0	Select consist functions F1 (Bit 0), F2 (Bit 1).…
5.4	#22	Consist function F0	0 - 255	0	Select consist function F0 forw (Bit 0), rev (Bit 1).

	CV	Designation	Range	Default	Description
5.7	#23	Acceleration variation	0 - 255	0	For temporary adjustment to CV #3
5.7	#24	Deceleration variation	0 - 255	0	For temporary adjustment to CV #4
-	#25	------			
-	#26	------			
5.10	#27	Asym. Stop (ABC)	0, 1, 2, 3	0	Bit 0 = 1: Stop, with right rail Bit 1: left rail
5.2	#28	RailCom Configuration	0 - 15 64 - 79	3	Bit 0 = 1: RailCom (Broadcast) Bit 1 = 1: Data Bit 2 = 1: deactivates OW reception Bit 3 = 1: deactivates OW transmission via Railcom Bit 6 = 1: High current RailCom (MX699 series only)
5.2	#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 = CVs #17, #18
5.14	#33	NMRA Function map F0	0 - 255	1	Function mapping for F0 forward
5.14	#34	NMRA Function map F0	0 - 255	2	Function mapping for F0 reverse
5.14	#35 - #46	Function mapp. F1 - F12	0 - 255	4,8,2,4,8,. .	Function mapping for F1 - F12
-	#47	------			
-	#48	------			
5.9	#49	HLU Acceleration	0 - 255	0	Multiplied by 0.4 = signal-controlled acceleration
5.9	#50	HLU Deceleration	0 - 255	0	Multiplied by 0.4 = signal-controlled deceleration
5.9	#51- #55	HLU Limits	0 - 255	0,20,40, …	Speed step for each of the 5 HLU speed limits
5.6	#56	Motor regulation	1 - 255	55	PID regulation: P-Value (tens digit), I-Value (Ones digit)
5.6	#57	Voltage reference	0 - 255	0	Value = 1/10 of fixed voltage. "0" = track voltage.
5.6	#58	BEMF intensity	0 - 255	255	Load compensation at low speeds
5.9	#59	HLU Reaction time	0 - 255	5	Delay for HLU changes, in tenth of a second
5.19	#60	Dimming	0 - 255	0	Reduction of function output voltage through PWM.
5.15	#61	ZIMO ext. mapping	1,2...97, 98	0	Configurations not covered by NMRA mapping
5.22	#62	Light effects mod.	0 - 9	0	Adjusts minimum dim value (in 10 % each)
5.22	#63	Light effects mod.	0 - 99	51	Cycle time (tens digit), Off-time extension (ones digit)
5.22	#64	Light effects mod.	0 - 9	5	Ditch light off-time modification
5.3	#65	SW-Subversion #	0 - 255	-	Completes the version number in CV #7.

	CV	Designation	Range	Default	Description
5.6	#66	Forward trimming	0 – 127, 129 - 255	0	Multiplies speed step by trim value/128
5.6	#67-#94	Free speed table	0 - 255	0	Internal speed step for each of the 28 external steps
5.6	#95	Reverse trimming	0 – 127 (129-255)	0	Multiplies speed step by trim value/128
-	#96	------			
5.4	#97	Consist key	0 – 28	0	= 1-28 (for F1 – F28): Button to switch between main address and consist adress
3.10	#100	Current asymmetry voltage	0 - 255		Currently measured absolute asymmetry of the rail voltage [0.1V] (to find problems with ABC detection) The CV #100 delivers when read out via PoM (=Prog On the Main, =OP Prog Mode) the asymmetry voltage measured AT THE TIME in tenths of a volt. For the read CV values of CV #100 the following applies: […] 2 = 0.2 V Asymmetry right track higher voltage 1 = 0.1 V Asymmetry right track higher voltage 0 = perfectly symmetrical signal 255= 0.1 V Asymmetry left track higher voltage 254= 0.2 V Asymmetry left track higher voltage […] The result is rounded to tenths of a volt, therefore the last bit may "flicker" a bit (e.g. with a measured rail voltage asymmetry of e.g. 1.44 V the CV sometimes returns 14 and sometimes 15 as CV value).
3.10	#101	Correction factor for CV #100	0 - 255	0	CV #101 can be used to define a correction factor in one of the two directions (only necessary for models with 6pol NEM 651 interface, where the consumers load one of the two rails). Offset adjustment of the asymmetry (signed: 128=-128 ... 127=+127) to compensate for resistance tolerances of the rail voltage measurement
5.16	#107	Light suppression	0 - 255	0	Light suppression for cab 1 (forward)
5.16	#108	Light suppression	0 - 255	0	Light suppression for cab 2 (rear)
5.16	#109	Extension of CV #107	Bit 0 - 5	0	Bit 0-2: 3rd Fu output is switched off together with CV#107 (FA1 - FA7) Bit 3-5: 4th Fu output is switched off together with CV#107 (FA1 - FA7). 7 = 1, the driver's cab light suppression is automatically activated in the Consist.
5.16	#110	Extension of CV #108	Bit 0 - 5	0	Like #109 but together with #108
5.7	#111	Emergency Delay time	0 – 255	0	This CV value is valid for Emergency Stop instead of CV #4, i.e. for single stop and collective stop emerg.
5.1 5.6	#112	Special ZIMO configuration bits	0 - 255	0	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)

	CV	Designation	Range	Default	Description
5.11 5.21					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) Bit 7 = 1: Pulse chain generation
5.6	#113	BEMF reduction	0 - 255	0	Intensity reduced at speed step defined in CV #10.
5.19	#114	Dim Mask 1	Bits 0 - 7	0	Individual outputs exempted from dimming per CV #60
5.19 5.24	#115	Uncoupler control	0 - 99	0	Eff 48: Pull-in V. (tens digit), Hold voltage (ones digit) Waiting time before driving away (hundreds)
5.24	#116	Autom. uncoupling	0 - 199	0	Unload (Hundredth) Separat.(Tens), speed (Ones digit)
5.20	#117	Flasher	0 - 99	0	ON time (Tens digit), OFF time (Ones digit)
5.20	#118	Flasher mask	Bits 0 - 7	0	Function outputs included for flashing as per CV #117.
5.19	#119	F6 low beam mask	Bits 0 - 7	0	Enter FO for low-beam switching with F6 as per CV #60
5.19	#120	F7 low beam mask	Bits 0 - 7	0	Enter FO for low-beam switching with F7 as per CV #60
5.7	#121	Expon. acceleration	0 - 99	0	Speed range included (Tens digit), curve (Ones digit)
5.7	#122	Expon. deceleration	0 - 99	0	Speed range included (Tens digit), curve (Ones digit)
5.7	#123	Adapt. accel./decel.	0 - 99	0	Accel. Convergence (Tens dig.), Decel. Conv. (Ones…)
5.11 5.13 5.25	#124	Shunting keys, Outputs instead of SUSI	Bits 0-4, 6 and 7	0	Shunting key (for half speed, accel. deactivation), Switch between SUSI – Logic level outputs
5.22	#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.
5.23 7.4	#133	FO4 for exhaust fan		0	= 0: FO4 as normal output = 1: for an exhaust fan.
5.10	#134	Asymm. stops (ABC)	1-14, 101…	106	Sensitivity (Hundredth), Threshold (Tens, ones digit).
5.8	#135	km/h - Control	2 – 20	0	= 1 → Calibration run; 5, 10, 20: Relation km/ spd. step
5.8	#136	km/h - Control	or:	RailCom	Contr. value after cal-run; or correct. value for RailCom

	CV	Designation	Range	Default	Description
5.23	#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 accelera-tion
5.12	#140	Distance controlled stopping	0-3,11-13	0	= 1: HLU or ABC = 2: manual = 3: both
5.12	#141	Distance controlled stopping	0 - 255	0	"Constant distance": Stop point = 155: 500 m
5.12	#142	Distance controlled stopping	0 - 255	5	High speed correction for ABC
5.12	#143	Distance controlled stopping	0 - 255	0	High speed correction for HLU
5.1	#144	Prog- / Update Lock	Bits 3, 4, 5, 6, 7	0	= 0: programming and updating unlocked Bit 3 = 1: CV write lock in "OP PROG Mode" Bit 4 = 1: ACK sound at CV programming Bit 5 = 1: CV read lock in "Service Mode" Bit 6 = 1: CV write lock in "Service Mode" Bit 7 = 1: update lock
5.6	#145	Alternative motor con-trol	-	0	= 1: Special setting for Fleischmann round motor = 2:. = 10: "normal" C-Sinus and Softdrive-Sinus = 11: alternative C-Sinus / Softdrive Sinus = 12: special C-Sinus and Softdrive-Sinus =13: special C- / Softdrive-Sinus control mode for the Märklin "Gottardo" engine
5.7	#146	Gear backlash compen.	0 - 255	0	Hundredth' of a second at min. speed after dir.-change
5.6	#147, …	Experimental-CVs	0 - 255	0	Special motor regulation settings
5.6	#151	Motor brake	0 - 9	0	= 1 - 9: Force and speed of application
5.19	#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	0 - 255	0	
5.13	#155	Half-speed key	0 - 19	0, 1 -28, 29, 30 for each	Function key selection (instead of CV #124)
5.13	#156	Momentum deact.	0 - 19		Function key selection (instead of CV #124)
5.13	#157	MAN key	0 - 19		Function key selection for MAN function
4 5.5 5.7	#158	Several sound bits + RailCom variants	0 - 255	4	Bit 0 = 1: SPECIAL MX648: Turns off external charging with FO1. Bit 1 = 1: DIESEL-MECHANICAL: No RPM increase when braking (see CV #364). Bit 2 = 0: old RailCom format with ID 3. = 1: current RailCom (kph) feedback with ID 7. Bit 3 = 1: "Looped" driving sounds will be faded out when switching to a different sound. Bit 4 = 1: Slows steam chuff frequency at high

	CV	Designation	Range	Default	Description
					speed 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 volume increases when braking Bit 7 = 1: SPECIAL MX645: ELECTRIC: Flashes of light (app. 0.1 sec) on FO7 when switch gear sound playing.
5.19 5.22	#159 #160	Effects on F7 / F8	0 - 255	0	Same as CVs #125 – #132 but for F7 and F8
5.25	#161	Servo Protocol	0 - 3	0	Bit 0 = 0: positive pulses, = 1: negative pulses Bit 1 = 0: active only w. moving, = 1: always active
5.25	#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
5.25	#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
5.25	#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
5.25	#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
5.25	#181 #182 #183 #184	Servo 1 Servo 2 Servo 3 Servo 4	0 - 114	0 0 0 0	Operating modes (One key, two keys …)
5.25	#185	Special live steam	1 - 3	0	Operating settings for live steam engines
--	#186 #189	Special pantograph configurations	-	0	Pantograph settings for special projects
5.22	#190 #191	Dimming times with effect 88	-	0	Turn-ON/OFF times for effects 88, 89 and 90
5.3	#250 #251 #252 #253	Decoder-ID	Read-only	-	Decoder's serial number
5.3	#260 #261 #262 #263	Lade-Code	-	-	for authorization of "coded" sound-projects
-	#264	------			
7 7.4	#265	Select from sound col-lection	1 – 32 101 - 132	1	= 1, 2 … 32: For steam sound = 101 - 132: For Diesel sound

	CV	Designation	Range	Default	Description
7.4	#266	Total volume	0 - 65 (255)	65	!!: >65: Over modulated, may damage speaker
0	#267	Chuff sound frequency	0 – 255	70	Only if CV #268 = 0; "Virtual cam sensor"
0	#268	Switching to real cam sensor	0 – 255	0	Bit 0 = 0: "Virtual cam sensor Bit 0 = 1: real cam sensor
0	#269	Accentuated lead-chuff	0 – 255	0	Increases volume of 1 chuff beat
0	#270	Longer chuff length at very low speeds	0 – 255	0	
0	#271	Overlapping effect at high speed	0 – 255	16	Overlapping chuff beats
0	#272	Blow-off duration	0 – 255	50	= 0: no blow-off sound, > 0: Time in tenth of a sec (Value 50 = 5 Seconds)
0	#273	Start-up delay during blow-off	0 – 255	0	= 0: No delayed start, > 0: Time in tenth of a sec (Value 50 = 5 Seconds)
0	#274	Blow-off schedule	0 – 255	30	The blow-off sound is suppressed if the engine wasn't standing still for the time defined here.
0	#275	Chuff sound volume at low speed and no-load	0 – 255	60	Chuff volume at low speed and "basic load". Automatic load test is necessary (CV #302=75).
0	#276	Volume at high speed and no-load	0 – 255	80	Chuff volume at high speed (full throttle). Automatic load test is necessary (CV #302=75).
0	#277	Chuff volume changes according to load	0 – 255	0	When deviating from the basic load, the chuff beat volume should be increasing (on inclines) or decreasing on declines (even muted).
0	#278	Load change threshold	0 – 255	0	Sound should not change with small load changes (i.e. in curves)
0	#279	Reaction speed to load change	0 – 255	0	Delaying sound changes when load changes.
7.7	#280	Load influence on Diesel engines	0 – 255	0	= 0: No influence; = 255: largest influence; Automatic load test is necessary (CV #302=75).
0	#281	Acceleration threshold for full load sound	0 – 255	1	Acceleration sound (chuff beats) changes to full volume from the speed step defined here.
0	#282	Duration of acceleration sound	0 – 255	30	Time in tenth of a second
0	#283	Chuff sound volume during full acceleration	0 – 255	255	The volume of steam chuffs at maximum acceleration.
0	#284	Threshold for deceleration sound	0 – 255	1	Steam chuffs are played back at less volume (or muted) signifying the reduced power requirement during deceleration.

	CV	Designation	Range	Default	Description
0	#285	Duration of reduced volume during deceleration	0 – 255	30	After the speed has been reduced, the sound should remain quieter for a specified time
0	#286	Volume level during deceleration	0 – 255	20	Defines the chuff volume during deceleration (Default: 20 = pretty quiet but not muted).
7.4	#287	Brake squeal threshold	0 – 255	20	The brake squeal should start when the speed drops below the specified speed step.
7.4	#288	Minimum driving time w/o brake squeal	0 – 255	50	Minimum driving time before brake squeal is played back.
7.7	#289	Thyristor: Stepping effect	1 – 255	1	= 1: no stepping effect, continuous ascend > 1: ascending scale according to the corresponding speed step interval.
7.7	#290	Thyristor sound, pitch at medium speed	0 – 100	40	
7.7	#291	Thyristor sound, pitch at maximum speed	0 – 100	100	
7.7	#292	Thyristor: speed step for medium speed	0 – 255	100	
7.7	#293	Thyristor control, Volume at steady speed	0 – 255	100	
7.7	#294	Thyristor control, Volume during acceleration	0 – 255	50	
7.7	#295	Thyristor control, Volume during deceleration	0 – 255	100	
7.7	#296	Electric motor, maximum sound volume	0 – 255	100	
7.7	#297	Electric motor, lowest speed step	0 – 255	30	Internal speed step at which the motor sound becomes audible.
7.7	#298	Electric motor sound, volume dependent on speed	0 – 255	100	Volume increase dependent on speed.
7.7	#299	Electric motor sound, Sound pitch dependent on speed	0 - 100	100	Sound pitch increase dependent on speed.
7.1	#300	Pseudo programming	0 – 255	0	For various sound sample mappings.
7.2	#301	Pseudo programming	0 – 255	0	For "Incremental Programming" of sound CVs
7.3	#302	Load test	75 – 76	75	Automatic load test
	#303 - #306	Reed 1 - 4 Sound configuration	0 - 255		Bit 0-4: Button to activate or deactivate reed input: 1-28 = F1-F28, 29 = F0, 30 = MAN button Bit 5: Button for reed input inverted function 0=sound active when button on,

	CV	Designation	Range	Default	Description
					1=when button off Bit 6: Loop active as long as reed is active Bit 7: Shorten active when reed becomes inactive Several reed sounds are possible at the same time.
7.4	#307	Brake key		0	Number defines a brake key (Brake curve is defined in CV #349)
7.4	#308	cornering squeal Reed input	0 - 28	0	Defines Reed input for cornering sqeals
5.7	#309	cornering squeal key	0 – 28	0	Key for activating/suppressing cornering squeals
7.4	#310	Sound ON/OFF key OR start-up delay	0 – 28, 255	8	Number defines a key for sound ON/OFF functions OR start-up delay for non-sound decoders
7.4	#311	Function sound ON/OFF key	0 – 28	0	Defines an ON/OFF key for sounds that play back with function keys. = 0: Function sound is always ON.
7.4	#312	Blow-off key	0 – 29	0	Defines a water blow-off key.
7.4	#313	Mute key	0 – 29, 101 -129	0	Mutes all sounds
7.4	#314	Mute fade in/out time	0 – 255	0	= 0 (to 10): minimum time setting of 1 sec. = 11 - 255: longer "fade" times
7.8	#315	Random generator Z1 Minimum interval	0 – 255	1	Defines the shortest possible interval between two consecutive pulses.
7.8	#316	Random generator Z1 Maximum interval	0 – 255	60	Defines the maximum time interval between two consecutive pulses
7.8	#317	Random generator Z1 Playback length	0 – 255	5	Times the random sound is repeated. = 0: Sound is played back only once.
7.8	#318	Random generator Z2 Minimum interval			See Z1
7.8	#319	Random generator Z2 Maximum interval			See Z1
7.8	#320	Random generator Z2 Playback length			See Z1
7.8	#321 #338	Random generator Z3 – Z8			
7.7	#339	Raising-Key	0 – 29	0	Defines a key to raise the diesel sound
7.7	#340	Coasting-Step	0 – 255	0	Diesel step the sound should be raised to and possible more "raising" keys.
7.8	#341	Switch input 1 Playback duration	0 – 255	0	The sound sample allocated to switch input 1 is played back for the duration defined with this CV.
7.8	#342	Switch input 2 Playback duration	0 – 255	0	The sound sample allocated to switch input 2 is played back for the duration defined with this CV.
7.8	#343	Switch input 3 Playback duration	0 – 255	0	The sound sample allocated to switch input 3 is played back for the duration defined with this CV.
7.7	#344	Run time of cooling fan after stop	0 - 255	0	Cooling fan (or other equipment) keeps running for 0-25.5 Seconds after coming to a stop

	CV	Designation	Range	Default	Description
7.7	#345	Sound switch key	0 - 29	0	Switches between sound sets of multi-system locomotives.
7.7	#346	Switch conditions	0 – 2	0	= 0 -> Switches only when sound is OFF = 1 -> Switches also when stopped with sound ON = 2 -> Switches w. stopped or running w. sound ON
7.7	#347	Solo driving	0 – 29	0	Defines a key for solo driving (engine only).
7.7	#348	Switch-over parameters for driving solo	0 - 4	0	=0 -> no function. =1 -> Diesel sound revs up unhindered to maximum rpm (as if CV #389=255) =2 -> reduced CV #3, CV #4 as per CV #390 =4 -> moves diesel sound thresholds up as in CV #391 If Bit2=0, CV #391 is always active.
5.7	#349	Brake time	0 – 255	0	As in CV 4. Brake key is defined with CV #309.
7.7	#350	Switchgear lock-out	0 – 255	0	Delay of switchgear sound at start-up.
5.23	#351	Exhaust fan speed when cruising	0 – 255	0	PWM settings of fan at cruising speed.
5.23	#352	Exhaust fan speed at motor starts and during acceleration	0 – 255	0	PWM settings at start-up and acceleration.
5.23	#353	Automatic smoke shut-down	0 – 255	0	Turns the heating element of the smoke generator OFF after the time defined here.
0	#354	Steam chuff frequency at speed step 1	0 – 255	0	Correction value to CV #267
5.23	#355	Exhaust fan speed at stand-still	0 – 255		PWM setting of fan at stand-still.
7.7	#356	Speedlock-Key	0 - 28	0	Sound is changed via speed controller without changing the speed.
7.7	#357	Thyristor control, Volume decrease at higher speeds	0 - 255	0	Internal speed step at which the thyristor sound volume should be reduced.
7.7	#358	Thyristor control, Volume reduction	0 – 255	0	Defines a curve as to how the thyristor sound should be lowered at the speed step defined in CV #357.
7.7	#359	Switch gear playback time	0 – 255	0	Time in tenth of a second the switch gear should be heard during speed changes.
7.7	#360	Switch gear playback after stop	0 – 255	0	How long the switch gear should be played back after coming to a stop.
7.7	#361	Switch gear sound playback delay	0 – 255	20	Switch gear sound delay when accelerating.
7.7	#362	Switchover threshold for 2nd thyristor	0 – 255	0	Defines a speed step at which a second thyristor sound for higher speeds is played back.
7.7	#363	Switch gear sound Speed / shift steps	0 – 255	0	Number of shift steps to cover the whole speed range.
7.7	#364	Diesel-Mechanical: Upshift RPM	0 – 100	0	Defines the typical drop in speed when shifting up.

	CV	Designation	Range	Default	Description
7.7	#365	Diesel-Mechanical: Max. RPM before up-shift	0 – 100	0	Defines the highest rpm before shifting up.
7.7	#366	Maximum turbo sound volume	0 – 64	0	Turbo volume
7.7	#367	Turbo rpm dependency on speed	0 – 255	0	Turbo playback frequency depending on engine speed.
7.7	#368	Turbo rpm dependency on accel/decel.	0 – 255	0	Playback frequency depends on the difference of set speed to actual speed.
7.7	#369	Min. load for turbo	0 – 255	0	Audibility threshold for turbochargers.
7.7	#370	Frequency increase of turbo	0 – 255	0	Speed of frequency-increase of the turbocharger.
7.7	#371	Frequency decrease of turbo	0 – 255	0	Speed of frequency-decrease of the turbocharger.
7.7	#372	Electric motor, Volume dependent on acceleration	0 - 255	0	Acceleration volume
7.7	#373	Electric motor, Volume dependent on braking	0 – 255	0	Deceleration volume
7.7	#374	Coasting-Key	0 – 29	0	Forces the sound to a specified speed step (CV #374)
7.7	#375	Coasting Step	0 – 255	0	Speed step for coasting key.
7.4	#376	Driving sound vol.	0 – 255	0	0 or 255 = Full volume
-	#377	------	-	-	-
7.7	#380	Manual electric brake key	0, 1 – 29	0 or 1	Defines a function key to manually control the sound of a "dynamic" or "electric" brake.
7.7	#381	Electric brake - minimum speed	0 - 255	0	The electric brake shall only be heard between the value defind in CV #381…
7.7	#382	Electric brake - maximum speed	0 – 255	0	…and the value in CV #382
7.7	#383	Electric brake - Pitch	0 – 255	0	0=Pitch independent of speed, 1-255=increases playback speed
7.7	#384	Electric brake – Deceleration threshold	0 – 255	0	The number of speed steps to be reduced during deceleration before the electric brake sound is played back.
7.7	#385	Electric brake – Downhill (neg. motor load)	0 - 255	0	= 0: no effect at "negative" load = 1 – 255: Sound triggered at "negative" load.
7.7	#386	Electric brake – Loop	0 - 15	0	Bit 3 = 0: Sound fades out at the sample end = 1: Sound ends without fading at end Bit 2…0: Increases playback time (0-7=0-7 seconds).
7.7	#387	Acceleration	0 – 255	0	Acceleration influence on diesel sound steps.

	CV	Designation	Range	Default	Description
		influence			
7.7	#388	Deceleration influence	0 – 255	0	Deceleration influence on diesel sound steps.
7.7	#389	Acceleration limit of diesel sound	0 – 255	0	Limits how far the sound step may deviate during acceleration from the actual speed.
7.7	#390	Momentum reduction - driving solo	0 – 255	0	Reducing CV #3, CV #4 when "Solo" driving key is engaged.
7.7	#391	Idle sound, when driving solo	0 – 255	0	Keep sound at idle up to this speed step when driving "solo".
7.8	#392	Switch input 3 Playback duration	0 - 255	0	The sound sample allocated to switch input 4 is played back for the duration defined with this CV.
7.7	#393	ZIMO-Config. 5 SW-Version 36.1 from SW-Version 37.0: Bit 7	0 – 255	0	Bit 0 = 1: bell activates ditchlight Bit 1 = 1: horn activates ditchlight Bit 2 = 1: high speed switchgear, sound samples are played back one after the other, not always sample1 Bit 3 = 1: highspeed switchgear, skip beginning and end of sound sample (when looping) also at start-up, only play middle part. Bit 4 = 1: thyristor 2, do not rise pitch Bit 5 = 1: switch SUSI to Reed input Bit 6 = 1: 4-fold extension of the steam interval Bit 7 = 1: start of smoke generator diesel with 2 separate generators (only MX699). Starting sample in ZSP: set 4 pointers
5 7	#394	ZIMO-Config. 4 SW version 33.14 and higher	0 – 255	0	Bit 0 = 1: switch. sparks on ELEC. locos on FO6. Bit 1 = 1: turn Beilhack Schneeschleuder on FO2 Bit 2 = 1: I2C onSUSI output. Bit 3 = 1: deactivate stay-alive unit with GPIOC on MX645. Bit 4 = 1: acceleration depends on range between current and target state Bit 5 = 1: fade steam chuffs64 Bit 6 = 1: inhibit accel. when braking key is active Bit 7 = 1: thyristor sound starts before departure
7.4	#395	Maximum volume	0 – 255	0	Max. volume for key defined with CV #396, #397
7.4	#396	Volume decrease key	0 – 29	0	
7.4	#397	Volume increase key	0 – 29	0	
7.7	#398	Automated coasting	0 – 255	0	The number of speed steps the train's speed has to be reduced within 0.5 seconds in order for the automatic coasting effect to set the motor sound to idle.
5.17	#399	"Rule 17",Speed dependent headlights	0 – 255	0	Switches to high beam at speed defined here. SEE CV #430!
5.18	#400 - #428	Input-Mapping	0 – 255	0	Matching function key (External Function) to function outputs F0 - F28.
	#429	------	-	-	-
5.17	#430	Function-Key	0 – 157	0	Value range: 0,1-29

	CV	Designation	Range	Default	Description
	#436 #442 #448 #454 #460 #466 #472 #478 #484 #490 #496 #502 #800 #806 #812 #818	From SW 32.0 "Swiss" light mapping!			The key defined here switches the function outputs listed under A1 and A2 ON or OFF. 1 – 28 for function keys F1 – F28, F29 is for F0. From SW 35.0: F-Key value + 128 (Bit 7 set) = Function inverted
5.17	#431 #437 #443 #449 #455 #461 #467 #473 #479 #485 #491 #497 #503 #801 #807 #813 #819	Master light switch	0 – 255	0	0=nothing defined,1-28 for Key F1-F28, 29 for F0 If Bit 7 is set (Value +128): The F-Key outputs will only turn on when the M-Key is also on. If Bit 6 is set (Value +64): The M-Key outputs will not be turned off when the F-key is on and driving in forward direction. If Bit 5 is set (Value +32): The M-Key outputs will not be turned off when the F-key is on and driving in reverse direction. 255=High beam function for any F-key – ONLY when the output in ON and dimmed (via CV #60, CV #114 or CV #152!
5.17	#432 #438 #444 #450 #456 #462 #468 #474 #480 #486 #492 #498 #504 #802 #808 #814 #820	A1 Forward	0 - 255	0	Value range: 0, 1-13, 14-15 1. Output to be switched on in forward direction. 0=no output, 1-13=FO1-FO13, 14=FO0v, 15=FO0r. Bit 7-5: Refers to 5 PWM-Config-CVs (#508 - #512). Configuration 6 (1100xxxx) Output is turned off. Config. 7 (1110xxxx) Output is turned on.
5.17	#433 #439 #445 #451 #457 #463	A2 Forward	0 – 255	0	Value range: 0, 1-13, 14-15 2. Output to be switched on in forward direction. 0=no output, 1-13=FO1-FO13, 14=FO0v, 15=FO0r. Bit 7-5: Refers to 5 PWM-Config-CVs (#508 - #512). Configuration 6 (1100xxxx) Output is turned off. Config. 7 (1110xxxx) Output is turned on.

	CV	Designation	Range	Default	Description
	#469 #475 #481 #487 #493 #499 #505 #803 #809 #815 #821				
5.17	#434 #440 #446 #452 #458 #464 #470 #476 #482 #488 #494 #500 #506 #804 #810 #816 #822	A1 Reverse	0 – 255	0	Value range: 0, 1-13, 14-15 1. Output to be switched on in reverse direction. 0=no output, 1-13=FO1-FO13, 14=FO0v, 15=FO0r. Bit 7-5: Refers to 5 PWM-Config-CVs (#508 - #512). Configuration 6 (1100xxxx) Output is turned off. Config. 7 (1110xxxx) Output is turned on.
5.17	#435 #441 #447 #453 #459 #465 #471 #477 #483 #489 #495 #501 #507 #805 #811 #817 #823	A2 Reverse	0 – 255	0	Value range: 0, 1-13, 14-15 2. Output to be switched on in reverse direction. 0=no output, 1-13=FO1-FO13, 14=FO0v, 15=FO0r. Bit 7-5: Refers to 5 PWM-Config-CVs (#508 - #512). Configuration 6 (1100xxxx) Output is turned off. Config. 7 (1110xxxx) Output is turned on.
5.17	#508	Swiss-Mapping PWM Value 1	0, 8 – 248	248	PWM-Value in Bit 7-3 - 0=Off, 248=100 %
5.17	#509	Swiss-Mapping PWM Value 2	0, 8 – 248	248	PWM-Value in Bit 7-3 - 0=Off, 248=100 %
5.17	#510	Swiss-Mapping PWM Value 3	0, 8 – 248	248	PWM-Value in Bit 7-3 - 0=Off, 248=100 %
5.17	#511	Swiss-Mapping PWM Value 4	0, 8 – 248	248	PWM-Value in Bit 7-3 - 0=Off, 248=100 %

	CV	Designation	Range	Default	Description
5.17	#512	Swiss-Mapping PWM Value 5	0, 8 – 248	248	PWM-Value in Bit 7-3 - 0=Off, 248=100 %
7.4	#513	Sound number F1			Sample number of function sound auf F1
7.4	#514	Funktionssound F1	0 – 255		**Volume setting**

	#515	Loop Info F1			Bit 0 to Bit2: Loop count 0-7
					Bit 3 = 1: repeat sound when "loop" is on (active F-key)
					      =sound looping
					Bit 4 = 1: play sound only when driving forwards
					Bit 5 = 1: Play sound only when driving backwards
					Bit 6 = 1: /shorten sound when off (deactivated F-key)
					      =sound shorten
					From SW version 5.00
					Bit 7 = 1: play sound only if drive and random sounds are active (F-button defined in CV #310 is active)

	#516	Sound number F2			Sample number of function sound auf F2
7.4	#517	Funktionssound F2	0 – 255		**Volume setting**
	#518	Loop Info F2	0 - 255		Loop parameter of function sound on F2
	#519	Sound number F3			Sample number of function sound auf F3
7.4	#520	Function sound F3	0 – 255		**Volume setting**
	#521	Loop Info F3			Loop parameter of function sound on F3
	#522	Sound number F4			Sample number of function sound auf F4
7.4	#523	Function sound F4	0 – 255		**Volume setting**
	#524	Loop Info F4			Loop parameter of function sound on F4
	#525	Sound number F5			Sample number of function sound auf F5
7.4	#526	Function sound F5	0 – 255		**Volume setting**
	#527	Loop Info F5			Loop parameter of function sound on F5
	#528	Sound number F6			Sample number of function sound auf F6
7.4	#529	Function sound F6	0 – 255		**Volume setting**
	#530	Loop Info F6			Loop parameter of function sound on F6
	#531	Sound number F7			Sample number of function sound on F7
7.4	#532	Function sound F7	0 – 255		Volume setting
	#533	Loop Info F7			Loop parameter of function sound on F7
	#534	Sound number F8			Sample number of function sound on F8
7.4	#535	Function sound F8	0 – 255		Volume setting
	#536	Loop Info F8			Loop parameter of function sound on F8

	CV	Designation	Range	Default	Description
	#537	Sound number F9			Sample number of function sound on F9
7.4	#538	Function sound F9	0 – 255		Volume setting
	#539	Loop Info F9			Loop parameter of function sound on F9
	#540	Sound number F10			Sample number of function sound on F10
7.4	#541	Function sound F10	0 – 255		Volume setting
	#542	Loop Info F10			Loop parameter of function sound on F10
	#543	Sound number F11			Sample number of function sound on F11
7.4	#544	Function sound F11	0 – 255		Volume setting
	#545	Loop Info F11			Loop parameter of function sound on F11
	#546	Sound number F12			Sample number of function sound on F12
7.4	#547	Function sound F12	0 – 255		Volume setting
	#548	Loop Info F12			Loop parameter of function sound on F12
	#549	Sound number F13			Sample number of function sound on F13
7.4	#550	Function sound F13	0 – 255		Volume setting
	#551	Loop Info F13			Loop parameter of function sound on F13
	#552	Sound number F14			Sample number of function sound on F14
7.4	#553	Function sound F14	0 – 255		Volume setting
	#554	Loop Info F14			Loop parameter of function sound on F14
	#555	Sound number F15			Sample number of function sound on F15
7.4	#556	Function sound F15	0 – 255		Volume setting
	#557	Loop Info F15			Loop parameter of function sound on F15
	#558	Sound number F16			Sample number of function sound on F16
7.4	#559	Function sound F16	0 – 255		Volume setting
	#560	Loop Info F16			Loop parameter of function sound on F16
	#561	Sound number F17			Sample number of function sound on F17
7.4	#562	Function sound F17	0 – 255		Volume setting
	#563	Loop Info F17			Loop parameter of function sound on F17
	#564	Sound number F18			Sample number of function sound on F18

	CV	Designation	Range	Default	Description
7.4	#565	Function sound F18	0 – 255		Volume setting
	#566	Loop Info F18			Loop parameter of function sound on F18
	#567	Sound number F19			Sample number of function sound on F19
7.4	#568	Function sound F19	0 – 255		Volume setting
	#569	Loop Info F19			Loop parameter of function sound on F19
	#570	Sound number F0			Sample number
7.4	#571	Function sound F0	0 – 255		Volume setting
7.4	#573	Sound number boiling			Sample number
7.4	#574	Boiling	0 – 255		Volume setting
7.4	#575	Sound number change of direction			Sample number
7.4	#576	Change of direction	0 – 255		Volume setting
7.4	#577	Sound number brake squeal			Sample number
7.4	#578	Brake sqeal	0 – 255		Volume setting
7.4	#579	Sound number thyristor sound			Sample number
7.4	#580	Thyristor sound	0 – 255		Volume setting
7.4	#581	Sound number starting whistle			Sample number
7.4	#582	Starting whistle	0 – 255		Volume setting
7.4	#583	Sound number blow-off			Sample number
7.4	#584	Blow-off	0 – 255		Volume setting
7.4	#585	Sound number E-motor			Sample number
7.4	#586	E-motor	0 – 255		Volume setting
7.4	#587	Sound number rolling sound			Sample number
7.4	#588	Rolling sound	0 – 255		Volume setting
7.4	#589	Sound number switchgear			Sample number

	CV	Designation	Range	Default	Description
7.4	#590	Switchgear	0 – 255		Volume setting
7.4	#591	Sound number thyristor 2			Sample number
7.4	#592	Thyristor 2	0 – 255		Volume setting
7.4	#593	Sound number panto up			Sample number
7.4	#594	Panto up	0 – 255		Volume setting
7.4	#595	Sound number panto down			Sample number
7.4	#596	Panto down	0 – 255		Volume setting
7.4	#597	Sound number panto hitting fork			Sample number
7.4	#598	Panto hitting fork	0 – 255		Volume setting
7.4	#599	Sound number turbo			Sample number
7.4	#600	Turboloader	0 – 255		Volume setting
7.4	#601	Sound number Dynamic Break			Sample number
7.4	#602	Dynamic Break	0 – 255		Volume setting
7.4	#671	Sample number Reed 4 (only MX699; playback duration see CV #392)			Sample number of the sound that shall be played back by Reed 4
7.4	#672	Reed 4 Sound (only MX699)			Volume setting
7.4	#726	Trigger Sound …	0 – 255		Sound number for connection 1
	#727	… on FO			Function output for connection 1: 1=FO0v,2=FO0r, 3=FO1, 4=FO2…14=FO12 and 255=additional fan for smoke generator).
	#728	Trigger Sound …	0 – 255		Sound number for connection 2
	#729	… on FO			Function output for connection 2 (values see CV #727)
	#730	Trigger Sound …	0 – 255		Sound number for connection 3
	#731	… on FO			Function output for connection 3 (values see CV #727)
	#732	Trigger Sound …	0 – 255		Sound number for connection 4

	CV	Designation	Range	Default	Description
	#733	… on FO			Function output for connection 4 (values see CV #727)
	#734	Trigger Sound …	0 – 255		Sound number for connection 5
	#735	… on FO			Function output for connection 5 (values see CV #727)
	#736	Trigger Sound …	0 – 255		Sound number for connection 6
	#737	… on FO			Function output for connection 6 (values see CV #727)
	#738	Sample number			Sample number according to sample information, for switch input S1
7.4	#739	Sound switch input S1	0 – 255		Volume setting
	#740	Sample number			Sample number for S2
7.4	#741	Sound switch input S2	0 – 255		Volume setting
	#742	Sample number			Sample number for S3
7.4	#743	Sound switch input S3	0 – 255		Volume setting
	#744	Sample number			Sample number according to sample information for random sound Z1
7.4	#745	Random sound Z1 (most of the time air pump / compressor)	0 – 255		Volume setting
	#746	Random sound Z1 – Loop Info			Loop parameters of random sound Z1; Loop = 8; short = 64
	#747	Sample number			Sample number for Z2
7.4	#748	Random sound Z2	0 – 255		Volume setting
	#749	Random sound Z2 – Loop Info			Loop parameters of random sound Z2
	#750	Sample number			Sample number for Z3
7.4	#751	Random sound Z3	0 – 255		Volume setting
	#752	Random sound Z3 – Loop Info			Loop parameters of random sound Z3
	#753	Sample number			Sample number for Z4
7.4	#754	Random sound Z4	0 – 255		Volume setting
	#755	Random sound Z4 – Loop Info			Loop parameters of random sound Z4

	CV	Designation	Range	Default	Description
	#756	Sample number			Sample number for Z5
7.4	#757	Random sound Z5	0 – 255		Volume setting
	#758	Random sound Z5 – Loop Info			Loop parameters of random sound Z5
	#759	Sample number			Sample number for Z6
7.4	#760	Random sound Z6	0 – 255		Volume setting
	#761	Random sound Z6 – Loop Info			Loop parameters of random sound Z6
	#762	Sample number			Sample number for Z7
7.4	#763	Random sound Z7	0 – 255		Volume setting
	#764	Random sound Z7 – Loop Info			Loop parameters of random sound Z7
	#765	Sample number			Sample number for Z8
7.4	#766	Random sound Z8	0 – 255		Volume setting
	#767	Random sound Z8 – Loop Info			Loop parameters of random sound Z8
7.3	#777	Results of the measuring run			PWM slowly forward
7.3	#778	Results of the measuring run			PWM fast forward
7.3	#779	Results of the measuring run			PWM slowly backward
7.3	#780	Results of the measuring run			PWM fast backward
5.17	#800 - #805	Swiss Mapping group 14 (F-, M-key, A1 Fw, A2 Fw, A1 Bw, A2 Bw)	….	0	All 6 CVs of group 14 are adjustable like group 1
5.17	#806 … #811	Swiss Mapping group 15 (F-, M-key, A1 Fw, A2 Fw, A1 Bw, A2 Bw)	….	0	All 6 CVs of group 15 are adjustable like group 1
5.17	#812 … #817	Swiss Mapping group 16 (F-, M-key, A1 Fw, A2 Fw, A1 Bw, A2 Bw)	….	0	All 6 CVs of group 16 are adjustable like group 1
5.17	#818	Swiss Mapping group	….	0	All 6 CVs of group 17 are adjustable like group 1

	CV	Designation	Range	Default	Description
	…#823	17 (F-, M-key, A1 Fw, A2 Fw, A1 Bw, A2 Bw)			
	#824	Key that is inverted by IN1			IN1 inverts the function of the key (key itself can invert the function)
	#825	Key that is inverted by IN2			IN2
	#826	Key that is inverted by IN3			IN3
	#827	Key that is inverted by IN4			IN4
	#828	Steam chuff cycle for set+1			Steam chuff cycle as in CV #267 but for set+1
5.12	#830	Braking distance forward high			CVs #830 - #833: Only decoders with 1K EEPROM (all sound decoders and many non-sound decoders, e.g. MX633 .. MX638) (Higher accuracy of braking distance than with CV #141) Braking distance with HLU, ABC, DC: value 1 for driving forward
5.12	#831	Braking distance forward low			Same as above, but for value 2
5.12	#832	Braking distance backward high			Braking distance with HLU, ABC, DC: value 1 for driving backward
5.12	#833	Braking distance backward low			Same as above, but for value 2
7.7	#835	Number of sets + key			Number of all set switching keys. These keys are always sorted one after the other, starting with the key defined in CV #345.
7.7	#837	Script sequences	Bi 0 - 7	0	Bit 0 - 7 = 1: Deactivate script 1 - 8
	#840 #841	Functions F13 - F20 or F21 - F28	0 - 255	0	Other functions switched on in analog mode

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 decoders can of course be 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, it is **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:

- 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

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

> **NOTE**: ZIMO command stations automatically read the configurations of the existing decoders (in the background during operation) and make them available on demand.

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 CVs back to the default values or the default values of a sound project.

> **ATTENTION**: 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

10 *Declaration of Conformity*

RoHS declaration of conformity

The EU Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment stipulates the compliance with limit values for the following substances:

Lead, mercury, hexavalent chromium	0.1 % each
Polybrominated biphenyl (PBB), polybrominated diphenyl ether (PBDE)	0.1 % each
Cadmium	0.01 %

ZIMO ELEKTRONIK GmbH ensures the conformity of the products described in this document with this directive by using only components, boards and other components which are RoHs compliant according to the confirmation of the respective manufacturers.