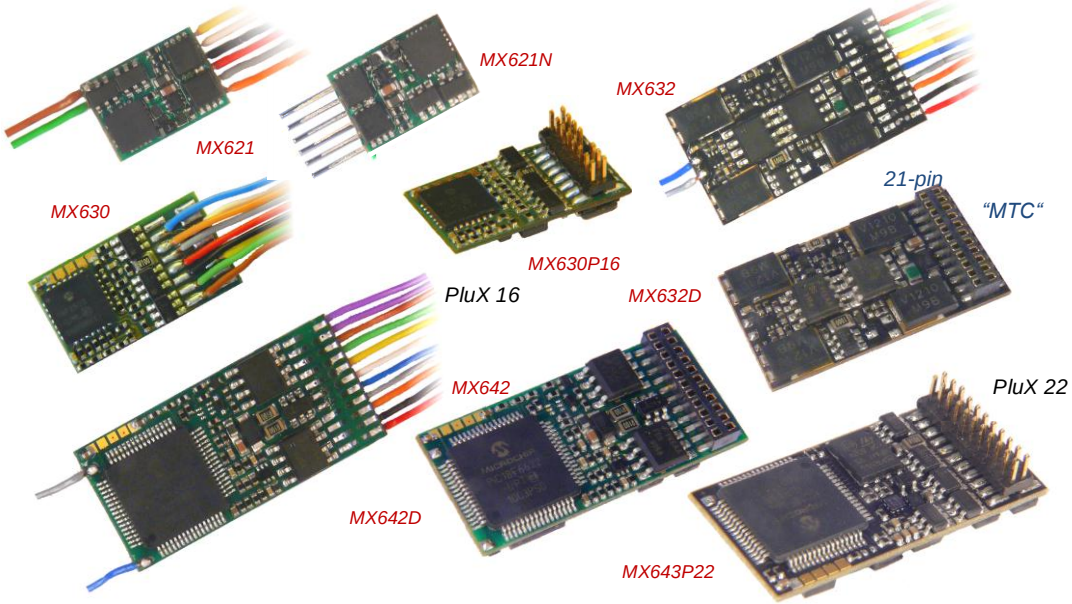
# INSTRUCTION MANUAL




*SUBMINIATURE - DECODER*

***MX621, MX621N, MX621R, MX621F***

*MINIATURE - DECODER (PLANNED)*

*MX620, MX620N, MX620R, MX620F,* ***MX622, MX622R, MX622F, MX622P12***

*HO - DECODER*

***MX630, MX630R, MX630F, MX630P16***

*HO , (O) - DECODER for MORE POWER*

***MX631, MX631R, MX631F, MX631D, MX631C***

*HO, O – HIGH OUTPUT and SPECIAL DESIGN DECODER*

***MX632, MX632R, MX632D, MX632C, MX632V, MX632W, MX632VD, MX632WD***

*PLANNED: SUBMINIATURE -* ***SOUND*** *- DECODER*

***MX648, MX648R, MX648F, MX648P16***

*PLANNED: MINIATURE -* ***SOUND*** *– DECODER*

***MX646, MX646R, MX646F, MX646N, MX646L,*** *MX647L*

*HO, (O) -* ***SOUND*** *- DECODER*

MX640, MX640R, MX640F, MX640D, MX640C,
MX642, MX642R, MX642F, MX642D, MX642C, MX643P16, MX643P22,
***MX645, MX645R, MX645F, MX645P16, MX645P22, MX644D, MX644C***

EDITION

First edition. SW version 25.0 for MX620, MX630, MX64D and MX640 – 2009 07 15
Corrections regarding decoder types for C-Sinus, and dim mask 2 -- 2009 07 25
SW version 26.0 – 2009 09 26
New MX632 decoder family included -- 2009 12 05
New MX631 decoder family included and CV amendments -- 2010 03 01
New MX643 decoders (PluX versions of the MX642) -- 2010 05 01
SW version 27.0 – 2010 07 25
SW version 28.3 – 2010 10 15
New decoder families MX646 and MX645 included, SW version 28.5 – 2010 12 01
SW version 28.13 – 2011 01 12
2011 01 22
SW version 28.25 – 2011 03 10
NEW MANUAL LAYOUT, SW version 30.7 – 2011 07 05
2011 07 15

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NOTE:

ZIMO decoders contain an EPROM which stores software that determines its characteristics and functions. The software version can be read out form CV #7 and #65. The current version may not yet be 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 numerous 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 repair 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.

<<< **Decoder types printed in gray are no longer in production**

# 1 Overview

These decoders are suitable for N, HOe, HOm, TT, HO, OO, Om and O gauge engines with standard or coreless motors (Faulhaber, Maxxon etc.)
They operate primarily in the **NMRA-DCC data format** with any NMRA-DCC compatible system, as well as the **MOTOROLA protocol** within Märklin systems and other MOTOROLA command stations. Zimo decoders also operate in **DC analog mode** with DC power packs (including PWM). Beginning with the July 2010 software version, ZIMO decoders also operate with **AC analog** (Märklin Transformers with over-voltage pulses for direction change).

| | |
|---|---|
| ***MX620*** *Family* | ***Production stopped in June of 2010; replaced by MX621.*** |

*12 x 6.5 x 2 mm No-Sound - 0.7 A DCC and DC-Analog (**not for** MOTOROLA)*

| | |
|---|---|
| ***MX621*** *Family* | ***The MX621 replaces the MX620 since December 2010.***<br>***Sub-miniature Decoder**,* with reduced ZIMO features; missing in the software are: MM (Motorola), Servos, SUSI, ZIMO special function mapping.<br>TYPCIAL APPLICATION: Vehicles in N, HOe and HOm. |

*MX621 plug configurations:*

| | |
|---|---|
| ***MX621*** | 7 wires (120mm long) for power pick-up, motor and 2 function outputs. Two more function outputs on solder pads. |
| ***MX621N*** | MX621 with 6-pin plug as per NEM651 and NMRA RP9.1.1, mounted on the circuit board. |
| ***MX621R*** | MX621 with 8-pin plug as per NEM652 on 70mm wires. |
| ***MX621F*** | MX621 with 6-pin plug as per NEM651 on 70mm wires. |

*14 x 9 x 2.5 mm (planned) No-Sound - 0.8A - 6 Fu-Outputs - 2 Servos - SUSI*

| | |
|---|---|
| ***Planned*** ***MX622*** *Family* | ***The MX622 will replace the MX620 on June 2011.***<br>***Miniature-Decoder***, with all ZIMO features.<br>TYPCIAL APPLICATION: Vehicles in N, HOe, HOm and in HO vehicles with limited space. |

*MX622 plug configurations:*

| | |
|---|---|
| ***MX622*** | 7 wires (120mm long) for power pick-up, motor and 2 function outputs. Two more function outputs on solder pads. |
| ***MX622R*** | MX622 with 8-pin plug as per NEM652 on 70mm wires. |
| ***MX622F*** | MX622 with 6-pin plug as per NEM651 on 70mm wires. |
| ***MX622P12*** | MX622 with **12-pin PluX connector**, mounted on circuit board. |

*20 x 11 x 3.5mm No-Sound - 1.0A - 6 Fu-Outputs - 2 Servos - SUSI*

| | |
|---|---|
| ***MX630*** *Family* | **Compact HO loco decoder,** for universal applications.<br>TYPICAL APPLICATION: Locomotives in HO, O or similar scale where space is limited. Due to excellent dielectric strength (50V), the decoder is also suitable for AC analog operation with the old Märklin transformers. |

*MX630 plug configurations:*

| | |
|---|---|
| ***MX630*** | 9 highly flexible wires (120mm) for pick-up, motor and 4 function outputs. Solder pads for 2 additional function outputs, logic level outputs or Servo outputs as well as SUSI. |
| ***MX630R*** | MX630 with 8-pin plug as per NEM652 on 70mm wires. |
| ***MX630F*** | MX630 with 6-pin plug as per NEM651 on 70mm wires. |
| ***MX630P*** | MX630 with **16-pin PluX connector,** mounted on circuit board. |

*20.5 x 15.5 x 4mm No-Sound - 1.2 A - 6 Fu-Outputs - 2 Servos - SUSI*

| | |
|---|---|
| ***MX631*** *Family* | ***H0-Decoder**,* similar to MX630 but with **more performance** and **energy storage circuitry** on board.<br>TYPICAL APPLICATION: HO and smaller O vehicles. Due to excellent dielectric strength (50V), the decoder is also suitable for AC analog operation with the old Märklin transformers. |

*MX631 plug configurations:*

| | |
|---|---|
| ***MX631*** | 11 highly flexible wires (120mm) for pick-up, motor and 4 function outputs. Solder pads for 2 additional function outputs, logic level outputs or Servo outputs as well as SUSI. |
| ***MX631R*** | MX631 with 8-pin plug as per NEM652 on 70mm wires. |
| ***MX631F*** | MX631 with 6-pin plug as per NEM651 on 70mm wires. |
| ***MX631D*** | MX631 with **21-pin „MTC“ plug** mounted on decoder board. |
| ***MX631C*** | Similar to MX631D but for **Märklin**-, **Trix**- **and similar vehicles**; which require FA3, FA4 as logic level outputs for motor control. |

*28 x 15.5 x 4mm No-Sound - 1.6A - 8 Fu-Outputs - 2 Servos - SUSI*

| | |
|---|---|
| ***MX632*** *Family* | ***High output decoder,** with built-in **energy storage circuitry.***<br>TYPICAL APPLICATON: HO, O and similar gauge, especially for vehicles with low voltage bulbs (1.5 or 5V). |

*Special versions and plug configurations of the MX632:*

| | |
|---|---|
| ***MX632*** | 11 highly flexible wires (120mm) for pick-up, motor and 4 function outputs. Solder pads for 4 additional function outputs, logic level outputs, Servo outputs as well as SUSI. |
| ***MX632R*** | MX632 with 8-pin plug as per NEM652 on 70mm wires. |
| ***MX632D*** | MX632 with **21-pin „MTC“ plug** mounted on decoder board. |
| ***MX632C*** | Similar to MX631D but for **Märklin**-, **Trix**- **and similar vehicles**; which require FA3, FA4 as logic level outputs for motor control. |
| ***MX632V, VD MX632W, WD*** | Decoders with **low voltage supply** for **function outputs:** ...V = 1.5V, ...W = 5V, ...VD or ...WD = with 21-pin plug. |

*20 x 11 x 4mm* ***SOUND*** *- 0.8A - 4 Fu-Outputs - 2 Servos - SUSI*

| | |
|---|---|
| ***Planned MX648 Family*** | ***Subminiature-Sound-Decoder, 1 Watt Audio on 8 Ohm speaker*** TYPICAL APPLICATION: Vehicles in N, TT, HOe, HOm and in HO vehicles with limited space. |

*MX648 plug configurations:*

| | |
|---|---|
| ***MX648*** | 9 highly flexible wires for pick-up, motor, 2 Fu-Outputs, speaker, solder pads for 2 more Fu-Outputs, logic level outputs, servos and SUSI. |
| ***MX648R*** | MX648 with 8-pin plug as per NEM652 on 70mm wires. |
| ***MX648F*** | MX648 with 6-pin plug as per NEM651 on 70mm wires. |
| ***MX648P16*** | MX648 with **16-pin PluX connector** (male), mounted on circuit board. |

*28 x 10.5 x 4mm* ***SOUND*** *- 1.0A - 4 Fu-Outputs - 2 Servos - SUSI*

| | |
|---|---|
| ***MX646 Family*** | ***Miniature-Sound-Decoder, 1 Watt Audio on 8 Ohm speaker*** TYPICAL APPLICATION: Vehicles in N, TT, HOe, HOm and in HO vehicles with limited space. |

*MX646 plug configurations (also for the interim type MX647):*

| | |
|---|---|
| ***MX646*** | 9 highly flexible wires for pick-up, motor, 2 Fu-Outputs, speaker, solder pads for 2 more Fu-Outputs, logic level outputs, servos and SUSI. |
| ***MX646N*** | MX646 with 6-pin plug as per NEM651 mounted on circuit board and two additional speaker wires. |
| ***MX646L*** | MX646 with **90°** 6-pin plug as per NEM651 mounted on circuit board and two additional speaker wires. |
| ***MX646R*** | MX646 with 8-pin plug as per NEM652 on 70mm wires. |
| ***MX646F*** | MX646 with 6-pin plug as per NEM651 on 70mm wires. |
| ***MX647L*** | Produced only until Oct. 2010, before the MX646W became available. |

| | |
|---|---|
| ***MX640 Family*** | ***Production stopped end of 2010; replaced by MX642 and MX644.*** |

| | |
|---|---|
| ***MX642 Family*** | ***Production stopped end of 2010; replaced by MX644 and MX645.*** |

| | |
|---|---|
| ***MX643 Family*** | ***Production stopped end of 2010; replaced by MX645.*** |

*30 x 15 x 4mm* ***SOUND*** *- 1.2A - 10 Fu-Outputs - 2 Servos - SUSI*

| | |
|---|---|
| ***MX645 Family*** | ***MX645 replaces MX642 (except ..D and ..C) and MX643 since January 2011.*** ***H0-Sound-Decoder, 3 Watt Audio on 4 Ohm speaker (or 2 x 8 Ohm),*** *with* ***energy storage circuitry.*** TYPICAL APPLICATION: HO, O and similar gauges. |

*MX645 plug configurations:*

| | |
|---|---|
| ***MX645*** | 13 highly flexible wires (120mm) for pick-up, motor, 4 Fu-Outputs, speaker, energy storage circuitry, solder pads for additional 4 Fu-Outputs, logic level outputs, servos and SUSI. |
| ***MX645R*** | MX645 with 8-pin plug as per NEM652 on 70mm wires. |
| ***MX645F*** | MX645 with 6-pin plug as per NEM651 on 70mm wires. |
| ***MX645P16*** | MX645 with **16-pin PluX connector,** 4 Fu-Outputs. |
| ***MX645P22*** | MX645 with **22-pin PluX connector,** 9 Fu-Outputs (+ extra output). |

*30 x 15 x 4mm* ***SOUND*** *- 1.2A - 6 Fu-Outputs - 2 Servos - SUSI*

| | |
|---|---|
| ***MX644 Family*** | ***MX644 replaces MX640D, ..C and MX642D, ..C since March 2011.*** ***H0-Sound-Decoder, 3 Watt Audio on 4 Ohm speaker (or 2 x 8 Ohm),*** *with* ***energy storage circuitry.*** TYPICAL APPLICATION: HO, O and similar gauges with 21-pin „MTC“ interface. |

*MX644 plug configurations:*

| | |
|---|---|
| ***(MX644)*** | 13 highly flexible wires (120mm) for pick-up, motor, 4 Fu-Outputs, speaker, energy storage circuitry, solder pads for additional 4 Fu-Outputs, logic level outputs, servos and SUSI. |
| ***MX644D*** | MX644 with **21-pin „MTC“ plug** mounted on circuit board. |
| ***MX644C*** | MX644 as above but for **Märklin**-, **Trix and similar**; FA3, FA4 logic level only. |

# 2 Technical Information

Allowable Track voltage **) .....minimum 10 V
MX620, MX640 (discontinued) ..... max. 24 V
MX621, MX622, MX646, MX647, MX648 ..... max. 35 V
MX630, MX631, MX632, MX644, MX645, … Digital or DC analog…. max. 35 V
MX630, MX631, MX632, MX642 operated with AC analog pulse….. max. 50V

Maximum continuous motor current. MX620, MX621, MX622, MX648 ..... 0.8 A
MX630, MX646 ..... 1.0 A
MX631, MX640, MX642, MX643, MX644, MX645 … ..... 1.2 A
MX632 ..... 1.6 A

Peak motor current……..MX620, MX621, MX646, MX648 ..……1.5 A
MX630 - MX632, MX640 - MX645 for @ 20 sec……2.5 A

Maximum total function output, continuous *)……. MX620, MX621. MX646 ..... 0.5 A
MX630 - MX632, MX640 - MX645 ..... 0.8 A

Maximum continuous current for LED outputs .....MX640, MX642, MX644…….. 10 mA ea

Maximum continuous total current (motor **and** functions)…… = maximum continuous motor current

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

MX640 - MX648: Memory size for sound samples…….. 32 Mbit (= 180 sec. at 22 kHz)
MX640 - MX648: Sample rate……depending on sound sample……11 or 22 kHz
MX640 - MX648: Number of independent sound channels …… 4
MX640 - MX648: Sound amplifier output (Sinus)…. (MX640, MX646, MX648) 1.1W, (others) 3 W
MX640: Loud speaker impedance……..(MX640, MX646, MX648) 8 Ohm, (others) from 3 Ohm

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

Dimensions (L x W x H) … ..... MX620, MX620N (excluding pins) …. ..... 14 x 9 x 2.5 mm
MX621, MX621N (excluding pins)……12 x 8.5 x 2.0 mm
MX622, MX622P16 (excluding pins) ..... 16 x 9 x 2.5 mm
MX630, MX630P16 (height w/o pins) ..... 20 x 11 x 3.5 mm
MX631, MX631D ..... 20.5 x 15.5 x 4.0 mm
MX632, MX632D ..... 28 x 15.5 x 4.0 mm
MX646 ..... 28 x 10.5 x 4 mm
MX648 ..... 20 x 11 x 4 mm
MX640 ..... 32 x 15.5 x 6.0 mm
MX642, MX643, MX644, MX645 .....30 x 15 x 4.5 mm

*) The short circuit protection is carried out for the total current of all outputs. Use the “soft start” option (i.e. CV #125 = 52) to prevent cold-start problems of light bulbs (in-rush current interpreted as a short circuit, which leads to the output being turned off)!

**) Note when operating with a DiMAX command station (Massoth): The DiMAX 1200Z command station is designed to keep the track voltage at 24V (which would exceed the DCC norm only marginally). In reality however the voltage laid on the track varies with the load (especially older command stations); starting at 30V at idle (dependent of mains voltage). Most ZIMO decoders, with the exception of the MX620, are able to deal with the excessive voltage; the MX640 however just barely (It is unlikely that a MX620 decoder is used with a DiMAX command station). Lowering the track voltage to an allowable level by adding a “fake load” (about 0.5A) would be an advantage to the regulating circuit.

**) Roco Lokmaus Systems also tend to put excessive idle voltages on the track (although not as serious, @ 26V), which could present a problem for the MX620 decoder. Other ZIMO decoder types would not be affected.

**Disclaimer related to Märklin/Trix locomotives (especially with C-Sinus):**

Märklin/Trix is not concerned about compatibility of their locomotives with third party products. Their decoder interfaces change often without notice. ZIMO can therefore not guarantee that the method of connection and operation described in this manual is possible with every locomotive. We are equally not liable for damages or destruction of locomotives and/or decoders as a result of mismatched interfaces.

### *Software Update:*

ZIMO DCC decoders are equipped to handle software updates by the user. An update device such as the ZIMO decoder update module **MXDECUP,** from 2011 **MXULF,** system-cab **MX31ZL** or **command station MX10)** is required. The update process is carried out by a USB stick (MXULF, MX31ZL / MX10) or by a PC with Windows operating system and the program “ZIMO Sound Program” **ZSP** or the “ZIMO Rail Center” **ZIRC** (MXDECUP).

The same hardware and software is also used to load sound projects into ZIMO sound decoder.

There is **no need to remove the decoder or to open up the locomotive.** Just set the locomotive on a section of track connected to the update module and start the update with the computer or other equipment mentioned above.

NOTE: Equipment inside the locomotive that is powered directly from the track (not through the decoder) can interfere with the update procedure. The same goes for energy buffers that are installed without heeding the advice in the “Installation and wiring” chapter, section “Use of an external energy source” (regarding a choke coil).

See the **last chapter** in this manual for more information on updating decoders or www.zimo.at !

SW updates can of course be done through ZIMO or your ZIMO dealer for a small fee.

### *Overload and Thermal Protection:*

The motor and function outputs of ZIMO decoders are designed with lots of reserve capacities and are additionally protected against excessive current draw and short circuits. Cutouts are encountered if the decoder is overloaded.

***Even though the decoder is well protected, do not assume it is indestructible. Please pay attention to the following:***

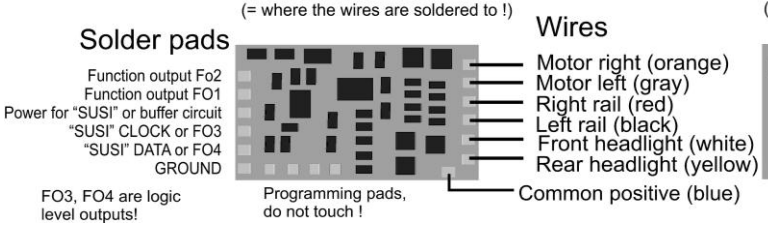
***Faulty decoder hook-up,*** *connecting the motor leads to track power for instance or an overlooked connection between the motor brushes and rail pick-ups is not always recognized by the overload protection circuit and could lead to damage of the motor end stage or even a total destruction of the decoder.*

***Unfit or defective motors*** *(e.g. shorted windings or commutator) are not always recognized by their high current consumption, because these are often just short current spikes. Nevertheless, they can lead to decoder damage including damage to end stages due to long-term exposure.*

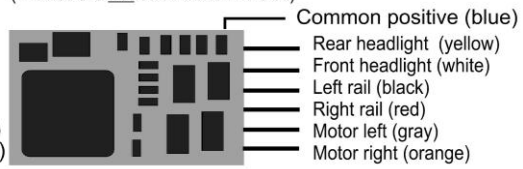
*The end stages of loco decoders (motor as well as function outputs) are not only at risk of high current but also* ***voltage spikes,*** *which are generated by motors and other* ***inductive consumers.*** *Depending on track voltage, such spikes can reach several hundred volts and are absorbed by special protection circuits inside the decoder.*

All ZIMO decoders are equipped with temperature sensors to measure their own operating temperature. Power to the motor will be turned off once that temperature exceeds 100°C. The headlights start flashing rapidly, at about 5 Hz, to make this state visible to the operator. Motor control will resume automatically after a drop in temperature of about 20°C, typically in 30 to 60 seconds.

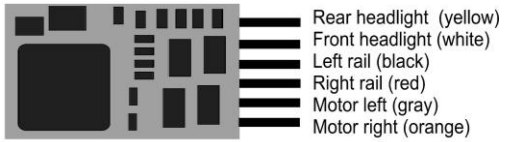
**MX620, MX620R, MX620F**
**Connection side**
(= where the wires are soldered to !)



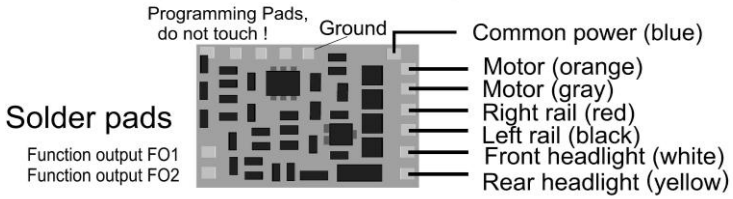

**MX620, MX620R, MX620F**
**Controller side**
(= Wires are **not** soldered to this side)



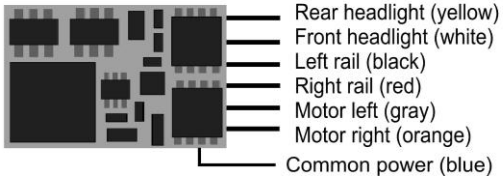

**MX620N** (= MX620 with 6-pin connector)
**Controller side**
(This is the correct installation position !)



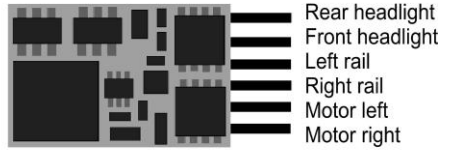

**MX621, MX621R, MX621F**
**Connection side**
(= where the wires are soldered to !)




**MX621, MX621R, MX621F**
**Controller side**
(= back side, where the wires are **not** soldered to !)

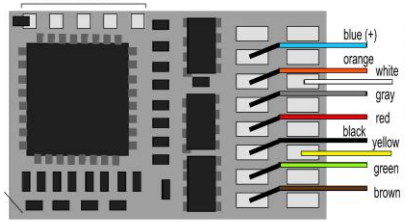



**MX621N** (= MX621 with 6-pin interface)
**Controller side**
(this is the correct installation position !))




Programming pads, do not touch !

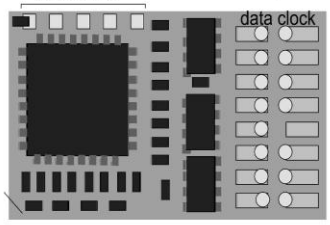
**MX630 Top Side, wired**




| | |
|---|---|
| Common power | (blue) |
| Motor right | (orange) |
| Front headlight (= Lfr) | white |
| Motor left | (gray) |
| Right rail | (red) |
| Left rail | (black) |
| Rear headlight (= Lrear) | yellow |
| Function output FO1 | (green) |
| Function output Fo2 | (brown) |

Programming pads, do not touch !

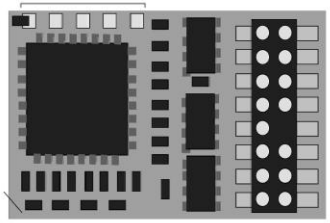
**MX630 Top Side, pin-out**



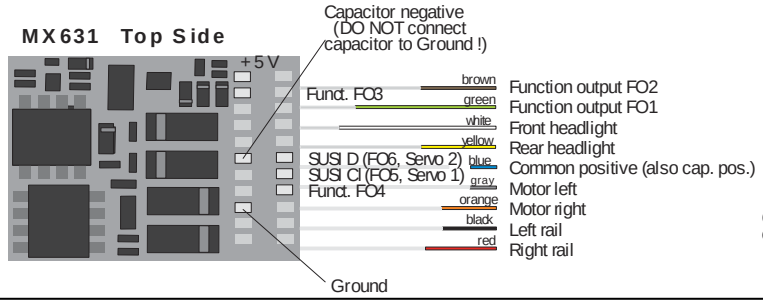

| | | |
|---|---|---|
| SUSI, Servo's (2, 1) or FO6, FO5 | | |
| Common (+) | | Ground |
| Motor right | | Front headl. |
| Motor left | | Common (+) |
| Right rail | | --- (Index) |
| Left rail | | Rear headl. |
| Function output | FO1 | FO3 |
| Function output | FO2 | Fo4 |

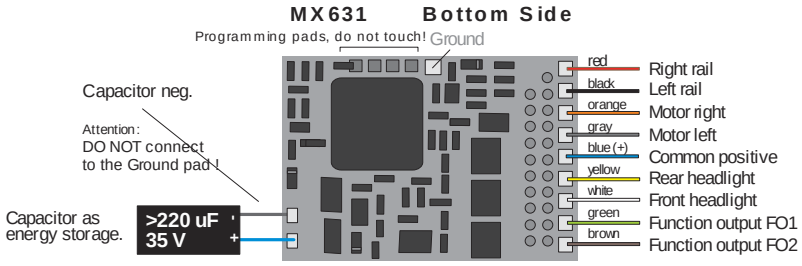
Programming pads, do not touch !

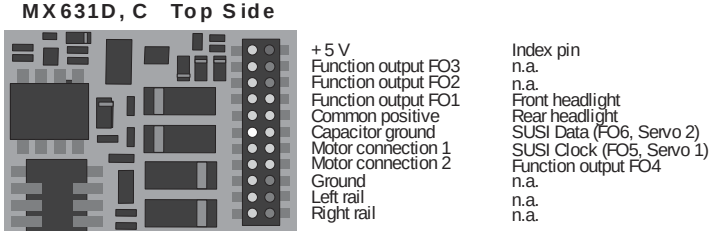
**MX630P (with PluX16)**

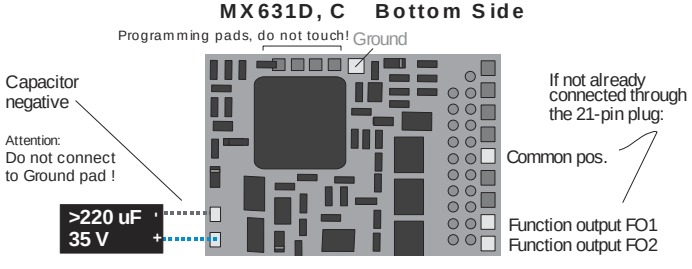


| | | |
|---|---|---|
| SUSI, Servo's (2, 1) or FO6, FO5 | | |
| Common (+) | | Ground |
| Motor right | | Front headl. |
| Motor left | | Common (+) |
| Right rail | | --- (Index) |
| Left rail | | Rear headl. |
| Function output | FO1 | FO3 |
| Function output | FO2 | FO4 |



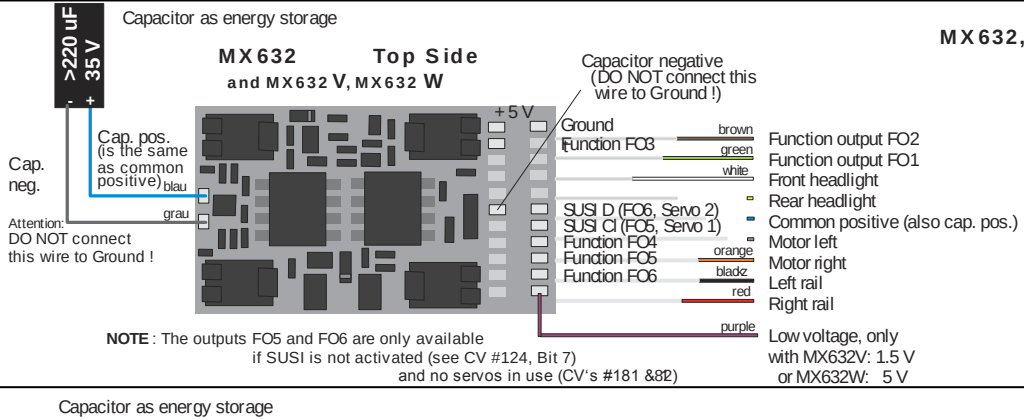



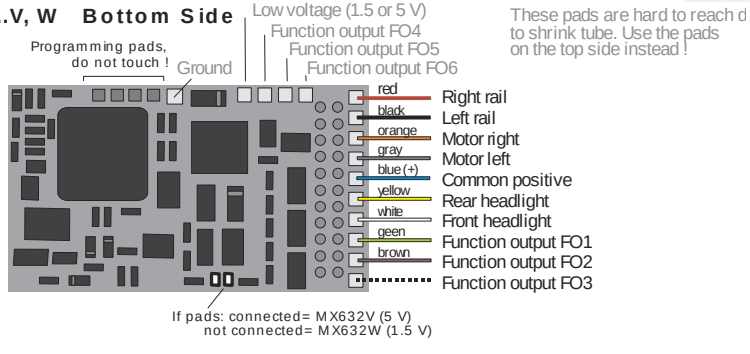




C versions differ from the D versions in the design of function outputs FO3 and FO4:

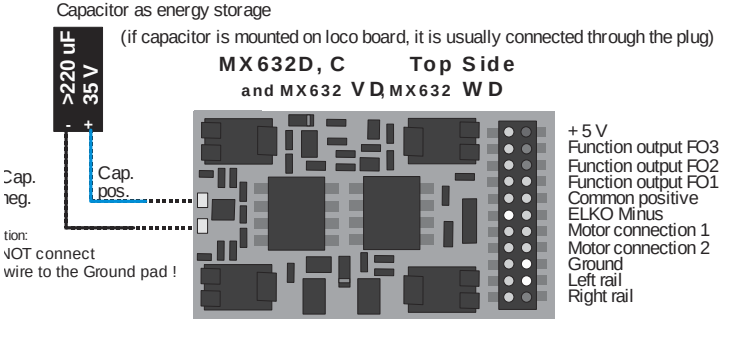
MX631D: FO3 and FO4 outputs are “normal” amplified outputs (same as headlights, FO1 etc.).

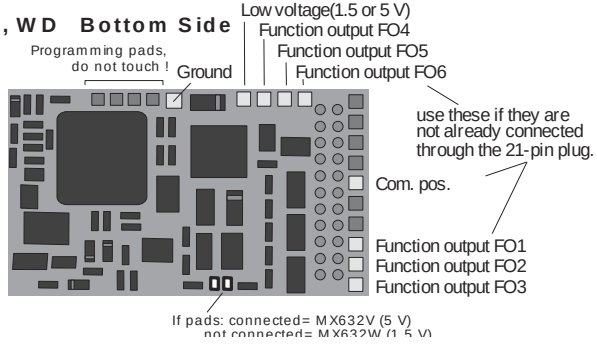
MX631C: FO3 and FO4 are logic level outputs.




These pads are hard to reach d
to shrink tube. Use the pads
on the top side instead !




„C versions differ from the D versions in the design of function outputs FO3 and FO4:

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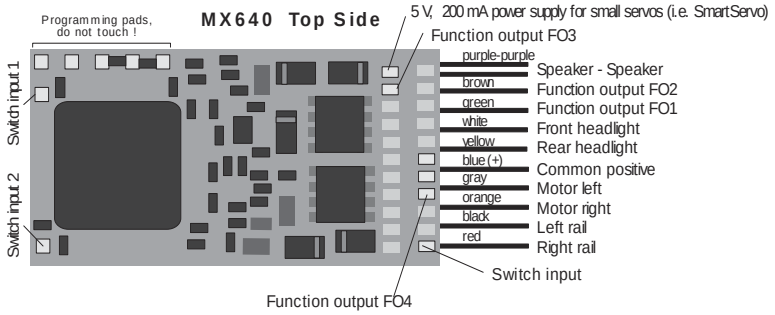
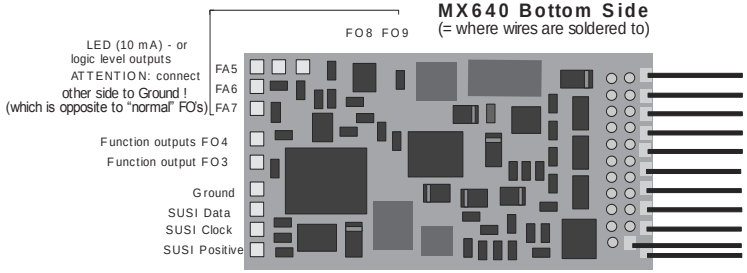
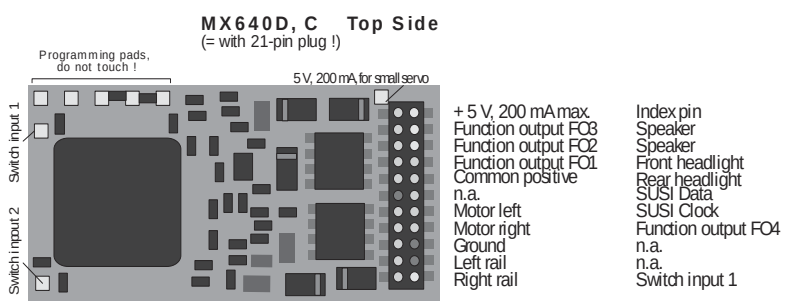
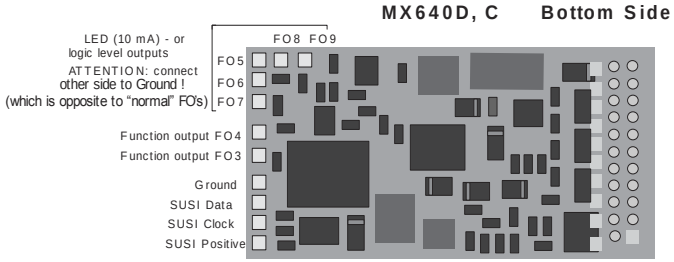
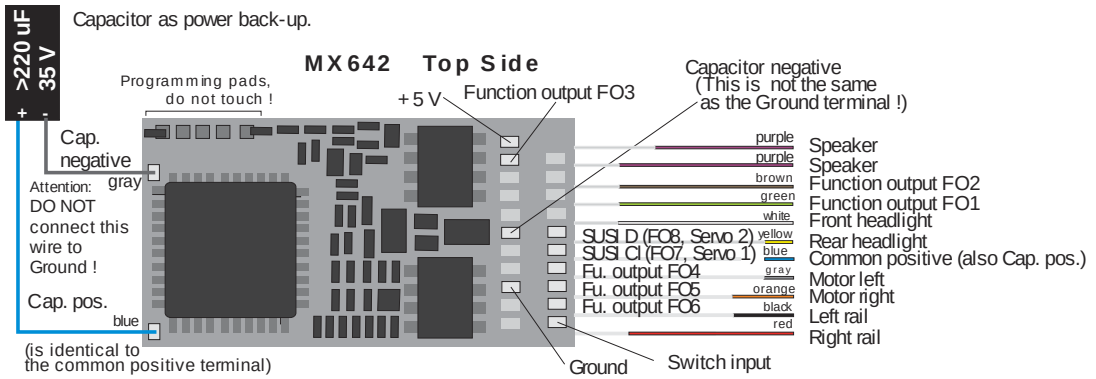


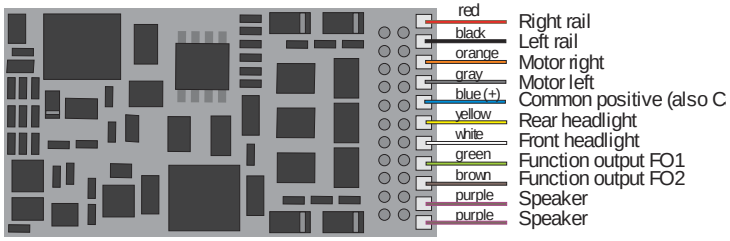



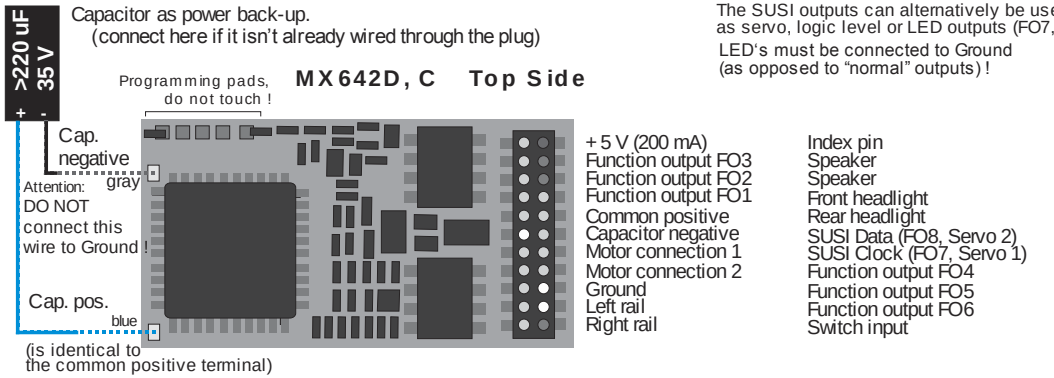



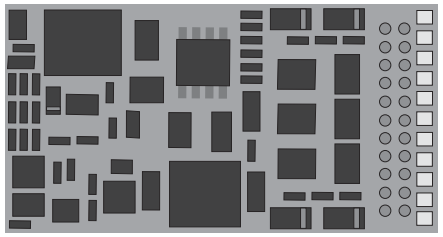

ATTENTION:
The decoder can be plugged in from either side, depending on the circuit board in the locomotive.



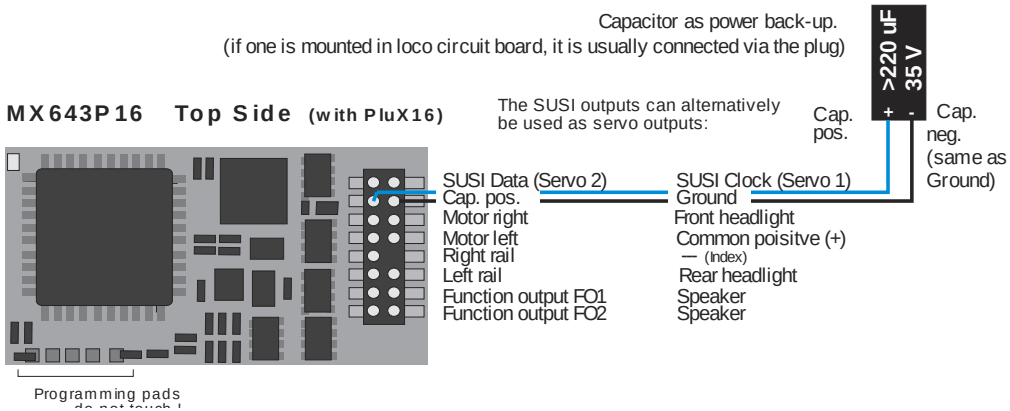



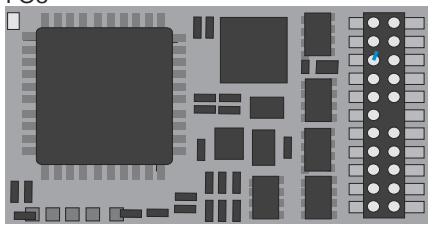




The SUSI outputs can alternatively be used as servo, logic level or LED outputs (FO7, FO8);
LED's must be connected to Ground (as opposed to "normal" outputs) !

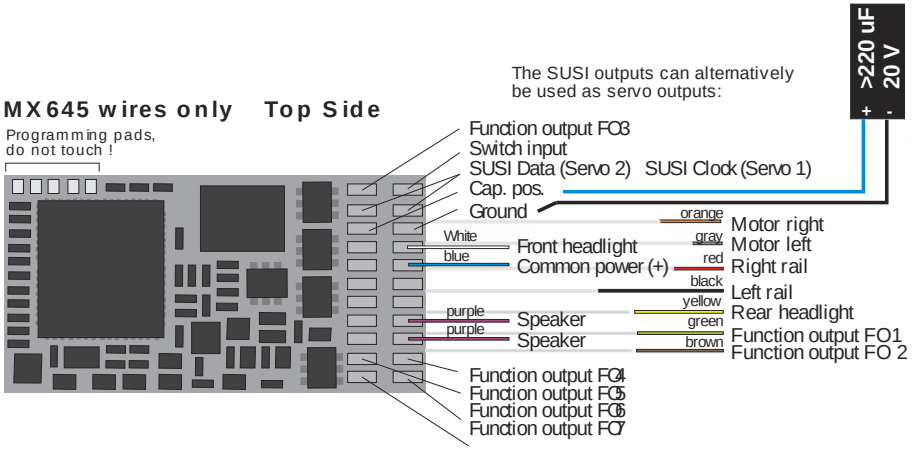



ATTENTION:
The decoder can be plugged in from either side, depending on locomotive circuit board.

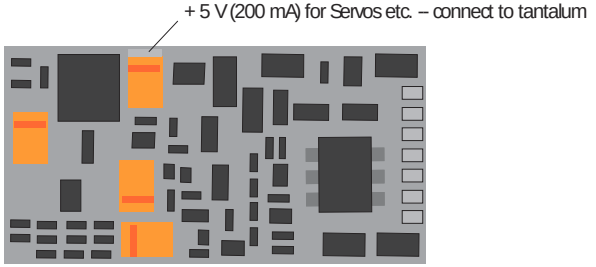


**MX645 wires only Top Side**



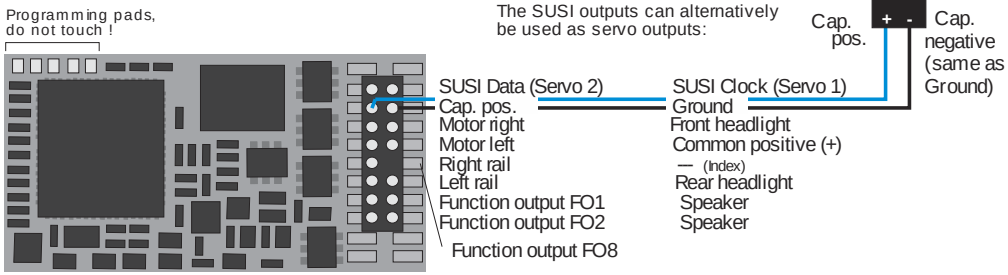

**MX645 (all Types) Bottom Side**



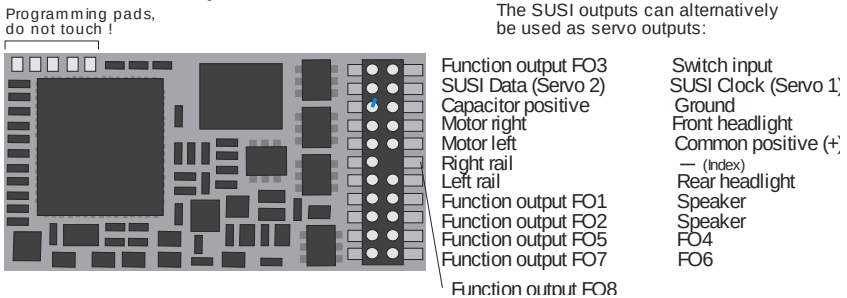

Capacitor as power back-up.
(is normally mounted on loco circuit board and connected via plug)

the same for MX645P22 and MX645P16.

**MX645P16 Top Side (with PluX16)**

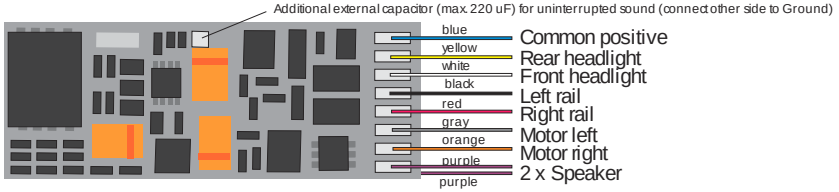



**MX645P22 Top Side (with PluX22)**



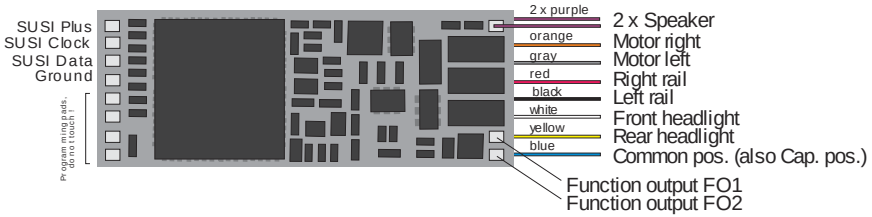
### MX646, ..R, ..F Top Side

(= wire side)

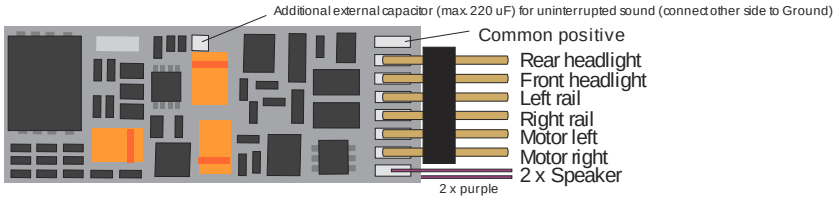



### MX646, ..R, ..F Bottom Side

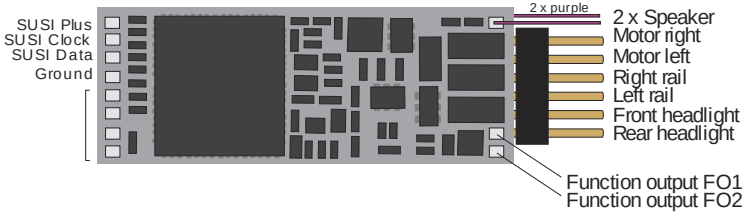
(= solder pad side)



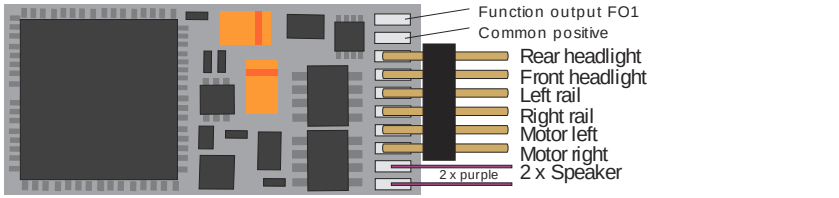

### MX646N, ..W Top Side



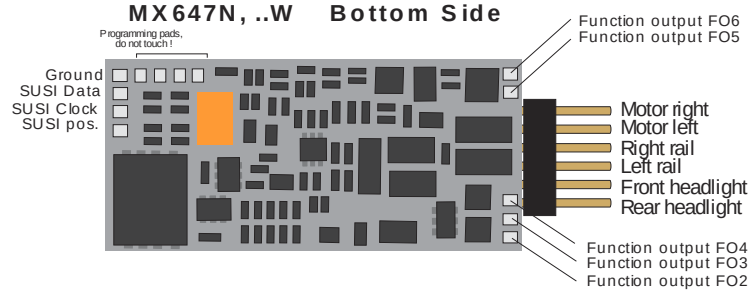

### MX646N, ..W Bottom Side




### MX647N, ..W Top Side




### MX647N, ..W Bottom Side



# 3 Addressing and Programming

ZIMO decoders can be programmed in

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

## *HELPFUL HINTS FOR CV PROGRAMMING:*

***If you are familiar with CV programming please skip this section and go directly to section 3.1!***

CV programming is not the same for all CV's. While the programming procedure is the same for all CV's, the calculation of the individual CV values varies.

For some CV's it is obvious what the value is supposed to be and can easily be derived from the "Range" and/or "Description" column in the CV table. This kind of CV can be compared to volume control.
For instance, CV#2 determines the minimum speed applied at speed step 1:

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #2 | Vstart | 1 – 252 (See add. notes) | 2 | Entered value = internal speed step assigned to lowest cab speed step.<br>Bit 4 in CV # 29 has to be 0; otherwise individual speed table is active. |

The "range" column states that any value from 1 to 252 may be used. The higher the value the faster the engine runs at speed step 1 and vice versa.

Another similar CV is the "dimming" factor in CV #60:

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #60 | Reduced function output voltage (Dimming) | 0 - 255 | 0 | The actual function output voltage can be reduced by PWM. Useful to dim headlights, for example.<br>Example values:<br># 60 = 0 or 255: full voltage<br># 60 = 170: 2/3 of full voltage.<br># 60 = 204: 80% of full voltage. |

Again, the range column states that any value from 1 to 252 may be used and in the "description" column it is explained that the brightness of the light increases with the value.

Other CV's are easier to understand if you think of them as small switch boards, where you can turn individual switches ON or OFF. Such a CV is made up of 8 "individual switches" called Bits and the group of Bits is known as a Byte (which is the CV itself or the switch board, if you will). On some CV's you can change the setting of all 8 Bits (switches) and on others only a select few. The Bits (switches) are numbered from 0 to 7 and each has a specific value (**see the chapter "Converting binary to decimal"** for more on binary calculations). Each Bit is turned ON by adding its value to the CV and turned OFF by subtracting its value. Add up the values of each Bit you want to turn ON and enter the total to the CV.

One such CV is CV #29:

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #29 | Basic configuration<br><br>CV #29 is calculated by adding the value of the individual bits that are to be "on":<br>Values to turn "on":<br>Bit 0: 1<br>Bit 1: 2<br>Bit 2: 4<br>Bit 3: 8<br>Bit 4: 16<br>Bit 5: 32<br>Bit 6: 64<br>Bit 7: 128<br><br>ZIMO MX21, MX31… cabs also display the individual bits; calculating bit values is no longer necessary! | 0 - 63 | 2 | Bit 0 - Train direction:<br>0 = normal, 1 = reversed<br>Bit 1 - Number of speed steps:<br>0 = 14, 1 = 28<br>Note: 128 speed steps are always active if corresponding information is received!<br>Bit 2 - DC operation (analog): *)<br>0 = off 1 = on<br>Bit 3 - RailCom („bidirectional communication")<br>0 = deactivated<br>1 = activated see CV #28!<br>Bit 4 - Individual speed table:<br>0 = off, CV # 2, 5, 6, are active.<br>1 = on, according to CV 's # 67 – 94<br>Bit 5 - Decoder address:<br>0 = primary address as per CV #1<br>1 = ext. address as per CV #17+18<br>Bits 6 and 7 are to remain 0! |

As explained in the description column of that CV, you can only change Bit 0, 1, 2, 3, 4 and 5. Bits 6 and 7 have to remain OFF (0) because they are not yet used for anything. To calculate the total CV value you have to first look at the description field of that CV and determine which Bit (switch) you want to have ON. Let's say we want speed steps 28 active, reverse the loco's direction because it doesn't agree with the cab's direction indication and we want to use the individual speed table. This means we have to have the Bits 1, 0 and 4 turned ON (= 1). All other Bits can be OFF (= 0). In the "Designation" field it shows the value for each Bit: Bit 0 = 1, Bit 1 = 2, Bit 2 = 4, Bit 3 = 8, Bit 4 = 16, Bit 5 = 32, Bit 6 = 64, and Bit 7 = 128. If we want to have Bits 1, 0 and 4 turned ON we add up the values for these Bits (2 + 1 + 16) and enter the total of 19 to CV #29.

Lastly there is a third kind of CV that sort of fits between the other two. Here you don't have to worry about Bits and their values. With those CV's the digit's position and value determines a specific action. Some of those digit positions act like a simple ON/OFF switch and others like a volume control.

For example, CV #56 can be used for fine-tuning a motor:

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #56 | Back-EMF control<br>P and I value | 0 – 199<br>(See add. notes) | 0<br>(is equal to 55, mid-range)<br><br>But:<br>default is not suitable for **coreless motors, i.e. MAXXON, FAULHABER!**<br>Use "100" instead. | Back-EMF compensation is calculated by PID algorithm (Proportional/Integral - Differential); modifying these values may improve the compensation characteristics in certain cases.<br>0 - 99: for „normal" DC motors (LGB etc.)<br>100 - 199: for coreless (MAXXON, Faulhaber, etc...)<br>Tens digit: Proportional (P) value; by default (0) is set to mid value and automatic adjustment with the goal of jerk free running. Proportional effect can be modified with settings of 1 – 4 and 6 – 10 (instead of the default 0 = 5).<br>Ones digit: Integral (I) value; is set by default to a mid-value. The Integral effect can be modified with settings of 1 – 9 instead of the default 0 = 5). |

As you can see in the "Range" field you can use any number between 0 and 199. However if you read the "Description" field it explains that each digit position controls a specific function. In this case, the hundredth digit (_xx) sets the decoder up for a coreless motor, the tens digit (x_x) modifies the proportional and the ones digit (xx_) the integral action. The hundredth digit acts just like a switch. If you use the hundredth digit (1__) the coreless motor control is turned ON. If you don't use it (_xx), the function is turned OFF. So for a normal DC motor you would only use the ones and tenth digit. With the tens digit (0 – 9) you can modify the proportional value and with the ones digit (0 – 9) the integral value.

Don't worry about the terms "proportional" or "integral" - just use the **"Step by step CV adjustment procedure"** later in the manual.

## 3.1 Programming in "Service mode" (on programming track)

Before programming is possible, it must be unlocked with

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

This is normally the case but in many sound projects the programming lock is activated to prevent accidental changes. Therefore, it is useful to check that CV, especially when programming attempts have already failed.

The acknowledgments of successful programming steps on the programming track as well as CV read-outs are accomplished by power pulses, which the decoder generates 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<br><br>Note: The programming lock has no effect on CV #144, which is therefore always accessible for unlocking. | Bits<br>6, 7 | 0<br>or<br>255 | = 0: programming and update lock not active<br>Bit 6 = 1: programming of the decoder in „Service Mode" is blocked as a protection against unwanted reprogramming.<br>Note: Programming in „Operations Mode" is not locked because any such programming only applies to the active loco address and reprogramming the wrong locomotive is therefore not possible.<br>Bit 7 = 1: Software updates via MXDECUP, MX31ZL or other means are locked. |
| #112 | Special ZIMO configuration bits | 0 - 255 | 4 =<br>00000100<br>that is Bit 1 = 0 (normal) | Bit 1 = 0: Normal acknowledgment in „Service Mode"; motor and headlight pulses.<br>= 1: High frequency pulses instead of normal acknowledgments from motor and headlights.<br>Bit 2 = 0: Loco number ID is OFF<br>etc. |

## 3.2 Programming in "Operations Mode" (on-the-main "PoM")

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

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

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

This is usually the default setting, except in certain sound projects or OEM CV sets, in which they need to be set first.

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #28 | RailCom Configuration | 0 - 3 | **3** | Bit 0 - RailCom Channel 1 (Broadcast)<br>0 = OFF **1 = ON**<br>Bit 1 - RailCom Channel 2 (Data)<br>0 = OFF **1 = ON** |
| #29 | Basic settings | 0 - 63 | 14 =<br>0000 **1**110<br>Bit 3 = 1 ("RailCom" is switched on) | Bit 0 - Train direction:<br>0 = normal, 1 = reversed<br>Bit 1 - Number of speed steps:<br>0 = 14, 1 = 28<br>Bit 2 - DC operation (analog): *)<br>0 = disabled 1 = enabled<br>Bit 3 - RailCom („bidirectional communication")<br>0 = deactivated **1 = activated**<br>Bit 4 - Individual speed table:<br>0 = off, CV # 2, 5 and 6 are active.<br>1 = on, according to CV 's # 67 – 94<br>Bit 5 - Decoder address:<br>0 = primary address as per CV #1<br>1 = ext. address as per CV #17+18 |

## 3.3 Decoder-ID, Load-Code, Decoder-Type and SW-Version

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #250, 251, 252, 253 | Decoder-ID<br>Also contains a code (in CV #250) that identifies the decoder type | 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.<br>The decoder ID is primarily used for automatic address recognition 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 decoders can be ordered for a small fee with the "load code" installed, which entitles the user to install "coded" sound projects of a selected sound "bundle".<br>The load code can also be bought and installed at a later date: see www.zimo.at or ZIRC. |
| #8 | Manufacturer ID<br>and<br>HARD RESET<br>with CV #8 = 8<br>or CV #8 = 0<br>or<br>ACTIVATION<br>of special CV sets | Read only<br>Reading out the decoder always shows "145", which is ZIMO's assigned number.<br>For pseudo programming see "Description" column on the right. | 145<br>( = ZIMO) | Reading out this CV always result in "145" ("10010001"), the number issued for ZIMO by the NMRA.<br>This CV is also used to reset various events with the help of Pseudo-Programming.<br>Pseudo-Programming means that the entered value is not really stored, but rather used to start a defined action.<br>**CV #8 = "8" ➔ HARD RESET**(NMRA standard); all CV's reset to the last active **CV set,** or the default values listed in this CV table if no such set was active.<br>CV #8 = "9" ➔ HARD RESET for LGB-operation (14 speed steps, pulse chain commands).<br>Further options: see chapter "CV Sets"! |
| #7 | SW-Version Number<br>Also see CV # 65 for Sub-Version Number<br>and<br>special procedures for programming with "Lokmaus-2" and other "low level" systems | Read only<br>Pseudo-programm. see explanation to the right | - | This CV holds the firmware version number currently in the decoder.<br>With the help of "Pseudo-programming" it also helps to program decoders with DCC systems of limited range:<br>Ones digit = 1: Subsequent programming value + 100<br>= 2: ... + 200<br>Tens digit = 1: Subsequent CV number + 100<br>= 2: … + 200<br>etc. = 9: … + 900<br>Hundreds digit = 0: Revaluation applies only once<br>= 1: … until power-off |
| #65 | SW-<br>Sub-Version Number<br>Also see CV #7 for Version Number | Read only | - | This CV indicates a possible sub-version number of a main version noted in CV #7.<br>The entire SW version number is thus composed of CV #7 and #65 (i.e. 28.15). |

## 3.4 The vehicle address(es) in DCC mode

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

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

☞ Most digital systems (with the possible exception of very old or simple products) calculate the value for the CV's involved automatically 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<br>MM: 1 - 80 | **3** | The "short" (1-byte) loco address (DCC,MM)<br>In the case of DCC:<br>The address in CV #1 is only valid if CV #29, Bit 5 = 0.<br>Otherwise, if CV #29 Bit 5 = 1, the long address in CV #17 + #18 applies. |
| #17 + #18 | Extended (long) address | 128 - 10239 | **0** | The long DCC address applies to addresses >127.<br>It is only active if CV #29 Bit5 = 1. |
| #29 | Basic Configuration | 0 - 63 | **14 = 0000 1110 with Bit 5 = 0 (for short address)** | Bit 0 - Train direction:<br>0 = normal, 1 = reversed<br>Bit 1 - Number of speed steps:<br>0 = 14, 1 = 28<br>Bit 2 - DC operation (analog): *)<br>0 = disabled 1 = enabled<br>Bit 3 - RailCom („bidirectional communication")<br>0 = deactivated 1 = activated<br>Bit 4 - Individual speed table:<br>0 = off, CV # 2, 5 and 6 are active.<br>1 = on, according to CV 's # 67 – 94<br>Bit 5 - Decoder address selection:<br>0 = short address as per CV #1<br>1 = long address as per CV #17+18 |

### *Decoder-controlled consisting (a.k.a. "Advanced consisting")*

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

- the DCC system (common practice with ZIMO systems, without changing any decoder CV's) or
- by programming the following decoder CV's individually, which can also be managed by some the 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 common consist address for 2 or more engines can be entered in this CV to each loco of the same consist.<br>If CV #19 > 0: Speed and direction is governed by this consist address (not the individual address in CV #1 or #17+18); functions are controlled by either the consist address or individual address, see CV's #21 + 22. |
| #21 | Consist functions F1 - F8 | 0 - 255 | 0 | Functions so defined here will be controlled by the consist address.<br>Bit 0 = 0: F1 controlled by individual address<br>= 1: …. by consist address<br>Bit 1 = 0: F2 controlled by individual address<br>= 1: …. by consist address<br>..... F3, F4, F5, F6, F7<br>Bit 7 = 0: F8 controlled by individual address<br>= 1: …. by consist address |
| , #22 | Headlight control in a consist | 0 - 3 | 0 | Select whether the headlights are controlled with the consist address or individual address.<br>Bit 0 = 0: F0 (forw.) controlled by individual address<br>= 1: …. by consist address<br>Bit 1 = 0: F0 (rev.) controlled by individual address<br>= 1: …. by consist address<br>Bit 2 = 0: F9 (forw.) controlled by individual address<br>= 1: …. by consist address<br>Bit 3 = 0: F10 (forw.) controlled by individual address<br>= 1: …. by consist address<br>Bit 4 = 0: F11 (forw.) controlled by individual address<br>= 1: …. by consist address<br>Bit 5 = 0: F12 (forw.) controlled by individual address<br>= 1: …. by consist address |

## 3.5 Analog operation

All ZIMO decoders are capable of operating on conventional layouts with DC power packs, including PWM throttles, in **analog DC** as well as in **analog AC** (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).

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 easily 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 some adjustment possibilities for analog operation where motor control and function outputs are concerned; these CV's can of course be read-out or programmed only with a DCC system or other programming device.

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #29 | Basic configuration | 0 - 63 | 14 = 0000 1**1**10 includes Bit 2 = 1 (Analog operation enabled) | Bit 0 - Train direction:<br>0 = normal, 1 = reversed<br>Bit 1 - Number of speed steps:<br>0 = 14, 1 = 28<br>Bit 2 – Automatic switchover to analog:<br>0 = disabled 1 = enabled<br>Bit 3 - RailCom („bidirectional communication")<br>0 = deactivated 1 = activated<br>Bit 4 - Individual speed table:<br>0 = off, CV # 2, 5 and 6 are active.<br>1 = on, according to CV 's # 67 – 94<br>Bit 5 - Decoder address:<br>0 = primary address as per CV #1<br>1 = ext. address as per CV #17+18 |
| #13 | Functions F1 – F8 in analog mode | 0 - 255 | 0 | Select functions that should be ON in analog operation.<br>Bit 0 = 0: F1 OFF in analog mode<br>= 1: …ON…<br>Bit 1 = 0: F2 OFF in analog mode<br>= 1: …ON…<br>..... F3, F4, F5, F6, F7<br>Bit 7 = 0: F8 OFF in analog mode<br>= 1: …ON… |
| #14 | Functions F0 (forward, reverse) and F9 – F12 in analog mode<br>and<br>acceleration, deceleration and motor control in analog | 0 - 255 | 64 that is Bit 6 = 1 | Select functions that should be ON in analog operation.<br>Bit 0 = 0: F0 (forw.) OFF in analog mode<br>= 1: …ON…<br>Bit 1 = 0: F0 (rev.) OFF in analog mode<br>= 1: …ON…<br>Bit 2 = 0: F9 OFF in analog mode<br>= 1: …ON…<br>..... F10, F11<br>Bit 5 = 0: F12 OFF in analog mode<br>= 1: …ON…<br>Bit 6 = 0: Analog operation with momentum as per CV's #3 + 4; often needed for sound<br>= 1: Analog operation without momentum from CV #3 + 4; immediate response to track voltage similar to classic analog control.<br>Bit 7 = 0: Analog operation **without** motor regulation.<br>= 1: Analog operation **with** motor regulation. |

Note: A decoder may have different settings than the default values, due to an installed sound project. This is especially true for motor regulation (CV #14, Bit 7), which is often enabled by the sound project. The regulation only works well with power packs that apply "clean" DC voltage (i.e. with an LGB 50 080); it is better to turn the motor regulation off if the track voltage is not properly rectified or consists of half-wave signals.

## 3.6 Motor Regulation

### The speed curve

There are two types of speed curves, which are selected with

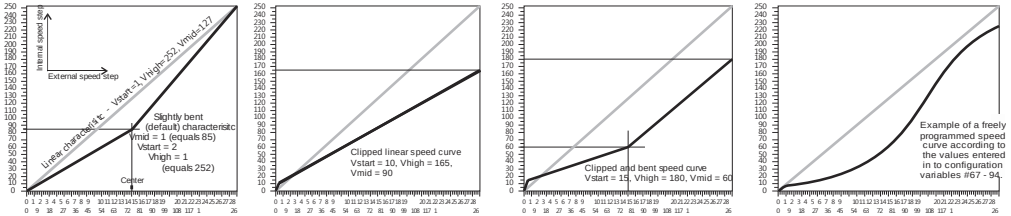
*CV #29, Bit 4* = 0: 3-step curve (defined by 3 CV's)

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

3-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.

☞ Such a three point curve is sufficient in most cases.

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




| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #2 | Start Voltage<br>Vstart<br>with 3-step curve if CV #29, Bit 4 = 0 | 1 - 255 | 1 | Internal speed step (1 … 255) applied as<br>**lowest** external speed step (= speed step 1) (applies to 14, 28, or 128 speed step modes)<br>= 1: lowest possible speed |
| #5 | Top Speed<br>Vhigh<br>with 3-step curve if CV #29, Bit 4 = 0 | 0 - 255 | 1<br>or<br>255 | Internal speed step (1 … 255) applied as<br>**highest** external speed step (14, 25 or 128, depending on the speed step mode selected in CV # 29, Bit 1)<br>= 1 (same as 255): fastest top speed possible. |
| #6 | Medium Speed<br>Vmid | 1,<br>¼ to ½ of the value in CV #5 | 1<br>(= @ 1/3 of top speed) | Internal speed step (1 … 255) applied as<br>**medium** external speed step (that is, speed step 7, 14 or 63 depending on the speed step mode selected in CV #29, Bit 1)<br>"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).<br>The speed curve resulting from CV #2, 5 and 6 is automatically smoothed out. |

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #29 | Basic configuration | 0 - 63 | 14 =<br>0000 1110<br>with Bit 4 = 0 (3-speed step) | Bit 0 - Train direction:<br>0 = normal, 1 = reversed<br>Bit 1 - Number of speed steps:<br>0 = 14, 1 = 28/128<br>Bit 2 - DC operation (analog): *)<br>0 = disabled 1 = enabled<br>Bit 3 - RailCom („bidirectional communication")<br>0 = deactivated 1 = activated<br>Bit 4 - Individual speed table:<br>0 = off, CV # 2, 5 and 6 are active.<br>1 = on, according to CV 's # 67 – 94<br>Bit 5 - Decoder address: 0 = primary address as per CV #1 1 = ext. address as per CV #17+18 |
| #67<br>.....<br>#94 | Individual speed table, if CV # 29, Bit 4 = 1 | 0 - 255 | *) | User programmable speed table.<br>Each CV corresponds to one of the 28 external speed steps that can be "mapped" to internal steps (1 – 255).<br>*) The 28-point default curve is also bent in the lower speed range. |
| #66<br>#95 | Directional speed trimming | 0 - 255<br>0 - 255 | 0<br>0 | Multiplication of the speed step by "n/128" (n is the trim value in this CV)<br>#66: for forward direction<br>#95: for reverse direction |

### The reference voltage for motor regulation

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

☞ The default value "0" in CV #57 selects the "relative reference", which automatically adjusts the reference voltage to the available track voltage. This setting is only useful though if the system can keep the track voltage constant at all times (stabilized track output) and the resistance along the track kept to a minimum. All ZIMO systems keep the track voltage stable even older systems, but not every system from other manufacturers do, especially the relatively cheap systems built before 2005.

☞ It is not recommended to set CV #57 to "0" with systems that don't keep track voltage stabilized. Instead set this CV about 2V below track voltage (i.e. 140 for 16V).

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

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #57 | Voltage reference | 0 - 255 | 0 | Absolute voltage in tenth of a volt applied to the motor at full speed (max. throttle setting).<br>Example: A system without stabilized track voltage is set to 22V at idle but drops to 16V under load: A good |

| | | | | |
|---|---|---|---|---|
| | | | | setting would be CV #57 = 140…150.<br>CV #57 = 0: automatically adjusts to the track voltage (relative reference); only useful with stabilized track voltage. |

## *Tweaking the motor regulation*

The motor's performance, especially at crawling speeds (as jerk-free as possible), can be fine-tuned with the following CV's:

### *CV #9 – Motor control frequency and EMF sampling rate*

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

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

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

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

### *CV # 56 – The PID regulation*

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

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

| *Vehicle, Type of Motor* | *CV #9* | *CV #56* | *Remarks* |
|---|---|---|---|
| | | | |
| | | | |
| W i l l b e | | | a d d e d l a t e r. |
| | | | |
| | | | |
| | | | |

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

Start with an initial setting of CV #56 = **11**; set the locomotive at a low speed, then hold it back with your 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**...

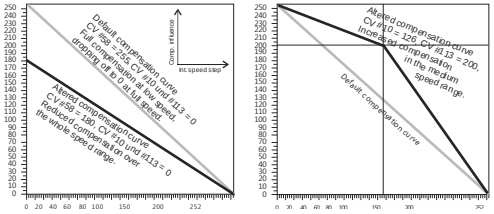
With the locomotive still running at a low speed, increase the tens digit in CV #56. For example: (if the test above resulted in CV #56 = 1**3**) start increasing the tens digit CV #56 = **2**3, **3**3 ,**4**3…As soon as jerky driving is detected, revert back to the previous digit → this would be the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

## *Load Compensation, Compensation Curve and Experimental CV's*

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

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

Locomotives operated in consists should never be operated with 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 this CV to define a 3-point curve.

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #58 | BEMF intensity | 0 - 255 | 255 | Intensity of back-EMF control for lowest speed step.<br>If required, an "intensity curve" can be achieved using CV #10, 58 and 113 to reduce load regulation at higher speeds.<br>Example:<br># 58 = 0: no back-EMF<br># 58 = 150: medium compensation,<br># 58 = 255: maximum compensation. |
| #10 | Compensation cut-off<br>This CV is seldom required | 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.<br>= 0: default curve is valid (as in CV #58). |
| #113 | Compensation cut-off<br>This CV is seldom required | 0 - 255 | 0 | The BEMF intensity is reduced to this value at the speed step defined in CV #10.<br>CV #113 together with CV's #58 and 10 form a 3-point BEMF curve. |
| #147<br>#148<br>#149<br>#150 | Experimental CV's for test purposes,<br>to find out whether certain automatic settings have a negative effect on motor regulation.<br>Using these experimental CV's will deactivate the automatic settings.<br>CV's #147 – 149 will likely be removed again from the decoder SW at some time. | | 0<br>0<br>0<br>0 | --- CV #147 Sampling time ---<br>Useful initial value: 20;<br>Too small a value leads to jerky behavior.<br>Too large a value leads to poor low speed control.<br>0= automatic control (CV #147 has no effect)<br>--- CV #148 D-Value ---<br>Useful initial value: 20;<br>Too small a value leads to poor regulation (regulates too little, too slow, engine jerks (rather slowly).<br>Too large a value leads to over compensation, the engine runs rough/vibrates.<br>0 = automatic control (CV #148 has no effect)<br>--- CV #149 P-Value ---<br>0 = automatic control (CV #149 has no effect)<br>1 = P-Value is fixed as per CV #56 (tens digit)<br>--- CV #150 Load compensation at top speed ---<br>Load compensation at top speed is normally always 0. This can be changed with CV #150.<br>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).<br>**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 at 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<br>= 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) after power to the motor is cut but the target speed is not reached (not slowing down).<br>The higher the value, the faster and harder the brake is being applied. |

## 3.7 Acceleration and Deceleration:

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

*CV's #3 and #4*

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

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

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

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

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

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #3 | Acceleration rate | 0 - 255 | (2) | The value multiplied by 0.9 equals' acceleration time in seconds from stop to full speed.<br>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.<br>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.<br>Bit 0 - 6: entered value increases or decreases acceleration time in CV #3.<br>Bit 7 = 0: adds above value to CV #3.<br>= 1: subtracts above value from CV #3. |
| #24 | Deceleration trimming | 0 - 255 | 0 | To temporarily adapt the acceleration rate to a new load or when used in a consist.<br>Bit 0 - 6: entered value increases or decreases acceleration time in CV #3.<br>Bit 7 = 0: adds above value to CV #3.<br>= 1: subtracts above value from CV #3. |
| #121 | Exponential acceleration | 0 - 99 | 0 | Acceleration time (momentum) can be stretched in the lower speed range:<br>Tens digit: Percentage of speed range to be included (0 to 90%).<br>Ones digit: Exponential curve (0 to 9).<br>EXAMPLE:<br>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:<br>Tens digit: Percentage of speed range to be included (0 to 90%).<br>Ones digit: Exponential curve (0 to 9).<br>EXAMPLE:<br>CV #122 = 11, 23 or 25 are typical initial test values. |
| #123 | Adaptive acceleration and deceleration | 0 - 99 | 0 | Raising or lowering the speed to the next internal step occurs only if the preceding step is nearly reached. The tolerance for reaching the preceding step can be defined by this CV (the smaller this value the smoother the acceleration/deceleration).<br>Value 0 = no adaptive accel. or decel.<br>Tens digit: 0 - 9 for acceleration<br>Ones digit: 0 - 9 for deceleration<br>EXAMPLE:<br>CV #123 = 11: strongest effect; sometimes affects the start up too much.<br>CV #123 = 22: typical setting. |
| #146 | Compensation for gear backlash during direction changes in order to reduce start-up jolt. | 0 - 255 | 0 | = 0: no effect<br>= 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.<br>How much time is required to overcome the backlash depends on various circumstances and can only be determined by trial and error.<br>Typical values are:<br>= 100: the motor turns about 1 revolution or a maximum of 1 second at the minimum speed.<br>= 50: about ½ a turn or max. ½ second.<br>= 200: about 2 turns or max. 2 seconds.<br>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 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.*

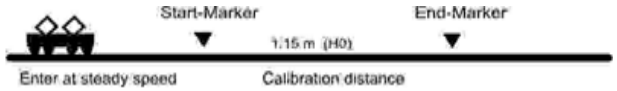
## 3.8 *Special Operating Mode "km/h – speed regulation"*

The km/h 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.




→ Set the engine on the track, with the proper travel direction selected, about 1 to 2 meters before the start marker and the function F0 (headlights) **turned off.** Acceleration times (in CV #3 of the decoder as well as settings in the cab) should be set to 0 or a very small value.

→ 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.

→ Move the speed regulator to a **medium speed** position (1/3 to ½ of full speed); the loco accelerates towards the start marker

→ 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.

→ 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** defines whether the "normal" or km/h operating mode is in use:

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 in speed limits through the "signal controlled speed influence" (CV's 51 – 55). The values entered to those CV's are also being interpreted in km/h.

| *CV* | *Designation* | *Range* | *Default* | *Description* |
|---|---|---|---|---|
| #135 | Km/h – Speed regulation - Activating, control and range definition | 2 - 20 | 0 | = 0: km/h – Regulation turned off; the "normal" speed regulation is in effect.<br>Start with Pseudo-Programming („Pseudo" = programmed value is not being stored):<br>CV #135 = 1 → Initiates a calibration run (see above)<br>Continue with "normal" programming of CV #135 (programmed value will be stored):<br>= 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…<br>= 20: each step represents 2 km/h; step 1 = 2 km/h, step 2 = 4 km/h, last step 126 = 253 km/h.<br>= 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 Setting of speed confirmation | CALIBRATION RUN or RailCom display factor | Read only 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.<br>or<br>correction factor for speed confirmation via RailCom or other method of bidirectional communication. |

### *Mph instead of km/h:*

Extending the calibration distance accordingly results in a mph speed regulation!

## 3.9 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.

* The speed limits "U"(Ultra low) and "L" (Low speed) as well as the intermediate limits of the "signal controlled speed influence" can be defined with configuration variables #51 to #55 as well as the 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.

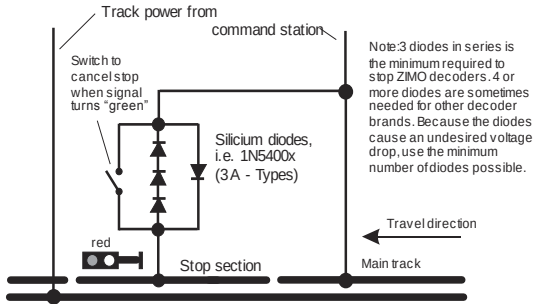
It is of utmost importance for a flawlessly working train control system using the signal controlled speed influence that the stop and related brake section lengths are arranged properly and consistently everywhere on the layout. Please consult the MX9 instruction manual.

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 HO is typically about 15 to 20 cm before the end of a stop section. Setting the loco up to stop precisely within the last centimeter of a stop section is not recommended.

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #49 | Signal controlled (HLU) acceleration | 0 - 255 | 0 | ZIMO signal controlled speed influence (HLU) with ZIMO MX9 track section module or future module<br>or<br>when using the "asymmetrical DCC signal" stopping method (Lenz ABC).<br>The content of this CV, multiplied by 0.4, equals the time in seconds for the acceleration event from standstill to full speed. |
| #50 | Signal controlled (HLU) deceleration | 0 - 255 | 0 | ZIMO signal controlled speed influence (HLU) with ZIMO MX9 track section module or future module<br>or<br>when using the "asymmetrical DCC signal" stopping method (Lenz ABC).<br>The content of this CV, multiplied by 0.4, equals the time in seconds for the deceleration event (braking) from full speed to standstill. |
| #51<br>#52<br>#53<br>#54<br>#55 | Signal controlled (HLU) speed limits<br>#52 for "U",<br>#54 for "L",<br>#51, 53, 55<br>for intermediate steps | 0 - 255 | 20<br>40 (U)<br>70<br>110 (L)<br>180 | ZIMO signal controlled speed influence (HLU) with ZIMO MX9 track section module or future module:<br>Each of the 5 speed limits (CV's #51 – 55) that can be applied with the ZIMO "signal controlled speed influence" can be defined with an internal speed step. |
| #59 | Signal controlled (HLU) delay | 0 - 255 | 5 | ZIMO signal controlled speed influence (HLU) with ZIMO MX9 track section module or future module<br>or<br>when using the "asymmetrical DCC signal" stopping method (Lenz ABC):<br>Time in tenth of a second until the locomotive starts to accelerate after receiving a higher signal controlled speed limit command. |

## 3.10 "Asymmetrical DCC-Signal" stops (Lenz ABC)

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




3 diodes in series (at least 4 when using Schottky diodes) and one parallel in the opposite direction is the usual arrangement.
The different voltage drops across the diodes results in an asymmetry of about 1 to 2V. The direction in which the diodes are mounted determines the polarity of the asymmetry and with it the driving direction a signal stop is initiated.

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

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #27 | Direction dependent stops<br>with asymmetrical DCC signal<br>(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).<br>Bit 1 = 1: Stops are initiated if voltage in left rail is higher than right rail (in direction of travel).<br>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! |

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| | | | | Bit 0 and Bit 1 = 1 (CV #27 = 3): Stops in both directions, regardless of rail polarity. |
| #134 | Asymmetrical threshold for stopping with asymmetrical DCC signal (Lenz ABC method). | 1 - 14,<br>101 - 114,<br>201 - 214<br><br>=<br>0,1 - 1,4 V | 106 | Hundreds digit: Sensitivity adjustment, changes the speed with which the asymmetry is being recognized.<br>= 0: fast recognition (but higher risk of errors, i.e. unreliable stopping).<br>= 1: normal recognition (@ 0.5 sec.), pretty save results (default).<br>= 2: slow recognition (@ 1 sec.), very reliable.<br>Tens and ones digit: Asymmetrical threshold in tenths of a volt. The voltage difference between the two half waves of the DCC signal defined here is the minimum required to be recognized as asymmetrical that starts the intended effect (usually braking and stopping of a train).<br>= 106 (Default) therefore means normal recognition at 0.6 V asymmetry. This value has proven itself to be appropriate under normal conditions; by using 4 diodes to generate the asymmetry. |
| #142 | High-speed correction for the ABC asymmetrical stop method | 0 - 255 | 12 | The recognition delay (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.<br>= 12: Default. This setting usually works fine if CV #134 is also set to default. |

## 3.11 DC brake sections a.k.a. “Märklin brake mode”

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

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

## 3.12 Distance controlled stopping – Constant stopping distance

After the type of constant stopping 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 with the help of the **signal controlled speed influence (ZIMO-HLU)** or the **asymmetrical DCC-signal (Lenz-ABC).** CV #140 is set for this purpose to 1 or 11.

Although of lesser practical value, the distance controlled stopping can also be activated **manually** by setting the speed on cab to 0 (with appropriate values in CV #140).

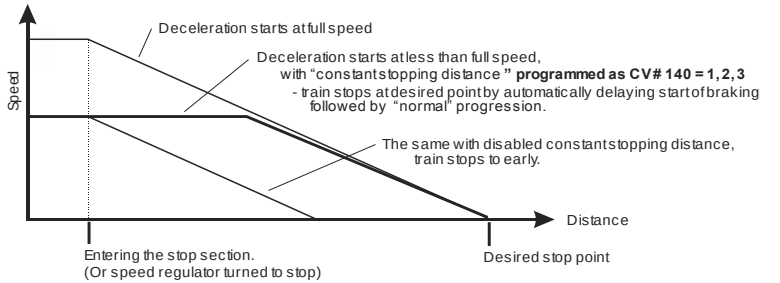
| | | | | |
|---|---|---|---|---|
| #140 | Distance controlled stopping (constant stopping distance)<br><br>Select a braking method and braking process | 0 - 255 | 0 | Activates distance controlled stopping as per CV #141 instead of time-constant braking according to CV #4.<br>= 1: automatic stops with ZIMO HLU (signal controlled speed influence) or ABC (asymmetrical DCC signal).<br>= 2: manual stops using the cab.<br>= 3: automatic and manual stops.<br>The start of braking is delayed in all cases above (= 1, 2, 3) when the train travels at less than full speed, to prevent an unnecessary long “creeping” (recommended).<br>On the other hand:<br>= 11, 12, 13 same meaning as above, but braking always starts immediately after entering the brake section. |
| #141 | Distance controlled stopping (constant stopping distance)<br><br>Distance calculation | 0 - 255 | 0 | This CV defines the “constant stopping distance”. The right value for the existing stop sections has to be determined by trial.<br>Use these figures as a starting point:<br>CV #141 = 255 is about 500m (500 yards) for a real train or 6m (18 ft) in HO.<br>CV #141=50 about 100 m (100 yards) for a real train or 1.2m in H0 (4 ft.). |
| #142 | Distance controlled stopping (constant stopping distance)<br><br>High-speed correction using the ABC method | 0 - 255 | 12 | The delayed recognition (see CV #134), but also unreliable electrical contact between rails and wheels affects stop point accuracy more so at higher speeds than at lower speeds. This effect is corrected with CV #142.<br>= 12: Default. This setting usually works fine if CV #134 is also set to default. |
| #143 | … compensation using the HLU method | 0 - 255 | 0 | The HLU method is more reliable than the ABC method; no recognition delay is usually required in CV #134; this CV can remain at default value 0. |

The distance controlled stopping can take place in two possible ways; see diagram below: **The first** is the **recommended method (CV #140 = 1, etc.),** where the train entering at less than full speed

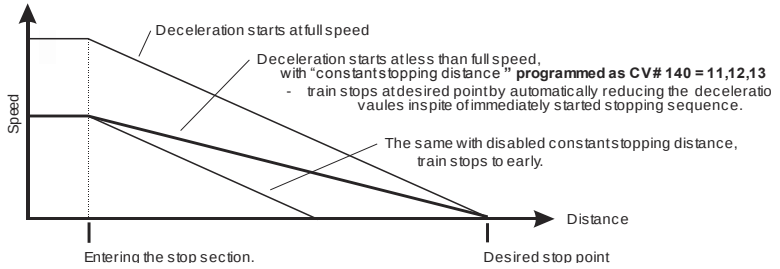
continues at the same speed for some time before it starts braking at a “normal” deceleration rate (same rate as would be applied at full speed).

In the second method (CV #140 = 11, etc.), 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 constant stopping distance method*




*Second constant stopping distance method*

☞ “Distance controlled stopping“, when activated, is **exclusively** applied **to decelerations leading to a full stop** but not in 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.

## 3.13 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.

With the help of CV #124, a shunting key can be defined (either the dedicated MAN key – only on ZIMO cabs - or the F4 or F3 key) with which the acceleration and deceleration rates may be reduced or eliminated altogether; furthermore, it is sometimes helpful to limit the throttle to half the speed range when maneuvering.

The key assignments for these shunting functions are, due to historical reasons, summarized in *CV #124,* which has its limitations and is also relatively confusing.

**From today’s perspective,** CV's #155, #156 and #157 are the preferred CV’s for these settings, where function keys can be selected in a systematic and unlimited manner for each of the shunting and MAN functions. CV #124 is still relevant though for the type of momentum deactivation.

| | | | | |
|---|---|---|---|---|
| #124 | Shunting key functions:<br><br>Low gear (half speed)<br>and<br>Momentum reduction or deactivation<br>NOTE:<br>Extended shunting key selection in CV’s #155, 156<br><br>**Bit 5**<br>DC stopping<br><br>**Bit 7**<br>Changing SUSI pins to logic level outputs | Bits 0 - 4, 6 | 0 | Select a function key for LOW GEAR ACTIVATION:<br>Bit 4 = 1 (and Bit 3 = 0): F3 as half-speed key<br>Bit 3 = 1 (and Bit 4 = 0): F7 as half-speed key<br>Select a function key for MOMENTUM DEACTIVATION:<br>Bit 2 = 0 (and Bit 6 = 0): “MN” key for deactivation,<br>Bit 2 = 1 (and Bit 6 = 0): F4 key for deactivation<br>Bit 6 = 1 (Bit 2 is irrelevant): F3 for deactivation.<br>Effect of above key (MN, F3 or F4) on MOMENTUM:<br>Bit 1, 0 = 00: no effect on momentum<br>= 01: removes momentum of CV #121 + #122<br>= 10: CV #3 + #4 reduced to ¼.<br>= 11: removes all momentum above.<br>**Bit 5 = 1:** “DC stopping”, see CV #29<br>**Bit 7 = 0:** SUSI active instead of normal functions<br>**= 1:** Normal function outputs instead of SUSI<br>EXAMPLES:<br>F3 for half speed-key: CV #124 = 16.<br>F3 for half speed-key and F4 to remove momentum completely: Bits 0, 1, 2 & 4 = 1; that is CV #124 =23.<br>F3 for half-speed key and removing momentum: Bits 0, 1, 4 &6 = 1; that is CV #124 = 83.<br>**Bit 5 = 1:** ”DC stopping“<br>**Bit 7 = 0**: SUSI-interface active<br>**= 1**: FU-outputs active instead of SUSI. |
| #155 | Selecting a function key as half-speed key | 0 - 19 | 0 | Expanding on the settings of CV #124, if another key is required than F3 or F7:<br>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.<br>CV #155 = 0 doesn't mean that the F0 key is assigned but rather that the setting in CV #124 is active. |
| #156 | Selecting a function key for deactivating momentum | 0 - 19 | 0 | Expanding on the settings of CV #124, if another key than F3, F4 or MAN is required for momentum deactivation:<br>CV #156: Defines the function key that deactivates or reduces the acceleration and deceleration times in CV's #3, 4, 121 and 122.<br>Whether the momentum is deactivated or reduced and by how much is still defined in CV #124, not CV #156:<br>CV #124, Bit 1, 0:<br>= 00: no effect on momentum<br>= 01: removes momentum of CV #121 + #122<br>= 10: CV #3 + #4 reduced to ¼.<br>= 11: removes all momentum.<br>In order to deactivate all momentum, CV #124 is typically set to a value 3 (the value may be different if other Bits in CV #124 are also set).<br>Assigning a key for momentum deactivation in CV #124 remains inactive if CV #156 > 0. |
| #157 | Selecting a function key for the MAN function<br>Only for non-ZIMO systems that don't have the MN key. | 0 - 19 | 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).<br>This function was expanded in later software versions to include "asymmetrical DCC signal stops" (Lenz ABC).<br>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. |

## 3.14 The NMRA-DCC function mapping

ZIMO decoders have between 4 and 12 function outputs (FO). Items connected to these outputs (lights, smoke generator etc.) are switched ON and OFF with the function keys of the cab. Which function key controls which function output can be defined with the NMRA's function mapping

*CV's #33 to #46.*

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

| NMRA Function | CV | Number key on ZIMO cabs | Function outputs | | | | | | Function outputs | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FA12 | FA11 | FA10 | FA9 | FA8 | FA7 | FA6 | FA5 | FA4 | FA3 | FA2 | FA1 | Rear light | Front light |
| F0 | #33 | *1 (L) fw* | | | | | | | *7* | *6* | *5* | *4* | *3* | *2* | *1* | *0*● |
| F0 | #34 | *1 (L) re* | | | | | | | *7* | *6* | *5* | *4* | *3* | *2* | *1*● | *0* |
| F1 | #35 | *2* | | | | | | | *7* | *6* | *5* | *4* | *3* | *2*● | *1* | *0* |
| F2 | #36 | *3* | | | | | | | *7* | *6* | *5* | *4* | *3*● | *2* | *1* | *0* |
| F3 | #37 | *4* | | | | *7* | *6* | *5* | *4* | *3* | *2* | *1*● | *0* | | | |
| F4 | #38 | *5* | | | | *7* | *6* | *5* | *4* | *3* | ● | *1* | *0* | | | |
| F5 | #39 | *6* | | | | *7* | *6* | *5* | *4* | *3*● | *2* | *1* | *0* | | | |
| F6 | #40 | *7* | | | | *7* | *6* | *5* | *4*● | *3* | *2* | *1* | *0* | | | |
| F7 | #41 | *8* | *7* | *6* | *5* | *4* | *3* | *2*● | *1* | *0* | | | | | | |
| F8 | #42 | *(L-) 9* | *7* | *6* | *5* | *4* | *3*● | *2* | *1* | *0* | | | | | | |
| F9 | #43 | *L- 1* | *7* | *6* | *5* | *4*● | *3* | *2* | *1* | *0* | | | | | | |
| F10 | #44 | *L- 2* | *7* | *6* | *5*● | *4* | *3* | *2* | *1* | *0* | | | | | | |
| F11 | #45 | *L- 3* | *7* | *6*● | *5* | *4* | *3* | *2* | *1* | *0* | | | | | | |
| F12 | #46 | *L- 4* | *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 these CV's by default:

CV #33 = 1
CV #34 = 2
CV #35 = 4
CV #36 = 8
CV #37 = 2
CV #38 = 4
CV #39 = 8
CV #40 = 16
and so on..

EXAMPLE of a function mapping modification: The output #4 (FO4) should be switched in addition to output #2 (FO2) with the F2 key (ZIMO #3 key). Outputs #7 (FO7) and #8 (FO8) should be switched (not additionally but instead) with the F3 and F4 keys.

The new values to be entered are as follows:

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

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

## 3.15 The extended ZIMO function mapping

Since the original NMRA function mapping does not allow for some desired 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.

The following programming

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

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

| | | | FO6 | FO5 | FO4 | FO3 | FO2 | FO1 | Headlight rear | Headlight front |
|---|---|---|---|---|---|---|---|---|---|---|
| F0 | *1 (L) fro.* | #33 | *7* | *6* | *5* | *4* | *3* | *2* | *1* | *0* ● |
| F0 | *1 (L) re.* | #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* |

**CV #61 = 1 or 2**

| NMRA Function | CV | Numerical keys of ZIMO cabs | Function outputs | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FO12 | FO11 | FO10 | FO9 | FO8 | FO7 | FO6 | FO5 | FO4 | FO3 | FO2 | FO1 | Rear light | Front light |
| F0 | #33 | 1 (L) forward | | | | | | | *7* | *6* | *5* | *4* | *3* | *2* | *1* | *0* ● |
| F0 | #34 | 1 (L) reverse | | | | | | | *7* | *6* | *5* | *4* | *3* | *2* | *1* ● | *0* |
| F1 | #35 | 2 | | | | | | | *7* | *6* | *5* | *4* | *3* | *2* | *1* | *0* |
| F2 | #36 | 3 | | | | | | | *7* | *6* | *5* | *4* | *3* ● | *2* | *1* | *0* |
| F3 | | 4 | | | | | | | | | | ● | | | | |
| F4 | #38 | 5 | | | | *7* | *6* | *5* | *4* | *3* | *2* ● | *1* | *0* | | | |
| F5 | | 6 | | | | | | | | | | | | | | |
| F6 | | 7 | | | | | | | | | | | | | | |
| F7 | | 8 | | | | | | | | | | | | | | |
| F8 | #42 | Shift – 9 | *7* | *6* | *5* | *4* | *3* ● | *2* | *1* | *0* | | | | | | |
| F9 | #43 | Shift – 1 | *7* | *6* | *5* | *4* ● | *3* | *2* | *1* | *0* | | | | | | |
| F10 | #44 | Shift – 2 | *7* | *6* | *5* ● | *4* | *3* | *2* | *1* | *0* | | | | | | |
| F11 | #45 | Shift – 3 | *7* | *6* ● | *5* | *4* | *3* | *2* | *1* | *0* | | | | | | |
| F12 | #46 | Shift – 4 | *7* ● | *6* | *5* | *4* | *3* | *2* | *1* | *0* | | | | | | |
| Directions Bit | | | | | | | | | | | | | | ● | | |

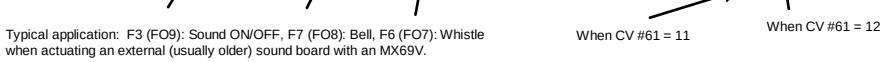
Typical application: F3 (FO9): Sound ON/OFF, F5 (FO8): Bell, F2 (FO7): Whistle when actuating an external (usually older) sound board.

When CV #61 = 1

When CV #61 = 2

### CV #61 = 11 or 12

| NMRA Function | CV | Numerical keys of ZIMO cabs | Additional function outputs of MX69V and MX690V (connector #2) | | | | | | Function outputs of all MX69 / MX690 (connector #1) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FO12 | FO11 | FO10 | FO9 | FO8 | FO7 | FO6 | FO5 | FO4 | FO3 | FO2 | FO1 | Rear light | Front light |
| F0 | #33 | 1 (L) forward | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0● |
| F0 | #34 | 1 (L) reverse | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1● | 0 |
| F1 | #35 | 2 | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| F2 | #36 | 3 | | | | | | | 7 | 6 | 5 | 4 | 3● | 2 | 1 | 0 |
| F3 | | 4 | | | | | | | | | | | | | | |
| F4 | #38 | 5 | | | | 7 | 6 | 5 | 4 | 3 | 2● | 1 | 0 | | | |
| F5 | | 6 | | | | | | | | | | | | | | |
| F6 | | 7 | | | | | | | | | | | | | | |
| F7 | | 8 | | | | | | | | | | | | | | |
| F8 | #42 | Shift – 9 | 7 | 6 | 5 | 4 | 3● | 2 | 1 | 0 | | | | | | |
| F9 | #43 | Shift – 1 | 7 | 6 | 5 | 4● | 3 | 2 | 1 | 0 | | | | | | |
| F10 | #44 | Shift – 2 | 7 | 6 | 5● | 4 | 3 | 2 | 1 | 0 | | | | | | |
| F11 | #45 | Shift – 3 | 7 | 6● | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | |
| F12 | #46 | Shift – 4 | 7● | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | |
| Directions Bit | | | | | | | | | | | | | | | | |

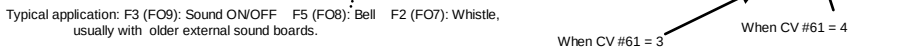



Typical application: F3 (FO9): Sound ON/OFF, F7 (FO8): Bell, F6 (FO7): Whistle when actuating an external (usually older) sound board with an MX69V.

CV #61 = 1, 2, 11, 12 is similar to the normal NMRA function mapping, but
…Output **FO1** can be actuated (when CV #61 = 1 or 11) by the directions Bit (when changing direction) or with F7 (when CV #61 = 2 or 12).
…Mapping function keys F2, F3 and F5 (when CV #61 = 1 or 2) or F6, F3 and F7 (when CV #61 = 11 or 12) with the function outputs FO7, FO9 and FO8, which corresponds to the usual hook-up (for ON/OFF, whistle and bell inputs) of older external sound modules.

### CV #61 = 3 or 4

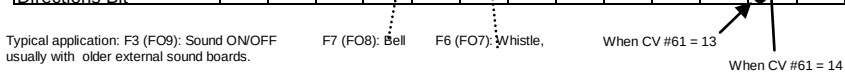
| | | | FO12 | FO11 | FO10 | FO9 | FO8 | FO7 | FO6 | FO5 | FO4 | FO3 | FO2 | FO1 | rear | front |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F0 | #33 | | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0● |
| F0 | #34 | | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1● | 0 |
| F1 | #35 | | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| F2 | #36 | | | | | | | ● | 7 | 6 | 5 | 4 | 3● | 2 | 1 | 0 |
| F3 fr | | | | | | ● | | | | | | ● | | | | |
| F3 re | | | | | | ● | | | ● | | | | | | | |
| F4 | #38 | | | | | 7 | 6 | 5 | 4 | 3 | 2● | 1 | 0 | | | |
| F5 | | | | | | | ● | | | | | | | | | |
| F6 | | | | | | | | | | | | | | | | |
| F7 | | | | | | | | | | | | | | ● | | |
| F8 | #42 | | 7 | 6 | 5 | 4 | 3● | 2 | 1 | 0 | | | | | | |
| F9 | #43 | | 7 | 6 | 5 | 4● | 3 | 2 | 1 | 0 | | | | | | |
| F10 | #44 | | 7 | 6 | 5● | 4 | 3 | 2 | 1 | 0 | | | | | | |
| F11 | #45 | | 7 | 6● | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | |
| F12 | #46 | | 7● | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | |
| Directions-Bit | | | | | | | | | | | | | | ● | | |




Typical application: F3 (FO9): Sound ON/OFF F5 (FO8): Bell F2 (FO7): Whistle, usually with older external sound boards.

### CV #61 = 13 or 14

| | | | FO12 | FO11 | FO10 | FO9 | FO8 | FO7 | FO6 | FO5 | FO4 | FO3 | FO2 | FO1 | rear | front |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F0 | #33 | | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0● |
| F0 | #34 | | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1● | 0 |
| F1 | #35 | | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| F2 | #36 | | | | | | | | 7 | 6 | 5 | 4 | 3● | 2 | 1 | 0 |
| F3 fr | | | | | | ● | | | | | | ● | | | | |
| F3 re | | | | | | ● | | | ● | | | | | | | |
| F4 | #38 | | | | | 7 | 6 | 5 | 4 | 3 | 2● | 1 | 0 | | | |
| F5 | | | | | | | | | | | | | | | | |
| F6 | | | | | | | | ● | | | | | | ● | | |
| F7 | | | | | | | ● | | | | | | | | | |
| F8 | #42 | | 7 | 6 | 5 | 4 | 3● | 2 | 1 | 0 | | | | | | |
| F9 | #43 | | 7 | 6 | 5 | 4● | 3 | 2 | 1 | 0 | | | | | | |
| F10 | #44 | | 7 | 6 | 5● | 4 | 3 | 2 | 1 | 0 | | | | | | |
| F11 | #45 | | 7 | 6● | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | |
| F12 | #46 | | 7● | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | |
| Directions Bit | | | | | | | | | | | | | | ● | | |




Typical application: F3 (FO9): Sound ON/OFF usually with older external sound boards.

**CV #61 = 13 or 14** are for the most part identical to the allocations on the previous page (CV #61 = 11 or 12), but with a **direction dependent function F3,** which actuates outputs FO3 or FO6 according to driving direction (typical applications are red taillights).

**CV #61 = 5 or CV #61 = 15**

| NMRA Function | CV | Numerical keys of ZIMO cabs | Function outputs | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FO12 | FO11 | FO10 | FO9 | FO8 | FO7 | FO6 | FO5 | FO4 | FO3 | FO2 | FO1 | Rear light | Front light |
| F0 | #33 | 1 (L) forward | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0● |
| F0 | #34 | 1 (L) reverse | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1● | 0 |
| F1 | #35 | 2 | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| F2 | #36 | 3 | | | | | | ● | 7 | 6 | 5 | 4 | 3● | 2 | 1 | 0 |
| F3 | | 4 forw. | | | | ● | | | | | | ● | | | | |
| F3 | | 4 rev. | | | | ● | | | ● | | | | | | | |
| F4 | | 5 forw. | | | | | | | | | ● | | | | | |
| F4 | | 5 rev. | | | | | | | | | | | | ● | | |
| F5 | | 6 | | | | | ● | | | ● | | | | | | |
| F6 | | 7 | | | | | | ● | | | | | | | | |
| F7 | | 8 | | | | | ● | | | | | | | | | |
| F8 | #42 | Shift – 9 | 7 | 6 | 5 | 4 | 3● | 2 | 1 | 0 | | | | | | |
| F9 | #43 | Shift – 1 | 7 | 6 | 5 | 4● | 3 | 2 | 1 | 0 | | | | | | |
| F10 | #44 | Shift – 2 | 7 | 6 | 5● | 4 | 3 | 2 | 1 | 0 | | | | | | |
| F11 | #45 | Shift – 3 | 7 | 6● | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | |
| F12 | #46 | Shift – 4 | 7● | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | |
| Directions Bit | | | | | | | | | | | | | | | | |

CV # 61 = 15 CV # 61 = 5

**CV #61 = 5 or 15:** For electric and diesel locos where **headlights and taillights as well as cab lights** are to be actuated by one function key each (F3 and F4) and **dependent on direction.** Also included in this assignment are the functions F2 and F5 (if CV #61 = 5) or F6 and F7 (if CV #61 = 15) on outputs FO7 and FO8 (preferably for whistle / bell of older external sound boards). These allocations were retained from the MX69 predecessors MX65 and MX66.

**CV #61 = 6** for **Swiss electric and diesel engines;** F3 either actuates a single white or two red lights as taillights.

Function outputs FO1 and FO4 are switched separately with F4 and direction.

**CV #61 = 6**

| NMRA Function | CV | Numerical keys of ZIMO cabs | Function outputs | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FO12 | FO11 | FO10 | FO9 | FO8 | FO7 | FO6 | FO5 | FO4 | FO3 | FO2 | FO1 | Rear light | Front light |
| F0 | #33 | 1 (L) forward | | | | | | | | | | | ● | | | ● |
| F0 | #34 | 1 (L) reverse | | | | | | | | ● | | | | | ● | |
| F0 forward if F3 off | | | | | | | | | | ● | | | | | | |
| F0 reverse if F3 off | | | | | | | | | | | | | ● | | | |
| F1 | #35 | 2 | | | | | | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| F2 | #36 | 3 | | | | | | | 7 | 6 | 5 | 4 | 3● | 2 | 1 | 0 |
| F3 | | 4 forw. | | | | ● | | | | | | ● | | | | |
| F3 | | 4 rev. | | | | ● | | | ● | | | | | | | |
| F4 | | 5 forw. | | | | | | | | | ● | | | | | |
| F4 | | 5 rev. | | | | | | | | | | | | | | |
| F5 | | 6 | | | | | | | | ● | | | | | | |
| F6 | | 7 | | | | | | ● | | | | | | | | |
| F7 | | 8 | | | | | ● | | | | | | | | | |
| F8 | #42 | Shift – 9 | 7 | 6 | 5 | 4 | 3● | 2 | 1 | 0 | | | | | | |
| F9 | #43 | Shift – 1 | 7 | 6 | 5 | 4● | 3 | 2 | 1 | 0 | | | | | | |
| F10 | #44 | Shift – 2 | 7 | 6 | 5● | 4 | 3 | 2 | 1 | 0 | | | | | | |
| F11 | #45 | Shift – 3 | 7 | 6● | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | |
| F12 | #46 | Shift – 4 | 7● | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | |
| Directions Bit | | | | | | | | | | | | | | ● | | |

## *The function mapping procedure with CV #61 = 98:*

This procedure offers much more freedom in mapping function outputs to function keys on the cab than is possible by setting configuration variables. To carry out this procedure though requires a bit more time and attention from the user.

**Preparation:** The loco must be on the main track (not on the programming track); the whole procedure is performed with operations mode programming. Set the loco direction to "forward" and turn all functions off.

→ **CV #61 = 98** Writing value "98" to CV #61 (in operations mode) starts the actual allocation procedure.

The decoder is now in a special programming mode, which will not end until the whole programming procedure is completed or the loco is lifted from the track for a few seconds.

→The decoder is now ready to accept the first function output allocation, starting with function output **F0 in forward direction.**

The function outputs to be assigned to F0 in forward direction are now actuated with the corresponding function keys (i.e. F0f, F0r, F1…F12). Any number of outputs can be included. Because only one F0 function key is available for F0f and F0r (headlights), it is necessary to press F0 repeatedly to select the desired configuration (which alternately actuates the front and rear headlights).
The assignment must be confirmed by pressing the **direction key.**

→The decoder is now ready to accept the next output assignment for **F0 but now for "reverse".** Continue as above! Again, once a selection is made press the **direction's key** to apply.

→**Continue in the same fashion for all function keys** (28 function-direction-combinations)**!**

→After the last function key (F12 "reverse") has been assigned, the function outputs F0f and F0r (both headlights) are turned on to indicate the end of this programming procedure.

→The finished allocations are **automatically activated** and CV #61 is set to "99" at the same time**.**

**Deactivation:**

CV #61 = 0 ... 97 (any value except 98 and 99) deactivates the function assignment and again activates the NMRA function mapping according to CV #33 to #46 or one of the CV #61 mappings, if a value between 1and 7 is entered. The assignment defined during this procedure though remains stored in the decoder.

**Reactivating already stored data:**

CV #61 = 99 reactivates the defined output allocations.

***NOTES:***

*The special effects (US-lighting, uncoupler, soft-start etc.) can also be assigned using above procedure. CV's #125, 126 etc. always refer to actual outputs!*

*It is possible to store and selectively reactivate several function output allocations with the help of the "CV-set" feature!*

Here is an overview of the function key sequence that has to be adhered to during this programming procedure:

| | | | |
|---|---|---|---|
| 1. F0 Forward | 2. F0 Reverse | 3. F1 Forward | 4. F1 Reverse |
| 5. F2 Forward | 6. F2 Reverse | 7. F3 Forward | 8. F3 Reverse |
| 9. F4 Forward | 10. F4 Reverse | 11. F5 Forward | 12. F5 Reverse |
| 13. F6 Forward | 14. F6 Reverse | 15. F7 Forward | 16. F7 Reverse |
| 17. F8 Forward | 18. F8 Reverse | 19. F9 Forward | 20. F9 Reverse |
| 21. F10 Forward | 22. F10 Reverse | 23. F11 Forward | 24. F11 Reverse |
| 25. F12 Forward | 26. F12 Reverse | | |

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

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

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

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

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

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

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

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

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

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

Alternative method:
- Use the function assignment procedure with CV #61 = 98; see above!
- CV's #107, 108 for "Unilateral light suppression", see below!

## 3.16 "Unilateral Light Suppression"

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

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #107 | Light suppression (i.e. front headlights AND additionally defined function output) at cab side 1 (front) | 0 - 255 | 0 | The value of this CV is calculated as follows:<br>The number of a function output (FO1…FO28) **x** 32<br>**+** number of a function key (F1, F2…F28)<br>**=** Value of CV #107<br>Function Key: That key (F1…F28) which should turn off ALL lights on the cab side 1 (front side) AND<br>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. |

## 3.17 The ZIMO "Input Mapping"

The NMRA function mapping limitations (only one of 8 functions 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 the **internally mapped functions** and especially without changes to the sound projects:

*CV's #400 … 428*

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

## 3.18 Dimming, Low beam and Direction Bits

Some function outputs may sometimes not be operated with full track power, as is the case for example with 18V bulbs and the track voltage at 24V (quite common on large scale model railroads). Other times the brightness needs to be reduced simply because the light of the bulb is too bright.

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"), which is by the way fully stabilized and does not change with changes in track voltage.

Alternatively or in addition to this (the dimming effect is not limited to devices connected to full track power but also works with low voltage), the PWM (pulse with modulation) voltage reduction is also available with

*CV #60,*

which defines the PWM duty cycle. Of course, this kind of voltage reduction is also interesting because it is easy to change at any time.

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

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

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

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #60 | Reduced function output voltage (Dimming).<br>Affects all function outputs. | 0 - 255 | 0 | Reduction of function output voltage with PWM (pulse-with modulation). Useful for headlight dimming for example.<br>Example values:<br>CV #60 = 0 or 255: full voltage<br>CV #60 = 170: 2/3 of full voltage.<br>CV #60 = 204: 80% of full voltage. |
| #114 | Dim Mask 1<br>=<br>Excludes certain function outputs from dimming per CV #60.<br>For higher function outputs go to<br>CV #152. | Bits<br>0 - 7 | 0 | Enter function outputs that are **not** to be **dimmed** as per CV #60. These outputs will use the full voltage available from the decoder's positive pin.<br>Bit 0 - front headlight,<br>Bit 1 - rear headlight,<br>Bit 2 - function output FO1, Bit 3 - FO2,<br>Bit 4 - function output FO3, Bit 5 - FO4<br>Bit 6 - function output FO5, Bit 7 - FO6<br>Bit value = 0: Output will be dimmed to the value |

| | | | | |
|---|---|---|---|---|
| | | | | defined in CV #60.<br>Bit value = 1: Output will not be dimmed.<br>EXAMPLE:<br>CV #114 = 60: FO1, FO2, FO3 and FO4 will not be dimmed; front and rear headlights will be dimmed according to CV #60. |
| #152 | Excluding specific function outputs from dimming as per CV #60<br><br>This is a continuation of Dim Mask 1 in CV #114<br>and<br>FO3, FO4 as direction bit mapping | Bits 0 - 5<br><br>and<br><br>Bit 6, Bit 7 | 0<br><br>0 | … continuation of CV #114.<br>Bit 0 - function output FO7,<br>Bit 1 - function output FO8,<br>Bit 2 - function output FO9,<br>Bit 3 - function output FO10,<br>Bit 4 - function output FO11,<br>Bit 5 - function output FO12.<br>Bit 6 = 0: „normal“<br>= 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). |

## *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.
The selected function outputs can be dimmed with the function turned ON or OFF (inverted action with Bit 7)

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

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

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

CV #115

can be used for an alternative low voltage supply. The respective function outputs must be defined as "uncoupler output" in the corresponding

CV's #125…#132, #159 and #160
(see "Special effects for function outputs).

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

# 3.19 The Flasher Effect

Flashing is actually a lighting effect just like all the others that are summarized in the CV's starting with #125; but for historical reasons are listed in their own CV's #117 and #118.

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #117 | Flasher functions<br><br>Outputs are assigned in CV #118. | 0 - 99 | 0 | Duty cycle for flasher function:<br>Tens digit = ON time<br>Ones digit = OFF time<br>(0 = 100msec, 1 = 200msec…..9 = 1 sec)<br>Example:<br>CV #117 = 55: Flashes evenly at 1 a second interval. |
| #118 | Flashing mask<br>-<br>Defines which outputs operate as flashers according to programmed in CV #117 | Bits 0 - 7 | 0 | Selected function outputs will flash when turned ON.<br>Bit 0 - front headlights<br>Bit 1 - rear headlights<br>Bit 2 - function output FO1, Bit 3 - …FO2<br>Bit 4 - …FO3, Bit 5 - function output FO4.<br>Bit value = 0: No flasher<br>Bit value = 1: Output flashes when turned ON.<br>Bit 6 = 1: FO2 flashes inverse! |

| | | | | |
|---|---|---|---|---|
| | | | | Bit 7 = 1: FO4 flashes inverse!<br>(for alternate flashing, i.e. wig-wag)<br>EXAMPLE:<br>CV #118 = 12: FO1 and FO2 are defined as flashers.<br>CV #118 = 168: Alternate flashing of FO2 and FO4. |

## 3.20 F1-Pulse Chains (Only for old LGB products)

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

## 3.21 Special Effects for Function Outputs

*(US and other lighting effects, Smoke generator, Uncoupler etc.)*

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

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

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

The values for these special effect CV's contain the

actual *6-Bit special effects code* *and the* *2-Bit directions code*

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

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

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

*direction dependent function outputs.*

EXAMPLE: CV #127 = 1, CV #128 = 2, CV #35 = 12 (FO1, FO2 operate in both directions, ON/OFF with F1 key).

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #125[1] | **Special effects**<br>American lighting effects as well as others such as uncoupler, smoke generator and more<br>on<br>function output F0 (front headlight)<br>Effects can be further adjusted and modified with CV's #62 - 64<br>and<br>CV #115 (for uncoupler). | | 0 | Bits 1, 0 = 00: bidirectional (active in both directions)<br>= 01: only active in forward direction<br>= 10: only active in reverse direction<br>ATTENTION in case of CV #125 and #126: change CV's #33, 34.... if direction is wrong!<br>Bits 7, 6, 5, 4, 3, 2 = Effect-Code<br>EXAMPLES<br>You want : Program CV #125 to: Mars light<br>forward only - 00000101 = 5<br>Gyralite independent of direction - 00011100 = 28<br>Ditch type 1 left, only forward - 00100101 = 37<br>**Uncoupler - 00110000 = 48**<br>**Soft start of output - 00110100 = 52**<br>**Automatic stop light - 00111000 = 56**<br>Automatic cab light OFF - 00111100 = 60<br>Auto. smoke OFF after 5 min – 01000000 = 64<br>Auto. smoke OFF after 10 min – 01000100 = 68<br>Speed/load depen. smoke - 01001000 = 72<br>Speed/load depen. diesel smoke - 01010000 = 80 |
| #126 | Special effects | | 0 | |

[1] Note to ditch lights: Ditch lights are only active when headlights and function F2 (#3 on Zimo cab) are on, which is prototypical for North American railroads. The ditch lights will only be working if the applicable bits in CV #33 and 34 are on (the definition in CV #125 - 128 in itself is not enough but a necessary addition). Example: If ditch lights are defined for F1 and F2, the bits #2 and 3 in CV #33 and 34 have to be set accordingly (i.e. CV # 33 = 13 (00001101), CV #34 = 14 (00001110).

| | | | | |
|---|---|---|---|---|
| | for<br>rear headlight<br>(default F0 reverse) | | | See CV #125 for details. |
| #127 -<br>#132 | Special effects for<br>FO1, FO2, FO3,<br>FO4, FO5, FO6 | | 0 | See CV #125 for details<br>#127 → FO1 #128 → FO2<br>#129 → FO3 #130 → FO4<br>#131 → FO5 #132 → FO6 |
| #159,<br>#160 | Special effects for<br>FO7, FO8 | | 0 | See CV #125 for details<br>#159 → FO7 #160 → FO8 |
| #62 | Light effects<br>modifications | 0 - 9 | 0 | Change of minimum dimming value |
| #63 | Light effects<br>modifications<br>or<br>Stop light OFF delay | 0 - 99<br><br>0 - 255 | 51 | Tens digit: sets cycle time (0 - 9, default 5), or start-up time during soft start with 001101 (0 - 0,9s)<br>Ones digit: extends OFF time<br>For stop light OFF delay (001110xx in CV #125, 126 or 127): Time in tenths of a second the stop lights remain ON after the street car comes to a full stop (range: 0 – 25 sec.). |
| #64 | Light effects<br>modifications | 0 - 9 | 5 | Ditch light OFF time modification |
| #353 | Automatic<br>smoke generator<br>shut-down | 0 - 255<br>=<br>0 - 106 min | 0 | For special effect codes “010010xx” or “010100xx” (smoke generator): Overheat protection: turns OFF from ½ min – about 2 hours.<br>= 0: Won’t turn off automatically.<br>= 1 … 252: Switches off automatically after 25 seconds/unit.<br>Maximum time therefore is about 6300 sec. = 105 min. |

## 3.22 Configuration of Smoke Generators

### *Smoke generators without fan, example: Seuthe 18V generator:*

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…FO6** (but not to FO7 or FO8) and the selected output must be programmed with the associated effect CV (with CV #127 for FO1, CV #128 for FO2 etc.) for the desired effect; in this case for load dependent smoke of steam engines (effect code “72”) or load dependent smoke of diesels (effect code “80”).

The selected function output is further defined by CV #137, 138 and 139 (“Definition of smoke generator characteristic”). These CV’s must be programmed with appropriate values otherwise the smoke generator will not produce any smoke.

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

CV #137 = 70…90: little smoke at standstill.

CV #138 = 200: The smoke intensity is increased to about 80% of its maximum capacity beginning with speed step 1 (lowest speed step), which produces relative heavy smoke.

CV #139 = 255: The smoke generator is driven to its maximum, which results in thick smoke under heavy acceleration.

| *CV* | *Designation* | *Range* | *Default* | *Description* |
|---|---|---|---|---|
| | Definition of smoke generator characteristic, connected to FO 1 – 6.<br>(provided a “smoke” function is selected for the appropriate output in CV #127-132) | | | The values in CV #137 – 139 define a smoke characteristic for the function outputs (FO1, FO2, FO3, FO4, FO5 or FO6; referred to below as FOx), provided a “smoke function” for a diesel or steam engine (value 72 or 80) has been selected in the associated CV #127 – 132: |
| #137 | PWM at stand still | 0 - 255 | 0 | CV #137: PWM of FOx at standstill |
| #138 | PWM at steady speed | 0 - 255 | 0 | CV #138: PWM of FOx at cruising speed |
| #139 | PWM during acceleration | 0 - 255 | 0 | CV #139: PWM of FOx at acceleration<br>(PWM = Pulse With Modulation) |

### *Synchronized steam chuffs or typical diesel smoke with fan-controlled smoke generators:*

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

The heating element of the smoke generator is connected – as in the example above with the “Seuthe” generator – on **FO1**…**FO6** 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 function output **FO4** (MX620-MX632 and MX646 on **FO2**); see chapter “Installation and wiring”).

The following CV’s must also be programmed:

CV #137, #138, #139 = 60, 90, 120 respectively: (IMPORTANT) if the heating element is not designed to operate at full track voltage (i.e. USA train smoke generator operates on 9V), the voltage at the function output must be limited, which is done with suitable values in CV #137, 138 and 139.

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; defines the fan speed (voltage) for start-up (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).

## 3.23 Configuration of Electric Uncouplers

*"System KROIS" and "System ROCO"*

When one or two of the function outputs **FO1…FO8** are assigned to the uncoupler function (CV #127 for FO1 etc.), the control of the couplers as well as the entire uncoupling process is defined by the settings in

*CV #115 and CV #116.*

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

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

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #115 | Uncoupler control<br>"Pull-in" time and "hold" voltage or use CV # 115 for an alternative second dim value<br>(dimming 0-90% using ones digit; tens digit must be 0) | 0 - 99 | 0 | Uncoupler function is only active if "uncoupler" is selected (value 48) in one of the CV's #125…132:<br>Tens digit (0 – 9): Time in seconds the coupler receives full voltage (pull-in time):<br>Value: 0 1 2 3 4 5 6 7 8 9<br>**seconds: 0 0,1 0,2 0,4 0,8 1 2 3 4** 5<br>Ones digit (0 to 9): hold-in power in percent of track voltage, 0 - 90%. Applied after the pull-in time elapsed (necessary for ROCO coupler, not needed for KROIS coupler). |
| #116 | Automatic disengagement during uncoupling | 0 - 99,<br>0 - 199 | 0 | Tens digit (0 – 9): Length of time the loco should move away (disengage) from train; values as in CV #115.<br>Ones digit (0 – 9) x 4 = Internal speed step applied for disengagement (Momentum per CV #3 etc.)<br>Hundredths digit = 0: No unloading.<br>= 1: Coupler unloading: engine moves toward train in order to relieve coupler tension, before uncoupling and disengaging from train.<br>Example:<br>CV #116 = 61: Loco uncouples and drives away from train for 2 seconds at speed step 4.<br>CV #116 = 155: Loco pushes first against train to unload couplers, uncouples and then drives away from train for 1 second at speed step 20. |

### *Notes to automated uncoupling with coupler unloading and train disengagement*

- 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 immediately aborted 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.

## 3.24 SUSI-Interface and Logic-Level Outputs

All decoders described in this manual (except for the MX621) have outputs that can either be used as a SUSI interface, as logic level outputs or for servo control. These outputs are available at solder pads or on the decoder plug (MTC or PluX), see the various decoder pin outs starting on page 5.

These outputs are active as SUSI interface by default. They can be switched for the alternative applications with CV #124 (Bit 7) or CV's #181 and #182 (see next chapter "Servo configuration.

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #124 | Shunting key functions:<br>Changing SUSI outputs | Bits 0 - 4, 6 | 0 | Bits 0 - 4, 6: Shunting key selection and HALF-SPEED ACTIVATON<br>**Bit 5 = 1:** " DC stopping"<br>Bit 7 = 0: SUSI active instead of normal functions<br>= 1: Normal function outputs instead of SUSI |

## 3.25 Servo Configuration

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #161 | Servo outputs: Protocol | 0 - 3<br>0<br>Note: CV #161 must be set to "2" for **Smart Servo RC-1!** | 0 | Bit 0 = 0: Servo protocol with positive pulses.<br>= 1: Servo protocol with negative pulses.<br>Bit 1 = 0: Control wire only active during movement<br>= 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)!<br>Bit 2 = 0: Moves to center position, if defined for two-key operation (see CV #181/182), when both function keys are OFF.<br>= 1: Servo runs only if function keys are pressed when in two-key operating mode (see CV #181/182). |
| #162 | Servo 1 - Left stop | 0 - 255 | 49<br>= 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<br>= 3 sec | Rotating speed; Time between defined end stops in tenths of a second (total range of 25 sec, default 3 sec.). |
| #166 - 169<br>#170 - 173<br>#174 - 177 | As above but for Servo 2<br>Servo 3<br>Servo 4 | | | |
| #181<br>#182<br>#183<br>#184 | Servo 1<br>Servo 2<br>Servo 3<br>Servo 4<br>Function assignment | 0 - 28<br>90 - 93<br>101-114 | 0<br>0<br>0<br>0 | = 0: Servo not in operation<br>= 1: Single-key operation with F1<br>= 2: Single-key operation with F2<br>and so on to<br>= 28: Single-key operation with F28<br>= 90: Servo action depends on loco direction: forward = turns left; reverse = turns right<br>= 91: Servo action depends on loco stop and direction: turns right when stopped and direction is forward, otherwise turns left.<br>= 92: Servo action depends on loco stop and direction: turns right when stopped and direction is reverse, otherwise turns left.<br>= 93: Servo action depends on loco movement: turns right when loco stopped, left when loco moving; direction makes no difference.<br>= 101: Two-key operation F1 + F2<br>= 102: Two-key operation F2 + F3<br>and so on to<br>=127: Two-key operation F27 + F28<br>= 111: Two-key operation F11 + F12<br>= 112: Two-key operation F3 + F6<br>= 113: Two-key operation F4 + F7<br>= 114: Two-key operation F5 + F8<br>(Two-key mode operates 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.<br>= 2: Servo 1 proportional, on speed regulator, Servo 2 for direction.<br>= 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.<br>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. |

# 4 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.
- the ***"bidirectional communication"*** according to ***"RailCom"*** is installed in all ZIMO decoders since 2004; in the large-scale decoders MX695, MX696 and MX697 operational since the beginning (basic functions, extended functions added 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.

RailCom is defined by the "RailCom working group" (Lenz, Kühn, Tams and ZIMO) with the goal of a uniform platform for RailCom applications. The same was first pursued by the NMRA RP's 9.3.1 and 9.3.2 for bidirectional communication but failed, largely due to the self-dissolution of the NMRA "DCC working group".

Just now in 2011 (the year this manual is published), the future of RailCom is uncertain because the manufacturer ESU (after loss of key OEM supplier contracts) is working since 2010 intensively to use the RailCom method for expanding its own market position.

By taking advantage of a patent by Lenz (who entered into close cooperation with ESU), it is tried to keep other market participants away from using RailCom altogether, or to force compliance through controls and sanctions to the specifications issued by ESU (based on what their own command stations require).

Therefore, ZIMO is preparing an alternative method (in collaboration with other ESU damaged companies) but currently (June 2011) has no name for it yet:

- The ***alternative method*** to RailCom is based on the above mentioned ZIMO loco number identification, which is realized by using that basic idea together with current technological means for a comprehensive feedback system. The scope of performance will be similar, or even greater than that of RailCom. From the users perspective who does not see the physical level of data transmission, but only the logical structure of data transmitted, the difference to RailCom will not be that big. That's why the following description is valid for both, RailCom as well as the alternative method.

„RailCom" is a registered trademark of Lenz Elektronik GmbH.

With the help of ***bidirectional communication*** according to RailCom or the alternative future method it will possible that

*decoders can acknowledge received commands -*

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

*up-to-date information 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 to 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 over two decades without bidirectional communication; but only with ZIMO components.

RailCom and/or the alternative method will be further developed over the coming years and add new applications, which of course require 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 km/h, load and decoder temperature.

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

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

RailCom in ZIMO Decoders is activated with

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

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

# 5 ZIMO SOUND – Selection and Programming

▶ Shipping decoders with a **ZIMO "sound collection"** installed is the preferred way of delivery and a specialty of the ZIMO sound concept, which is possible due to the large data storage capacity of the decoders: sound samples and CV parameters for several engines (i.e. for 5 engines) are stored in each decoder. The preferred sound for a given locomotive can be selected with the cab (no need to load a different sound sample from the computer).

At the same time, 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 a whistle from 10 different whistles (or several whistles on different function keys); furthermore a selection of bells, compressors, steam shovel, oil burner or break squeal etc.

The "sound collection" itself is a special form of the "sound projects" (see below) and is also listed at www.zimo.at (under "UPDATE" and "decoder"), ready for download and installation in case the decoder wasn't ordered with the desired sound files.

▶ **Free ZIMO sound projects ("Free D'load")** are available from www.zimo.at (follow "UPDATE", Decoder"), usually in two different versions:

1) as **"ready-to-use" project:** This is a **.zpp file,** which once downloaded, can be installed as is in to the decoder with the MXDECUP update module or MX31ZL cab (or MX10) and the help of the program **ZIRC (ZIMO Rail Center)** or with the MX31ZL and a USB stick (or MX10 and SD-card). All assignments, parameters and CV values that are part of the project will be installed as well.

Even though it is a ready-to-use project, many of the function assignments and settings can still be changed to suit your own taste after the project is installed, with the procedures and CV changes described in the operating manual.

2) as **"full-featured" project:** this is a **.zip file,** which cannot be directly installed into the decoder but must be unzipped and processed by the program **ZSP (ZIMO Sound Program).** Function assignments and CV settings can easily be changed within ZSP and sound files can be edited with a sound editing program or replaced with files from other collections.

After the sound project has been edited, it can be loaded in to the decoder from the program ZSP via the MXDECUP or MX31ZL (or MX10). Individual adjustments can be made to the decoder with the procedures and CV's explained in this manual. The new decoder values can be backed up by sending the data back to ZSP.

▶ **PROVIDER sound projects ("Coded Provider")** are also available for a **small fee** from the **ZIMO sound database,** but can only be used with **"coded decoders",** which are decoders containing the **load code.** "Coded decoders" are bought as such (for a small surcharge) or converted by buying and installing the load code in to normal decoders at a later date. The load code is only valid for one decoder (identified by the **decoder ID**), but entitles the buyer to use all sound projects of a specific sound bundle (i.e. all sound projects from Heinz Däppen). Also see the ZIMO sound database in the UPDATE pages at www.zimo.at.

"Coded Provider" projects are contributions by **external ZIMO partners** (shown as "Provider" in the ZIMO data base such as Heinz Däppen for Rhätische Bahnen and US steam engines), who are paid for their efforts through the sale of the "Load codes".

▶ The "preloaded" sound projects are not just available as a temporary substitute for a download with a load code, but also for many other custom sound projects (for free and for a small fee).

▶ The sound is **adjustable** and **fine-tunable** during operation with the help of **"incremental programming"** by gradually increasing or decreasing values, without awareness of the different CV values. This includes:

- how the sound should react to inclines, declines and acceleration events. This allows for a fast adaptation to changing operating situations (single engine or engine on heavy goods train);
- when the water drainage sound should be played at start up, or the break squeal when stopping the train; and much more.

### *Loco type selection with CV #265 --*

*(The software and sound organization will undergo changes over time; CV #265 may not yet be final)*

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #265 | Loco type selection | 1<br>2<br>…<br>101<br>102<br>… | 1 or 101<br>Steam = 1<br>Diesel = 101 | = 0, 100, 200: Reserved for future applications<br>= 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.<br>= 101, 102 … 132: Select among various diesel engines (if several diesel sounds are in the collection). |

Note: Until further notice, only a single diesel sound will be loaded (CV #265 = 101)

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

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

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

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

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

Z1 – compressor Z2 – coal shoveling Z3 – injector

The switch inputs are allocated to the following by default:

S1 – long whistle S2 – nothing S3 – cam sensor

### *Special procedures for owners of non-ZIMO DCC systems:*

*(Owners of ZIMO MX1 "model 2000", EC or HS command stations can skip this half page)*

Configuration variables #266 to #355 are used for the selection and allocation of sound samples as well as other settings. Programming CV's in this range is no problem for high-level systems (such as the current ZIMO DCC systems) both in "service mode" or "operations mode".

There are however many DCC systems in use (some still in production) that can only access CV's to #255 or even worse to #127 or CV #99.

If the CV value range is also limited (i.e. 0 to 99 instead of 0 to 255): see CV #7.

For such applications, ZIMO sound decoders offer an alternative way of reaching higher CV's via lower numbers. This is done with an initial "Pseudo-Programming" of

**CV #7 = 110 or** = **120 or = 130**

which increases the CV numbers about to be accessed by 100 or 200. For example:

If programming CV #266 = 45 is not possible, programming CV #7 = 110 followed by CV #166 = 45 executes the desired programming of CV #266 = 45

or

if neither CV #266 = 45 nor CV #166 = 45 is possible, programming CV #7 = 120 followed by CV #66 = 45 also leads to the result of CV #266 = 45.

The initial CV #7 – "Pseudo-Programming" state – remains active for further programming (which means CV #267 is entered as #167, CV #300 as #200 and so on) until the decoder is powered down. ATTENTION: After re-booting the system, the "Pseudo-Programming" is lost, that is programming CV #166 is indeed accessing CV #166 again. See below to prevent this!

The "Pseudo-Programing" can also be stopped without power interruption with

**CV #7 = 0**

which means that the programming reverts back to the original CV #166.

Using as an initial "Pseudo-Programming"

**CV #7 = 210 or 220**

achieves the same results as above but remains active even after the system is powered down. This state can only be cancelled with

**CV #7 = 0,**

which is important to remember in order to program lower CV's again.

*A simplified procedure (**w/o CV #300**) is available with MX31 (SW1.22) or MX31ZL (SW3.05)*

### *Selecting a new or replacing the current chuff set (only for steam):*

The following procedures are always used in the same way in spite of the flexible decoder layout with 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.

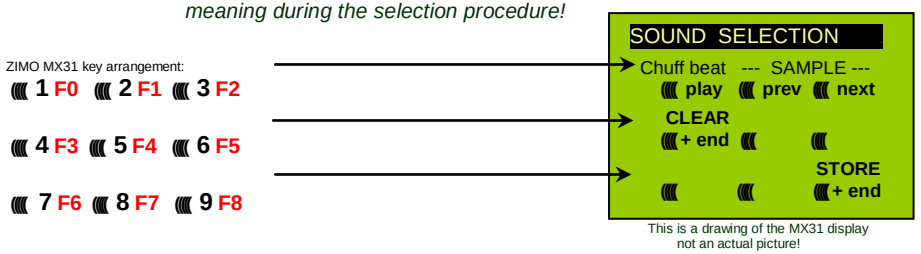
The **selection procedure** is started with a "Pseudo-Programming" in operations mode ("on-the-main"):

**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.

The function key identifications (and the MX31 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!*




This is a drawing of the MX31 display not an actual picture!

**F0 =** play : plays back the current chuff sound for evaluation; only possible with the engine at a stand still, since the chuff sounds are played 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, whereas with the engine running the selected file immediately replaces the currently active.

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

**F8 = STORE** + end : The **selection procedure** is **stopped** and the last selected chuff set replaces 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" 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,
…. playback is tried (F0) but no sound sample is available,
…. a wrong key is pressed (F4, F5 etc.)

The **"confirmations 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 and brake squeal sounds:*

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 = 134** for the driving sound of ELECTRIC engines .
**CV #300 = 136** for the switchgear sound of ELECTRIC engines .
**CV #300 = 133** for blow-off sound =cylinder valves (STEAM only) .

NOTE: the blow-off sound selected here is also used as the blow-off sound actuated with a function key (see CV #312).

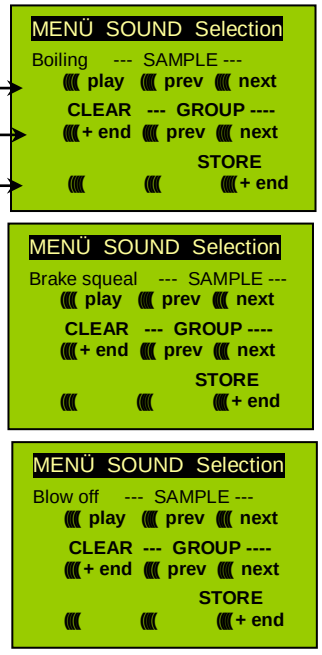
The selection procedure for background sounds is the same as for the selection of chuff sounds. EXCEPT: the engine should be at a **standstill** because the **speed regulator** is used **for setting the volume** for the relevant sound file!

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 MX31 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 selection procedure.

**F3 =** CLEAR + end : **Selection procedure** is **stopped** and the current sample removed.

**F8 =** STORE + end : **Selection procedure** is **stopped** and new selection activated.

The **selection procedure** can be **ended** by any other programming procedure or by removing power. Functions cannot be actuated during this procedure!

*A simplified procedure (**w/o CV #300**) is available with MX31 (SW1.22) or MX31ZL (SW3.05)*

***Allocating sound samples to function keys F1 … F12:***

A sound sample can be allocated to each function key F1…F12 from the sound samples stored in the decoder. It is absolutely permissible to have a function key assigned for a function output (FO1, FO2 etc.) as well as for a sound function, both of which will be activated when the key is pressed.

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

**CV #300 = 1** for function F1
**CV # 300 = 2** for function F2
**etc.**
**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.*

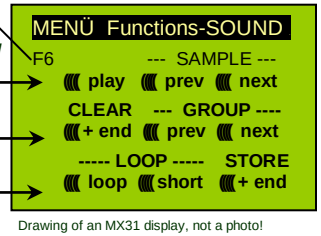
The engine should remain **stationary** though since the **speed regulator** is used **for volume settings** during the allocation procedure!

*Depends on entry: F1 . . . F12*

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

ZIMO MX31 key arangement:

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




Drawing of an MX31 display, not a photo!

**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 playback 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 marks (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** without a 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 a group is reached; use the appropriate key (F1, F2) to scroll in the opposite direction to listen to the other stored sounds,

…. the last stored sound group is reached (with F4 or F5); use the appropriate key (F4 or F5) to scroll in the opposite direction.

…. play-back 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:*

MX640 decoders provide 8 simultaneously playing random sound generators. The timing of them is determined by CV's; see "CV table" from CV #315.

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

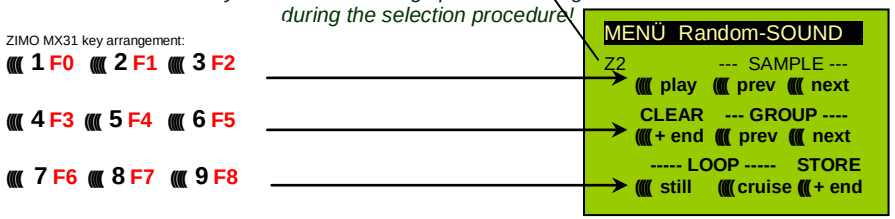
The **allocation procedure** for random sound is initiated with a "Pseudo-Programming" in operations mode programming:

**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.**

*Depends on entry: Z1 . . . Z8*

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




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!*

*A simplified procedure (**w/o CV #300**) is available with MX31 (SW1.22) or MX31ZL (SW3.05)*

### *Allocation of sound samples to switch inputs S1 and S2:*

The MX640 has 3 switch inputs available, of which two ("1" & "2") are freely available to the user while one ("3") is usually reserved for a cam sensor input; which can also be used for other inputs if not used for a cam sensor (i.e. the virtual cam sensor is used instead). These inputs can accept reed switches, optical or hall-effect sensors and similar; see chapter 8: "Connecting speaker, cam sensor".

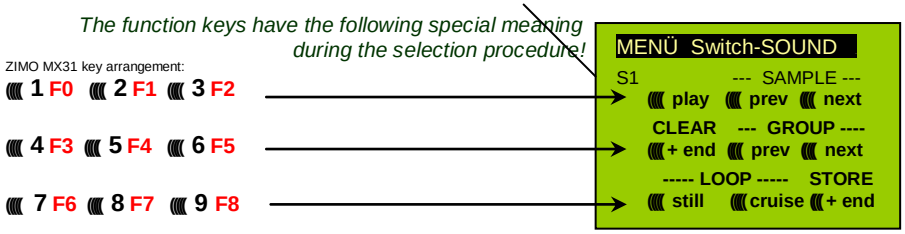
A sound sample can be allocated to each switch input, from the pool of stored samples in the decoder; playback times can be set with the help of CV's #341, 342 and 343, see CV table.

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

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

*Depends on entry: S1…S4*

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




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.

### *Automated test run to determine the motors "basic load" factor:*

The following procedure is necessary to enable load dependent chuff sounds (volume and sound changes with inclines and load….) that is, to optimize the current values.

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 with changes in load. For the decoder to 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) that is, the "basic load" of an engine or train, which due to gearbox losses, power pick-ups etc. is often considerably higher on model trains than on the real railroad. 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).

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.

For easier handling of different "basic loads", provisions will be made with future SW versions that allow the recording of several "basic load" factors and the easy switching between a light running locomotive and a "heavy" train.

### *Programming sound CV's:*

Configuration variables are for optimizing the sound effect for a specific locomotive and for special operating situations. The **programming** can be done either on the programming track in **service mode,** on the main track in **operations mode** or with **"incremental programming".**

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

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

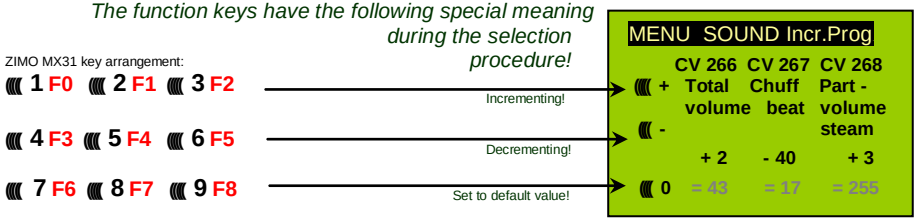
**CV #301 = 66**,

which changes the function keys to INC and DEC keys, first for CV #266 (that is the CV number derived from the value 66 + 200).

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

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

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




Drawing of an MX31 display, not a photo!

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

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

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

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

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

The **"cuckoo jingle"** sounds when….

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

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

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

## *CV Table for SOUND CONFIGURATIONS*:

The following CV's can be programmed both **"normal"** (i.e. CV #... = ...) and **"incremental"** (Exception: CV #280 for diesel engines). "Incremental programming" is especially useful when the proper value cannot be calculated in advance and must be determined by trial, which is often the case with many sound parameters.

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

| CV | Designation | Range | INC-step | De-fault | Description |
|---|---|---|---|---|---|
| LEIT - CV **#266** | Total volume | 0 - 255 | 5 | 65 | The value "65" results (mathematically) in the highest possible distortion-free playback volume; but values of up to 100 can be perfectly suitable because distortions in this volume range are hardly audible. Plus, the usefulness of a sound also depends on the quality of the sound sample. |
| #267 | Chuff sound frequency with „virtual cam sensor"<br>for STEAM engines<br>also see CV #354 | 0 - 255 | 1 | 70 | CV #267 is only active if **CV #268 = 0:**<br>Chuff beats follow the "virtual cam sensor"; an actual cam sensor is not needed in this case.<br>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:<br>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<br>and<br>trigger count for chuff rate<br>for STEAM engines | 0 - 255 | 1 | 0 | = 0: "Virtual" cam sensor is active (to be adjusted with CV #267, see above).<br>= 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.<br>= 2, 3, 4 … real cam sensor, several triggers in sequence (2, 3, 4 …) result in one chuff beat. |
| LEAD - CV **#269** | Lead-chuff accentuated<br>for STEAM engines | 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 | PROJEKT not functional yet:<br>Longer chuff length at very low speeds<br>for STEAM engines | 0 - 255 | 10 | ? | PROJECT (not yet implemented):<br>The chuff sounds of a real engine are extended when driving at very low speeds due to the mechanical valve control. This effect can be more or less accentuated with CV #270. |
| #271 | Overlapping effect at high speed<br>for STEAM engines | 0 – 255 (useful up to @ 30) | 1 | 16 | The individual steam chuffs overlap each other at high speed on a real engine. 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.<br>This is not always desired in model railroading because it doesn't sound that attractive, hence CV #271, with which an adjustment is possible to have the chuff beats accentuated at high speed or rather fade away. |
| LEIT - CV **#272** | Blow-off duration<br>for STEAM engines | 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.<br>Value in CV #272 = time in tenth of a second!<br>Note: If the blow-off sound is also allocated to a function key (as delivered on F4, see CV #312), the automated blow-off sound can be shortened or extended with the relevant function key. Automated blow-off and function blow-off are inevitably the same (per selection/allocation).<br>**= 0**: no blow-off sound played back |
| #273 | Start-up delay during blow-off<br>for STEAM engines | 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.<br>This can be imitated with CV #273 by automatically delaying the start.<br>This effect is cancelled when a shunting function with momentum deactivation is being activated (see allocation of F3 or F4 in CV #124!)<br>= 0: no start delay<br>= 1: Special setting for blow-off via speed regulator; no start-up delay but setting the speed to the lowest speed step initiates the blow-off sound only without starting the motor (only with 128 speed steps).<br>= 2: Start-up delay in tenths of a second, Recommendation: no value > 20 (> 2 sec) |
| #274 | Blow-off schedule<br>for STEAM engines | 0 - 255 = 0 - 25 sec | 10 | 30 | During shunting operations that often requires many short trips with associated idle times, opening and closing the cylinder valves every time is not usually done. CV #274 causes the blow-off sound to be suppressed if the engine wasn't standing still for the time defined here.<br>Value in CV #274 = time in tenth of a second!<br>Note: Shunting with permanently open cylinder valves can be achieved by actuating the function |

| CV | Designation | Range | INC-step | De-fault | Description |
|---|---|---|---|---|---|
| | | | | | key that is assigned for blow-off sound (F4 by de-fault or by function key assignment with CV #312 = 2, 3, 4…, see above). |
| LEIT - CV **#275** | Engine (chuff) sound<br>-<br>Volume at low speed and no-load<br><br>for STEAM engines:<br>Steam chuffs<br><br>for DIESEL engines:<br>Engine sound<br><br>for ELECTRIC engines:<br>Often relevant for ventilator sounds<br>(Thyristor and motor sounds however are set-up with CV's #289 and up) | 0 - 255 | 10 | 60 | **To set up load dependent sound do the following in the order shown:**<br>*"Automated recording" of the motor's "basic load" factor; see above!*<br>*Check or adjust volume in CV #275 and #276.*<br>*Check CV #277 (should have been "0" up to this point), see below!*<br>*Also CV #278 and #279, if required.*<br><br>This CV adjusts the chuff volume at "basic load" (same conditions as during the automated record-ing run), at about 1/10 of full speed.<br>Note: For practical purposes (but not absolutely necessary), CV #275 is set by trial to the proper value using the "incremental programming" at low speed. Because the volume at various speeds is interpolated between the values in CV #275 and #277 it is **not** necessary to run at an exact speed step during this set-up, as long as it is around 1/10 of full speed.<br>This adjustment is best performed with CV #277 set to "0" (default) so that the setting for "no-load driving" is not influenced by load factors. |
| #276 | Engine sound<br>-<br>Volume at high speed and no-load | 0 - 255 | 10 | 80 | Same procedure as in CV #275 above, but for high speed.<br>CV **#276** defines the "basic-load" chuff sound vol-ume at full speed. Set the speed regulator to max-imum during this set-up.<br>All notes in CV #275 are also valid for this CV! |
| #277 | Driving sound changes in regards to load | 0 - 255 | 10 | 0<br>=<br>no reac-tion | When deviating from the basic load (as deter-mined by the "Automated recording of the motor's "basic load" factor", see above), the chuff beat volume should be increasing (on inclines) or de-creasing on declines (even muted).<br>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 sound to small load changes can be suppressed (i.e. in curves) in or-der to prevent chaotic sound impressions.<br>Suitable settings can only be determined by trial (with "incremental programming). |

| CV | Designation | Range | INC-step | De-fault | Description |
|---|---|---|---|---|---|
| #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.<br>Suitable settings can only be determined by trial (with "incremental programming" of CV's **#**278 and #279 together). |
| #280 | Load influence<br><br>For DIESEL engines | 0 - 255 | 10 | 0 | This CV determines (at least temporarily in SW version 15) the reaction of the diesel sound to load: RPM and performance steps of diesel-hydraulic engines, cruise/idle rpm of diesel-electrics and shift points of geared engines.<br>= 0: no influence, dependent on motor rpm<br>= to 255: large influence.<br>It is highly recommended to perform the automat-ed **test run** with CV #302 = 75 first (see text above in CV #302). |
| LEAD - CV **#281** | Acceleration threshold for full load sound | 0 – 255<br>(internal speed steps) | 1 | 1 | More powerful and louder chuff sounds should be played back indicating increased power require-ments during accelerations, compared to "basic load". As is the case with the prototype, the in-creased 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.<br>The "engineer" can in this fashion adjust the sound (by increasing the speed by 1 step) in an-ticipation of an imminent incline.<br>=1: Acceleration sound played back at full volume if speed has increased by just one speed step.<br>= 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<br>=<br>0 - 25 sec | 10 | 30<br>=<br>3 sec | The acceleration sound should remain for a cer-tain length of time after the speed increased (oth-erwise each single speed step would be audible, which is unrealistic).<br>Value in CV #282 = time in tenth of a second! |
| #283 | Engine sound volume during full acceleration | 0 - 255 | 10 | 255 | The volume of steam chuffs at maximum acceler-ation is set with CV #283 (default: 255 = full vol-ume).<br>If CV #281 = 1 (acceleration threshold set to 1 speed step), the volume defined here is applied |

| CV | Designation | Range | INC-step | De-fault | Description |
|---|---|---|---|---|---|
| | | | | | with each speed increase, even if it's just 1 step. |
| LEAD - CV **#284** | Threshold for deceleration sound | 0 -255 (internal speed steps) | 1 | 1 | Steam chuffs should be played back at less volume (or no sound at all) signifying the reduced power requirement during deceleration. The sound reduction logic is analog to a reversed acceleration (per CV #281 to #283).<br>= 1: Reduces sound to minimum (as per CV #286) when speed is reduced by just 1 step.<br>= 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).<br>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).<br>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). |
| LEAD - CV **#287** | Brake squeal threshold | 0 – 255 (internal speed steps) | 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 squeal | 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!).<br>Note: Brake squeal sounds can also be assigned to a function key (see allocation procedure CV #300 = …), with which they can be played manually or stopped! |
| #289 | Thyristor control Sound pitch for stepping effect of ELECTRIC engines From SW version 20 | 1 - 255 | 10 | 1 | The pitch of the thyristor control sound of many engines (typical example: Taurus) should not ascend evenly but rather in steps (scale).<br>= 1: no stepping effect, even ascend<br>1 - 255: ascending scale according to the corresponding speed step interval. |
| LEAD - CV #290 | Thyristor control Sound pitch at medium speed for ELECTRIC engines | 0 - 100 | 10 | 40 | Percentage of the thyristor pitch increase at medium speed compared to standstill. Define the "medium speed" in CV #292.<br>= 0: no change, pitch remains the same as at standstill. |

| CV | Designation | Range | INC-step | De-fault | Description |
|---|---|---|---|---|---|
| | From SW-version 20 | | | | = 1- 99: corresponding change in pitch<br>= 100: pitch doubles already at "medium speed". |
| #291 | Thyristor control Sound pitch at maximum speed for ELECTRIC engines From SW-version 20 | 0 - 100 | 10 | 100 | Percentage of the thyristor pitch increase at maximum speed compared to standstill.<br>= 0: no change, pitch remains the same as at standstill.<br>= 1- 99: corresponding change in pitch<br>= 100: pitch doubles at "maximum speed". |
| #292 | Thyristor control Speed step for medium speed for ELECTRIC engines | 0 - 255 | 10 | 100 | Internal speed step defined as "medium speed" for the pitch level according to CV #290.<br>The CV's #290 – 292 form a three-point characteristic curve for the pitch of the thyristor control sound, starting at standstill, where the original sample is always played back. |
| LEAD - CV #293 | Thyristor control Volume at steady speed for ELECTRIC engines | 0 - 255 | 10 | 30 | Thyristor control-sound volume at steady speed (no acceleration or deceleration in process).<br>Note: load dependency is set with CV's #277 and up but is not yet possible with SW-Version 4. |
| #294 | Thyristor control Volume during acceleration for ELECTRIC engines | 0 - 255 | 10 | 100 | Volume during heavier accelerations; the value in CV #294 should be larger than in CV #293 to be useful (so that the volume increases when the engine accelerates).<br>A lower volume is automatically selected at lesser accelerations (exact algorithm is not finalized with SW-Version 4). |
| #295 | Thyristor control Volume during deceleration Motor sound of ELECTRIC engines | 0 - 255 | 10 | 50 | Volume during heavier decelerations (braking); the value in CV #295 may be higher or lower than in CV #293, depending on whether the thyristors are stressed during power feedback to the net (which increases the volume) or not (which decreases the volume). |
| LEAD - CV #296 | Peak motor sound volume for ELECTRIC engines | 0 -255 | 10 | 100 | Maximum volume of motor sound at full speed or at the speed defined by CV #298. |
| #297 | Motor sound, when sound becomes audible for ELECTRIC engines | 0 -255 | 10 | 30 | Internal speed step at which the motor sound becomes audible; the sound starts quietly at this speed and reaches the maximum volume as per CV #296 at the speed defined in CV #298. |
| #298 | Motor sound, starting point of | 0 -255 (> CV# 297) | 10 | 128 | Internal speed step at which the motor sound reaches full volume; at this speed step the motor |

| CV | Designation | Range | INC-step | De-fault | Description |
|---|---|---|---|---|---|
| | full volume for ELECTRIC engines | | | | sound is played back at full volume according to CV #296. |
| #299 | Motor sound, Sound pitch dependent on speed Electric engines | 0 -255 (> CV #297) | 10 | 100 | The motor sound is played back faster in accordance with this CV with increasing speed.<br>= 0: Pitch (playback speed) will not be raised.<br>= 1 … 100: Intermediate values.<br>= 100: Doubles pitch<br>> 100: same as 100 for now; reserve for SW expansion. |
| **MORE CV's belonging to this group after the next table (starting at CV #344)!!!** | | | | | |

**The following CV's are not suitable for the "incremental programming",** because they either are too difficult to test immediately (large time intervals for random generators) or single bits need to be set. They are programmed the usual way (CV # = …).

| CV | Designation | Range | De-fault | Description |
|---|---|---|---|---|
| #310 | ON/OFF key for engine and random sound | 0 - 19, 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.<br>= 255: engine and random sound is always ON. |
| #311 | ON/OFF key for function sound | 0 - 19 | 0 | A key can be assigned with which all function sounds (i.e. F2 – whistle, F6 – bell etc.) can be turned on and off. No key is programmed for this at delivery.<br>= 0: does not mean that F0 is assigned for this task but rather that the function sounds are always active.<br>= (#310), if the same value is entered here as in CV #310, the key defined in #310 turns all sound ON/OFF.<br>= 1 ... 12: Separate ON/OFF key for function sound. |
| #312 | Blow-off key | 0 - 19 | 4 = F4 | Defines a function key to play-back the blow-off sound manually (that is the same sound programmed with CV #300 = 133 to be played back automatically). For example: to do shunting with „open valves".<br>= 0: no key assigned (use this setting if keys are used for other purposes). |
| #313 | Mute key, from SW version 2 | 0 - 19<br>101 - 119 | 8 | This CV assigns a function key with which the driving sounds can be faded in and out, i.e. when the train becomes invisible after disappearing behind scenery. F8 is used by default, which is already the sound on/off key but now does so softly.<br>= 0: No mute key or mute function.<br>= 1…19: Assigned function key.<br>= 101…119: Assigned function key with inverted action. |
| #314 | Mute – fade in/out time | 0 - 255 | 0 | Time in tenths of a second for sound fading in/out when mute button is pressed. Total range is 25 seconds.<br>= 0: 1 sec, which is the same as a value of 10. |
| #315 | Minimum interval for random generator Z1 | 0 - 255 = 0 - 255 sec | 1 | The random generator produces 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.<br>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.<br>Special note to random generator Z1:<br>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! |

| CV | Designation | Range | De-fault | Description |
|---|---|---|---|---|
| #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 duration defined in CV #317.<br>= 0: Sample plays once (in the defined duration) |
| #318<br>#319<br>#320 | As above but for sound generator Z2 | 0 - 255<br>0 - 255<br>0 - 255 | 20<br>80<br>5 | By default, Z2 is assigned for coal shoveling at stand-still. |
| #321<br>#320<br>#323 | As above but for sound generator Z3 | 0 - 255<br>0 - 255<br>0 - 255 | 30<br>90<br>3 | By default, Z3 is assigned for the injector at stand-still. |
| #324<br>#325<br>#326 | As above but for sound generator Z4 | 0 - 255<br>0 - 255<br>0 - 255 | | As delivered, this random generator is not assigned to any sound. |
| #327<br>#328<br>#329 | As above but for sound generator Z5 | 0 - 255<br>0 - 255<br>0 - 255 | | As delivered, this random generator is not assigned to any sound. |
| #330<br>#331<br>#332 | As above but for sound generator Z6 | 0 - 255<br>0 - 255<br>0 - 255 | | As delivered, this random generator is not assigned to any sound. |
| #333<br>#334<br>#335 | As above but for sound generator Z7 | 0 - 255<br>0 - 255<br>0 - 255 | | As delivered, this random generator is not assigned to any sound. |
| #336<br>#337<br>#338 | As above but for sound generator Z8 | 0 - 255<br>0 - 255<br>0 - 255 | | As delivered, this random generator is not assigned to any sound. |
| #341 | Switch input 1<br>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.<br>= 0: Play sample back once (duration as recorded) |
| #342 | Switch input 2<br>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.<br>= 0: Play sample back once (duration as recorded) |
| #343 | Switch input 3<br>(if not used for the cam sensor)<br>Playback time | 0 - 255 = 0 - 255 sec | 0 | The sound sample allocated to switch input 3 is played back for the duration defined with this CV.<br>= 0: Play sample back once (duration as recorded) |

**Continuation from CV #299 of the previous CV table!!!**

| CV | Designation | Range | De-fault | Description |
|---|---|---|---|---|
| #344 | Run-on time of motor sounds after stops (Cooling fan etc.)<br>for DIESEL and ELECTRIC engines | 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.<br>= 0: Won't run after stop<br>= 1 … 255: Runs for another 1 to 25 seconds. |
| #345 | Quick-select key between the sounds of a MULTI-SYSTEM engine | 1 - 19 | 0 | Defines a function key (F1 – F19) which switches between two sound types (i.e. between an electro and diesel sound of a multi-system engine). This feature is only intended for certain sound projects (i.e. RhB Gem), where the two sound types are part of the same sound collection. |
| #350 | Delay of switchgear sound after start up<br>for ELECTRIC engines. | 0 - 255 = 0 - 25 sec | 0 | The switchgear on some engines (i.e. E10) should not be heard immediately after start-up but rather after some time defined here.<br>= 0: Switchgear is heard immediately after start-up. |
| #351 | Exhaust fan speed at steady speed<br>for DIESEL engines | 1 - 255 | 128 | The fan speed is adjusted with PWM; the value in CV #351 defines the speed at steady cruise.<br>= 128: Half of the available voltage is applied to the fan motor. |
| #352 | Exhaust fan speed at acceleration and motor start-up<br>for DIESEL engines | 1 - 255 | 255 | To generate the puff of smoke at start-up or heavy smoke under hard acceleration, the fan motor is set to a higher speed (usually full speed).<br>= 255: Motor receives full voltage at start-up. |
| #353 | Automatic shut-down of smoke generator<br>for STEAM and DIESEL engines | 0 - 255 = 0 - 106 min | 0 | If the smoke generator is controlled by one of the Special Effects "010010xx" or "010100xx" in CV's 127 – 132 (for one of the function outputs FO1 to FO6), it will turn off automatically after the time defined here (to prevent overheating).<br>= 0: Won't turn off automatically.<br>= 1 … 255: Switches off automatically after 25 seconds/unit. Maximum time therefore is about 6300 sec. = 105 minutes. |
| #354 | Steam chuff frequency<br>at<br>speed step 1 | 1 - 255 | 0 | CV #354 works only if used together with CV #267!<br>CV #354 compensates for the non-linear speed measurement for the "virtual cam sensor":<br>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).<br>= 0: no effect<br>= 1…127: more chuff beats in relation to CV #267,<br>= 255…128: less chuff beats. |

| Continuation from CV #299 of the previous CV table!!! | | | | |
|---|---|---|---|---|
| CV | Designation | Range | De-fault | Description |
| #355 | Fan speed at stand-still<br>for STEAM and DIESEL engines | 1 - 255 | 0 | Supplements to the adjustments in CV #133 und the effects of code “72” (steam engines) or “80” (diesel engine), which covers the fan only during start-up and running.<br>CV #355 on the other hand adjusts the fan speed at standstill, so that a small amount of smoke is being pushed out in those situations. |
| #357 | Thyristor control<br>Lowering the volume at higher speeds<br>for ELECTRIC engines | 0 - 255 | 0 | Internal speed step at which the thyristor sound volume should be reduced. |
| #358 | Thyristor control<br>Volume reduction curve at higher speeds<br>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.<br>= 0: no reduction.<br>= 10: reduced by about 3% per speed step.<br>= 255: aborts the sound when the speed step defined in CV #357 is reached. |
| #359 | Switch gear sound<br>Playback duration for the switch gear sound during speed changes<br>for ELECTRIC engines | 0 - 255 | 30 | Time in tenth of a second the switch gear should be heard during speed changes (adjustable from 0 – 25 sec.).<br>Effective only if switch gear sound is part of the sound project. |
| #360 | Switch gear sound<br>Playback duration for the switch gear sound after coming to a stop<br>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.).<br>= 0: no sound after stop. |
| #361 | Switch gear sound<br>Delay between playbacks<br>for ELECTRIC engines | 0 - 255 | 20 | When speed changes occur in rapid succession, the switch gear sound would play too often.<br>CV #361: Time in tenth of a second as the minimum time interval between switch gear sound playbacks (adjustable from 0 – 25 sec.). |
| #362 | Thyristor control<br>Switchover threshold for second thyristor sound<br>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)<br>= 0: no second thyristor sound. |

| Continuation from CV #299 of the previous CV table!!! | | | | |
|---|---|---|---|---|
| CV | Designation | Range | De-fault | Description |
| #363 | Switch gear sound<br>Dividing the speed into shift steps<br>for ELECTRIC engines | 0 - 255 | 0 | Number of shift steps over 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…<br>= 0: synonymous with 5; which are 5 switch steps over the whole speed range. |
| #364 | Speed drop during upshifts<br>for DIESEL engines with mech. transmission engine brake. | | 0 | See sound projects (i.e. VT 61) |
| #365 | Highest rpm before upshifts<br>for DIESEL engines with mech. transmission engine brake. | | 0 | See sound projects (i.e. VT 61) |
| #366 | Maximum turbo sound volume<br>for DIESEL engines | 0 - 255 | 48 | |
| #367 | Speed dependency of turbo<br>for DIESEL engines | 0 - 255 | 150 | Frequency depends on speed. |
| #368 | Acceleration dependency of turbo<br>for DIESEL engines | 0 - 255 | 100 | Frequency depends on the difference of set speed to actual speed (acceleration). |
| #369 | Minimum load for turbo<br>for DIESEL engines | 0 - 255 | 30 | Audibility threshold for turbochargers; the load is derived from CV #367 and 368. |
| #370 | Frequency increase of turbo<br>for DIESEL engines | 0 - 255 | 25 | Speed of frequency increase of the turbocharger. |
| #371 | Frequency decrease of turbo<br>for DIESEL engines | 0 - 255 | 15 | Speed of frequency increase of the turbocharger. |

## *Summary of actions when "The sound is too loud"*

This subject corresponds to a frequent request of model railroaders, who find ZIMO sound decoders as OEM equipment in locomotives (Roco, Fleischmann, Hag... since 2010), which often have the volume set at the factory to the maximum value in order to increase the effect ...

The simplest corrective action to take is of course to lower the overall volume with the help of CV #266, by reading the value first and subsequently programming a lower value. However, this will of course influence not only the driving sound but also the function sounds (whistle, horn, brake squeal etc.), with the result that the latter often become too quiet. Therefore…

**Reduce driving sound volume** (WITHOUT changing the function sounds) for **STEAM engines:**

Read out the values in CV's #275, #276, #283 and #286 (see CV table for detailed information) and program with lower values. It is often enough to simply modify the CV's **#**275 and **#**276, which are relevant to cruising speed and it is often only at that speed that too high a volume is annoying.

NOTE (also applies to DIESEL and ELECTRIC engines): The default values shown in the CV table are most often not used because other values are used within the sound project. That's why the actual values should always be read out first, followed by programming a (usually) lower value.

**Reduce driving sound volume** (WITHOUT changing the function sounds) for **DIESEL engines:**

Here again, reducing the values in the CV's **#**275, #276, #283 and #286 results in a lower volume for the driving sounds.

In contrast to steam engines the values in these 4 CV's are the same or very close to each other because diesel motors don't react as much to load; as a precaution though, they should still be read out separately.

**Reduce driving sound volume** (WITHOUT changing the function sounds) for **ELECTRIC engines:**

The same CV's **#**275, #276, #283 and #286 on electric engines are most often used "only" for the cooling fan (in some cases they are not used at all), but this may be handled differently from one sound project to another.

However, the volume of the thyristor sound can be set through the CV's #293, #294, #295 and the engine sound with #296 (see CV table for detailed descriptions). If necessary read out the current values of these CV's and replace them with smaller values.

# 6 Installation and Wiring

### General information:

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

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

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

### Do noise suppression components on a locomotive motor have a negative effect on motor regulation?

**Yes, sometimes . . .**

Explanation: Motors of model railroad locomotives are often equipped with choke coils and capacitors, which are supposed to suppress or filter out electric noise (causing poor TV reception etc.), caused by the sparks arcing across the motor's brushes.

Such components impair the motor regulation. Compared to others, ZIMO decoders manage quite well and there is hardly a difference in performance with or without those components in place. However, in recent years larger choke coils are being installed in many locomotives than was the case earlier – and these can noticeably compromise drivability.

The potentially "harmful" choke coils are often recognizable by their shape, as they look like a resistor with color bands (in contrast to a wire wound ferrite bar). That doesn't mean though that these choke coils have a negative effect in all cases.

**Lessons learned and accompanying measures…**

ROCO, BRAWA, HORNBY – so far present no problems, no action necessary.
FLEISCHMANN H0 with "Round motors" – choke coils are no problem; capacitors should be removed if necessary, especially the ones between frame and motor (may destroy the decoder if left in place)!
Newer Bühler motors – no problems so far.

TRIX H0 – choke coil between track and decoder plug should be removed!

MINITRIX, FLEISCHMANN PICCOLO – very inconsistent; removing of capacitors is often advantageous; choke coils on the other hand presented no problems so far.

Indications of a harmful effect of such components, besides a general unsatisfactory motor control (jerking…), are:

- weak BEMF compensation: as confirmation, set the decoder for testing purposes to low frequency – CV #9 = 200 – and see whether the control compensation becomes stronger. If that's the case, the choke coils are most likely to blame.

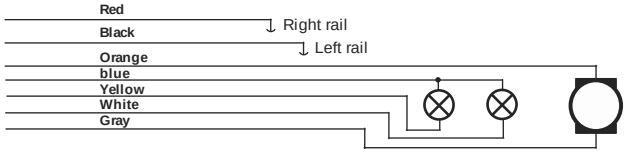
- if a difference in compensation is noticeable between 20 kHz and 40 kHz (selectable in CV #112, Bit 5), it is very possible that the choke coils or capacitors are the cause.

Remedy: **Bypass choke coils** (or replace with wire strap)**!** Remove capacitors! Capacitors are less likely to interfere with motor regulations but cannot be ruled out (see "Round motor" above).

### Locomotives with 6 or 8 pin NMRA interface . . .

. . . are easy to retrofit with the MX...**R**, MX...**F**, MX...**N** (e.g. MX630R or MX620F) etc. They come with the appropriate 8 (R) or 6 (F, N) pin connector. There is usually enough room provided in such locos. Removing the dummy plug from the loco automatically interrupts all damaging connections and the decoder can be plugged in instead. This is unfortunately not always true with some loco manufacturers. It is advisable to use an ohmmeter to confirm that motor connections are isolated from the power pick-ups before plugging in a decoder.

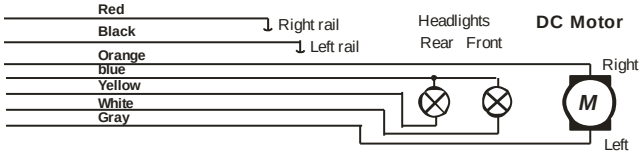
In some cases it is necessary to hardwire some decoder leads besides just plugging in a plug. An example of this is the MX630R that has more outputs available than the standard 8-pin plug has pins. For hard-wiring of decoder leads use the explanations below.




### Hard-wiring a locomotive…

#### … with a DC motor and headlights:

This probably represents the **most common wiring diagram** for H0 installations. All other diagrams that follow are modified or extended versions of this one.

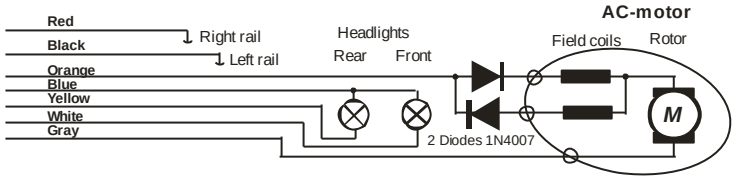



Lights connected as shown on this diagram are direction controlled and switched on/off by the F0 key (1 on Zimo cab). The lights can also be controlled independently with F0 and F1 for example (1 and 2 on Zimo cab), using function mapping CV's #33, 34, 35.

PLEASE NOTE: Body mounted light bulbs that are hard to isolate can be left as is. The body acts as the power supply to the bulb. The blue lead from the decoder must not be connected to the bulbs in such circumstances. The white and yellow leads are connected to the other side of the bulbs. The brightness of the headlights will be reduced with such an application

#### . . . with an AC engine:

Two additional 1N4007 diodes (or equivalent) are required as shown in the diagram below when installing a decoder in a loco equipped with an AC motor. They can be obtained at your local electronic store or from ZIMO.



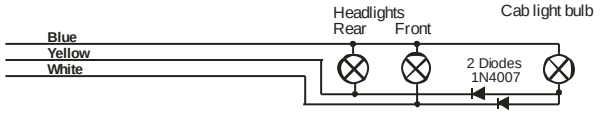

Most locomotives with AC motors get the power supplied by a third rail, which is of no significance as far as the motor hook-up is concerned. The above schematic is therefore valid for AC locomotives running on two or three rail track (instead of "right rail" and "left rail" think "outside rails" and "center rail").

Note: many locomotive manufacturers supply field magnets that can be used in place of the motor's field coil. Using a field magnet turns an AC motor into a DC motor, which is connected as such (see above) and can also utilize the decoders BEMF feature (BEMF does not work with AC motors).

### *Additional hook-up for cab lighting controlled with F0 key:*

This is no longer of much use today; it is a remainder from a time when decoders only had two function outputs, which were used for the headlights and the cab light. Cab lights connected this way can be switched with the F0 key but in contrast to the headlights were non-directional.

This is however a general schematic that can be used in cases where something is to be operated by several different function outputs, but the same outputs used independent of each other. There are 2 diodes required (type 1N4007 or equivalent) available from ZIMO or any electronic parts supply store.

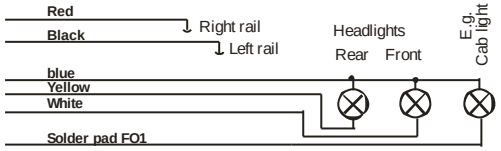



### *Connecting function outputs FO1, FO2, FO3, FO4…:*

Depending on decoder type, function outputs FO1 and higher are available on wires, solder pads or part of a connector (i.e. the MX620 offers FO1 and FO2 on solder pads, the MX630 and MX632 on wires with higher outputs on solder pads) and can be connected in the same fashion as headlights.

For mapping the outputs to function keys, see chapter 5; the function outputs FO1 and FO2 are mapped by default with function keys F1 and F2.

**Also see note on MX632 below!**



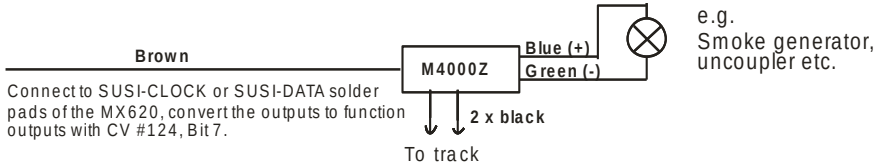

### *Using logic level outputs:*

ZIMO decoders also have so called logic level outputs in addition to the normal function outputs, to which current consuming devices may not be connected directly. Use a ZIMO M4000A amplifier or similar transistor switching device, when connecting logic level outputs with a load.

Some logic level outputs are used alternatively for the "SUSI-CLOCK" and SUSI-DATA" connections and can be switched back to logic level outputs when setting CV #124 Bit 7 = 1 (if SUSI is not required). Furthermore, the same pins can be used for servo control (activated with CV's #181 & 182).

**NOTE MX632:** The logic level outputs FO5 and FO6 of the MX632 are identical in their function as the amplified outputs FO5 and FO6 (not FO7 and FO8 as was first announced); however, **neither the amplified outputs FO5/FO6 nor the logic level outputs FO5/FO6 are functional, if they are defined for "SUSI" (CV #124, Bit 7) or servo control (CV's #181, 182) are activated!!**

The brown lead of an **amplifier module M4000Z** is connected with the relevant logic level output solder pad of the decoder.




### *Connecting DIETZ sound modules without "SUSI" / "virtual cam sensor"*

See Dietz instruction manual regarding the installation and connection of their sound modules to a ZIMO decoder.

For a good acoustic impression of steam engines, it is important that the chuffs are synchronized to wheel revolutions. Therefore a cam sensor should be installed and connected to the sound module (reed switch, optical or hall-effect sensor), which sends exactly 2 or 4 pulses to the module (depending on loco type).

Sound modules can usually generate their own chuff rate based on speed information (e.g. coming through the SUSI interface from a decoder), if no cam sensor can be installed or installation proves too difficult. The result is often poor with a chuff rate that is too fast at low speeds (the SUSI protocol is not precise enough in that respect).

To improve this situation, ZIMO decoders come with a **"virtual cam sensor".** Function output FO4 is converted to a "virtual cam sensor" function with the help of CV #133 and connected with the cam sensor input of the sound module (e.g. Dietz, reed switch input); this in addition to SUSI or other connections.

The virtual cam sensor is of course not capable of synchronizing chuff rates to wheel positions but rather to wheel speed, which is of little difference to the viewer.

The chuff rate of the "virtual cam sensor" can be defined per wheel revolution with CV #267 and CV #354; consult the CV table in ZIMO sound chapter.

### *Connecting of DIETZ or other sound modules with "SUSI":*

The SUSI interface developed by Dietz is an NMRA standard and defines the connection between sound modules and loco decoders, provided the sound module is also equipped with such an interface.

Due to space restrictions on small decoders, the SUSI interface composed of 4 conductors (2 data, ground and power) is not built as a plug-in connector but instead uses **4 solder pads** (see decoder drawings in the chapter "Technical specifications" in this manual).

Speed and load information (uphill, downhill, startup etc.), as well as programming values for the sound module CV's (#890…) are sent via the SUSI data lines (CLOCK and DATA) from the decoder to the sound module.

**Accessing SUSI CV's in the SUSI module:** These CV's are in the 890 range, according to the standard (NMRA DCC Draft RP), which is not accessible with many DCC systems (ZIMO cabs MX2 and MX21 were also limited to 255 - until mid-2004). For this reason, ZIMO decoders allow access to these CV's with numbers in the 190's!

### *Connecting an electric (un)coupler (System "Krois"):*

In order to prevent damage to the delicate core of an uncoupler from continuous power, appropriate adjustments can be made with special CV's for one or several function outputs.

First, write the value "48" to the special effect CV that is assigned to the same output an uncoupler is connected to (e.g. CV #127 for output #1, CV #128 for output #2 etc.)

Next define a limit for the uncoupler's activation time in CV #115 (see CV-table):

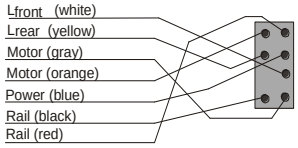
With the **"Krois uncouplers"**, it is recommended to use a value of "60", "70" or "80" for CV #115; this means that the pull-in voltage (full track voltage) is limited to 2, 3 or 4 seconds. A reduced "hold" voltage is not required for Krois, that's why the ones digit is left at 0. Other uncouplers may need a reduced hold voltage though, like the ones from ROCO for example.

Regarding the "automated train disengagement" and/or "automatic coupler unloading" see CV #116 in the chapter "Addressing and programming", section "3.23 Configuration of Electric Uncouplers".

### *MX620R, MX630R… with NMRA 8-pin interface (NEM 652):*

The "R" designated decoders come with an 8-pin plug mounted to the end of its wires, which fits in to the socket of a DCC ready loco. Remove the dummy connector from the socket and plug the decoder in its place, that's all.

All the necessary connections to power, motor and headlights are established with this interface. Other outputs have to be hard wired.

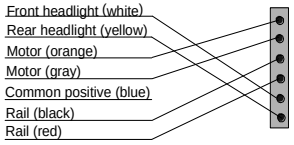



### *MX620F, MX630F… with NMRA 6-pin interface (NEM 651):*

The "F" designated decoders come with a 6-pin plug mounted to the end of its wires, which fits into the socket of a DCC ready loco.

The brightness of the headlight is reduced since the blue wire (common supply) is not part of this interface. The light bulbs get their power directly from the power pick up.

The blue wire is still available at the decoder and can be used if required, but when used on aforementioned bulbs that get power directly from the track (usually through the frame) they must first be isolated from the power source!

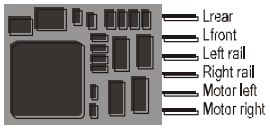



### *MX620N, MX621N - plugs directly into the 6-pin interface (NEM 651):*

Many N, Hoe, HOm as well as some HO engines have this socket installed with the required minimum space of 14 x 9 mm to accept the decoder.

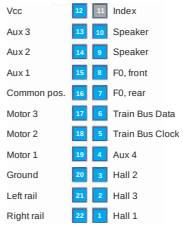
ATTENTION:
Plug the decoder into the socket with the pins down and the **microprocessor on top** (visible)!

**MX620**
**Micro processor side shown**
(connector pins are soldered to **other** side !)

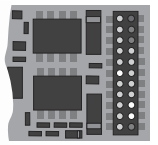


### *MX631D, MX632D, MX632VD, MX632WD, MX640D, MX642D, MX644D MX631C, MX632C, MX640C, MX642C. MX644C - with 21-pin interface:*

These decoders have a 21-pin female plug on the circuit board (no wires), which allows the decoder to be plugged directly in to the 21-pin male receptacle of locomotives equipped with such interfaces. There are actually 22 pins present but one of those pins (#11, top right) serves as a key to prevent wrong installations. The 21-pin interface is standardized by the NMRA-DCC PR 9.1.1., just like the 6 and 8-pin interfaces (see schematic below left).

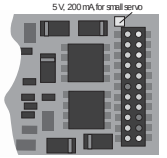



**MX632D, C and MX632 VD, MX632 WD Top Side**



| | |
|---|---|
| + 5 V | Index pin |
| Function output FO3 | n.a. |
| Function output FO2 | n.a. |
| Function output FO1 | Front headlight |
| Common positive | Rear headlight |
| Low voltage (...V, W) | SUSI Data (or FO6, Servo 2) |
| Motor connection 1 | SUSI Clock (or FO5, Servo 1) |
| Motor connection 2 | Function output FO4 |
| Ground | Function output FO5 |
| Left rail | Function output FO6 |
| Right rail | n.a. for capacitor negative (not grour on special reques |

**MX640D Top Side**
(= 21-pin plug side!)




| | |
|---|---|
| + 5 V, 200 mA max. | Index pin |
| Function output FO3 | Speaker |
| Function output FO2 | Speaker |
| Function output FO1 | Front headlight |
| Common positive | Rear headlight |
| n.a. | SUSI Data |
| Motor connection left | SUSI Clock |
| Motor connection right | Function output FO4 |
| Ground | n.a. |
| Left rail | n.a. |
| Right rail | Switch input 1 |

Since the original definition of the 21-pin interface was designed for a certain motor configuration (C-Sinus), some of the pins are not used for the intended purpose (Hall, motor 3) with "normal" applications and are being used for other functions instead.

The "C-Type" decoders MX631C, MX632C, MX640C, MX642C differ from the "D-type" by the function outputs FO3 and FO4: logic level outputs for “C”, normal outputs for “D”.

"C-Type" for Märklin. Trix and LS-models.

**21-pin decoder plugged into loco board, i.e. TRIX**

Plugged in right side up, pins of the loco board penetrate through the decoder board into the socket.

**21-pin decoder plugged into loco board, i.e. BRAWA**

Decoder is plugged in upside down !

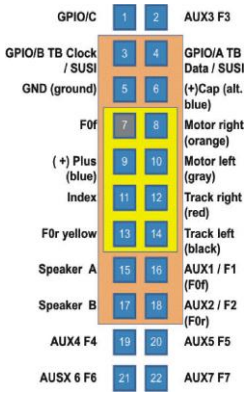
Therefore, depending on decoder configuration, there are slightly different pin configurations on the 21-pin socket connector. These additional outputs can be used only when the vehicle is specially adapted to it. For example, the function outputs FO4 - FO6 and the low voltage supply are also available at other solder pads on the decoder; see the connection diagrams in the chapter “Technical Information”.

Decoders with the 21-pin plug **can be installed in two ways depending on the locomotive;** the board below the connector is perforated, so that, the decoder can be plugged in from the top or bottom end. The index pin 11 prevents a wrong installation by not allowing the decoder to be pushed all the way down.

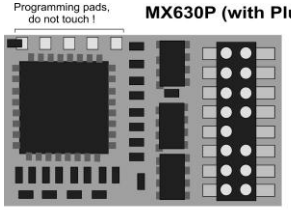
## *MX630P16, MX643P16 and MX643P22… - Decoder with PluX-Connector:*

In contrast to the 21-pin interface (see above), the PluX connection has the male connector mounted on the decoder and the female on the loco board. “PluX” is available with 8, 12, 16 and 22 pin connectors and also use one of the pins for indexing.

The PluX system is defined by the NMRA 9.1.1 and the NEM, including the maximum dimensions for standardized decoders.




**MX630P (with PluX16)**




| | |
|---|---|
| SUSI, Servo‘s (2, 1) or FO6, FO5 | |
| Common (+) | Ground |
| Motor right | Front headl. |
| Motor left | Common (+) |
| Right rail | --- (Index) |
| Left rail | Rear headl. |
| Function output | FO1 FO3 |
| Function output | FO2 FO4 |

The MX630P comes with a 16-pin male plug (15 usable pins, 1 index pin) and can be plugged into engines with 16-pin sockets but also in engines with 22-pin sockets (see drawing at right: brown area accepts 16-pin decoder, total area for 22-pin decoder.

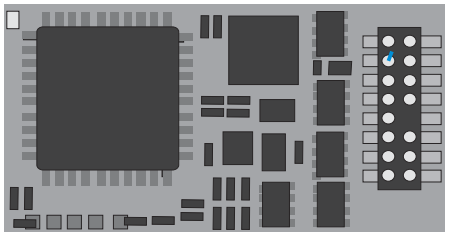
In 8-pin (yellow) and 12-pin equipped locomotives it depends on the available space whether the 16-pin version can be used.

The MX630P, which is not a sound decoder, uses the two pins originally defined for speaker outputs for the additional outputs FO3 and FO4 instead. This will not damage anything even in case the locomotive has a speaker connected to those pins.

Capacitor as energy back-up.
(usually on decoder board and automatically connected via plug)

**MX643P16 Top Side (connector side)**

The SUSI outputs can be used alternatively as servo outputs;

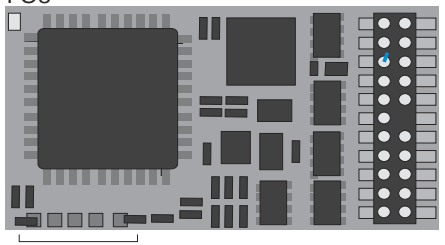



| | |
|---|---|
| SUSI Data (Servo 2) | SUSI Clock (Servo 1) |
| Capacitor positive | Ground |
| Motor right | Front headlight |
| Motor left | Common positive |
| Right rail | — (Index) |
| Left rail | Rear headlight |
| Function output FO1 | Speaker |
| Function output FO2 | Speaker |

**MX643P22 Top Side (connector side)**

The SUSI outputs can be used alternativelyas servo outputs;

FO8




| | |
|---|---|
| Function output Fo3 | Switch input |
| SUSI Data (Servo 2) | SUSI Clock (Servo 1) |
| Capacitor positive | Ground |
| Motor right | Front headlight |
| Motor left | Common positive |
| Right rail | — (Index) |
| Left rail | Rear headlight |
| Function output FO1 | Speaker |
| Function output FO2 | Speaker |
| Function output FO5 | FO4 |
| Function output FO7 | FO6 |

### *Connecting servo and SmartServo motors:*

2 servo control outputs are available on the MX620, MX630. MX632 and MX640 decoders for the control of commercially available servo motors or **SmartServo RC-1** (Manufactured by TOKO Corp. Japan). The servo solder pads or pins on the 21-pin or PluX connector can also be used alternatively for SUSI or as logic level outputs.

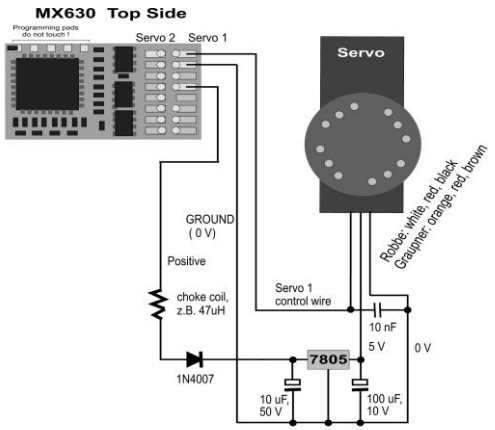
The SUSI and logic level functions are not available if the servo mode is activated (through CV's #181 and 182, see below); this is also true for the function outputs FO5 and FO6 on the MX632.

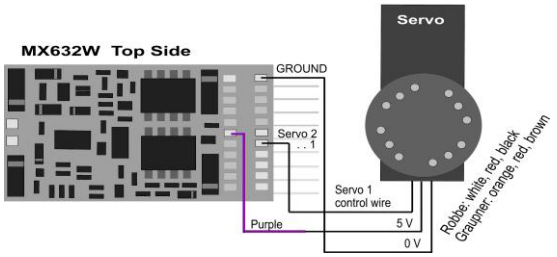
The models **MX632W** and **MX632WD** contain a **5V power supply** to power servos directly; the 5V supply on the MX640 is limited to 200mA.

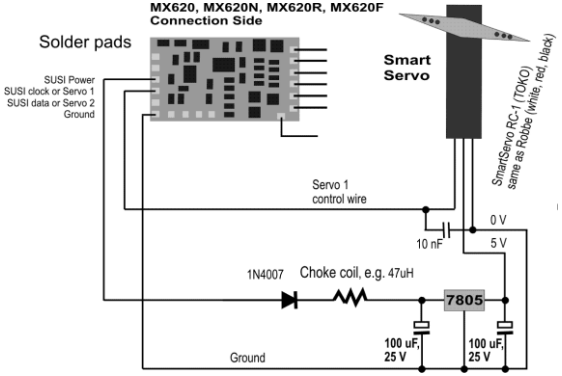
For other decoder types, the 5V must be supplied by an external voltage regulator such as the readily available LM7805; connected as shown in the drawing.

The outputs can be activated for servo control duty with CV's #181 and CV #182 (the value in each must be different than 0).
With the help of CV #181 and #182, the servo functions can be mapped to various function keys (plus direction) and selected for control with either one or two function keys.

CV's #161 to #169 define the servos end positions and rotating speed, see CV table.
CV #161 also defines the appropriate servo protocol. "Normal" for most servos is positive pulses (which is also the default setting); furthermore a selection can be made whether the servo is powered only while it is being moved or remains powered at all times. The latter should only be used if the servo position could change by outside mechanical influences.




### *Connecting MX640 and MX642 to servo and SmartServo motors:*

Two servo connections are provided on the MX640 for commercially available servos and SmartServo RC-1 (Manufacturer: TOKI Corp., Japan). These are normally the **SUSI outputs** but can also be used **as servo outputs** instead. The connections are in the form of either solder pads or part of the 21-pin socket, depending on the decoder type. Each output can be connected directly with a servo input.

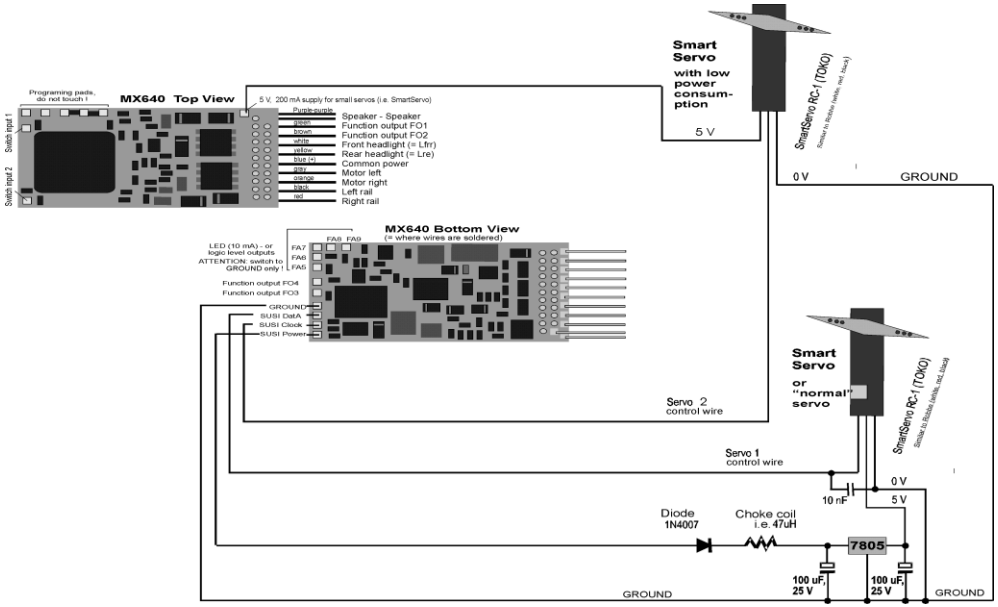
"Energy-saving" servos (max. 200mA) can be powered directly by the MX640!

For servos with higher energy consumptions, the 5V operating voltage must be supplied by an external voltage regulator such as the readily available LM7805 as shown in the drawing.

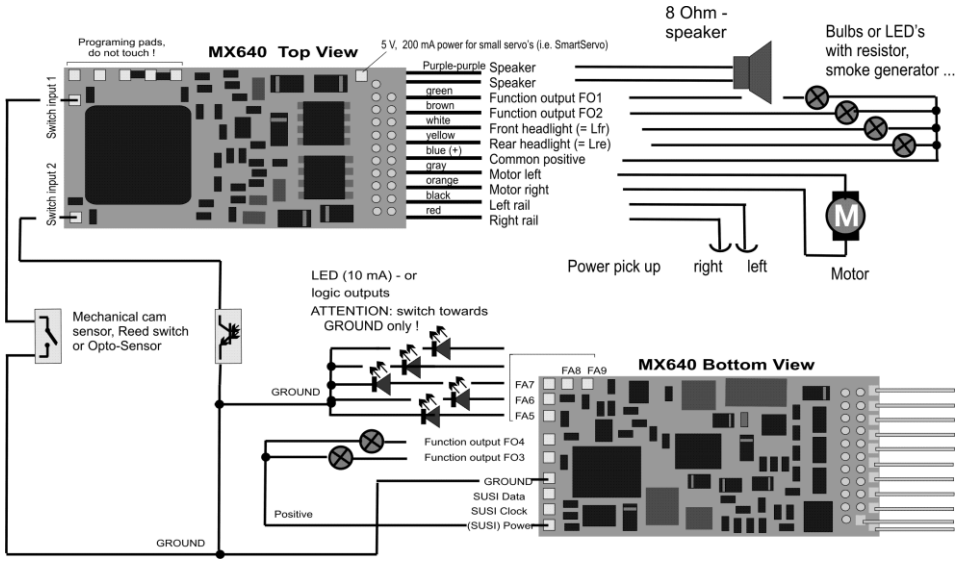
The outputs can be activated for servo control duty with CV's #181 and CV #182 (the value in each must be different than 0). With the help of CV #181 and #182, the servo functions can be mapped to various function keys (and direction) and selected for control with either one or two function keys.

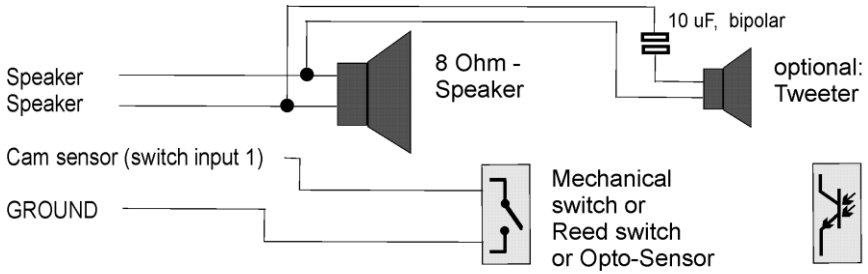
CV's #161 to #169 define the servos end positions and rotating speed, see CV table.

The appropriate servo protocol can be selected with CV #161. "Normal" for most servos is positive pulses (which is also the default setting); furthermore a selection can be made whether the servo is powered only while it is being moved or remains powered at all times. The latter should only be used if the servo position could change by outside mechanical influences. For the **SmartServo:** Bit 1 of CV #161 must always be set, that is CV #161 = 2!



### *MX640… – Complete Schematic including Sound Connections*




### *MX642, MX644, MX645 …*

More recent sound decoder versions are to be wired the same way, except that

- ground, switch input and common power are on solder pads on the top side or common power from the blue wire and
- only 2 LED outputs (MX642) or none are available, which can be used alternatively to the SUSI pads on the top side solder pads.

*Also see the decoder schematics on the first pages of this manual.*

### *Connecting speaker, cam sensor:*

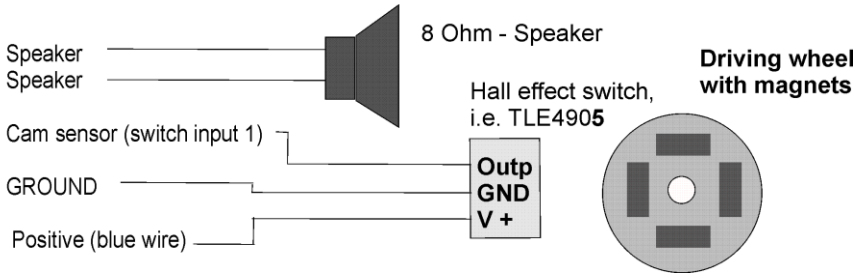
In order to operate the MX640 as a sound decoder, the following items must/may be connected:

- mandatory – SPEAKER – Any 8-ohm speaker or two 4 Ohm speakers connected in series can be used. Speaker with higher impedance are also allowed but will result in reduced volume.

An additional tweeter (also 8 ohms or higher) can be connected, if desired; the connection should be made via a bipolar capacitor (10 uF bipolar for 2 kHz frequency).

- optional – ***CAM SENSOR –*** Normally, ZIMO decoders are programmed for the "virtual cam sensor", which can be fine-tuned with CV #267 and CV #354. If a real cam sensor is to be used, the settings of CV #267 must be changed to 0 or 1 depending whether each pulse or every second pulse should trigger a chuff beat. See chapter 6!

Mechanical contacts, Reed switches, optical switches and Hall Effect switches are suitable as cam sensors.



### *Connecting an external energy source (capacitor) for uninterrupted driving on dead track sections:*

Energy storage devices connected to the decoder have many benefits; even very small capacitors as of 100uF have positive effects, larger ones even more so:

- Prevents stalling and flickering lights on dirty track sections or frogs, especially in conjunction with the ZIMO "smart stopping" feature (requires at least 1000uF to be effective)
- Lowers decoder operating temperature especially with low-impedance motors (at least 100uF)
- when RailCom is used:
  Eliminates the energy loss created by the "RailCom gap", reduces motor noise caused by Rail-Com and improves the quality (= legibility) of the RailCom signal (at least 100uF)

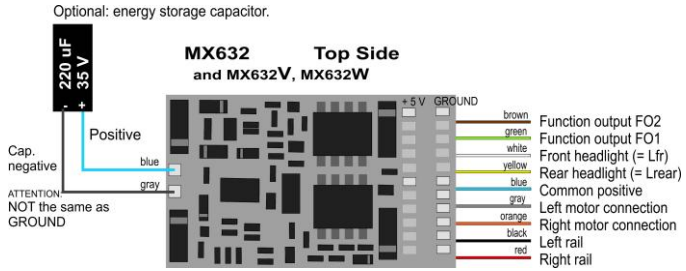
The required voltage strength of the capacitor is given by the track voltage; 25V is suitable for all cases. Smaller 16V capacitors should only be used if track voltage will never be higher than that.

A simple connection between the decoder and ground is not advisable because of undesired side effects: Software updates, sound installation, programming in Service Mode and the ZIMO loco number identification feature can be negatively influenced or may not work at all.

## Decoders prepared for direct capacitor hook-up:

Among the decoders described in this manual, only the **MX631, MX632** and the sound decoder **MX642, MX643, MX644 and MX645** have the necessary components on board for a **direct connection,** without the need of additional external components

.

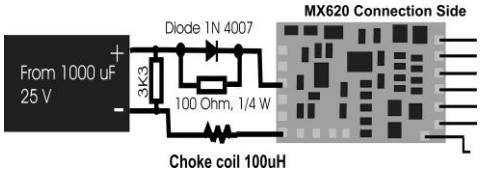


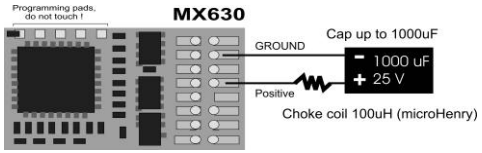

This decoder comes with a small capacitor (220uF) to get you acquainted with the energy storage technique. Larger capacitors of up to 10'000uF are recommended and are readily available (also from ZIMO if necessary) and can simply be connected in parallel. A series of gold caps can also be used (i.e. 8 gold caps at 2.5V each connected in series).

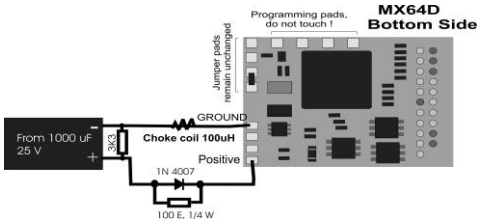
## Decoders **not** prepared for direct capacitor hook-up:

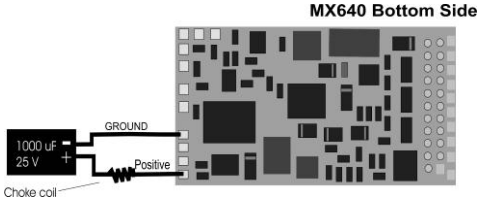
Here, a simple connection of a capacitor between the decoder's ground and common positive is not advisable, since it could lead to undesired side effects: Software updates, sound installations, programming in service mode (on the programming track) and the ZIMO loco number identification will be more difficult or even impossible. This applies to the decoders **MX620, MX621 and MX630** as well as the sound decoders **MX640, MX646 and MX647,** which require additional external components to be added by the user in order to prevent above mentioned side effects.

Capacitor sizes of up to 220uF (possibly even up to 470uF) only need a choke coil (100mH / 100mA, also available form ZIMO) to enable decoder firmware updates with the MXDECUP update module and ZIMO's loco number identification pulses.



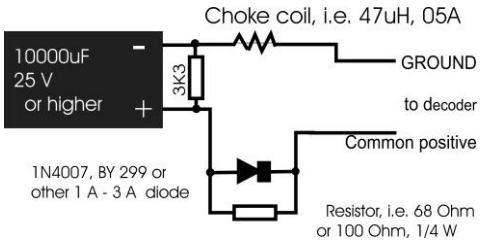




If larger capacitors are used, which is actually a good idea, the circuitry should be expanded. The condenser in these cases is recharged through a 100 ohm resistor. This is necessary so that the command station doesn't interpret the high in-rush current during boot-up, caused by charging up those capacitors, as a short circuit when a large number of loco's so equipped are on the layout. The diode (e.g. 1N4007) is required to bypass the resistor when power is needed by the decoder.

NOTE: If signal stops by "asymmetrical DCC signal" (= Lenz ABC, implemented in ZIMO decoders early 2005) is employed, the resistor-diode combination is necessary in any case (even when using small capacitors) to ensure that the decoder can detect the asymmetry of the signal!

Please use the schematic below as a guide when building your own energy storage circuit. The resistor shown (100 Ohm, ¼ W) and the diode (1N4007) are required for the reasons mentioned above.




The 3300 Ohm resistor shown in the drawing above (not absolutely necessary) serves the following purpose:
Even though a large capacitor supplies the motor and lights for just a few tenths of a second (1000uF) or a few seconds (e.g. 4700uF), the remaining energy keeps the decoder memory alive for several minutes, although the voltage dropped below the level required to drive the motor and/or lights. This is sometimes a rather undesired effect. For example: If a running loco is taken from the track and the speed afterwards set to zero, the loco would briefly run at the previous speed when it

is set back on the track within a minute or so. Using the above-mentioned resistor would erase the memory after just a few seconds.

ZIMO offers a collection of components under the part number **SPEIKOMP** that are needed when building a do-it-yourself energy module for ZIMO MX620, MX63, MX64, MX630 and MX640 decoders. The set contains a diode, resistors, choke coil and a few capacitors (larger capacitors supplied by the user can and should be used if sufficient space is available inside the engine).

## Smart stop management on “dead” track sections:

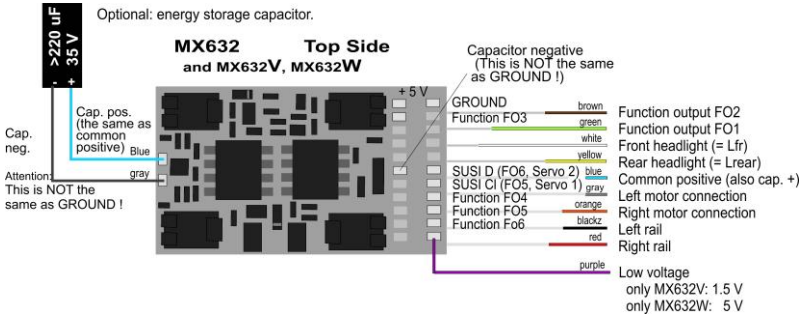
If power to the decoder is interrupted due to dirty rails, wheels or insulated frogs, the decoder automatically keeps the engine going even if the engine is supposed to come to a stop. The engine is allowed to come to a full stop as soon as power to the decoder is restored. With the engine stopped the decoder tests again for track power and if needed moves the engine another very short distance until track power again is restored. Power for the engine during “smart stopping” is of course coming from the capacitor. This prevents a situation where an engine is parked on dirty track and later can’t drive away, due to normal internal power dissipation of capacitors over time.

## *MX632V, MX632W, MX632VD, MX632WD - the special MX632 design with built-in low voltage supply*

These decoders contain an efficient **1.5V** or **5V regulator,** which can be directly connected to low voltage bulbs. The low voltage is available at the purple wire and is used for the corresponding loads in place of the “common positive” (blue) wire.

MX632V and MX632VD (1.5V) decoders facilitate the installation considerably especially in high quality brass models (which are often equipped with such bulbs), because it eliminates the installation of an external voltage regulator (that often requires some sort of heat dissipation).

MX632W and MX632WD (5V) decoders are primarily meant for large scale engines (i.e. LGB) that are often equipped with 5V bulbs. The 5V supply can also be used to drive servos, which eliminates the need for an external voltage regulator.




## *MX640, MX642, MX643, MX644, MX645, MX646 - connecting smoke generators to steam and diesel engines:*

***With a “Seuthe” 18V smoke generator as example:***

In addition to a simple ON/OFF function with a function output of your choice, the MX640/MX642 is also capable to adapt the smoke **volume** to the **load** (almost no smoke at **standstill**, little smoke at **cruising**, heavy smoke at **start-up** etc.).

This requires the smoke generator to be connected to one of the function outputs **FO1** to **FO6** and the selected output must be programmed with the associated special effect CV (with CV #127 for FO1, CV #128 fir FO2 etc.) for the desired effect; in this case for load dependent smoke for steam engines (effect code “72”) or load dependent smoke for diesels (effect code “80”).

EXAMPLE: - Steam engine, smoke generator connected to function output FO5: CV #131 = 72.

The selected function output is further defined by CV #137, 138 and 139 (“Definition of smoke generator characteristic”). These CV’s must be programmed with appropriate values otherwise the smoke generator will not produce any smoke.

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

CV #137 = 70…90: little smoke at standstill.

CV #138 = 200: The smoke generator output is increased to about 80% of its maximum capacity beginning with speed step 1 (lowest speed step), which produces relatively heavy smoke.

CV #139 = 255: The smoke generator is driven to its maximum, which results in thick smoke under heavy acceleration.

***Synchronized steam chuffs or typical diesel smoke with fan-controlled smoke generators:***

The MX640, MX642, MX645….. can produce steam puffs, with the help of a smoke generator with built-in fan, that are synchronized with the chuff sound or load dependent diesel smoke (i.e. diesel engine smoke at start-up, controlled by the sound project) without additional electronic components.

The heating element of the smoke generator is connected – as in the example above with the “Seuthe” generator – on **FO1…FO6** 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 function output **FO4** (with **MX620-MX632** and **MX646 FA2)**; the other wire of the fan motor often requires a low voltage (check with the manufacturer) and is therefore connected to an external voltage regulator or to the 5V supply of the decoder, if 5V is suitable for the fan motor.

The CV’s must be programmed as follows:

CV #137, #138, #139 = 60, 90, 120 respectively: (IMPORTANT) if the heating element cannot operate at full track voltage; the voltage at the function output must be limited, which is done with suitable values in CV #137, 138 and 139.

CV #133 = 1: (IMPORTANT) this configures output FO4 as a fan output.

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 special effect code “80” is selected in the applicable CV for FO1…FO6. This defines the fan speed (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 (voltage) at standstill (usually for very little smoke output).

# 7 MX631C, MX632C, MX640C, MX642C for C-Sinus (Softdrive)

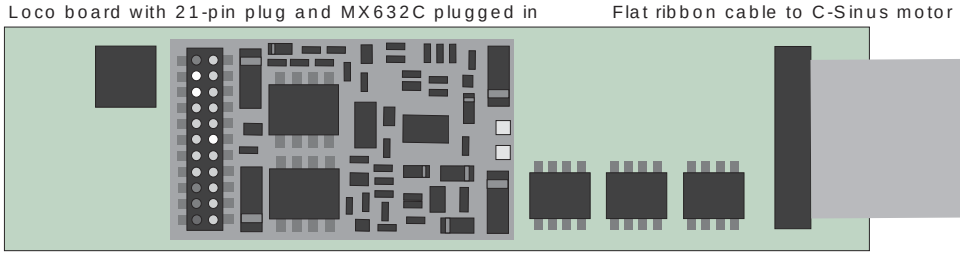
The **MX631C, MX632C, MX640C** and **MX642C** are made especially for Märklin and Trix engines with **C-Sinus motors** and are equipped with a 21-pin interface. The decoder also **supplies** the necessary **5V** the C-Sinus board needs to operate (which „normal“ decoders are not capable of!).

The C-type decoder can be used, regardless of the type of motor, for **Märklin, Trix and Märklin compatible** engines which cannot process normal functions on function output FO3 and FO4, but require logic level outputs instead.

The C-type decoders differ from the normal 21-pin plug (MX631D, MX632D, MX640D, MX642D) in the use of output pins FO3 and FO4. The D version has normal (amplified) outputs on these pins while the C version has logic level outputs. These logic level outputs supply the needed 5V for activating the C-Sinus or Softdrive loco board or for the selection between the front to rear power pick-up, which is installed in many vehicles.

The MX631C, MX632C (or MX640C, MX642C sound decoder) is plugged into the pins of the loco board with the top side of the decoder pointing up, whereby the pins are being pushed through the decoder board in order to make contact with the decoder socket. The position is given by the loco board and is also keyed by the missing pin 11 (on the loco board) and missing hole in the same location on the decoder board.

The picture below shows a sample layout; the loco board may however vary from case to case.




Before plugging in the decoder, check the C-Sinus board whether it contains **0-Ohm resistors; see CAUTION on the next page!!**

MX631C, 632C and MX640C, MX642C are “normal” decoders for “normal” motors except for the function outputs FO3 and FO4, which can be switched to **C-Sinus motor control** by programming: **CV #145 = 10** if the engine originally came with a Märklin/Trix decoder or **CV #145 = 12** if the original decoder was from ESU (recognizable by a blue circuit board).

With the help of **CV #145** the decoder can also be configured for some special versions, which becomes necessary due to different decoder interface layouts on the part of Märklin/Trix, see CV table!

Locomotives equipped with C-Sinus capable ZIMO decoders can be operated in the **NMRA-DCC-data format** as well as the **MOTOROLA protocol,** but not in analog mode (DC)!

No motor regulation, known as BEMF, takes place when the decoder operates in the C-Sinus mode, since the motor tries to keep the target speed precisely in all situations. The relevant configuration variables, among them CV #9, #56 and #58, are without effect!

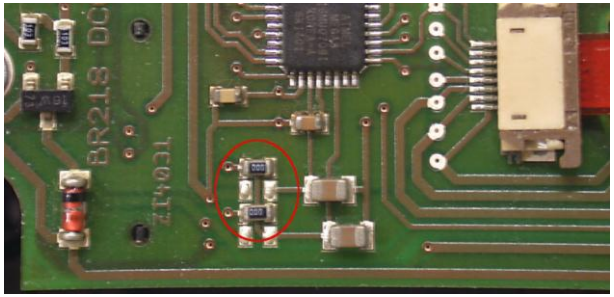
## *CAUTION:*

Unfortunately, Märklin/Trix has played a “dirty trick” (although probably not on purpose): Beginning with a specific model or past a certain date, the protective resistors on the loco board input side have been omitted, or more precisely, instead of the 100kO resistors useless **0 Ohm resistors** are being installed. The resulting voltage is too high for the loco board which will not only destroy the board but can also damage the decoder, unless the decoder has been switched to the C-Sinus mode before being plugged in with CV #145 = 10 or 12.

**But even if CV #145 = 10 or 12 is set first, there is no guarantee that the loco board with 0 Ohm resistors will survive in the long run (even though there is no visible problem at the moment)!**

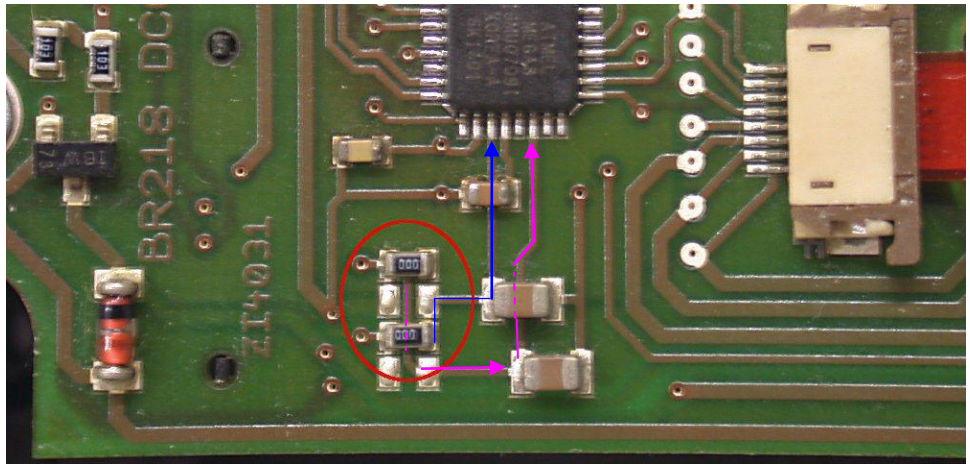
Background information: Although the 21-pin interface in Märklin and Trix locomotives is virtually identical to the standardized NMRA-DCC 21-pin interface, Märklin keeps modifying it whenever the need arises (several versions, “misapplication” of function outputs for motor activation and now the mentioned electrical input changes); their own brand decoder is the only one that is being taken into account through all this. The installation of other brand decoders is obviously not desired…

***CORRECTIVE MEASURE:*** The **MX631C, MX632C** or **MX640C, MX642C must not** be installed if **zero-ohm resistors** (markings **“000”**) are found on the loco board in place of actual protective resistors (markings “104”). It is imperative that these are being replaced with **100KO resistors (“104”)** before installing the decoder. Relevant ZIMO decoders will be shipped with the necessary resistors.



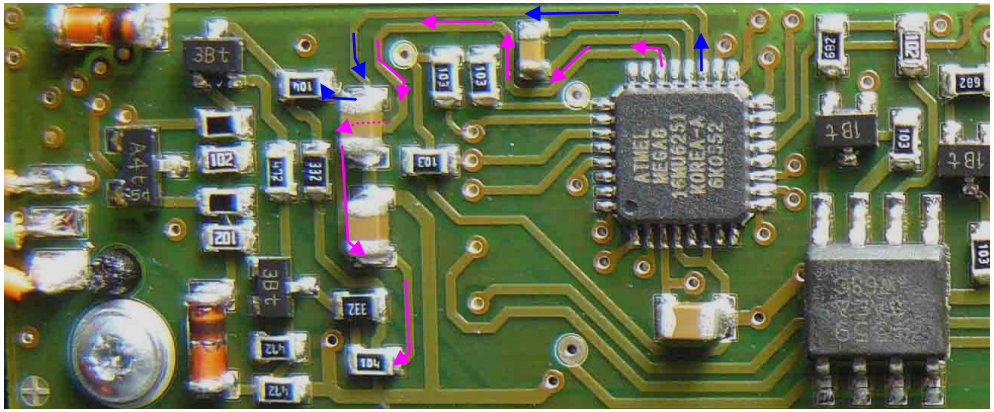
Above is a picture showing a loco board with the useless (“000”) resistors; in such cases it is not allowed to plug in a MX631C, MX632C… decoder!

Due to the many different C-Sinus boards that have been produced it is impossible for us to provide precise information about the location of these resistors on each board. Because the resistors may be mounted in different locations on the board in your engine, we would suggest that you find them by following the traces. First study the picture below. The blue and pink arrows are pointing out the traces that connect these resistors with the processor. Note the processor pins those tracers are leading to.




Next find the same pins on the processor of your board and follow those traces carefully. They should lead to resistors marked as either “104” or as “000” (see below). If they are “104” proceed with the decoder installation. If they are marked as “000” they have to be replaced before the decoder is installed.

This picture shows a different Märklin C-Sinus board and how the resistors in question can be located by following the traces back from the controller pins.




## CAUTION II – Disclaimer of Liability

Märklin/Trix obviously is not concerned about compatibility of their locomotives with third-party products. The interfaces are being changed often and without notice. ZIMO cannot guarantee that the information given in this manual regarding connection and programming/operating procedures are correct in all instances and cannot assume liability for damages to loco boards and/or decoders as a result of such circumstances.

# 8 ZIMO decoders and competitor systems

All Zimo decoders comply with NMRA standards and recommended practices and can be used on layouts with other brands of NMRA compliant systems.

What most systems of other manufacturers have in common, in contrast to ZIMO systems, is that track power is not stabilized or only partly stabilized and often relatively weak (in regards to voltage but amperage as well). This can lead to uneven speeds and/or limited top speed because Zimo decoders are of course programmed by default to operate on stabilized and regulated track power from a Zimo command station of up to 24V.

It is recommended in such cases to:

- change **CV #57** (reference voltage) from ”0” (automatic regulation based on given track voltage) to a fixed voltage. For example: “140” for a DCC system with a typical track voltage of 16 - 18V. In this case 14V will be used as reference, which leaves a certain safety margin during voltage drops.

Does not apply to MX62 decoders, where a fixed value is always used.

## *ZIMO decoder with Lenz “DIGITAL plus” from software version 2.0*

This system uses 28 speed steps beginning with version 2.0 and 128 steps with version 3.0 and up. It also programs in direct mode according to NMRA DCC standards and is therefore fully compatible with Zimo decoders.

All Zimo decoders are set to 28 speed steps by default. Make sure the system is also set to 28 steps for the decoder address in question. Incompatibility will be the result if the speed steps between decoder and system do not agree with each other; which is most often noticed by non-working headlights. It would only make sense to switch the system from 14 steps to 28 or 128 speed steps rather than setting the decoder back to 14 steps, which would result in unnecessary poor drivability.

All configuration variables are accessible; see the cab manual in question for programming procedure. The address is located in the registry’s position #1.

The configuration variables #49 to #54 will have no effect, since the signal controlled speed influence is only supported by Zimo systems.

## *ZIMO decoder with ROCO Lokmaus-2*

Although the Lokmaus-2 allows CV programming, its display is limited to two digits only and therefore limits the number of CV’s and their values to 99.

Zimo decoders offer a special pseudo-programming feature with CV #7 (that normally stores the software version number) to allow unrestricted programming. It is called pseudo-programming because the permanently stored value in CV #7 cannot be overwritten but rather holds a temporary value that allows the Lokmouse2 to be used for expanded programming capabilities (see CV table); the engine must not be running during the programming procedure!

Example:

To enter a value of 160 (which is not possible with a Lokmouse-2 because value is >99) to CV #5 (max. speed) proceed as follows:

First program CV #7 to 1, followed immediately by setting CV #5 to 60. No power interruptions between those steps are allowed. Explanation: The value 1 in CV #7 actually 01 (tens digit=0 and ones digit=1) causes the decoder to add 100 to the CV **value** that will be entered in the next programming step. Therefore, a value of 60 entered to CV #5 with the Lokmouse2 is stored as 160!

Example:

To program CV #122 (exponential deceleration), for example, with a value of 25 do the following:

Again, go to CV #7 and enter a value of 10, then go to CV #22 and enter a value of 25.

Explanation: CV #7 = 10. The 1 in the tens digit causes the decoder to add 100 to the CV **address** in the following programming step. As a result, CV #122 will be programmed instead of CV #22!

## *ZIMO decoder with DIGITRAX Chief*

No problems expected with this system!

The Digitrax system usually operates at 28 or 128 speed steps. If for some reason the headlights don’t work, confirm that indeed the system and the decoder are set to the same number of speed steps and if necessary, change the speed steps at your cab to 28 or 128 steps.

# 9 Predefined CV - Sets

The following described CV sets are available from software version 27.0, but **only in non-sound decoders,** like the MX620, MX621, MX630, MX631 and MX632. More CV sets will be added with future software versions.

There are no CV sets available for sound decoders (at least not until July 2010); the corresponding task is performed by CV lists within the sound projects.

CV sets are prepared lists of CV values that are embedded in the decoder software; when desired, one of these lists can be activated by a "pseudo-programming" of CV #8.

Decoders delivered as **"normal" decoders** don't have any of the existing lists activated. All CV's contain the normal values as shown in the CV tables as default. However, an existing CV set can be activated with the "CV #8" procedure (see below).

Decoders delivered as "**OEM" decoders,** i.e. decoders installed by the loco manufacturer, usually have the correct CV set activated. The decoder can be set back to the "normal" (default) values if desired, with the "CV #8" procedure (see below).

### *The existing CV sets as of OCTOBER 2010:*

CV set, activate with **CV #8 = 10**
for **ROCO ICN** non-sound version with factory installed MX630P16. Deliveries began in August 2010.

| | | |
|---|---|---|
| CV # | 2 = 4 | Lowest speed step set for jerk free running of the ICN |
| | 3 = 6 | Acceleration |
| | 4 = 2 | Deceleration |
| | 5 = 252 | Top speed setting corresponds to default setting. |
| | 6 = 85 | Medium speed (speed curve) |
| | 9 = 95 | Motor regulation: High sample rate to prevent jerky behavior |
| | 10 = 128 | CV's #10, 113, 150 are set for full regulation up to top speed |
| | 29 = 6 | Analog operation activated, RailCom turned OFF |
| | 56 = 33 | PID-Control (BEMF) optimized for ICN |
| | 105 = 161 | ROCO ID code |
| | 106 = 1 | ROCO ID code |
| | 113 = 255 | CV's #10, 113, 150 are set for full regulation up to top speed |
| | 122 = 31 | Exponential braking (non-linear deceleration for smoother stops) |
| | 144 = 128 | Update lock to prevent accidental disruptions |
| | 146 = 30 | Gear back-lash compensation at direction change (ensures smooth starts) |
| | 150 = 255 | CV's #10, 113, 150 are set for full regulation up to top speed |

CV set, activate with **CV #8 = 11**
created for locomotive manufacturer **HAG**, Decoder MX631D, as of June 2010.

| | | |
|---|---|---|
| CV # | 3 = 3 | Acceleration |
| | 4 = 2 | Deceleration |
| | 9 = 88 | Motor regulation: High sample rate and long sample time |
| | 13 = 1 | FO1 is turned ON in analog mode |
| | 56 = 61 | Low integral value in PID regulation (BEMF) |
| | 58 = 170 | Reduced motor regulation |
| | 112 = 36 | Motor control frequency set to 40 kHz |
| | 124 = 128 | SUSI deactivated; both connections are used as logic-level function outputs |
| | 152 = 64 | FA3, FA4 used for directions bit, for the control of ESU wiper reversing switch |

CV set, activate with **CV #8 = 12**
created for **Hobby-Trade**, Decoder MX631D, as of October 2010.

| | | |
|---|---|---|
| CV # | 3 = 15 | Acceleration |
| | 4 = 8 | Deceleration |
| | 6 = 120 | Medium speed (Speed curve adjustment) |
| | 35 = 12 | Function assignment |
| | 35 = 48 | Function assignment |
| | 124 = 2 | Acceleration and deceleration momentum to be reduced to ¼ of CV #3 and 4. |
| | 127 = 2 | Directional taillights |
| | 128 = 1 | Directional taillights |
| | 129 = 170 | Direction dependence for other equipment |
| | 130 = 36 | Direction dependence for other equipment |
| | 155 = 4 | Half speed (low gear) with F4 |
| | 156 = 4 | Momentum deactivation with F4 |

CV set, activate with **CV #8 = 13**
created for **Hobby-Trade**, Decoder MX631C ("Märklin" style or ESU design), as of October 2010.

| | | |
|---|---|---|
| CV # | 3 = 10 | Acceleration |
| | 4 = 7 | Deceleration |
| | 35 = 0 | No action with function key F1 |
| | 36 = 0 | No action with function key F2 |
| | 37 = 0 | No action with function key F3 |
| | 61 = 97 | Standard function mapping replaced by the one without left-shift. |
| | 124 = 4 | Acceleration and deceleration momentum to be reduced to ¼ of CV #3 and 4. |
| | 155 = 4 | Half speed (low gear) with F4 |
| | 156 = 4 | Momentum deactivation with F4 |

### *The "CV #8" – procedures for handling of CV sets:*

Normally, the CV #8 contains the manufacturer identification number, in ZIMO's case that would be "145". That value cannot be changed, and is the reason why this CV can also be used for pseudo programming (pseudo because the entered value is not really saved) to execute various actions.

CV #8 is about a decoder's HARD RESET (which is standardized for all decoders) as well as the CV set handling (only for ZIMO decoders).

**CV #8 = xx** (xx = Number of the desired CV set); a HARD RESET will be performed, where all CV's part of a CV set are set back to the "CV set default" values, and the remaining CV's to the default values of the decoder (according to the CV table in this instruction manual).

**CV #8 = 8** (this is the NMRA standard reset); all CV's are restored to the values of the previous hard reset, i.e. the same CV set is reused as with the previous "CV #8 = xx" command; the remaining CV's once again restore to the decoder's default values.
This is also the correct HARD RESET for OEM cases, where a ZIMO decoder was installed by the loco manufacturer and the correct CV set was activated at that time.

CV #8 = 8 is therefore the "normal" HARD RESET if one wants to return to the starting point because programming errors have been made, for example.

**CV # 8 = 0** (this is one of ZIMO's own command); all CV's are reset to the default values, regardless of any previously active CV sets.

Individual CV's can of course be programmed differently at any time, even after a CV set has been activated.

# 10 Converting binary to decimal

If, according to the CV table, a CV calls for setting individual bits (which is the case with CV #29, 112 and 124, for example) proceed as follows:

Each bit has a specific value:

Bit 0 = 1
Bit 1 = 2
Bit 2 = 4
Bit 3 = 8
Bit 4 = 16
Bit 5 = 32
Bit 6 = 64
Bit 7 = 128

The decimal values of all bits of a CV that are supposed to be set are added up (Bit... = 1 in the CV-table). All other bits (Bit....= 0) are ignored. Note that bits are numbered from right to left.

Example:

Bit 0, 2, 4 and 5 are supposed to be set (Bit...=1); but not Bit 1, 3, 6 and 7 (Bit…=0).

This results in a bit-set of 00110101and a decimal value of:

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |

0 + 0 + 32 + 16 + 0 + 4 + 0 + 1 = 53 (decimal value)

The calculation in reverse:

A trial and error method is used to determine individual bits from a decimal figure: start with the largest value. If a number is larger or equal to 128 then Bit 7 = 1. If the remaining number is larger or equal to 64 then Bit 6 = 1 and so on.

Example:
The decimal figure of 53 is neither larger or equal to 128, nor larger/equal to 64 but is larger than 32. Therefore Bit 7 = 0, Bit 6 = 0 but Bit 5 = 1; the rest of 21 (53 - 32 = 21) is larger than 16 (Bit 4 = 1), the remaining 5 (21 - 16 = 5) is not larger than 8 but is larger than 4 (Bit 3 = 0, Bit 2 = 1), and finally 1 (5 - 4 = 1) is not larger/equal to 2 but is equal to 1 (Bit 1 = 0, Bit 0 = 1).

# 11 Operating with Märklin MOTOROLA Systems

Using the MOTOROLA mode of a ZIMO decoder makes only sense if the system used is not capable of operating in the DCC format. DCC is substantially more powerful and should be the preferred protocol with a multi-protocol system.

The MOTOROLA data format is recognized automatically by the decoder.

Addressing and CV programming is possible with the current **Mobile Station** as well as the **Märklin 6021 command station.** The procedure in the first case is automated and easy to do (see operating manual of the Mobile Station); with older systems however it is very tedious (because this system doesn't provide much help):

*Instruction for CV programming with the Märklin 6021 central unit:*

*Start the programming mode by:*

*1. selecting the address of the engine to be programmed*

*2. press the "STOP" key at the central unit and wait a few seconds*

*3. Crank the speed regulator past the left stop and hold (direction switch)*

*4. press the "START" key*

*5. release the speed regulator*

*The front headlight of the engine should now be flashing once per second indicating that the decoder is in the programming mode.*

*You can now choose between two programming modes:*

*1. Short mode: programming is limited to CV's 1 – 79 and a value range from 0 – 79*

*2. Long mode: the values to be used in each case are split and transmitted in two steps (CV 1-799, value range 0-255)*

*The short mode is always active after entering the programming mode.*

*To change to the long mode write 80 to CV #80 (enter address 80 and change direction twice to change to the long mode).*

- ***Short mode:***

  *Enter the CV to be programmed in the central unit as an address and briefly operate the direction switch.*

  *The headlight now quickly flashes twice.*

  *Now enter the desired value for the selected CV and again operate the direction switch briefly (enter 80 for a value of 0).*

  *The headlight flashes once indicating that you can program the next CV or end the programming by turning the track power off.*

- ***Long mode:***

  *Remember to set address 80 for a value of 0!*

  *Enter the hundreds and tens digit in the central unit of the CV you want to program. For example: for CV 123 enter 12 and operate the direction switch.*

  *The headlight now quickly flashes twice.*

*Now enter the ones digit of the same CV (for example: for CV 123 enter 03) and operate the direction switch again.*

*The headlight briefly flashes 3 times.*

*Enter the hundreds and tens digit in the central unit for the value you want to program and operate the direction switch.*

*The headlight briefly flashes 4 times.*

*Now enter the ones digit of the value and operate the direction switch again.*

*Again, the headlight flashes once indicating that you can program the next CV or end the programming by turning track power off.*

# 12 DC – Analog Operation

ZIMO decoders switch automatically to analog when DC voltage is present and CV #29 is set accordingly (Bit 2 = 1, which is the default setting).

Operation is possible with various power packs:

- "normal" DC throttles, with poor or no ripple control
- smooth power from a power supply unit
- PWM throttles such as the Roco analog mouse.

The following CV adjustments are possible for analog operation:

⇨ CV #14, Bit 7 = 0: Analog operation without motor regulation
Bit 7 = 1: Analog operation with motor regulation (is of particular value with\ sound; for example: that the chuff frequency fits the wheel movements)

⇨ CV #14, Bit 6 = 0: Analog operation with momentum as per CV #3 and 4.
Bit 6 = 1: Analog operation without momentum.

⇨ CV #13, CV #14: Select function outputs that should be ON in analog mode.

SUGGESTION: With extensive analog operation it is recommended to use the **update lock CV #144, Bit 7, for example: CV #144 = 128,** to avoid interference and poor performance!

# 13 AC – Analog Operation (AC-Transformer)

ATTENTION: Decoders of the **MX621 family** (miniature decoder) and **MX640** (older sound decoders) **do not** have the dielectric strength to cope with the surge pulses (>30V) required for direction change, as is used in the classic AC operation!

# 14 CV – Summery List

This list summarizes all CV's in numerical order, with very short descriptions (as a reminder). **Detailed information** can be found in the **preceding chapters** ("Configure", "ZIMO Sound").

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #1 | Short address | 1 – 127 | 3 | The "short" address; active when Bit 5 in CV #29 is 0. |
| #2 | Start voltage | 1 - 255 | 1 | Internal speed step for **lowest** external speed step. |
| #3 | Acceleration rate | 0 - 255 | (2) | Multiplied by 0.9 equals' acceleration time. |
| #4 | Deceleration rate | 0 - 255 | (1) | Multiplied by 0.9 equals' deceleration time. |
| #5 | Top speed | 0 - 255 | 1 (=255) | Internal speed step for **highest** external speed step. |
| #6 | Medium speed | 32 - 128 | 1 (=1/3 # 5) | Internal speed step for **medium** external speed step. |
| #7 | SW-Version number | Read-only | - | The current SW number; for subversion see CV #65. |
| #8 | Manuf.-ID, Reset, Set | 0, 8, Set # | 145 (ZIMO) | given by the NMRA; CV #8 = 8 → Hard Reset. |
| #9 | Motor regulation. | 1 - 255 | 55 | Sample time (tens digit), sample rate (ones digit) |
| #10 | Compensation-Cutoff | 0 - 252 | 0 | Internal speed step, where BEMF intensity per CV#113. |
| #11 | ------ | | | |
| #12 | ------ | | | |
| #13 | Analog functions F1 - F8 | 0 - 255 | 0 | Select analog functions F1 (Bit 0), F2 (Bit 1)... |
| #14 | Analog funct. F0, F9 … | 0 - 255 | 0 | Select analog functions, F0 forw (Bit 0), rev (Bit 1)... |
| #15 | ------ | | | |
| #16 | ------ | | | |
| #17,18 | Extended address | 128 -10239 | 0 | The long address. Active when CV #29, Bit 5 = 1. |
| #19 | Consist address | 0 - 127 | 0 | Consist address active when > 0. |
| #21 | Consist function F1 - F8 | 0 - 255 | 0 | Select consist functions F1 (Bit 0), F2 (Bit 1)…. |
| #22 | Consist function F0 | 0 - 3 | 0 | Select consist function F0 forw (Bit 0), rev (Bit 1). |
| #23 | Acceleration variation | 0 - 255 | 0 | For temporary adjustment to CV #3 |
| #24 | Deceleration variation | 0 - 255 | 0 | For temporary adjustment to CV #4 |
| #25 | ------ | | | |
| #26 | ------ | | | |
| #27 | Asym. Stop (ABC) | 0, 1, 2, 3 | 0 | Bit 0 = 1: Stop, with right rail Bit 1: left rail |
| #28 | RailCom Configuration | 0, 1, 2, 3 | 3 | Bit 0 = 1: RailCom (Broadcast) Bit 1 = 1: Data |
| #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<br>Bit 1 – Speed step system: 0 = 14, 1 = 28, 128<br>Bit 2 – Automatic analog operation<br>Bit 3 – RailCom: 0 = OFF, 1 = ON<br>Bit 4 – Speed curve: 0 = 3-point, 1 = free definition<br>Bit 5 – Short/long address: 0 = CV #1, 1 = CV's #17,18 |
| #33 | NMRA Function map F0 | 0 - 255 | 1 | Function mapping for F0 forward |

| CV | Designation | Range | Default | Description |
|---|---|---|---|---|
| #34 | NMRA Function map F0 | 0 - 255 | 2 | Function mapping for F0 reverse |
| #35-46 | Function mapp. F1 - F12 | 0 - 255 | 4,8,2,4,8,... | Function mapping for F1 ... F12 |
| #47 | ------ | | | |
| #48 | ------ | | | |
| #49 | HLU Acceleration | 0 - 255 | 0 | Multiplied by 0.4 = signal controlled acceleration |
| #50 | HLU Deceleration | 0 - 255 | 0 | Multiplied by 0.4 = signal controlled deceleration |
| #51-55 | HLU Limits | 0 - 255 | 20,40,… | Speed step for each of the 5 HLU speed limits |
| #56 | BEMF Parameter | 1 - 255 | 55 | PID regulation: P-Value (tens digit), I-Value (Ones digit) |
| #57 | Voltage reference | 0 - 255 | 0 | Value = 1/10 of fixed voltage. “0” = track voltage. |
| #58 | Back-EMF intensity | 0 - 255 | 255 | Load compensation at low speeds |
| #59 | HLU Reaction time | 0 - 255 | 5 | Delay for HLU changes, in tenth of a second |
| #60 | Dimming | 0 - 255 | 0 | Reduction of function output voltage through PWM. |
| #61 | ZIMO ext. mapping | 1,2...97,98 | 0 | Configurations not covered by NMRA mapping |
| #62 | Light effects mod. | 0 - 9 | 0 | Adjusts minimum dim value |
| #63 | Light effects mod. | 0 - 99 | 51 | Cycle time (tens digit), Off-time extension (ones digit) |
| #64 | Light effects mod. | 0 - 9 | 5 | Ditch light off-time modification |
| #65 | SW-Subversion # | 0 - 255 | - | Completes the version number in CV #7. |
| #66 | Trim value forward | 0 - 255 | 0 | Multiplies speed step by trim value/128 |
| #67-94 | Free speed table | 0 - 255 | 0 | Internal speed step for each of the 28 external steps |
| #95 | Trim value reverse | 0 - 255 | 0 | Multiplies speed step by trim value/128 |
| #96 ... | ------ | | | |
| 105, 6 | User data | 0 - 255 | 0 | Free memory space for user data |
| #107 | Light suppression | 0 - 255 | 0 | Light suppression for cab 1 (forward) |
| #108 | Light suppression | 0 - 255 | 0 | Light suppression for cab 2 (rear) |
| 109 … | ------ | | | |
| #112 | Special ZIMO configuration bits | 0 - 255 | 4 = 00000100 also Bit 2 = 1 (Loco ID pulses ON, 20 kHz) | Bit 1 = 1: High frequency acknowledgements<br>Bit 2 = 0 / 1: ZIMO loco ID ON/OFF<br>Bit 3 = 1: 8 Functions-Mode (for old ZIMO systems)<br>Bit 4 = 1: Pulse chain recognition (for old LGB-System)<br>Bit 5 = 0 / 1: Motor control at 20 kHz or 40 kHz<br>Bit 6 = 1: „Märklin“-Braking (+ CV # 29, Bit 2, # 124, 5) |
| #113 | BEMF reduction | 0 - 255 | 0 | Intensity reduced at speed step defined in CV #10. |
| #114 | Dim Mask 1 | Bits 0 - 7 | 0 | Individual outputs exempted from dimming per CV #60 |
| #115 | Coupler control | 0 - 99 | 0 | Eff 48: Pull-in V. (tens digit), Hold voltage (ones digit) |
| #116 | Autom. uncoupling | 0 - 199 | 0 | Unload (Hundredth) Separat.(Tens), speed (Ones digit) |
| #117 | Flasher | 0 - 99 | 0 | ON time (Tens digit), OFF time (Ones digit) |
| #118 | Flasher mask | Bits 0 - 7 | 0 | Function outputs included for flashing as per CV #117. |
| #119 | F6 low beam mask | Bits 0 - 7 | 0 | Enter FO for low-beam switching with F6 as per CV #60 |
| #120 | F7 low beam mask | Bits 0 - 7 | 0 | Enter FO for low-beam switching with F7 as per CV #60 |
| #121 | Expon. acceleration | 0 - 99 | 0 | Speed range included (Tens digit), curve (Ones digit) |
| #122 | Expon. deceleration | 0 - 99 | 0 | Speed range included (Tens digit), curve (Ones digit) |
| #123 | Adapt. accel./decel. | 0 - 99 | 0 | Accel. Convergence (Tens dig.), Decel. Conv. (Ones…) |
| #124 | Shunting key 1 | Bits 0-4, 6 | 0 | Shunting key (for half speed, accel. deactivation),<br>Switch between SUSI – Logic level outputs |
| #125<br>#126<br>#127<br>#128<br>#129<br>#130<br>#131<br>#132 | Effects F0 front<br>F0 rear<br>F1<br>F2<br>F3<br>F4<br>F5<br>F6 | 0 - 255 | 0 | Bits 1, 0 = 00: directional (active in both directions)<br>= 01: only forward<br>= 10: only reverse<br>Bits 7, 6, 5, 4, 3, 2 = Effect-Code, i.e.:<br>Uncoupler - 00110000 = “48”<br>Soft-Start for function output - 00110100 = “52”<br>Autom. Brake light - 00111000 = „56“<br>and so on. |
| #133 | ------ | | | |
| #134 | Asymm. stops (ABC) | 1-14,101,, | 106 | Sensitivity (Hundredth), Threshold (Tens, ones digit). |
| #135 | km/h - Control | 2 - 20 | 0 | = 1 → Calibration run; 5, 10, 20: Relation km/ spd. step |
| #136 | km/h - Control | or: | RailCom | Contr. value after cal-run; or correct. value for RailCom |
| #137<br>#138<br>#139 | Smoke generator characteristics | 0 - 255<br>0 - 255<br>0 - 255 | 0<br>0<br>0 | Eff 72,80: CV #137: PWM of FOx at stand still<br>CV #138: PWM of FOx at cruising speed<br>CV #139: PWM of FOx during acceleration |
| #140 | Distance controlled stop | 0-3,11-13 | 0 | = 1: HLU or ABC = 2: manual = 3: both |
| #141 | Distance controlled stop | 0 - 255 | 0 | “Constant distance”: Stop point = 155: 500 m |
| #142 | Distance controlled stop | 0 - 255 | 12 | High speed correction for ABC |
| #143 | Distance controlled stop | 0 - 255 | 0 | High speed correction for HLU |
| #144 | Prog,/ Update Lock | Bits 6, 7 | 0 | Bit 6 = 1: „Service mode“-Lock, Bit 7 = 1: Update-Lock |
| #145 | ------ | | | |
| #146 | Gear backlash compen. | 0 - 255 | 0 | Hundredth’ of a second at min. speed after dir.-change |
| 147,… | Experimental-CV‘s | 0 - 255 | 0 | Special motor regulation settings |
| #151 | Motor brake | 0 - 9 | 0 | = 1 … 9: Force and speed of application |
| #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 | | | |
| #155 | Half speed | 0 - 19 | 0 | Function key selection (instead of CV #124) |
| #156 | Momentum deactivation | 0 - 19 | 0 | Function key selection (instead of CV #124) |
| #157 | MAN-Function | 0 - 19 | 0 | Function key selection |
| 158, ... | ------ | | | |
| #159 | Effects on F7 | 0 - 255 | 0 | Same as CV“s #125 – 132 but for F7 |

| | | | | |
|---|---|---|---|---|
| #160 | F8 | | | |
| #161 | Servo Protocol | 0 - 3 | 0 | Bit 0 = 0: positive pulses , = 1: negative pulses<br>Bit 1 = 0: active only w. moving, = 1: always active |
| #162<br>#163<br>#164<br>#165 | Servo 1 left stop<br>Servo 1 right stop<br>Servo 1 center stop<br>Servo 1 speed | 0 - 255 | 49<br>205<br>127<br>30 | Defines left stop position<br>Defines right stop position<br>for 3-position control<br>Time in tenth of seconds between left and right stop |
| #166<br>#167<br>#168<br>#169 | Servo 2 left stop<br>Servo 2 right stop<br>Servo 2 center stop<br>Servo 2 speed | 0 - 255 | 49<br>205<br>127<br>30 | Defines left stop position<br>Defines right stop position<br>for 3-position control<br>Time in tenth of seconds between left and right stop |
| #170<br>#171<br>#172<br>#173 | Servo 3 left stop<br>Servo 3 right stop<br>Servo 3 center stop<br>Servo 3 speed | 0 - 255 | 49<br>205<br>127<br>30 | Defines left stop position<br>Defines right stop position<br>for 3-position control<br>Time in tenth of seconds between left and right stop |
| #174<br>#175<br>#176<br>#177 | Servo 4 left stop<br>Servo 4 right stop<br>Servo 4 center stop<br>Servo 4 speed | 0 - 255 | 49<br>205<br>127<br>30 | Defines left stop position<br>Defines right stop position<br>for 3-position control<br>Time in tenth of seconds between left and right stop |
| #181<br>#182<br>#183<br>#184 | Servo 1<br>Servo 2<br>Servo 3<br>Servo 4 | 0 - 114 | 0<br>0<br>0<br>0 | Operating modes (One key, two keys …) |
| #185 | Special live steam | 1 - 3 | 0 | Operating settings for live steam engines |
| 186, .. | ------ | | | from CV #190: intended for “RailCom-CV’s” |
| #250,<br>251,<br>252,<br>253 | Decoder-ID | Read-only | - | Decoder’s serial number |
| #260,<br>261,<br>262,<br>263 | Lade-Code | - | - | for authorization of "coded" sound-projects |
| #264 | ------ | | | |
| #265 | Select sound-collection | 1, 2, 3, … | 1 | = 1, 2, … 32: Select among the stored sounds |
| #266 | Total volume | 0 - 65 (255) | 65 | !!: >65: Over modulated, may damage speaker |
| #267<br>- 399 | Sound-Parameter | - | - | Sound generation settings<br>(see sound CV table above) |
| #400<br>#401<br>…..<br>#428 | Input-Mapping | 0 - 255 | 0 | External function (Function key) for internal F0<br>External function (Function key) for internal F1<br>……<br>External function (Function key) for internal F28 |

# 15 ZIMO Decoder - Software Update

## … and Sound Installation

All current ZIMO decoders can be updated with new firmware by the end user with the help of the update module MXDECUP or MXDECUPU (with USB converter), the MX31ZL or with the new MX10 command station.
New software versions can be downloaded at no charge from ZIMO's web site: www.zimo.at (under "UPDATE") and add new features, improvements and corrections to the decoder firmware.

First download a so-called **"Decoder Software Collection File"** from the UPDATE pages at the zimo web site: www.zimo.at, usually the one marked ***aktuell*** (the last line in the update list). It contains the latest firmware **for all ZIMO decoders.** The correct file for the decoder at hand will be automatically selected during the update process.

The update itself can be done in different ways:

- With the **decoder update module MXDECUP** via a **computer,**
  using the serial port of the MXDECUP or
  the USB-serial convertor with the MXDECUPU.

The MXDECUP(U) is connected with the computer, power supply and a section of track. Set the engine on this "update" track. Start the program **"ZIMO Rail Center" (ZIRC)** on the computer. ZIRC selects the proper software from the "decoder software collection file" and installs it in the decoder when prompted to do so.

The **"ZIMO Sound Program" (ZSP)** can also be used instead of ZIRC. As the name implies, this program is used for editing and installing sound projects to ZIMO sound decoders but can also be used to update decoder firmware in all ZIMO decoders (sound, non-sound and accessory decoders).

The programs **ZIRC** and **ZSP** can also be downloaded at no charge from www.zimo.at

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- With the **system cab MX31ZL** and a **computer**
  using the USB interface of the MX31ZL.

The MX31ZL is used in this case just like an MXDECUP (see above) and the procedure is also controlled by the PC with **ZIRC** or **ZSP**.
This is of advantage especially to the ZIMO system user, since the cost of a MX31ZL is about the same as a MX31 with MXDECUPU. The MX31ZL can also be used for updates without a computer (see below) and most of all; it is also a complete DCC system.

- With a **USB stick** and a **MX31ZL,**

In this case, the "decoder software collection file" is first loaded onto the USB stick. Plug the stick to the MX31ZL (with the help of the adapter that comes with the MX31ZL) and use the MX31ZL to proceed with updating as many decoders as desired (but of course, only ZIMO decoders). This process doesn't require a computer and no direct connection to one (see MX31ZL instruction manual).

- With a **USB-Stick** and a **MX10 command station,**

Similar procedure as with the MX31ZL; more information follows when the MX10 becomes available.

*MXDECUP*

*RS-232 – DSUB-9-Plug*

*Connector for update track control LED's behind socket*

*MX31ZL with USB-Stick*

*Socket for power supply*

The update module MXDECUP(U) is shipped with a power supply, a RS-232 cable and a USB converter (with MXDECUPU).

### *Implementation and operation:*

A **section of track** is used as "update track" and connected to the 2-pin screw terminal of the MXDECUP(U). Set the engine with the decoder that is to be updated on the track. The decoder can of course be connected with its red and black wires directly to the track connector of the module instead.
In contrast to the CV-programming procedure, the update procedure with the corresponding acknowledgment does not depend on the load connected to the decoder (such loads are neither necessary nor hindering).

### *Please note...*

**Electrical loads in the loco** that are not connected to the decoder may potentially present a problem (since the decoder cannot turn the load off), because of the 150mA power limit of the MXDECUP. The update process may fail in such cases and the relevant loads must first be removed or remove the decoder from the locomotive.

Make sure the choke coil recommended in chapter 17 is actually installed, if **external buffer circuits** (capacitors) are used to maintain power to the decoder on dirty track sections. Acknowledgments from the decoder to the MXDECUP are otherwise not possible.
Although there is a "blind update option" available in ZSP that operates without acknowledgements, its use is not really recommended.

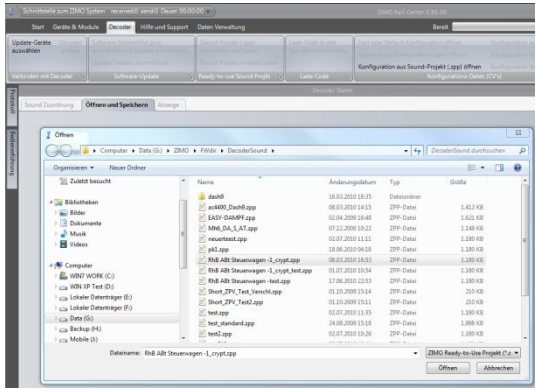
Now, plug-in the ***power supply*** at the MXDECUP. The green LED, visible in the connector recess, should now be lit. Next, connect the MXDECUP with the ***computer*** using either the RS-232 cable or the RS-232 cable with USB converter. The green LED now turns off again (both LED's are dark).

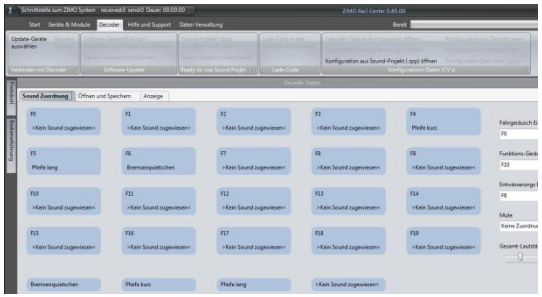
### *Using the "ZIMO Rail Center" ZIRC for software updates and loading of sound:*

The program ZIRC is used together with the MXDECUP or MX31ZL; for MXDECUP hook-up and operations see above; for MX31ZL, see operating manual.

Note: The MX31ZL can be used in two ways for decoder updates: with a computer and ZIRC as described here (where the MX31ZL behaves like a MXDECUP), or with a USB stick without using a computer during the update process, which is not described here (see MX31 instruction manual).

# Editing Project Files (Function mapping, function - sound assignment) with ZIRC





**Quick Guide:**

ZIRC is used “offline” that is, neither a decoder update module nor a decoder or any other product needs to be connected with the computer.

The project files to be edited are either files with .zpv or .zpp extensions, most often though the .zpp files, a.k.a. “Ready-to-use” sound projects.

The editing involves CV lists that are part of sound projects (usually “Ready-to-use” sound projects), which among other things contain the CV’s for function mapping and special effects (US lighting, couplers etc.) as well as the allocation of function keys to sound samples.

The sound samples themselves however **cannot** be modified or exchanged with this procedure!

- On the welcome screen, click on the **“Decoder”** tab.

- ZIRC then displays a page with detailed descriptions of tasks for decoders, and task panes can be opened by selecting "Configuration Data (CVs)" in the page header, or other task panes, such as "Software Update", or loading "Sound Projects" into the decoder.

- In the task pane for "Decoder Configuration Data", click on **"Open Configuration from Sound Project File (.zpp)"**.

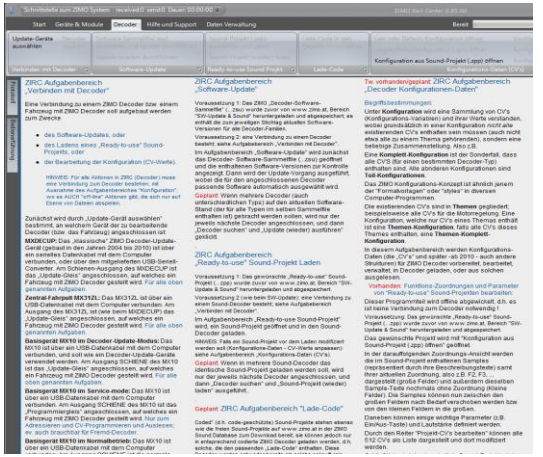
- This opens a pop-up window where you can select the desired “Ready-to-use” sound project.

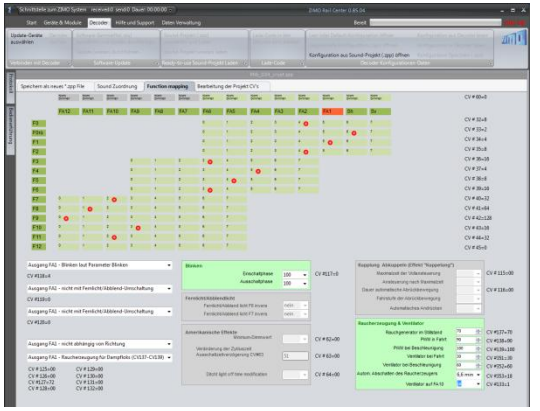
- A new page appears with the following tabs: **"Sound Assign"**, **"Function mapping"** and **"Edit CV List"**.

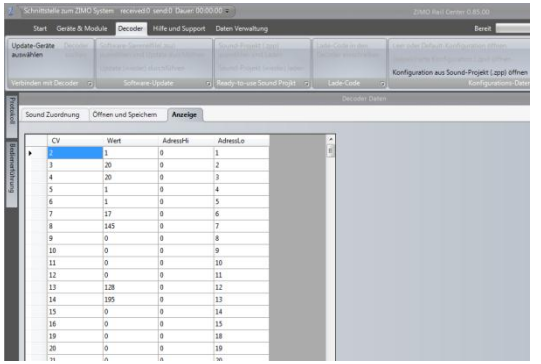
- In **"Sound Assign"** the individual sound samples can be dragged and dropped to the desired function keys, even to the narrow fields below that never had a function asigned; "empty" means the function key should not trigger a sound.

- **"Function mapping"** provides an easy to use function mapping (with ZIMO decoder support) , which allows for the adjustment of the CVs according to the requirements of the model and the user. In particular, the functions can be classified here and parameters set.

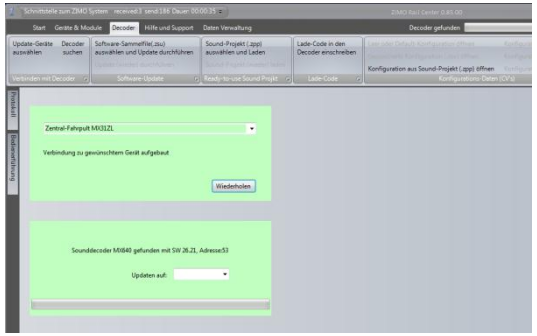
- In **"Save as new .zpp file"** the sound project can be saved with a new name or over-write the old one







# ZIMO Decoder Software Update and Loading of Sound-Projects with ZIRC



**Quick Guide:**

ZIRC is used together with either a MXDECUP update module, MX31ZL, MX32ZL or MX10 command station.

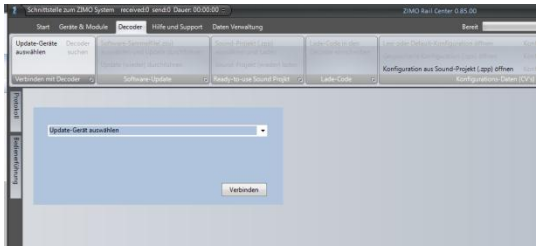
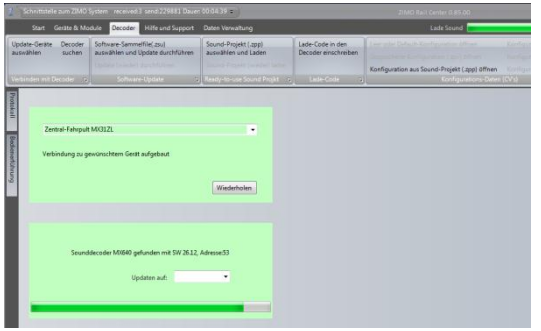
- Select **"Decoder"** on the welcome.

- Then the user selects either,
  - to prepare data (CV editing, see above) or
  - to apply SW-Updates immediately, or load "Ready-to-use" sound projects (under "Decoder suchen").

- Click on "Update Gerät auswählen", select your update device from the list and click on "Verbinden".

ZIRC establishes a connection to the update-devices (MX31ZL, MXDECUP, MX10...) and displays them on the **Produckt-Panel**. It then identifies any decoders connected to these devices (displayed in **Decoder-Panel**).

In the Decoder-Panel select the task to be performed, either **"Decoder-Update"** or "**Sound-Projekt-Laden"** (not both at the same time!).

The software update is performed with the assistance of a Wizard, the decoder software can be automatically downloaded from the ZIMO website (if an Internet connection is present) or it can be saved on a PC (or USB stick) and used from there.

To load a "Ready-to-Use" sound project, the desired .zpp file must first be found and selected. Select "Öffnen" and the file will be loaded into the decoder.