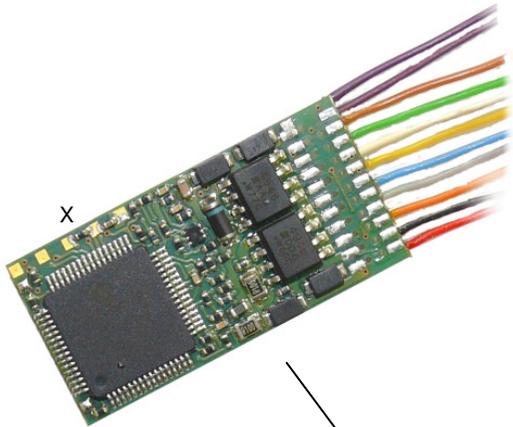


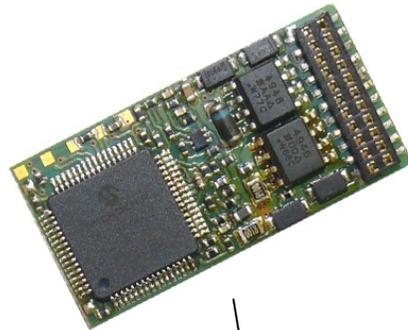
INSTRUCTION MANUAL

EDITION

2008 03 01
SW-Version 2 --- 2008 04 25
SW-Version 4 --- 2008 07 15



"Hardwire" Decoder: MX640, MX640R, MX640F



Decoder with on-board plug: MX640D

H0 - SOUND - DECODER

MX640, MX640R, MX640F, MX640D, MX640C

1. Overview	2
2. Technical Information	2
3. Addressing and Programming – CV table	4
4. Additional notes to Configuration Variables (CV's).....	14
5. "Function mapping" as per NMRA Standard; and ZIMO - Extensions.....	20
6. ZIMO SOUND – Selection and Programming	26
7. Bidirectional communication = "RailCom"	35
8. Installation and wiring of the MX640	36
9. The MX640 and competitor systems	39
10. Special - CV - Sets.....	39
11. Converting binary to decimal.....	40
12. MX640 with Märklin MOTOROLA systems	40
13. Software Update with MXDECUP	41

A hard copy of this instruction manual is not part of a decoder shipment; a few copies are sent to the ZIMO dealer at no charge (about 1 for every 10 decoders shipped); more can be ordered for a nominal fee or downloaded free of charge from www.zimo.at

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.

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 12!

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 service, see www.zimo.at !

1. Overview

Sound decoders of the MX640 family are for H0, 00, 0m, 0 or similar scales (possibly also for H0e, H0m and TT). They are compatible for engines with standard DC motors as well as for coreless motors (Faulhaber, Maxxon, Escap etc.); special settings are available for the latter.

The MX640 operates primarily in the standardized **NMRA DCC data** format as used by ZIMO DCC systems as well as DCC system of other manufacturers, but can also operate in the MOTOROLA protocol.

MX640	"Hardwire" Version (11 highly flexible wires, color coded according to NMRA DCC standard) for rails, motor, 4 function outputs and speaker.
MX640R	MX640 with 8-pin plug (medium interface per NMRA RP 9.1.1.) on 70 mm wires. Separate speaker wires.
MX640F	MX640 with 6-pin plug (small interface per NMRA RP 9.1.1.) on 70 mm wires. Separate speaker wires.
MX640D	Version with 21-pin socket on decoder (as per NMRA RP 9.1.1.).
MX690C	Version with 21-pin socket on decoder for Märklin and Trix locomotives with C-Sinus or Softdrive-Sinus motor and 21-pin interface (via C-Sinus board).

2. Technical Information

Allowable Track voltage **)	12 - 24 V
Maximum continuous motor output	1.2 A
Peak motor current	2 A
Maximum continuous power of 6 function outputs *)	0.8 A
Maximum continuous power of 5 LED outputs	each 0.1 A
Maximum continuous total current	1.2 A
Storage capacity for sound samples	32 Mbit
Sample rate, adapting to sound sample characteristic	11 or 22 kHz
Number of independent playable sound channels	4
Amplified output	Sinus 1.1 W
Impedance of speakers	8 Ohm
Operating temperature	- 20 to 100 °C
Dimensions (L x W x H) .. MX640, MX640R, MX640F (with shrink tube)	32 x 16 x 6 mm
MX640D, MX640C	31.5 x 15.5 x 6 mm

*) The short circuit protection is carried out for the total current of all outputs. In the unlikely event that the outputs are turned off due to cold-start problems of light bulbs (power surge at turn-on leading to a short), the "soft-start" option should be utilized (see CV #125 = 52 etc.)!

**) When used with the DiMAX command station (Massoth): The DiMAX 1200Z, according to its instruction manual, should deliver 24V to the track (which would only be marginally higher than specified by the DCC standard). In reality though, the unit (especially older versions) powers the track with a varying voltage heavily dependent on load, starting with 30V at idle (depending on line voltage!) all the way down to 20V under heavy load. The ZIMO large-scale decoders (usually....) just tolerate the 30V (in contrast to many other brand decoders); it is better though to lower the track voltage with a constant load (@ 0.5A) to an allowable level.

OVERLOAD 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. The affected output is turned off once an overload situation exists and subsequent load tests are performed by the decoder, which is often recognized as flashing headlights.

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 commentators) 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.

Since the capacity and speed of such circuits is limited, the track voltage should not be selected unnecessarily high; that is not higher than recommended for the rolling stock in question. The full adjustable range of a Zimo command station (up to 24V) should only be utilized in special cases. Although ZIMO decoders are suitable for 24V operation, that may not be the case when interacting with some other equipment.

THERMAL PROTECTION:

All ZIMO decoders have the ability 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.

As with all other ZIMO decoders:

DO-IT-YOURSELF SOFTWARE UPDATE

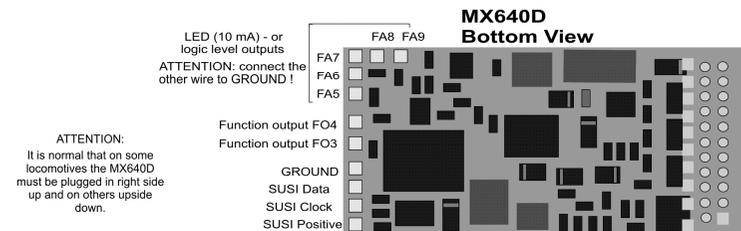
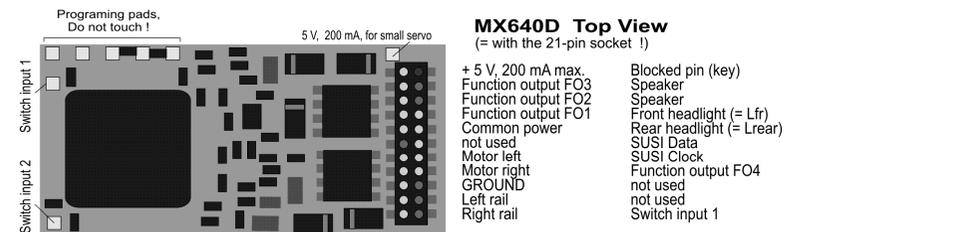
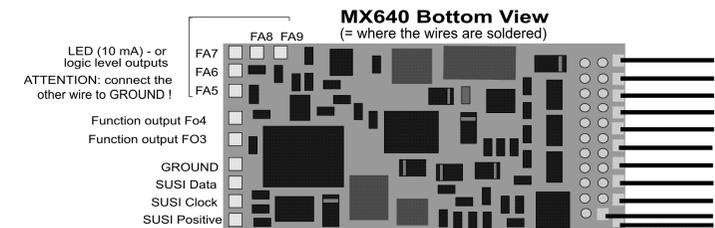
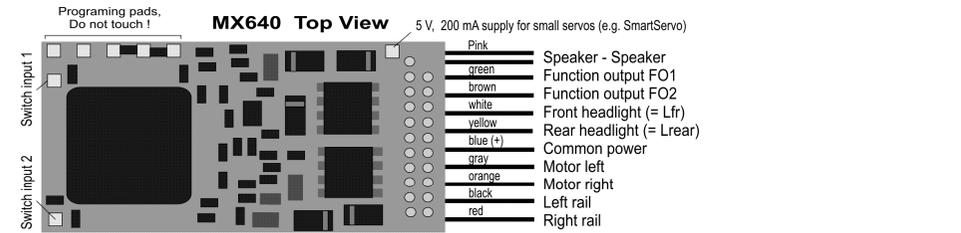
Beginning with production date September 2004 (MX620 since introduction), ZIMO DCC decoders are equipped to handle a software update by the user. A **ZIMO decoder update module (e.g. MXDECUP or MX31ZL)**, a PC with Windows operating system, a serial port (or USB and converter) and the program **ZIMO Service Tool "ZST"** is required. The update module is used independent of the command station and can therefore be used with any DCC system!

The same hardware and software is also used for sound project installations to sound decoders.

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.

See the **chapter "Software Update"** in this manual for more information on updating decoders or visit www.zimo.at

SW updates are of course still available for a small fee by sending decoders to ZIMO or your ZIMO dealer.



3. Addressing and Programming – CV table

Every loco decoder requires a separate unique address with which the loco is controlled using a cab. **All NMRA-DCC compliant decoders have 3 as their factory default address** (NMRA standardized decoder address at delivery).

DECODER INSTALLATION:

After installing the new decoder in a locomotive (see chapter “Installation and wiring”), it can be tested with address #3. As a minimum, either the motor or headlights need to be connected (better yet both), to enable decoder acknowledgment during programming. Doing a complete installation before programming the decoder is often more practical.

THE ADDRESSING AND PROGRAMMING PROCEDURE:

The **procedure** for programming and reading of addresses and configuration variables is covered in detail in the **instruction manual for the cab (MX21, MX31....)**. For other systems consult the appropriate manual.

Programming a decoder with a PC and ADaPT software (by E.Sperrer, software developer) is a lot easier and more convenient!

Technical note to decoder acknowledgments during programming:

When programming a decoder with a cab or computer, every successful programming step will be made visible by the decoder. The same acknowledgment method is used when reading the configuration variables.

The acknowledgment is based on short power pulses that the decoder generates by briefly turning the motor and headlights on, which the command station recognizes at the programming track. It follows that the acknowledgment and read out of a decoder is only successful if the current consumption is high enough, which means that the motor and headlights have to be connected or at least one of the two.

The decoder won't use the headlights for acknowledgment if CV #60 is set to a value of 40 or less. This is to prevent damage to bulbs since this setting is often used in conjunction with low voltage bulbs. The motor is then the only load used for acknowledgments!

The following pages show the tables for configuration variables (CV's).

▲ **Table of configuration variables CV's #1 to #255**

followed by (chapter 4, 5):

▲ **SUPPLEMENTAL NOTES (“Add. Notes”) and Function mapping.**

followed by (chapter 6):

▲ **ZIMO SOUND selection and programming;** description of basic functionality and operating procedures, and

▲ **Table of configuration variables CV's # 256 to #511.**

HELPFUL HINTS FOR CV PROGRAMMING:

If you are familiar with CV programming please skip this section and go directly to the CV table below!

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 acts similar to a volume control.

For instance, CV#2 determines the minimum speed applied at the cab's first speed step:

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

The “range” column clearly suggests any value from 1 to 252. The higher the value the faster the engine runs at speed step 1 and vice versa.

Another similar CV is the “dimming” 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. Example values: # 60 = 0 or 255: full voltage # 60 = 170: 2/3 of full voltage. # 60 = 204: 80% of full voltage.

Again, the range column suggests using a value between 1 and 255 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 a small switch board, 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). The developer determines how many bits of a CV can be altered. 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 the value of each Bit you want to turn ON and enter the total to the CV.

One such CV is CV #29 (next page):

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

In this CV you can only change the setting of Bit 0, 1, 2, 3, 4 and 5. Bits 6 and 7 have to remain OFF 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 indicator 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. By the way, the Bit numbering and their values are the same for all CV's used in this way, not just CV #29. 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 calculate Bit 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. Both of these kind of settings may be used in the same CV.

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

CV	Designation	Range	Default	Description
#56	Back-EMF control P and I value	0 – 199 (See add. notes)	<p>0 (is equal to 55, mid-range)</p> <p>But: default is <u>not</u> suitable for coreless motors, i.e. MAXXON, FAULHABER! Use "100" instead.</p>	<p>Back-EMF compensation is calculated by PID algorithm (Proportional/Integral - Differential); modifying these values may improve the compensation characteristics in certain cases.</p> <p>0 - 99: for "normal" DC motors (LGB etc) 100 - 199: for coreless (MAXXON, Faulhaber, etc...)</p> <p>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).</p> <p>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).</p>

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 in this case acts just like a switch. If you use the hundredth digit (1_) the coreless motor function 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 tens 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.

THE MX640 CONFIGURATION VARIABLES:

Configuration Variables can be defined within the programming procedures to improve the driving characteristics of a locomotive and for many other application specific adjustments.

The meaning of Configuration Variables (CV's) is in part standardized by the NMRA DCC RECOMMENDED PRACTICES, RP-9.2.2. There are however certain CV's that are for Zimo decoders only, in some cases exclusively for specific types of Zimo decoders.

Always use the specifications for the decoder in question, since the value range may differ between manufacturers, even with standardized CV's; in this case use the table below.

CV	Designation	Range	Default	Description
#1	Loco address	1 – 127	3	The "short" (1-byte) loco addresses; Is active when Bit 5 in CV #29 is 0.
#2	Vstart	1 – 252 (See add. notes)	2	Entered value = internal speed step assigned to lowest cab speed step. Bit 4 in CV # 29 has to be 0; otherwise individual speed table is active.
#3	Acceleration rate	0 - 255	12	Multiplied by 0.9 equals' acceleration time in seconds from stop to full speed.
#4	Deceleration rate	0 - 255	12	Multiplied by 0.9 equals' deceleration time in seconds from full speed to complete stop.
#5	Vhigh	0 – 252 (See add. notes)	1 (= 252)	Entered value = internal speed step assigned to highest cab speed step, according to the number of speed steps selected (14, 28 or 128). 0 and 1 = no effect. Bit 4 in CV #29 has to be 0, otherwise speed table is active.
#6	Vmid	1, A useful value for is ¼ to ½ of the value in CV #5 (See add. notes)	1 (= about 1/3 of top speed)	Entered value = internal speed step assigned to the cabs center speed step (=step 7,14 or 63 according to the number of speed steps selected: 14, 28 or 128) "1" = default (medium speed is 1/3 of full speed, that is: with CV #5 = 255, CV #6 is 85, otherwise lower). Bit 4 in CV #29 has to be 0, otherwise speed table is active. The 3-point curve that results from the settings in CV's #2, 5, 6 is automatically smoothed out; not jolt noticed at mid-speed!
#7	Software version and Temporary register when programming with a "Lokmaus 2" and similar low level systems.	Read only Only version number can be read Pseudo-Programming		This CV normally displays the decoder software version. For user of Lokmaus 2 : Pseudo-programming (because programmed value is not really stored) as an initial step for programming or read-out of a higher CV (#>99) and/or a higher value (>99) for systems that

CV	Designation	Range	Default	Description
	See section "Operation within other systems" in this manual. And for programming help of higher CV numbers with „medium level" systems such as Intellibox or Lenz; especially for sound sample selection and sound CV's. I.e. to program CV #300 = 100	with values: for Lokmaus 2: 1, 2, 10, 11, 12, 20, 21, 22 And for Sound-Prog: 110, 120, 130, 210, 220, 230 (see chapter 6)		can only program a limited within a limited number and value range : Ones digit = 1: The entered CV value will be increased by 100 during the actual programming. Ones digit = 2: ...increases by 200. Tens digit = 1: The entered CV number will be increased by 100 during the actual programming. Tens digit = 2: ...increases by 200. Tens digit = 3: ...increases by 300. Hundredth digit = 1: CV number conversion is retained until system is powered down. = 2: ...is retained until reset with CV #7 = 0. For Lokmaus-2: see section „ZIMO decoders in competitor systems"! SOUND – selection and programming: see chapter 6!
#8	Manufacturer ID and HARD RESET with CV #8 = 8 or LOADING of special CV sets	Read only all additional programming is pseudo only; read-out always shows "145", which is ZIMO's assigned number	145 (= ZIMO)	NMRA assigned manufacturer ID for Zimo is: 145 ("10010001") Pseudo-Programming ("Pseudo" = programmed value is not really stored): CV #8 = "8" -> HARD RESET (NMRA standard: all CV's reset to default values). CV #8 = "0" -> HARD RESET (ZIMO special: all CV's reset to currently stored sound project). CV #8 = "9" -> HARD RESET for LGB-operation (14 speed steps, pulse chain).
#9	Motor frequency and EMF sampling rate Recommendation for coreless motors, i.e. MAXXON, FAUL-HABER: CV #9 = 12	0 High frequency, mid-range sampling rate 1- 99 High frequency, modified sampling rate or 255-176 Low frequency (See add.	0 High frequency, mid-range sampling rate	=0: Default motor control with high frequency (20 / 40 kHz) and an EMF-sampling rate that automatically adjusts between 200Hz (low speed) and 50Hz. Tens digit 1 - 4: Reduced sampling rate compared to default (less noise!) Tens digit 6 - 9: Increased sampling rate compared to default (to improve low speed performance!) Ones digit 1 – 4: EMF sampling time shorter than default setting (good for coreless motors for less noise, more power) Ones digit 5 - 9: EMF sampling time longer than default (may be needed for 3-pole motors or similar) = 255 - 176: Low frequency - 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.

CV	Designation	Range	Default	Description
		Notes: "Step by step CV..." ("Strategie")		<u>Examples of low frequencies:</u> # 9 = 255: frequency of 30 Hz, # 9 = 208: frequency of 80 Hz, # 9 = 192: frequency of 120 Hz.
#10	EMF Feedback cut-off NOTE: This CV is seldom required.	0 - 252 (See add. notes)	0	Assigns an internal speed step above which back EMF intensity is reduced to the level defined in CV #113. CV #10, #58 and #113 together define a back-EMF curve. If either CV #10 or #113 is set to 0 a default curve is valid.
#13	Analog functions	0 - 255	0	Selects function outputs F1 to F8 that should be "on" in analog mode. Each bit equals one function; Bit 0 = F1, Bit 1 = F2, Bit 6 = F7, Bit 7 = F8.
#14	Analog functions Acceleration and deceleration in analog operation.	0 - 127	64 (Bit 6 = 1)	Bits 5 to 0: Select function outputs F12 to F9 as well as FLr and FLf that should be "on" in analog mode. Each bit equals one function (Bit 0 = front headlightBit 5 = F12). Bit 6 = 1: Analog operation without acceleration and deceleration according to CV #3 and #4. Bit 6 = 0: Analog operation with acceleration and deceleration according to CV #3 and #4.
#17 + #18	Extended address	128 - 10239	0	The long 5-digit primary address (>127). This address is only active when Bit 5 in CV #29=1. Otherwise address entered in CV #1 is active (<127).
#19	Consist address	0 - 127	0	An additional address that is used to operate several locos in a consist. If a consist address is assigned to this CV, commands for the primary and extended addresses (CV's #1 and #17/18) will be ignored by the decoder. This CV is seldom used within ZIMO systems, since it is more comfortable to build and control consists with the cab (using the "normal" single addresses).
#21	Consist functions for F1 - F8	0 - 255	0	Selected functions that should operate with the consist address. (Bit 0 for F1, Bit 1 for F2, Bit 2 for F3 etc.) Applicable Bits set to 0 = function controlled by single primary address. Applicable Bits set to 1 = function controlled by consist address.
#22	Consist address activates headlights	0 - 3	0	Select whether the headlights are controlled with consist address or single address (Bit 0 for front headlight, Bit 1 for rear headlight) Respective Bit = 0: function output controlled with single address

CV	Designation	Range	Default	Description
				Respective Bit = 1: function output controlled with consist address
#23	Acceleration trimming NOTE: This CV is seldom required.	0 - 255	0	To temporarily adapt the acceleration rate, i.e. to a new load or when used in a consist. Bit 0 - 6: entered value increases or decreases acceleration time in CV #3. Bit 7 = 0: value added. = 1: value subtracted.
#24	Deceleration trimming NOTE: This CV is seldom required.	0 - 255	0	To temporarily adapt deceleration rate, i.e. to load or when used in consist. Bit 0 - 6: entered value increases or decreases deceleration time in CV #4. Bit 7 = 0: value added. = 1: value subtracted.
#27	Direction dependent stops with asymmetrical DCC signal (Lenz "ABC" method)	0, 1, 2, 3	0	This CV activates the direction dependent stopping feature with asymmetrical DCC signal (also known as Lenz "ABC"). Bit 0 = 1: Stops are initiated if voltage in right rail is higher than left rail (in direction of travel). THIS, CV #27 = 1, IS THE COMMON APPLICATION for this feature (provided the decoder is wired to the correct rail). Bit 1 = 1: Stops are initiated if voltage in left rail is higher than right rail (in direction of travel). Stopping is directional if only one of the two bits is set (not both). Traveling in the opposite direction will have no effect. Use the other bit! In case the train stops in the wrong direction! Bit 0 and 1 = 1 (value = 3): Stops in both directions. NOTE: See CV #134 for setting the asymmetrical threshold if problems are encountered (e.g. train won't stop with asymmetrical signal or stops without asymmetrical signal present).
#29	Basic configuration CV #29 is calculated by adding the value of the individual bits that are to be "on": Values to turn Bit "on": Bit 0: 1 Bit 1: 2 Bit 2: 4 Bit 3: 8 Bit 4: 16	0 - 63	14 = 0000 1110	Bit 0 - Train direction: 0 = normal, 1 = reversed Bit 1 - Number of speed steps: 0 = 14, 1 = 28 Note: 128 speed steps are always active if corresponding information is received! Bit 2 - DC operation (analog): *) 0 = off 1 = on Bit 3 - RailCom („bidirectional communication") 0 = deactivated 1 = activated Bit 4 - Individual speed table: 0 = off, CV #2, 5, 6, are active.

CV	Designation	Range	Default	Description
	Bit 5: 32 Bit 6: 64 Bit 7: 128 ZIMO MX21, MX31... cabs also display the individual bits; calculating bit values is no longer necessary!			1 = on, according to CV 's #67 – 94 Bit 5 - Decoder address: 0 = primary address as per CV #1 1 = ext. address as per CV #17+18 Bits 6 and 7 are to remain 0! <u>Example:</u> #29 = 2: normal direction, 28 speed steps, DCC operation only, speed table according to CV #2, 5, 6, primary address as in CV #1. #29 = 14: DC mode and RailCom added. #29 = 22: DC mode and individual speed table according to CVs #67 – 94 added. #29 = 0: 14 (instead of 28) speed steps, necessary for some older third party systems. *) For polarity dependent DC braking , set CV #29, Bit 2 = "0" and CV #124, Bit 5 = "1"! *) For polarity independent DC braking (Märklin brake-modules) set CV #29, Bit 2 = "0" and CV 124, Bit 5 = "1" and additionally CV #112, Bit 6 = 1!
#33 #34 #35 #36 #37 #38 #39 #40 #41 #42 #43 #44 #45 #46	Function mapping according to NMRA standard	(See „Function mapping“)	1 2 4 8 2 4 8 16 4 8 16 32 64 128	Function mapping according to NMRA: #33 - 46 = 1, 2, 4... Outputs are set to F0 - F12 by default. Headlight switches with direction and can be turned on/off with F0 key (Key #1 or L on Zimo cab). Also see "NMRA function mapping" at the end of this chapter.
#49	Signal controlled acceleration ZIMO "HLU" - Method	0 - 255	0	Entered value multiplied by .4 equals acceleration time in seconds from stop to full speed when: "ZIMO signal controlled speed influence" (requires ZIMO MX9 or MX900 track section module) or "asymmetrical DCC signal" method (Lenz ABC) is employed.
#50	Signal controlled deceleration ZIMO „HLU“ - Method	0 - 255	0	Entered value multiplied by .4 equals acceleration time in seconds from full speed to complete stop when: "ZIMO signal controlled speed influence" (requires ZIMO MX9 or MX900 track section

CV	Designation	Range	Default	Description
				module) or "asymmetrical DCC signal" method (Lenz ABC) is employed.
#51 #52 #53 #54 #55	Signal dependent speed limits #52 for "U", #54 for "L", #51, 53, 55 for intermediate steps	0 - 252	20 40 (U) 70 110 (L) 180	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. These CV's are also intended for use with the "asymmetrical DCC signal stop" in case it'll be further developed for more speed limits.
#56	Back-EMF control P and I value Recommended for coreless motors, i.e. MAXXON, FAUL-HABER: CV #56 = 100 (default of 55 is <u>not</u> suitable)	0 - 199 (See add. notes)	0 (= to 55, mid-range)	Back-EMF compensation is calculated by PID algorithm (Proportional/Integral/Differential); modifying these values may improve the compensation characteristics in certain cases. 0 - 99: for „normal“ DC motors 100 - 199: for coreless (MAXXON, Faulhaber, etc) 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). 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).
#57	Voltage reference	0 - 255 (See add. notes)	0	The entered value divided by ten is the peak voltage applied to the motor at full speed. #57 = 0: results in automatic adjustment to current track voltage (relative reference).
#58	Back-EMF intensity	0 - 255 (See add. notes)	255	Intensity of back-EMF control for lowest speed step. Example: # 58 = 0: no back-EMF # 58 = 150: medium compensation, # 58 = 255: maximum Compensation. If required, an "intensity curve" can be achieved using CV #10, 58 and 113 to reduce load regulation at higher speeds.
#59	Signal dependent reaction time	0 - 255	5	This value divided by 10 is the time in seconds it takes to start a signal controlled acceleration after receiving a higher speed limit command with: "ZIMO signal controlled speed influence" (requires ZIMO MX9 or MX900 track section module) or "asymmetrical DCC signal" method (Lenz ABC).

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. Example values: # 60 = 0 or 255: full voltage # 60 = 170: 2/3 of full voltage. # 60 = 204: 80% of full voltage.
#61	Special ZIMO function mapping	0 - 7, 67, 98, 99 <small>(See "Function mapping")</small>	0	For applications not covered by NMRA function mapping (CV #33 - #46), for example: "Swiss lighting"; see "function mapping – ZIMO extensions". = 1, 2, 3, 4... Special function mapping table for often used lighting variations. = 67: Alternative function mapping without the usual „left shift“. = 98: starts a flexible function mapping for directional function control, automated function turn-off after stopping and more. See "ZIMO special function mapping" at the end of this chapter!
#67-94	Individual speed table	0 - 252 <small>(See add. notes)</small>	**)	User programmable speed table. Only active if Bit 4 in CV #29 is set to 1. Each CV corresponds to one internal speed step that can be "mapped" to an external step (in-between speed steps will be interpolated when using 128 speed steps).
#66 #95	Directional speed trimming	0-255 0-255	0 0	Multiplication of the current speed by "n/128" (n is the trim value in this CV) #66: for forward direction #95: for reverse direction
#105 #106	User data	0 - 255 0 - 255	0 0	Free memory space to store user supplied data.
#112	Special ZIMO configuration bits Values to turn Bit "on": Bit 0: 1 Bit 1: 2 Bit 2: 4 Bit 3: 8 Bit 4: 16 Bit 5: 32 Bit 6: 64 Bit 7: 128 ZIMO MX21, MX31... cabs also display the individual bits; calculating bit values is	0 - 255	4 = 00000100	Bit 1 = 0: Motor brake off = 1: active brake for locos without worm gear. Bit 2 = 0: Loco number recognition off = 1: ZIMO loco number recognition on (Turning the loco number recognition off prevents a possible ticking sound if this feature is not used). Bit 3 = 0: reacts only to the (new) NMRA-MAN-Bit = 12 function mode = 1: reacts to old MAN bit = 8 function mode Bit 4 = 0: Pulse chain recognition off = 1: Pulse chain recognition on (use with LGB systems)

CV	Designation	Range	Default	Description
	no longer necessary!			Bit 5 = 0: 20 kHz frequency = 1: 40 kHz frequency Bit 6 = 0: normal (also see CV #129 description) = 1: non-directional DC braking („Märklin-Brake mode") Bit 7 = 0: no pulse chain generation = 1: Generates pulse chain commands for LGB sound modules on output FO1. Only in MOTOROLA format: Bit 3 = 0: normal, 4 functions for each address = 1: next higher address is used to control 4 more functions, for a total of 8 functions, which is otherwise not possible within a MOTOROLA system.
#113	EMF reduction <small>Note: This CV is rarely necessary</small>	0 - 255 <small>(See add. notes)</small>	0	Intensity of back-EMF is reduced above the speed step defined in CV #10, to the value entered here. Together, CV #10, #58 and #113 define a BEMF curve. If set to 0, BEMF is totally cut-off above the speed step defined in CV #10.
#114	Dimming mask	Bits 0 - 5	0	Bit 0 to 5 for one function output each (Bit 0 = front headlight, Bit 1 = rear headlight, Bit 2 = function output F1, etc.) Bit value=0: Output dimmed to value defined in CV #60. Bit value=1: Output not dimmed.
#115	Uncoupler control (KROIS and ROCO) "Pull-in" time and "hold" voltage CV # 115 alternatively used for additional dim value <small>(0-90% according to ones digit; set tens digit to 0)</small>	0 - 99 <small>See add. notes</small>	0	Active if "uncoupling" is selected (with value of 48) in CV #125.....132: Tens digit = 0 - 9, pull-in time in seconds of applied full voltage: Value: 0 1 2 3 4 5 6 7 8 9 Seconds: 0 .1 .2 .4 .8 1 2 3 4 5 Ones digit = 0 to 9, hold power in percent of track voltage, 0 - 90%. Applied after the pull-in time elapsed (i.e. for ROCO uncoupler)
#116	Automated uncoupling procedure	0 - 99 100 - 199 <small>See descript. in chapter 7!</small>	0	Tens digit (0 - 9): Length of time the loco should move away from train; values as in CV #115. Ones digit (0 - 9) = x 4: Internal speed step applied to loco (Momentum per CV #3 etc.) Hundredths digit = 0: No tension relieve. = 1: Tension relieve: loco moves toward coupler (to relieve tension) before moving away.
#117	Flasher	0 - 99	0	Duty cycle for flasher function: Tens digit = on time (0= 100msec.....9= 1 sec) Ones digit = off time (0= 100msec.....9= 1 sec)

CV	Designation	Range	Default	Description
#118	Flashing mask	Bits 0 - 7	0	Bit 0 to 5 for one function output each (Bit 0 = front headlight, Bit 1 = rear headlight, Bit 2 = function output F1, etc.) Bit values = 0: no flasher Bit values = 1: output flashing Bit 6 = 1: 4th output flashing inverse! Bit 7 = 1: 6th output flashing inverse!
#119	Low beam mask for F6	Bits 0 - 7	0	Bit 0 to 5 for one function output each (Bit 0 = front headlight, Bit 1 = rear headlight, Bit 2 = function output F1, etc.) Bit values = 0: no low beam function Bit values = 1: Low beam with key F6, brightness determined by value in CV #60. Bit 7 = 0: normal effect of F6. = 1: effect of F6 inverted.
#120	Low beam mask for F7	Bits 0 - 7		Same as in CV #119 but for F7 key.
#121	Exponential acceleration	0 - 99 (See add. notes)	00	Acceleration time (momentum) can be stretched in the lower speed range: Tens digit: Percentage of speed range to be included (0 to 90%). Ones digit: Exponential curve (0 to 9).
#122	Exponential deceleration	0 - 99 (See add. notes)	00	Deceleration time (momentum) can be stretched in the lower speed range: Tens digit: Percentage of speed range to be included (0 to 90%). Ones digit: Exponential curve (0 to 9).
#123	Adaptive acceleration and deceleration	0 - 99 (See add. notes)	0	Raising or lowering the speed occurs only after the speed reaches the defined range of speed steps of the previously set target speed. CV #123 contains the number of speed steps in the target speed that must be reached (the smaller this value the smoother the acceleration/deceleration). Tens digit: 0 - 9 for acceleration Ones digit: 0 - 9 for deceleration Value 0 = no adaptive accel. or decel.
#124	Shunting key functions: Momentum reduction or deactivation and	(See add. notes)	0	Bit 2 = 0: "MAN" key for shunting, = 1: F4 key for shunting (see Bit 6 if F3 key instead of F4) Bit 0 = 0: no effect with above key's = 1: removes momentum of CV #121+122 Bit 1 = 0: no effect, = 1: CV #3 + 4 reduced to ¼.

CV	Designation	Range	Default	Description
	Low gear and SUSI assignment.			Bit 0 + Bit 1 = 0: no effect = 1: removes all momentum above. Bit 3 = 1: F7 as half speed key Bit 4 = 1: F3 as half speed key Bit 5 = 1: For "DC" stopping method *) Bit 6 = 1: F3 as shunting key (instead of F4 as in Bit 2). *) If polarity dependent "DC" stopping method is used (i.e. Märklin), set CV #29, Bit 2 = 0 and CV #124, Bit 5 = 1!
#125 ¹	Special effects Uncoupler, "soft start" of function outputs at activation and automated function "ON/OFF" according to various criteria's or US lighting effects. Operates with F0 in forward direction by default, unless assigned different through function mapping. Effects can be further adjusted and modified with CVs #62 - 64 and CV #115 (for uncoupler)		0	The CV definitions described here are valid for CV #125 to #132. Some of the functions below may not necessarily be suitable for CV #125 and #126 as these outputs are usually connected to headlights. Bits 0,1 value = 0: independent of direction =1:active in forward direction =2:active in reverse direction ATTENTION: change CV's #33, 34.... if direction is wrong! Bits 2 - 7 value = 4 Mars light = 8 Random Flicker = 12 Flashing headlight = 16 Single pulse strobe = 20 Double pulse strobe = 24 Rotary beacon simulation. = 28 Gyralite = 32 Ditch light type 1, right = 36 Ditch light type 1, left = 40 Ditch light type 2, right = 44 Ditch light type 2, left = 48 Uncoupler as in CV#115 = 52 Soft start up of function output = 56 Automatic stop lights for street cars, see CV #63 = 60 Function output turns off automatically at speed >0 (i.e. turns off cab light at start). = 64 Function output turns off automatically after 5 min. (i.e. to protect a smoke generator from overheating). = 68 Turns off automatically after 10 minutes. = 72 Speed or load dependent smoke for steam engines as per CV's

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)).

CV	Designation	Range	Default	Description
				<p>#137 – 139 (Preheating, heavy smoke at full speed or load).</p> <p>= 76 As above, but turns off automatically after 10 min., also actuation only with function key (but not when function is already on at power-on).</p> <p>= 80 Operation-dependent smoke for diesel engines as per CV's #137-139 (Preheating, heavy smoke at motor start-up sound and acceleration). Proper fan control as defined in CV #133.</p> <p>= 84 As above, but turns off automatically after 10 min., also actuation only with function key (but not when function is already on at power-on).</p> <p style="text-align: center;"><u>EXAMPLES</u></p> <p>You want : Program CV #125 to:</p> <p>Mars light forward only - 5 Gyalite independent of direction - 28 Ditch type 1 left, only forward - 37 Uncoupler - 48 Soft start of output- (i.e. headlights) 52 Automatic stop light - 56 Automatic cab light turn-off - 60 Smoke turns off after 5 min automatically - 64 Smoke turns off after 10 min automatically - 68 Speed/load dependent smoke - 72 Speed/load dependent smoke and auto-off - 76 Speed/load dependent diesel smoke - 80 Speed/load dependent diesel smoke and auto-off - 84</p>
#126	Special effects For rear headlight (default F0 reverse)		0	Bits 0,1 value = 0: independent of direction =1: active in forward direction =2: active in reverse direction ATTENTION: change CV's #33, 34.... if direction is wrong! See CV #125 for details.
#127	Special effects for FO1 (default F1)		0	See CV #125 for details. The "ATTENTION" note in CV #125 and #126 are <u>not</u> relevant for this and the following CV's (#127...); they are usually not assigned to direction dependent functions!
#128	Special effects for FO2 (default F2)		0	See CV #125 for details.
#129 - #132	Special effects for FO3, FO4, FO5, FO6 (default F3, F4, F5, F6)		0	See CV #125 for details.

CV	Designation	Range	Default	Description
#62	Light effects modifications	0 - 9	0	Change of minimum dimming value (FX_MIN_DIM)
#63	Light effects modifications or Stop light OFF delay	0 – 99 0 – 255	51 @ 0.5 sec	Tens digit: sets cycle time (0 - 9, default 5), or start up time during soft start (0 - 0,9s) Ones digit: extends "off" time Ones digit with activated stop lights (value 56 in CV #125 – 132): If stop light is activated with value 56 in CV #125, 126 or 127: Time in tenths of a second (range: 0 – 25 sec.) the stop lights remain on after the street car comes to a full stop.
#64	Light effects modifications	0 - 9	5	Ditch light off time modification
#133	Fan control from SW version 4 Function output 4 as virtual cam sensor for external sound modules or FO4 as output for a fan of a smoke generator	0, 1 200 - 255	0	= 0 (Default): FO4 is used as normal function output, not as virtual cam sensor. = 1: FO4 supplies cam sensor pulses, either from the virtual or real cam sensor. See CV #267 and 268! = 200 – 255: The steam fan of a smoke generator is connected to FO10. If the smoke generator itself (heating element) is defined as a "Special Effect" in one of the CV's #125 - 132 as = 72 or = 76 for a steam engine or = 80 or = 84 for a diesel, the fan (FO10) will be actuated with the function key for the smoke generator (heater) – which is the one that is assigned for the "Special Effects" output and - is synchronized with the steam chuffs in case of steam engines - is activated when the motor's start-up sound is played back as well as under load. For diesel engines, the value behind the "2" (0 – 55) is the time the start-up smoke should be delayed from the start-up sound.
#134	Asymmetrical threshold for stopping with asymmetrical DCC signal (Lenz ABC method)	1 - 14, 101 - 114, 201 - 214 = 0,1 - 1,4 V	106	Hundredths digit: Sensitivity adjustment, changes the speed with which the asymmetry is being recognized. = 0: fast recognition (but higher risk of errors, i.e. unreliable stopping. = 1: normal recognition (@ 0.5 sec.), pretty

CV	Designation	Range	Default	Description
				<p>save results (default). = 2: slow recognition (@ 1 sec.), very reliable. Tenths and ones digit: Asymmetrical threshold in tenths of a volt. This voltage difference between the half waves of the DCC signal is the minimum required to be recognized as asymmetrical that starts the intended effect (usually braking and stopping of a train). Also see CV #27! = 106 (Default) therefore means 0.6 V. This value has proven itself to be appropriate under normal conditions; by using 4 diodes to generate the asymmetry, see chapter 4! ¹</p>
#135	km/h – Speed regulation - Activating, control and range definition	2 – 20	0	<p>= 0: km/h – Regulation turned off; the “normal” speed regulation is in effect. Start with Pseudo-Programming („Pseudo“ = programmed value is not being stored): CV #135 = 1 -> Initiates a calibration run (see chapter 4, „km/h – speed regulation“) Continue with “normal” programming of CV #135 (programmed value will be stored): = 2 to 20: speed steps / km/h – factor; e.g.: = 10: each step (1 to 126) represents 1 km/h; that is step 1 = 1 km/h, step 2 = 2 km/h, step 3 = 3 km/h, = 20: each step represents 2 km/h; step 1 = 2 km/h, step 2 = 4 km/h, last step 126 = 253 km/h. = 5: each step represents .5 km/h; step 1 = .5 km/h, step 2 = 1 km/h, last step 126 = 63 km/h. See chapter 4, „km/h – speed regulation“!</p>
#136	km/h – Speed regulation - Control number read-out	-	-	<p>A numeric value can be read-out after a successful calibration run, which was used to calculate the speed. This value is interesting because it is (almost) independent from the selected speed during the calibration run. The uniformity of the resulting values from several calibration runs may be an indication of the calibration quality. See chapter 4!</p>
From SW vers 4	Characteristic curve of a smoke generator connected to one of the FO's 1 – 6 (for which a “smoke effect” is selected in the associated CV #127 – 132).			<p>The three values in CV's #137 – 139 define a characteristic curve (FO1, FO2, FO3, FO4, FO5 or FO6, below as FOx) for the function output that is defined in CV #127 – 132 for a “smoke effect” of a steam or diesel engine, i.e. 72, 76, 80 or 84.</p>

CV	Designation	Range	Default	Description
#137 #138 #139	PWM at standstill PWM at minimum speed PWM at maximum speed	0 - 255 0 - 255 0 - 255	0 0 0	<p>If Bit 0 in CV #112 = 0; Characteristic is speed dependent (nominal value): CV #137: PWM of FOx at stand still CV #138: PWM of FOx at speed step 1 CV #139: PWM of FOx at highest speed step If Bit 0 in CV #112 = 1; Characteristic is load dependent: CV #137: PWM of FOx at stand still and when braking CV #138: PWM of FOx at speed step 1 CV #139: PWM of FOx at highest speed step, when accelerating and under high load.</p>
#140	Distance controlled stopping (constant stopping distance) Select start of braking and braking process	0 - 255	0	<p>Activates distance controlled stopping as per CV #141 in place of time-constant braking according to CV #4. = 1: automatic stops with “signal controlled speed influence” or “asymmetrical DCC signal”. = 2: manual stops using the cab. = 3: automatic <u>and</u> manual stops. The start of braking is delayed in above cases (= 1, 2, 3), if the train travels at less than full speed to prevent an unnecessary long “creeping” (recommended). On the other hand: = 11, 12, 13 selection as above but braking starts always immediately after entering the brake section.</p>
#141	Distance controlled stopping (constant stopping distance) Distance calculation	0 - 255	0	<p>This CV defines the “constant stopping distance”. The right value for the existing stop sections has to be determined by trial. Use these figures as a starting point: CV #141=255 is about 500m (or 6m in H0), CV #141=50 about 100 m (or 1.2m in H0)</p>
#142	Distance controlled stopping (constant stopping distance) High-speed correction using the ABC method	0 - 255	12	<p>The delayed recognition (see CV #134) but also unreliable electrical contact between rail and wheels has a larger effect on a stop point at higher speeds than at lower speeds. This effect is corrected with CV #142. = 12: Default. This setting usually works fine if CV #134 is set to default also.</p>
#143	... compensation using the HLU method	0 - 255	0	<p>Since the HLU method is more reliable than the ABC method, no recognition delay is usually required in CV #134; therefore this CV can also remain at default setting 0.</p>

CV	Designation	Range	Default	Description
#144	Programming and update lock	Bits 6, 7	0 or 255 (255 = „FF“, which for “old” decoders is the same as 0)	This CV was introduced to prevent unintentional decoder changes or loss of functions due to an inadvertent entry to the update mode. = 0: Unrestricted CV programming and decoder updates. Bit 6 = 1: No programming possible in service mode : protection against unintentional programming. Note: “on-the-main” programming is still possible. Bit 7 = 1: Software updates normally executed with the MXDECUP, MX31ZL or future devices are blocked. (Unlock this CV with “on-the-main” programming)
#145	Alternative motor control method	0, 1, 10, 11, 12	0	= 0: normal control mode (DC & coreless motors (Faulhaber, Maxxon)) = 1: special control for low-impedance DC motors (often Maxxon); this mode allows the connection of a capacitor (10 or 22uF) to the decoders positive and ground pads which puts less stress on the decoder and motor (but only if a capacitor is actually present!) This method has not been tested thoroughly. = 10: “normal” C-Sinus and Softdrive-Sinus control mode (same as CV #112, Bit 0 = 1), FO4 is fixed and not available as a function output. = 11: alternative C-Sinus / Softdrive Sinus control mode, FO4 is available as normal function output (not suitable for all C-Sinus or Soft drive-Sinus equipped locomotives). = 12: special C-Sinus and Softdrive-Sinus control mode for interfaces requiring the normal motor output instead of the otherwise more common C-Sinus output, FO4 is fixed and not available as function output. = 13: special C- / Softdrive - Sinus control for “Märklin Gottardo” (and perhaps other Märklin engines, instead of the otherwise usual C-Sinus output), FO3 is fixed for directional selection of front/rear 3 rd rail pick-up and therefore not useable otherwise.
#161	Protocol for all servo outputs	0 - 3	0	Bit 0 = 0: Servo protocol with positive pulses. = 1: Servo protocol with negative pulses. Bit 1 = 0: Control wire active during movement

CV	Designation	Range	Default	Description
				= 1: ... always active (consumes power, vibrates at times but holds position even under mechanical load). For SmartServo RC-1 , CV # 161 = 2 is a must!
#162	Servo 1 Left stop	0 - 255	49 = 1 ms pulse	Defines the servo's left stop position.
#163	Servo 1 Right stop	0 - 255	205	Defines the servo's right stop position.
#164	Servo 1 Center position	0 - 255	127	Defines a center position, if three positions are used.
#165	Servo 1 Rotating speed	0 - 255	30 = 3 sec	Rotating speed; Time between defined end stops in tenths of a second (total range of 25 sec). Default = 3 sec.
#166 to #169	As above for servo 2			
#181 #182	Servo 1 Servo 2 Function assignment	0 - 114 90 - 93 from SW-Version 18	0 0 0 0	= 0: Servo not in operation = 1: Single-key operation with F1 = 2: Single-key operation with F2 etc. = 90: Servo action depends on loco direction: forward = turns left; reverse = turns right = 91: Servo action depends on loco stop and direction: turns right when stopped and direction is forward, otherwise turns left. = 92: Servo action depends on loco stop and direction: turns right when stopped and direction is reverse, otherwise turns left. = 93: Servo action depends on loco movement: turns right when loco stopped, left when loco moving; direction makes no difference. Note: “left/right” is determined by the stop point settings with CV #162 and #163! = 101: Two-key operation F1 + F2 = 102: Two-key operation F2 + F3 etc. (left/right in each case) = 111: Two-key operation F11 + F12 = 112: Two-key operation F3 + F6 = 113: Two-key operation F4 + F7 = 114: Two-key operation F5 + F8

4. Additional notes to Configuration Variables (CV's)

Optimal Control, Automated Stops, Effects . . .

Two ways of programming speed curves:

Programmable speed curves can often optimize the driving characteristics of an engine. These curves alter the relationship between the cab's speed regulator settings and the engines speed (that is between 14, 28 or 128 external speed steps of the cab and the 252 internal speed steps of the decoder).

Which one of the two speed curves the decoder applies is determined by Bit 4 of Configuration Variable #29: "0" assigns the first type - Three Step Programming, defined by just three CV's; "1" assigns the second type - Programmable Speed Table, defined by 28 individual CV's.

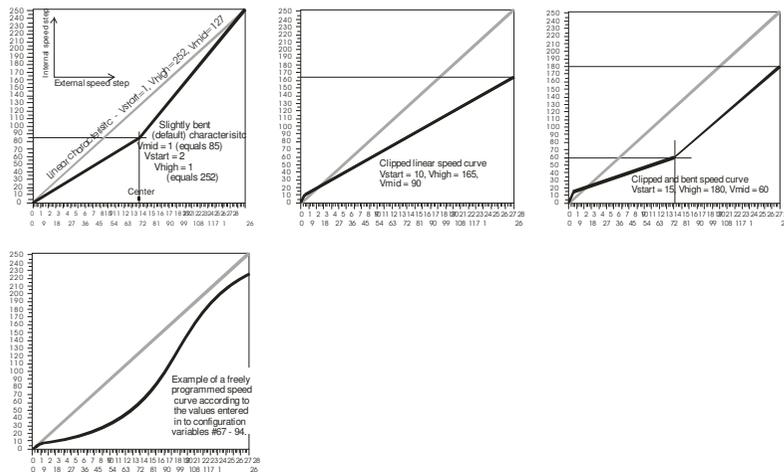
Three step programming: by using the Configuration Variables #2 for Vstart, #5 for Vhigh and #6 for Vmid.

Vstart defines one internal speed step out of a total of 252 to the first speed step of the cab, Vhigh to the highest speed step and Vmid to the center speed step of the cab. In this way a simple bent acceleration curve can be achieved with an expanded lower speed range.

A slightly bent curve is active by default (CV #6 = 1), that is the center speed step is limited to 1/3 of full speed.

Programmable speed table: with the help of the programmable speed table, **free programming** of all **Configuration Variables** from #67 to 94 is possible. Each of the 28 external speed steps is assigned to one internal step (0 to 252). If 128 external speed steps are used, an interpolation algorithm is used to calculate the steps in between.

NOTE: The three step programming is in most cases entirely sufficient for good drivability; the relatively complex procedure of defining a speed table is only recommended with the help of software like ADaPT that graphically draws the speed curve and automatically sends the data to the decoder.



Motor control frequency and EMF scanning rate:

In case of **Faulhaber, Maxxon or similar** motors (Coreless):
 Start with special **CV #9 = 12** and **CV #56 = 100** programming !!!

The **motor** is controlled by **pulse with modulation** that can take place at either low or high frequency. This frequency is selected with **configuration variable #9** (NMRA conforming formula, see CV table).

High frequency control: The motor is controlled at 20kHz in default mode or whenever a value of "0" is entered to CV #9, which can be raised to 40kHz with bit 5 in CV #112. The effect is comparable to operating with DC voltage and is likewise just as **noiseless** (no hum as with low frequency) and easy on the motor (minimum thermal and mechanical stress). It is ideal for coreless motors (recommended by Faulhaber!) and other high performance motors (most modern motors, including LGB). It is not recommended however, for AC motors and some older motors.

When operating at high frequency, power to the motor is interrupted periodically in order to determine the current speed by measuring back-EMF (voltage generated by the motor). The more frequently this interruption takes place, that is the higher the **EMF sampling frequency**, the better the load compensation performs (see next page); but that also results in a certain loss of power. This sampling frequency varies automatically in the default mode (CV #9 = 0) 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.

* It is recommended in most cases where an improvement is still required for **MAXXON, Faulhaber or similar motors**, to select a lower sample frequency such as **CV #9 = 11, 12, 21, 31** etc after CV #56 was programmed to 100; this will in any case reduce motor noise!

* for **older type motors** use rather the opposite, e.g. **CV #9 = 88**.
 Also see CV table and the following page!

Low frequency control: Entering a value between 176 and 255 to CV #9 drives the motor between **30 and 150 Hz**. Most often used value is 208 for 80 Hz. This is rarely used today and is only suitable for AC motors with field coils.

The load compensation:

All Zimo decoders come equipped with **load compensation**, also known as BEMF to keep a **constant speed**, regardless whether the engine is pulling a short or long train uphill, downhill or around a tight radius (although the speed will not be held 100% constant, especially in the upper speed range). This is accomplished by constantly comparing the desired value (speed regulator setting) and the actual value at the motor, determined with the EMF method (EMF stands for Electro Motive Force and is the force (power) produced by the motor when it is turned without power applied to it).

The **Reference Voltage** used for the BEMF algorithm can be defined by **CV #57** as either absolute or relative (default).

Absolute Reference:

A voltage value is defined in CV #57 as a base line for the BEMF calculation. For example: if 14V is selected (CV value: 140), the decoder then tries to send the exact fraction of the voltage indicated 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 "absolute reference" is to be preferred to the "relative reference" when using other vendors' systems (particularly those that don't keep the track voltage stabilized)!

Relative Reference: The speed range is automatically adjusted to the available track voltage, if a 0 is entered to CV #57 (default). Therefore, the higher this voltage is set at the command station (adjustable between 12V and 24V) the faster the train will be over its entire speed range.

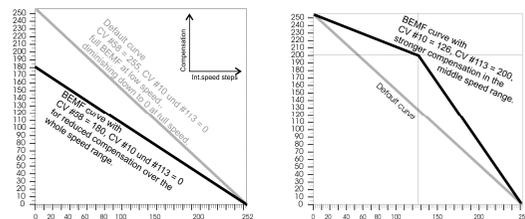
The relative reference is suitable as long as a constant voltage is present (which is the case with all Zimo systems but not all competitor systems) and the resistance along the track is kept to a minimum.

The driving characteristic of an engine can further be optimized by adjusting the **intensity of load compensation with CV #58**. 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 engines from stalling or picking up speed under load. BEMF should rather be reduced as speed increases, so that at full speed the motor receives full power with little BEMF. A slight grade dependent speed change is often considered more prototypical. Consists also should never be operated with 100% BEMF because it causes the locomotives to fight each other by compensating too hard and too fast, which could lead to derailments.

The degree of load compensation can be defined with **Configuration Variable #58** from no compensation (value 0) to full compensation (value 255). This, in effect, is the amount of compensation applied to the lowest speed step. Typical and proven values are in the range of 100 to 200.

If an even more precise load compensation is required (though hardly ever necessary), **configuration variable #10 and #113** presents a solution. CV #10 defines a speed step at which the **load compensation is reduced to the level defined in CV #113**. Both CV's have to have a value other than 0. If either CV #10 or #113 is set to 0, BEMF is again solely based on CV #58.



Regarding **configurations variable #56** – also see CV table and the following chapter on "Step by step....."!

Acceleration and deceleration characteristics (momentum):

Configuration Variables #3 and #4 provide a way of setting a **basic linear acceleration and deceleration rate** according to NMRA rules and regulations. That is, the speed is changed in equal time intervals from one speed step to the next.

To simply achieve smooth transitions during speed changes, a value between 1 and 3 is recommended. The true slow starts and stops begin with a value of about 5. Programming a value higher than 30 is seldom practical!

The momentum can be modified with **Configuration Variables #121 and #122** to an **exponential acceleration and deceleration** rate, independent from each other. This in effect expands the momentum in the lower speed range. The area of this expansion (percentage of speed range) and its curvature can be defined.

A typical and practical value is "25" (as starting point for further trials).

The **adaptive acceleration and deceleration procedure** defined by **configuration variable #123** will not allow a change in speed until the previous target speed step of an acceleration/deceleration event is nearly reached.

Most often applied values are "22 or "11", which can noticeably reduce a start-up jolt (the effect increases with smaller figures).

Step by step CV adjustment procedure to optimize engine performance:

It is recommended to systematically program a decoder since setting the CV's for load compensation and momentum can result in a certain interaction with each other:

* To begin, select the highest possible number of speed steps the system can operate in, that would be 128 for Zimo (select the number of speed steps at the cab for the decoder address in question). All Zimo decoders are set by default to 28 /128 speed steps. If used with systems that are restricted to 14 steps set Bit 1 in CV #29 to 0.

* Next set the engine to the lowest step, recognizable on the Zimo cab's when the bottom LED next to the speed slider changes color from red to green and/or the speed step 1 is displayed on the screen of the MX21/MX31 cabs (change the cab to 128 speed steps first, it is set by default to 28 speed steps!).

If the engine is now running to slow or not at all, increase the value in CV #2 (default 2), if it runs too fast decrease the value. If the individual speed table is used (CV #67 - 94, active if bit 4 of CV #29 is set), set the lowest speed step with CV #67 instead and adjust the rest of the speed table CV's accordingly.

* The EMF sampling process (see previous page) is critical for smooth even low speed behavior and quiet motor performance which can be modified with CV #9 (but also with CV #56!). This CV is also used to set the decoder to low frequency motor control, which is used only rarely with older AC motors.

By default, CV #9 is set to high frequency at 20 kHz (can be raised to 40 kHz with Bit 5 of CV #112) and automatically adapts the EMF sample rate to the loco speed. If drivability is not flawless or too much motor noise is audible, fine-tuning is possible with the help of CV #9 and CV #56.

In case of a **coreless motor design** such as **Faulhaber, MAXXON or similar**, start by setting **CV #56 = 100** (in place of the default value of 0 (zero) for "normal" motors); the "1" in the hundred digit causes among others the mid-range setting to match high-efficient motors, which is similar to a value of "11" but with further adjustment possibilities in both directions using the tens and ones digit.

With CV #9 the frequency and the length of the EMF sampling, which interrupts power to the motor, can be adjusted independently: using the tens and ones digit of the configuration variable, each in the range of 1 – 9.

In general: ♦ High-efficient motors such as Faulhaber, Maxxon, Escap etc can manage with fewer samples; both values can therefore be set low (i.e. CV #9 = 11 or 22), which lowers the noise level and increases the available power. Especially the length of the sample time (ones digit) can often be set to a minimum (1). ♦ If an engine with an older motor design runs rough at low speeds, the

sample frequency (tens digit) is usually the one that needs to be set to a larger value (>5), which often requires the sample time (ones digit) to be set to a higher value as well (>5); i.e. CV #9 = 88. ♦ If during acceleration with applied momentum (i.e. CV #3 = 10) the speed visibly rises in steps (which has nothing to do with the actual speed steps), the sampling time (ones digit) should be increased above 5, e.g. CV #9 = 58.

* If, after setting CV #9, the engine still doesn't run smoothly enough at the lowest speed step, changing the values of the ones and tens digit in CV #56 (default value 55) will often improve it. These values define the proportional and integral portion of the PID control. By default (CV #56 = 0) or with the setting for coreless motors such as Faulhaber, MAXXON etc (CV #56 = 100, see above), the proportional value adjusts itself automatically and the integral value is set to mid-value. Depending on the type of motor, other values than the default value can be used, such as 77, 88 or 99 for older locos that run rough or 33, 22, or 11 for newer locos with more efficient motors (Faulhaber, MAXXON etc). With the help of the integral value a possible overcompensation can be improved by moving the value of CV #56 (ones digit) away from the center "5".

* After increasing the value of CV #56, check that the engine is not running jerkily at mid speed level. Use CV #58 to counteract that. Either reduce the value of CV #58 (default 250) down to between 150 and 200 to generally reduce the load compensation, or use CV #10 and #113 to cut the load compensation at a speed just below the start of the jerky motion (the compensation is reduced to the level defined with CV #113 at the speed step defined with CV #10).

* If after the above adjustments the engine's speed is still fluctuating use CV #57 for further fine-tuning. With a default value of 0, load compensation is based on the measured track voltage. If this voltage fluctuates, the speed will fluctuate also. The cause is usually a DCC system that can't compensate for voltage drops (other than Zimo systems) or dirty wheels or track. To prevent such fluctuations the current track voltage x10 is entered to CV #57 (not idle track voltage, rather voltage under load). For example, if an engine needs 14 V (measured under load) a value of 140 should be entered. Sometimes it's even better to keep this value about 20% lower to compensate for a slight internal voltage drop in the decoder.

* Next, we check to see whether the loco's initial start is smooth or abrupt. This can be seen well with some momentum added. Temporarily, set some momentum with CV #3 and #4. Use CV #3 for acceleration and CV #4 for deceleration adjustments. Start with a value of 5.

The adaptive acceleration/deceleration procedure can now be used to eliminate abrupt starts by changing the value in CV #123. Start with a value of 30. The lower the value, the stronger the effect will be (e.g. 10 results in the strongest effect for acceleration, 90 or 99 the weakest). The tens digit is for defining the adaptive acceleration and the ones digit for the adaptive deceleration. To achieve the same results for both acceleration and deceleration enter the same value in tens and ones, in this example 33. However, if used in automated operations where precise stop points are required, set the ones digit to 0.

* After changing the values in CV #123 the basic momentum may need to be readjusted to your preferences; first with CV's #3 and #4 (basic momentum) and if desired with CV's 121 and 122 (exponential momentum).

* If a locomotive starts up too fast or comes to a stop too quickly, which is often the case even though the basic momentum is set to your liking, use CV #121 and #122 to add an exponential acceleration and deceleration curve. This in effect will stretch the time the locomotive spends in the lower speed range. Often used values for these CV's are in the range of 25 to 55. Tens digits define the percentage of the speed range to be included in this curve (20% - 50% in this example). Ones digits define the curvature.

Notes on acceleration behavior versus speed steps:

An acceleration or deceleration sequence according to CV #3 and 4 that is the timely succession of speed steps is always based on the internal 252 steps which are spaced identical from 0 to full speed. Neither speed table (three steps nor individual speed table) has any effect on the acceleration or deceleration behavior. The speed tables only define the target speed for a particular speed dialed-in by the cab.

This means that the acceleration or deceleration behavior can not be improved by a bent speed curve as defined by CV #2, #5, #6 or the individual speed table CV's #67 - 94. The exception to this could only be a cab or computer controlled acceleration or deceleration event. A decoder controlled acceleration or deceleration event can only be influenced by CV #121 and #122.

- If applicable see section "Settings for the signal controlled speed influence"!
- If applicable see section "Setting for stopping with ..."!
- If applicable see section "Distance controlled stopping" (constant stopping distance)!

Km/h – Speed regulation -

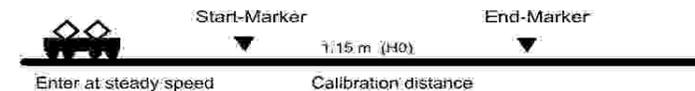
CALIBRATION and operation

The km/h speed regulation is a new, 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. Preferably, all engines of a layout should be set to the same method. Engines equipped with non-ZIMO decoders can be set up similarly through the programmable speed table (although with more effort and less precise because there is no readjustment taking place by the decoder).

The ZIMO readjustment: the decoder is not limited to converting the speed steps to a km/h scale but rather ensures that the desired speed is held, by recalculating the already traveled distance and automatically readjusts itself.

A CALIBRATION RUN; should be performed with each loco:

First, we need to determine the **calibration track:** a section of track that measures 100 scale meters (plus the necessary length before and after, for acceleration and deceleration), of course without inclines, tight radii and other obstacles; for example, for HO (1:87) 115cm; for G-scale (1:22.5) 4.5m. Start and end points of the calibration distance need to be marked.



* Set the loco 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 (momentum in CV #3 of the decoder as well as settings in the cab) should be set to 0 or a small value to prevent any speed changes inside the calibration distance. Otherwise, the length of track before the calibration marker needs to be increased accordingly.

* The calibration mode is now activated by programming **CV #135 = 1** (operational 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 1/2 of full speed); the loco accelerates towards the start marker.

* When 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 is varied.

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: each speed step (1 to 126) becomes 1 km/h: that is step 1 = 1 km/h, step 2 = 2 km/h, step 3 = 3 km/h ... to step 126 = 126 km/h

CV #135 = 5: each speed step (1 to 126) becomes 1/2 km/h: that is step 1 = .5 km/h, step 2 = 1 km/h, step 3 = 1.5 km/h, ... to step 126 = 63 km/h (for local or narrow gauge railways!)

CV #135 = 20: each speed step (1 to 126) becomes 2 km/h: that is step 1 = 2 km/h, step 2 = 4 km/h, step 3 = 6 km/h, .to step 126 = 252 km/h (High speed trains!)

The speed regulation in km/h is not just useful for direct cab 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.

Mph speed regulation:

A mph speed regulation can be achieved by extending the calibration distance accordingly!

Settings for the ZIMO "signal controlled speed influence" (HLU)

ZIMO digital systems offer a second level of communication for transmitting data from the track sections to engines that are in such sections. The most common application for this is the "signal controlled speed influence", that is the stopping of trains and applying of speed limits in 5 stages issued to the track sections as required with the help of MX9 track section modules or its successors. See ZIMO flyers at www.zimo.at and MX9 instruction manual.

The term "**HLU**" method was coined over the years after the speed limit designation "H" (=Halt or stop), "L" (=Low speed) and "U" (Ultra low speed).

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

Please note that the signal controlled acceleration and deceleration times 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 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.

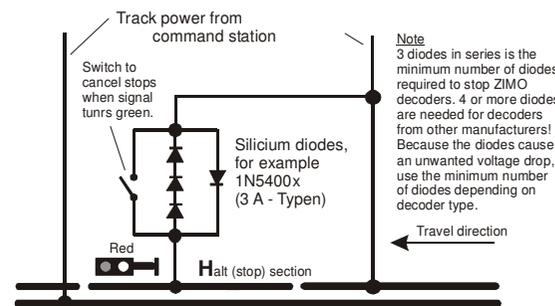
It is of utmost importance for a flawlessly working train control system using the signal controlled speed influence that the stop and related brake sections are arranged properly everywhere on the

layout, especially in terms of their length and consistency. Please consult the MX9 instruction manual and the STP manual.

The braking characteristics should be set up on a suitable test track so that all locos come to a complete stop within about 2/3 of the stop section, which is in HO typically about 15 to 20 cm before the end of a stop section (deceleration rate adjusted with CV #4 and CV #50 as well as the reduced speed with CV #52 for "U"). Setting the loco up to stop precisely within the last centimeter of a stop section is not recommended because such an exact stop point is, for various reasons, hardly repeatable every time.

Settings for stopping with "asymmetrical DCC signal" (Lenz ABC)

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



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

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

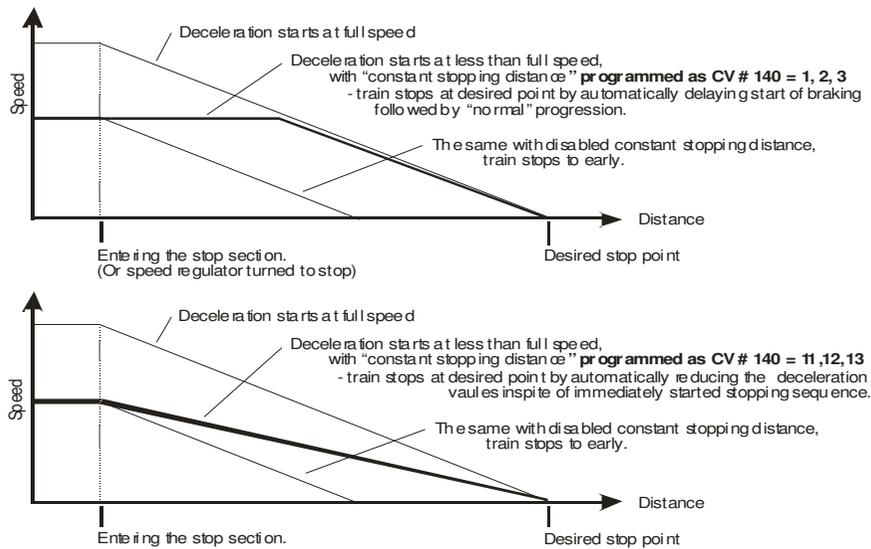
The asymmetrical threshold can be modified with CV #134 if necessary, default is 0.4V. At the time of writing, the "asymmetrical DCC signal" has not been standardized and many DCC systems pay no attention to this feature!

Distance controlled stopping – Constant stopping distance

When this feature is selected with CV #140 (= 1, 2, 3, 11, 12, 13) it keeps the stopping distance as close as possible to the one defined in CV #141, independent of the speed when entering the stop section.

This method is especially suitable in connection with automated stops in front of a red signal with the help of the **ZIMO signal controlled speed influence** or the **asymmetrical DCC-signal** (see above). CV #140 is set for this purpose to 1 or 11 (see below for details).

Although of lesser practical value, the distance controlled stopping can also be activated directly by the cab or computer when the speed is set to 0 (by programming CV #140 with appropriate values of 2, 3, 12 or 13).



The distance controlled stopping can take place in two possible ways; see diagram above: **The first** is the **recommended method (CV #140 = 1, etc.)**, where the train entering at less than full speed continues at first at the same speed 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 with the braking procedure, 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 this capability in order to harmonize the brake sequences.

Also, the second method may 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.

"Distance controlled stopping", when activated, is exclusively applied to decelerations leading to a full stop. Reductions in speed or acceleration events are not affected by this (still handled by CV #4 etc.).

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 is *not* controlled by CV #122! The application of CV #121 for exponential acceleration however remains unchanged.

Automated uncoupling procedure; also see "connecting an electric coupler" in chapter 7:

As described in chapter 7, the control of an electric coupler (System Krois) is defined by CV's #127, 128 etc. (function output effects) and CV #115 (timing).

With the help of CV #116 the decoder can be programmed so that the uncoupling loco automatically moves away from the adjoining coupler without moving the speed regulator (which is sometimes inconvenient because the uncoupler key needs to be pressed at the same time).

The tens digit in CV #116 defines **how long (0.1 to 5 sec)** the loco should move away from the adjoining coupler, the ones digit defines **how fast (internal speed step 4 to 36)** it should move away, see CV table. The momentum used during this acceleration/deceleration event is governed as usual by the relevant CV's (#3, #4 etc.). The hundreds digit of CV #116 causes the loco to automatically **push against the adjoining coupler before** the uncoupling process starts in order to relieve coupler tension (otherwise the couplers can't open).

Other hints:

- The procedure is activated if the tens digit in CV #166 is other than 0; if desired (and CV #116 > 100), the loco pushes first automatically against the coupler in the opposite direction!
- The procedure (acceleration) takes place at the moment the coupler is activated, although only if the loco is at rest at the time of coupler activation (speed regulator in 0 position). If the loco is still moving, the procedure starts as soon as the loco comes to a complete halt provided the button for this function is still being activated.
- The procedure ends when the function is turned off (by releasing the key if in momentary mode or by pressing the key again if in latched mode), or when the programmed time limits have been reached (CV #115 for the coupler and CV #116 for the loco detachment phase).
- Moving the speed slider during an automated uncoupling procedure stops the process immediately.
- The driving direction during coupler detachment is always according to the cab setting; directional settings in the "Effects" definition for uncoupling (Bits 0 and 1 of CV #127, CV #128 etc.) will not be applied.

Shunting and half-speed functions:

By defining the different Configuration Variables (#3, 4, 121, 122, 123), a prototypical acceleration and deceleration behavior is achieved that often makes shunting very difficult.

With the help of CV #124, a shunting key can be defined (either the dedicated MAN key within a ZIMO system or the keys F4 or F3) with which the acceleration and deceleration rates may be reduced or eliminated all together.

CV #124 may also be used to define either F7 or F3 as low gear key. With this function turned on, the throttle is used for half the decoder's full speed range, which is just like shifting down into low gear.

Example: The F7 key should act as low gear and the F4 key should reduce the momentum down to 1/4. According to the CV table, the bits in CV #124 are to be set as follows: Bit 0 = 0, Bit 1 = 1, Bit 2 = 1 and Bit 3 = 1. The sum of the individual bit values (0+2+4+8 = 14) is entered as a decimal value.

“On-the-fly” - programming (a.k.a. on-the-main):

Configuration variables can also be changed on the main track as well as on the programming track, without interfering with other trains operating on the layout.

All CV's, with the exception of address CV's, can be modified on the main. Please note though that the verification and read-out of CV values will not be possible until the bidirectional communication is implemented (in the course of 2006 with SW updates for the ZIMO command stations “model 2000” and MX1EC as well as decoders).

If no bidirectional communication is available, “on-the-fly” programming should primarily be used for CV's where a change is immediately visible (e.g. Vstart, Vmax, signal controlled speed influence settings, etc). Don't use it to program the 28 speed steps in the speed table for example, which is preferably done at the programming track (where programming can be confirmed through acknowledgments).

Consult the ZIMO cab instruction manual for on-the-fly programming steps!

The allocation of function outputs (“function mapping”):

Depending on decoder type, ZIMO decoders have between 4 and 14 function outputs (FO...). The loads connected to these outputs, such as headlights, smoke generator etc. are switched on and off with the function keys (F...) on the cab.

Which key (F...) controls which function output (FO...) can be specified by a series of Configuration Variables.

The configuration variables #33 to #46 forms the NMRA function mapping according to their rules and regulations as shown in the table on the right.

Extended flexibility, more directional functions and automated time controlled lights-out with CV # 61:

CV #61 offers fixed output assignments, especially liked for Swiss lighting systems (CV #61 = 6 or 7) but also offers flexible assignments by means of a special programming procedure (CV #61 = 98), with which each function/direction command can be assigned to specific function outputs. An automated turn-off feature, which turns designated function outputs off after the loco comes to a stop is also available. More information follows on the next 3 pages!

An alternative method for directional functions:

According to the NMRA function mapping (see right) only function F0 is intended to change with the direction and is usually used for the front and rear headlights. All other functions from F1 to F12 can only be used independent of direction.

Using CV #125 – 132 allows other functions (i.e. F1, F2, F3...) to be controlled according to direction by taking advantage of Bits 0 and 1 (while at the same time leaving the "Effects Bits" unchanged).

Example 1: The red taillights on the front and rear end of a locomotive are connected to FO1 and FO2; both are to be switched with F1 and should change with direction. In order to do that set CV #35 to “12” (Bit 2 for FO1 and Bit 3 for FO2 in CV #35), CV #127 to “1” and CV #128 to “2” - thus function output 1 is turned on in forward direction only and output 2 in reverse. Special effect codes in bit 2 - 7 all remain at 0.

Example 2: The taillights should not be switched individually and independent from the headlights as in the example above but rather the two loco ends should be properly lighted (white and red lights) and switched on/off with F0 (front) and F1 (rear). This allows turning all lights off on the appropriate loco end, if cars are coupled to the loco.

This can be achieved as follows: Front white headlights on function output “Front headlight” and front red taillights on function output 2; rear white headlights on function output 1 and rear red taillights on function output “Rear headlights”.

CV #33 = 1 (= default, front white light on F0 “front headlights), CV #34 = 8 (front red lights on F0 “rear headlights”), CV #35 = 6 (both rear white and red lights on F1 !), CV #126 = 1 and CV #127 = 2 (Directional change of rear white and red lights with “Effect”-CV’s).

Alternative method: Use the function mapping procedure CV #61 = 98; see later in this chapter!

5. “Function mapping” as per NMRA Standard; and ZIMO - Extensions

The configuration variables CV #33 to #46 refer to the function keys (F...) of the cab; the single bits to the function outputs (FO...) of the loco decoder. The function keys are matched to the function outputs by setting the appropriate bits. Multiple assignments are permissible.

“Mapping” according to NMRA standards with default assignment shown as ●:

NMRA Functions	CV	Number key on ZIMO cabs	Additional function outputs LED outputs (Solder pads)			MX640 function outputs Plug #1							
			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	4	3	2●	1	0						
F8	#42	9	4	3●	2	1	0						
F9	#43	1	4●	3	2	1	0						
F10	#44	2	4	3	2	1	0						
F11	#45	3	4	3	2	1	0						
F12	#46	4	4	3	2	1	0						

~~□~~ = Shift-Key

The above table shows the default settings; that is, the function key numbers correspond to the same numbered outputs. Therefore the following values were written to the configuration variables:

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

EXAMPLE of changing CV’s for individual assignments (●):

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

EXAMPLE above: The output #5 (FO5) should be switched in addition to output #3 (FO3) 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, which results in the above configuration (●).

The new values to be entered are as follows: CV36=40; #37=32; #38=64.

ZIMO – Special function mapping

The relevant allocations can be activated by programming the desired number to configuration variable #61. Function F1 along with some others can be mapped with specific function outputs, with the help of the NMRA function mapping. For example, function output FO1 can be allocated to function F2 (CV #35 = 4) or special shunting lighting can be realized with CV #35 = 3 (both headlights on).

CV #61 = 97

Alternative function mapping for MX640 without “left-shift”:

CV #61 = 67 overrides the higher CV’s “left shift” (from CV #37) of the NMRA function mapping (see previous page), which allows to map higher function keys with lower function outputs (e.g. It is not possible with NMRA function mapping to map F4 to FO1 but it is possible this way; the downside is that function outputs FO7 and FO8 can no longer be accessed!).

Therefore:

			FO6	FO5	FO4	FO3	FO2	FO1	Headlights rear	Headlights front
F0	#33	1 (L) forw	7	6	5	4	3	2	1	0 ●
F0	#34	1 (L) rev	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	2	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	9	7	6	5	4	3	2	1	0

and so on

and so on.

CV #61 = 1 or 2

NMRA Functions	CV	Numerical keys of ZIMO cabs	Function Outputs										
			FO9	FO8	FO7	FO6	FO5	FO4	FO3	FO2	FO1	Rear light	Front light
F0	#33	1 (L) forw				7	6	5	4	3	2	1	0 ●
F0	#34	1 (L) rev.				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	U – 9											
F9	#43	U – 1	4 ●	3 ●	2	1	0						
F10	#44	U – 2	4 ●	3	2	1	0						
F11	#45	U – 3	4	3	2	1	0						
F12	#46	U – 4	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.

Wenn CV #61 = 1

Wenn CV #61 = 2

CV #61 = 1 or 2 is very similar to the normal NMRA function mapping (which is CV #61 = 0), but...
 ...for many applications desired: actuation of FO1 by the driving direction, that is by the “directional bit” (when CV #61 =1) or by F7 (when CV #61 = 2).

CV #61 = 11 or 12

NMRA Functions	CV	Numerical keys of ZIMO cabs	Function Outputs											
			FO9	FO8	FO7	FO6	FO5	FO4	FO3	FO2	FO1	Rear Light	Front Light	
F0	#33	1 forw.				7	6	5	4	3	2	1	0	●
F0	#34	1 rev.				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	U - 9	4	3	2	1	0							
F9	#43	U - 1	4	●	3	2	1	0						
F10	#44	U - 2	4	●	3	2	1	0						
F11	#45	U - 3	4	●	3	2	1	0						
F12	#46	U - 4	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.

When CV #61 = 11 When CV #61 = 12

CV #61 = 3 or 4

NMRA Functions	CV	Numerical keys of ZIMO cabs	Function Outputs											
			FO9	FO8	FO7	FO6	FO5	FO4	FO3	FO2	FO1	Rear light	Front light	
F0	#33	1 forw.				7	6	5	4	3	2	1	0	●
F0	#34	1 rev.				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	#38	5	7	6	5	4	3	2	●	1	0			
F5		6												
F6		7												
F7		8												
F8	#42	U - 9	4	3	2	1	0							
F9	#43	U - 1	4	●	3	2	1	0						
F10	#44	U - 2	4	●	3	2	1	0						
F11	#45	U - 3	4	●	3	2	1	0						
F12	#46	U - 4	4	●	3	2	1	0						
Directions Bit														

CV #61 = 3 CV #61 = 4

CV #61 = 11, 12 is again very similar to the normal NMRA function mapping, but...

...actuation of FO1 by the driving direction or F7 (same as with CV #61 = 1 or 2),

CV #61 = 3 or 4 are for the most part identical to the allocations on the previous page (CV #61 = 1 or 2), but with a **direction dependent function F3**, which actuates outputs FO3 or FO6 according to driving direction (typical applications are red taillights).

...Actuation of output FO1 with driving direction (when CV #61 = 3), which is the **directions bit**, or with F6 (CV #61 = 4).

CV #61 = 13 or 14

NMRA Functions	CV	Numerical keys of ZIMO cabs	Function Outputs										
			FO9	FO8	FO7	FO6	FO5	FO4	FO3	FO2	FO1	Rear light	Front light
F0	#33	1 forw.				7	6	5	4	3	2	1	0●
F0	#34	1 rev.				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	#38	5	7	6	5	4	3	2●	1	0			
F5		6											
F6		7			●							●	
F7		8	4	3●	2	1	0						
F8	#42	U - 9	4	3●	2	1	0						
F9	#43	U - 1	4●	3	2	1	0						
F10	#44	U - 2	4	3	2	1	0						
F11	#45	U - 3	4	3	2	1	0						
F12	#46	U - 4	4	3	2	1	0						
Directions Bit													

CV #61 = 13 CV #61 = 14

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 15

NMRA Functions	CV	Numerical keys of ZIMO cabs	Function Outputs										
			FO9	FO8	FO7	FO6	FO5	FO4	FO3	FO2	FO1	Rear light	Front light
F0	#33	1 forw.				7	6	5	4	3	2	1	0●
F0	#34	1 rev.				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	U - 9	4	3●	2	1	0						
F9	#43	U - 1	4●	3	2	1	0						
F10	#44	U - 2	4	3	2	1	0						
F11	#45	U - 3	4	3	2	1	0						
F12	#46	U - 4	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) independent of 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).

ZIMO – Special function mapping

Function mapping procedure with CV #61 = 98:

This procedure allows free allocation of function outputs to function keys (on the cab) that is not possible by setting fixed values in configuration variables.

To carry out this procedure requires a bit more time and attention from the user.

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

* **CV #61 = 98** Writing 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 (as many as desired) to be assigned to F0 in forward direction, are now actuated

with the corresponding function keys (i.e. FLf, FLr, F1...F12).

Because only one function key (F0) is available for FLf and FLr (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's 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 FLf and FLr (both headlights) are turned on to indicate the end of this programming procedure.

Confirm again by actuating the **direction key**.

* After confirmation, the finished allocations are **automatically activated** and CV #61 is set to “99”.

Deactivation:

CV # 61 = 0 ... 97 (any value except 98 and 99) deactivates the function assignment and again activates the function mapping according to CV #33 to #46 or CV #61, if a value between 1 and 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.

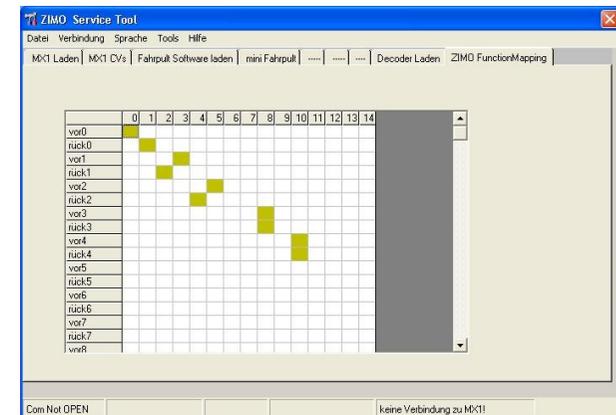
NOTES:

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 re-activate several function output allocations with the help of the “CV-set” feature!

For a better understanding, the function keys are listed here in the sequence they are defined:

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



An easy to work with tool that replaces the “CV #61 = 98” procedure will become available later, as part of the “**ZIMO Service Tool**” **ZST**, where the desired functions can be “mapped” into a table and the procedure described above will be carried out automatically!

6. 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 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 selecting for example a chuff sound from 5 different chuff samples and a whistle from 10 available 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.

► ZIMO “ready-to-use” sound projects are available from www.zimo.at (follow “UPDATE”, “Decoder”). On the same pages, information about the prototype with some videos and mp3 sound samples are available as well as the project specific function assignments and CV settings. More sound projects will be added continuously, also with the assistance of ZIMO partners through their home pages or web shops.

The desired sound project is first downloaded and stored in the computer; then sent to the decoder with the help of the software “ZSP” (ZIMO Sound Program) and the decoder update module MXDECUP (or the system cab MX31ZL). As is the case with decoder firmware updates, the decoder remains in the locomotive and is set as is on the “update” track.

If needed the original ZIMO sound project can be edited with the ZIMO sound program (ZSP) before sending it to the decoder – to change function assignments, random generators and other settings, for example. Once the editing is done, the sound project can be sent to the decoder as described above.

It is possible to change function assignments, sound and other parameters during normal operations via the cab and if desired to upload the relevant data to the computer (again on the update track with the help of ZSP). In this way a new custom sound project can be put together, saved and used in other engines.

Still more comfortable is the use of an USB stick on the system cab MX31ZL for installing sound projects into decoders – without a computer that requires a connection to the layout, program installation etc.

ZIMO sound decoders can also be special ordered with the favorite sound project installed.

► “Homemade” ZIMO sound projects using private sound files can also be put together with the help of the ZIMO sound program (ZSP). Sound samples from all available sources, including your own recordings, can be used.

In the course of 2008, ZSP will be further developed and later integrated into a new comprehensive program (ZISP or ZIRC). The development will be carried out side by side with the extension of the decoder software, in order to find new possibilities in sound composition:

► Shipping decoders with many samples (“Sound collections”) “on board” is also a **trend-setting concept** because advancing chip technology in the coming years will offer more and more storage capacities (at the same foot print and negligible increase in cost – ZIMO decoders will “grow” in this respect with every year).

- The sound is **adjustable** and **fine-tunable** with the help of “**incremental programming**” by gradually increasing or decreasing values, without awareness of the different CV values.
- sound to be heard on level track and no load (as per personal desire from “almost nothing” to full volume);
- 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;
- how the steam chuffs should overlap each other at high speed (changing to a constant hiss or still accentuated chuffs);
- and much more.

Loco type selection with CV #265 – current layout for the MX640, SW-Version 1:
(Software and organization of sound will undergo changes over time; CV #265 is not yet final)

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

Operating the sound decoder for the first time (Sound collection “Euro-steam”):

As delivered, the MX640 comes with typical engine sound activated and function-sounds allocated to function keys:

Function F8 – turns engine sounds on/off,

sounds activated by function keys remain active regardless (an on/off key can be assigned for these as well with CV #311, which could also be F8).

The sound in case of the MX640 with “**European steam collection**” 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 function sounds are allocated to these **function keys**:

- | | |
|-----------------------------------|---|
| F2 – short whistle | F9 – compressor |
| F4 – water drain (blow off...) | F10 – generator (also comes on with F0) |
| F5 – long whistle (playable) | F11 – injector |
| F6 – bell | |
| F7 – coal shoveling or oil burner | |

F0, 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 ranges are 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!

With **CV #7 = 0**

the "Pseudo-Programming" is stopped, which means that programming CV #166 is again programming this CV.

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 if once again lower CV's need to be programmed!

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!).

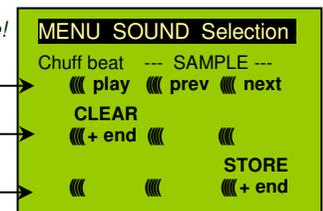
The "Pseudo-Programming" (meaning that the entered value is not really stored in memory) has the effect that the **function keys F0 to F8** no longer actuate function outputs but instead are now available for **special tasks** within the sound selection procedure. The function keys should be set to momentary, 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 in a different layout.

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

ZIMO MX31 key arrangement :

F0 F1 F2
F3 F4 F5
F6 F7 F8



This is a drawing of the planned 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; 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, with the engine running the selected file replaces the currently active.

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

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

The **selection procedure** is also stopped when programming anything else (e.g. CV #300 = 0 or any other value but also any other CV) or by turning off power to the system. 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,
- play-back is tried (F0) but no sound sample 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
- 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).
- CV #300 = 134 for the driving sound of an ELECTRIC engine

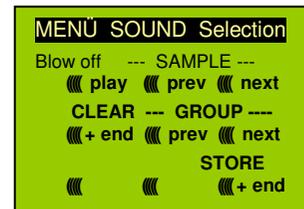
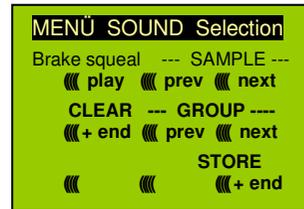
The selection procedure for background sounds is the same as for the selection of chuff sounds except the engine should be at a **stand still** because the **speed regulator** is used **for setting the volume** for the relevant sound file!

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

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

Allocating sound samples to function keys F1 ... 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
- CV #300 = 3 for function F3
- 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.

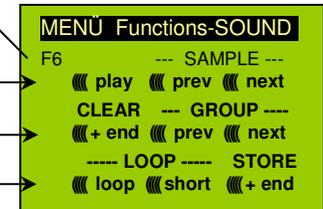
The engine should remain **stationary** though since the **speed regulator** is used **for volume settings** during the allocation procedure!

Depends on entry: F1 ... F12

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

ZIMO MX31 key arrangement :

- 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.); plays back 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

Playable whistle! repeating the sound between the loop marks (the loop marks are part of the sound file).

F7 = short: If F7 is “on” when exiting the allocation procedures, the sound sample is shortened and played back for the duration of the function actuation, by omitting the center portion.

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

If F6 or F7 are not actuated, the sound sample then is always played back in the 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 played back when this function key is pressed.

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

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

The "**cuckoo jingle**" sounds when....

.... the last stored sound sample of that group is reached; use the key to scroll in the opposite direction (F1, F2) to listen to the other stored sounds,

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

.... play-back is tried (F0) but no sound sample available,

.... a wrong key is pressed.

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

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

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

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

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

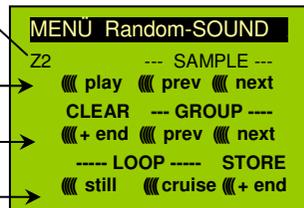
- CV #300 = 101 for random generator Z1
(Z1 has special logic incorporated for the compressor and should therefore always be used for that)
- CV #300 = 102 for random generator Z2
- CV #300 = 103 for random generator Z3
- etc.

Depends on entry: Z1... Z8

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

ZIMO MX31 key arrangement :

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



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

F0 = play: play back

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

but

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

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

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

Allocation of sound samples to switch inputs S1 and S2:

The MX640 has 3 switch inputs available (at connector #2), 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 by the user 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.

To each switch input, a sound sample can be allocated from the pool of stored samples in the decoder; play-back 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

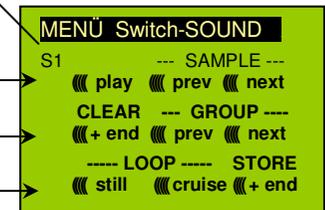
- CV #300 = 111 for switch input S1
- CV #300 = 112 for switch input S2
- CV #300 = 113 for switch input S3
- and so on...

Depends on entry: S1...S4

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

ZIMO MX31 key arrangement :

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



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

F0 = play: play back

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

Automated recording of 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, also known as BEMF. 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 will result in analogously changed chuff sounds.

Initiated with “Pseudo-Programming”

CV #302 = 75

an automated run is performed to record the “basic load” factor in forward direction;

ATTENTION: the engine (or the 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, reverse is considered identical to forward).

Note: A “heavy” train (a train with higher rolling resistance due to power pick ups 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 a future SW version that allows 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 to actuate function outputs. The function keys are assigned to this 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 is not only the leading CV #266 assigned for incremental programming but CV #266, #267 and #268 as well.

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

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

ZIMO MX31 key arrangement :

☛ 1 F0 ☛ 2 F1 ☛ 3 F2

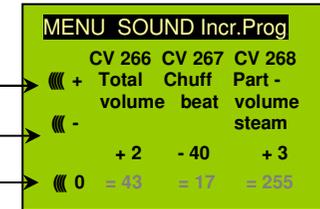
Incrementing !

☛ 4 F3 ☛ 5 F4 ☛ 6 F5

Decrementing !

☛ 7 F6 ☛ 8 F7 ☛ 9 F8

Set to default !



Drawing of an MX31 display, not a photo!

The last line shown in gray (absolute CV values) will no 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: All CV and parameter sets can be read out and written to the decoder and, if required, edited with a computer with the help of the MXDECUP programming module!

CV tables 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 during the "incremental programming" procedure.

CV	Designation	Value range	INC steps	De-fault	Description
LEAD - CV #266	Total volume	0 - 255	5	65	The value "65" results (mathematically) in the highest possible distortion-free play back 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 used.
#267	Chuff sound frequency with „virtual cam sensor"	0 - 255	1	70	CV #267 active only if CV #268 = 0 : Chuff beats follow the "virtual cam sensor"; an actual cam sensor is not needed in this case. The default setting "70" results in about 4, 6 or 8 chuffs per wheel revolution, depending on the chuff set selected; because it also depends in large part on the motor and gearbox used, an individual adjustment is necessary in most cases in order to achieve the desired chuff frequency. This is the reason for CV #267: The lower the value the higher the chuff frequency and vice versa.
#268	Switching to real cam sensor and trigger count for chuff rate	0 - 255	1	0	= 0: "Virtual"cam sensor is active (to be adjusted with CV #267, see above). = 1: real cam sensor is active (connected to switch input 2 of the MX640, see chapter 8); each negative spike results in a chuff beat. = 2, 3, 4 ... real cam sensor, several triggers in sequence (2, 3, 4 ...) result in a chuff beat.
LEAD - CV #269	Lead-chuff accentuated	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: Longer chuff length at very low speeds	0 - 255	10	?	PROJECT (not yet implemented): The chuff sounds of a real engine are extended when driving at very low speeds due to the mechanical valve control. This effect can be more or less accentuated with CV #270.

CV	Designation	Value range	INC steps	De-fault	Description
#271	Overlapping effect at high speed	0 - 255 (useful up to about 30)	1	16	The individual steam chuffs should overlap each other at high speed like on a real engine. Because the frequency of the chuffs increase but won't shorten to the same extend they will eventually blend in to a weakly modulated swoosh. This is not always desired in model railroading because it doesn't sound that attractive, hence CV #272 with which an adjustment is possible whether the chuffs should be accentuated at high speed or rather fade away.
LEAD - CV #272	Blow-off duration	0 - 255 = 0 - 25 sec	10	50 = 5 sec	Opening the cylinder valves on a prototype steam engine for the purpose of water drainage is entirely up to the engineer. An automated draining at start-up is more suitable in model railroading; CV #272 defines how long after start-up the blow-off sound should play. Value in CV #272 = time in tenths of a second! Note: If the blow-off sound is also allocated to a function key (on F4 as delivered, 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). = 0: no blow-off sound played back
#273	Delayed start after blow-off	0 - 255 = 0 - 25 sec	1	0	Opening the cylinder valves and with it the related blow-off sound on a real steam engine starts most often before the engine even starts to move. This can be imitated with CV #273 by automatically delaying the start. This effect is cancelled when a shunting function with momentum deactivation is being activated (see allocation of F3 or F4 in CV #124!) = 0: no delay = 1: Special setting for blow-off via speed regulator; no delay but the lowest speed step means "no driving but blow-off instead" (only with 128 speed steps). = 2: Start-up delay in tenths of a second, Recommendation: no value > 20 (> 2 sec)
#274	Blow-off schedule	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. Value in CV #274 = time in tenths of a second! Shunting with permanently open cylinder valves can be achieved by actuating the function key that

CV	Designation	Value range	INC steps	De-fault	Description
					is assigned for blow-off sound (F4 by default or by function key assignment with CV #312 = 2, 3, 4..., see above).
LEAD - CV #275	Engine (chuff) sound volume at low speed and no-load	0 - 255	10	60	<p>To set up load dependent sound do the following in the order shown:</p> <p><i>“Automated recording of the motor’s “basic load” factor”; see above!</i></p> <p><i>Adjusting sound volume in CV #275 and #276.</i></p> <p><i>Adjusting CV #277 (should have been “0” up to this point), see below!</i></p> <p><i>If required also CV #278 and #279.</i></p>
					<p>With this CV the chuff volume at “basic load” (that is under the same conditions as during the automated recording run) is adjusted at a speed of about 1/10 of full speed.</p> <p>Note: For practical purposes (but not absolutely necessary), CV #275 is set to the proper value by trial 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.</p> <p>This adjustment is best performed with CV #277 set to “0” (default) so that the setting for “unloaded driving” is not influenced by load factors.</p>
#276	Engine (chuff) sound volume at high speed and no-load	0 - 255	10	80	<p>Same procedure as in CV #275 above, but for high speed.</p> <p>CV #276 defines the “no-load” chuff sound volume at full speed. Set the speed regulator to maximum during this set-up.</p> <p>All notes in CV #275 are also valid for this CV!</p>
#277	Degree of volume change under load for driving (chuff) sound.	0 - 255	10	0 = no change	<p>When deviating from the basic load (as determined by the “Automated recording of the motor’s “basic load” factor”, see above) the chuff beat volume should be increasing (on inclines) or decreasing (or muted) on declines.</p> <p>CV #277 defines the degree of change, which is to be set to the proper value by trial.</p>
LEAD - CV #278	Load change threshold	0 - 255	10	0	<p>With this CV, a change in sound to small load changes can be suppressed (i.e. in curves) in order to prevent chaotic sound impressions.</p> <p>Suitable settings can only be determined by trial (with “incremental programming”).</p>
#279	Reaction time to load	0 - 255	1	0	With this CV the reactions in sound to changes in load can be delayed, whereas the factor is not just

CV	Designation	Value range	INC steps	De-fault	Description
	change				<p>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.</p> <p>Suitable settings can only be determined by trial (with “incremental programming” of CV’s #278 and #279 together).</p>
#280	Load influence for DIESEL engines	0 - 255	10	0	<p>This CV determines (at least temporarily in SW version 15) the reaction of the diesel sound to load: RPM levels and load steps of diesel-hydraulic engines, cruise/idle rpm of diesel-electrics and shift points of geared engines.</p> <p>= 0: no influence, dependent on motor rpm = to 255: large influence.</p> <p>It is highly recommended that the automated test run with CV #302 = 75 is performed first (see text above under CV #302).</p>
LEAD - CV #281	Acceleration threshold for full load sound	0 – 255 (internal speed steps)	1	1	<p>Compared to the “basic load”, more powerful and louder chuff sounds should be played back for increased power requirements during accelerations. As is the case with the prototype, the increased sound should be noticeable before the increase in speed becomes visible, since the latter is a result of the increased steam volume supplied to the pistons. It is therefore practical that the heavy acceleration sound is played back when the speed has increased by just one speed step (when no real speed change is noticed), to be able to control the proper sound sequence with the speed regulator.</p> <p>The “engineer” can in this fashion adjust the sound (by increasing the speed by 1 step) in anticipation of an imminent incline.</p> <p>=1: Acceleration sound played back at full volume if speed has increased by just one speed step. = 2, 3.... Acceleration sound played back at full volume only after increasing speed by this number of speed steps; before that: proportional volume.</p>
#282	Duration of acceleration sound	0 - 255 = 0 - 25 sec	10	30 = 3 sec	<p>The acceleration sound should remain for a certain length of time after the speed increased (otherwise each single speed step would be audible, which is unrealistic).</p> <p>Value in CV #282 = time in tenths of a second!</p>
#283	Engine sound volume at full acceleration	0 - 255	10	255	<p>The volume of steam chuffs at maximum acceleration is set with CV #283 (default: 255 = full volume).</p> <p>If CV #281 = 1 (acceleration threshold set to 1 speed step), the volume defined here is applied with every speed increase (even if increased by just 1 step).</p>

CV	Designation	Value range	INC steps	De-fault	Description
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). = 1: Reduces sound to minimum (as per CV #286) when speed is reduced by just 1 step. = 2, 3 ... sound reduced to minimum after lowering speed by this number of steps.
#285	Duration of reduced volume on deceleration	0 - 255 = 0 - 25 sec	10	30 = 3 sec	After the speed has been reduced, the sound should remain quieter for a specific time (analog to the acceleration case). Value in CV #285 = time in tenths of a second!
#286	Volume level during deceleration	0 - 255	10	20	CV #286 is used to define the chuff volume during deceleration (Default: 20 = pretty quiet but not muted). If CV #284 = 1 (deceleration threshold set to 1 speed step), the volume defined here is applied with every reduction in speed (even if decreased by just 1 step).
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. That is usually a shunting run and often without any cars (in reality it is mostly the cars that are squealing not the engine itself!). Note: Brake squeal sounds can also be assigned to a function key (see allocation procedure CV #300 = ...), with which 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. = 1: no stepping effect, even ascend 1 - 255: ascending scale according to the corresponding speed step interval.
LEAD - CV #290	Thyristor control: Sound pitch at medium speed for ELECTRIC engines From SW-version 20!	0 - 100	10	40	Percentage of the increased pitch of the thyristor sound at medium speed compared to standstill. Define the "medium speed" in CV #292. = 0: no change, pitch remains the same as at standstill. = 1- 99: corresponding change in pitch = 100: pitch doubled already at "medium speed".

CV	Designation	Value range	INC steps	De-fault	Description
#291	Thyristor control: Sound pitch at maximum speed for ELECTRIC engines From SW-version 20!	0 - 100	10	100	Percentage of the increased pitch of the thyristor sound at maximum speed compared to standstill. = 0: no change, pitch remains the same as at standstill. = 1- 99: corresponding change in pitch = 100: pitch doubled at "medium 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. The CV's #290 - 292 form a three-point characteristic curve for the pitch of the thyristor control sound, starting at standstill, whenever the original sample is being 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). Note: sound changing to load will be 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). At lesser accelerations a lower volume is selected automatically (exact algorithm is not finalized with SW-Version 4).
#295	Thyristor control Volume during deceleration Motor sound of ELECTRIC engine	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 rather decreases the volume).
LEAD - CV #296	Motor sound, highest 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, where 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 full volume for ELECTRIC engines	0 - 255 (> CV#297)	10	128	Internal speed step at which the motor sound reaches full volume; at this speed step the motor sound is played back at full volume according to CV #296.

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	Value range	De- fault	Description
#310	On/off key for engine <u>and</u> random sound	0 - 12, 255	8	Defines the function key (by default F8) that turns the engine sound (chuffs, boiling, blow-off's, brake squeals...) as well as the random sound (compressor, coal shoveling...) ON or OFF. = 255: engine and random sound is always ON.
#311	On/off key for function sound	0 - 12	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. = 0: <u>does not mean</u> that F0 is assigned for this task but rather that the function sounds are always active. = (#310), if the same value is entered here as in CV #310, the key defined in #310 turns all sound on/off. = 1 ... 12: Assigns separate key to turn function sound on/off.
#312	Blow-off key	0 - 12	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“. = 0: no key assigned (use this setting if keys are used for other purposes).
#313	Mute key from SW version 2	0 – 12	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. = 0: No mute key or mute function.
#314	Fade in/out time	0 – 255	0	Time in tenth of a second for sound fading in/out when mute button is pressed. Range is 25 seconds. =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. Sound samples are assigned to the random generator Z1 with the help of the procedure CV #300 = 101, see above! By default, the compressor is assigned to Z1. Special note to random generator Z1: The random generator Z1 is optimized for the compressor (which should be played back shortly after the train has stopped); therefore the default assignment should be retained or at the most be used for a different compressor. CV #315 also determines the proper time the compressor is started after coming to a stop!

CV	Designation	Value 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); the actual pulses are evenly spaced between the values in CV #315 and #316.
#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. = 0: Sample plays once (in the defined duration)
#318 #319 #320	As above but for sound generator Z2	0 - 255 0 - 255 0 - 255	20 80 5	By default, Z2 is assigned for coal shoveling.
#321 #320 #323	As above but for sound generator Z3	0 - 255 0 - 255 0 - 255	30 90 3	By default, Z3 is assigned for the injector.
#324 #325 #326	As above but for sound generator Z4	0 - 255 0 - 255 0 - 255		As delivered, this random generator is not assigned to any sound.
#327 #328 #329	As above but for sound generator Z5	0 - 255 0 - 255 0 - 255		As delivered, this random generator is not assigned to any sound.
#330 #331 #332	As above but for sound generator Z6	0 - 255 0 - 255 0 - 255		As delivered, this random generator is not assigned to any sound.
#333 #334 #335	As above but for sound generator Z7	0 - 255 0 - 255 0 - 255		As delivered, this random generator is not assigned to any sound.
#336 #337 #338	As above but for sound generator Z8	0 - 255 0 - 255 0 - 255		As delivered, this random generator is not assigned to any sound.
#341	Switch input 1 Playback time	0 - 255 = 0 - 255 sec	0	The sound sample allocated to switch input 1 is played back for the duration defined with this CV. = 0: Play sample back once (as recorded)
# 342	Switch input 2 Playback time	0 - 255 = 0 - 255 sec	0	The sound sample allocated to switch input 2 is played back for the duration defined with this CV. = 0: Play sample back once (as recorded)
# 342	Switch input 3 (if not used for the cam sensor) Playback time	0 - 255 = 0 - 255 sec	0	The sound sample allocated to switch input 3 is played back for the duration defined with this CV. = 0: Play sample back once (as recorded)

Installing new sound samples in ZIMO sound decoders:

WILL BE ADDED LATER or check www.zimo.at

New sound samples can be installed with the software "ZST" (ZIMO Service Tool), the **MXDECUP (decoder update module)** or the **MX31ZL** directly on the track without opening the locomotive.

Projects for future SW versions of the MX640 sound decoder:

The ZIMO sound decoder MX640 implemented as described on the previous pages corresponds to the software version 4. The following extensions and improvements are planned for future SW updates. Also included, as far as possible, will be suggestions made by users.

► The project "**CV sets**", which has already been implemented to some extent in connection with other features, will gain new significance for sound decoders: Many adjustments in the area of sound selection, sound allocation and CV's are actually not just dependent on the engine type but on the operating situation as well (i.e. load dependency, brake squeal but also non-sound functions such as lighting). For this reason it is planned to offer a way of easily switching between several stored parameters (CV sets).

7. Bidirectional communication = "RailCom"

The future oriented technology for which all ZIMO decoders have been prepared since 2004 (hardware), has also been installed in the MX640 decoders and is functional from the beginning (basic functions).

"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 and status information are being transmitted by the decoders.

The definitions for RailCom are determined by the "RailCom working group" (Lenz, Kühn, Tams and ZIMO), before that by the NMRA RP's 9.3.1 and 9.3.2 for bidirectional communication; with the goal of a uniform platform for "RailCom" applications.

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

With the help of  = bidirectional communication, it will

be possible that the decoder can acknowledge received commands, -

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

send current data from decoders to the command station -

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

decoder addresses are recognized by "local" detectors -

- the actual loco positions are determined by local detectors connected to individual track sections (integrated in future MX9 track section modules). This however has been possible with ZIMO's own loco number recognition for over a decade without bidirectional communication, but only with ZIMO components.

Starting in 2007, RailCom will be further developed over the coming years and will bring new applications, which of course require new software updates in decoders and other equipment. In the first phase - 2008, SW version 18 – ZIMO large-scale decoders will be 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) with some decoder data such as actual speed, load and decoder temperature.

On the system side, a third party product is available from the beginning – the address display LRC120, which is a "local" RailCom detector displaying the loco address of one track section. In the course of 2007, the MX31ZL will become available with an integrated "global" RailCom detector and finally "global" RailCom detectors for the installation into ZIMO command stations MX1EC, MX1, MX1HS as well as MX31 cabs.

The RailCom function is activated with CV #29, Bit 3 and is also the default setting (see chapter 3 and CV list)

"RailCom" is a trademark of Lenz Elektronik GmbH.

8. Installation and wiring of the MX640

General information:

There has to be enough **free space inside the engine** so that the decoder can freely be mounted. Pay particular attention that no pressure is exerted on the decoder when the loco housing is being reinstalled and that no movable parts can contact the decoder or wires.

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

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

Do noise suppression components on a locomotive motor have a negative affect 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 noise (poor TV reception etc.) caused by the sparks arcing across the motor's brushes.

Such components impair the motor regulation. Although ZIMO decoders manage quite well, that is 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 of 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.

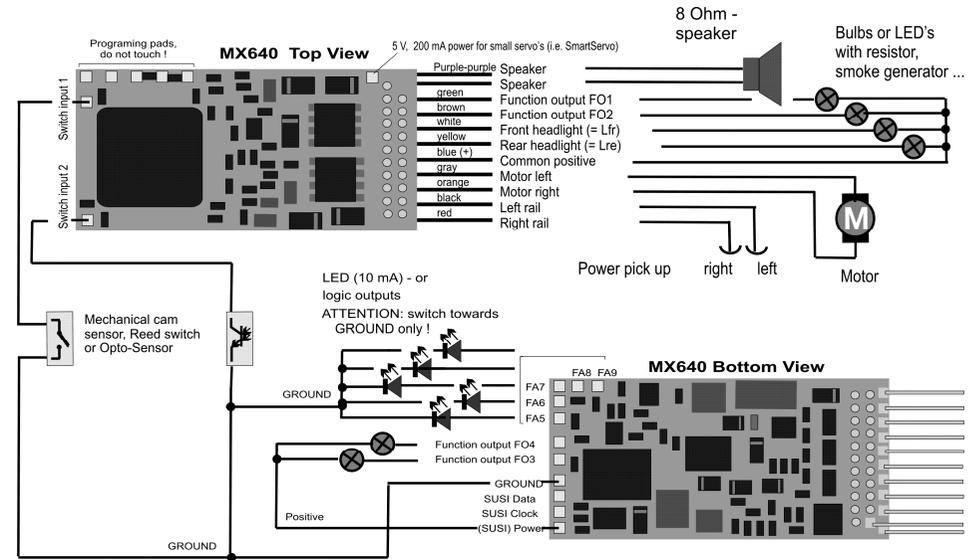
Fleischmann locomotives with "Round motors" (an older motor design) often have extremely bad filter components; **especially dangerous are those capacitors that connect between the motor connections and the frame, which can even lead to the destruction of the decoder end stage!** These components are often hard to see and to get at.

Indications of an actual negative effect of such components, besides a general unsatisfactory motor control (jerking...), are:

- weak control compensation: as a test, set the decoder to low frequency – CV #9 = 200 – and check to see whether the control compensation becomes stronger. If that's the case, the choke coils are most likely to blame for the weak compensation in the high frequency range.

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

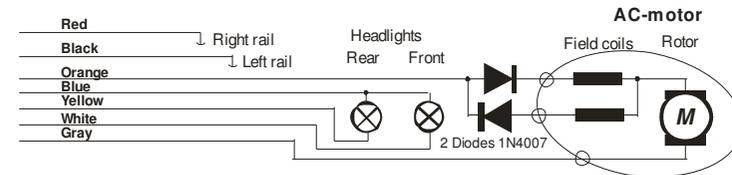
Remedy: **Bypass** (or remove) **choke coils, remove capacitors!** Capacitors are less likely to interfere with motor regulations but cannot be ruled out especially for the Fleischmann "Round motor", see above.



PLEASE NOTE: Body mounted light bulbs that are hard to insulate 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 in such an application.

SPECIAL CASES of locomotives with AC motors:

Two additional 1N4007 diodes (or equivalent, for at least 1A) are required as shown in the diagram below. They can be obtained at your local electronic store or from ZIMO at minimal cost.

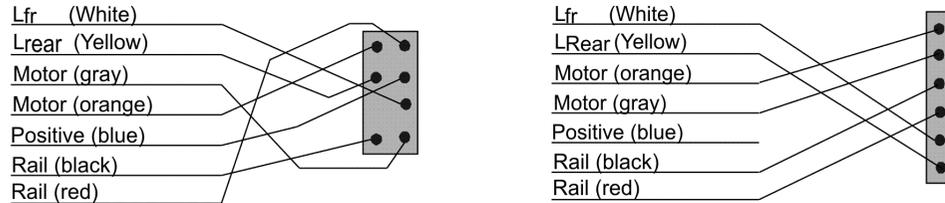


Most locomotives that run with an AC motor get the power supplied by a third rail, which doesn't change anything as far as the motor hook-up is concerned. The above schematic is therefore valid for AC locomotives running on two or three rail track.

Locomotives with standardized interface. . (8-pin, 6-pin or 21-pin)

... are easy to retrofit with the MX...R or MX...F that come with an 8-pin (NEM652) or 6-pin (NEM

651) plug, although only what the interface connections control (i.e. rails, motor, headlights. Other functions and speakers must be wired separately). There is usually enough room provided in such locomotives and by removing the dummy plug from the loco, all damaging connections mentioned at the beginning of the chapter are broken (except for interference components mentioned earlier) and the decoder can be plugged in instead.



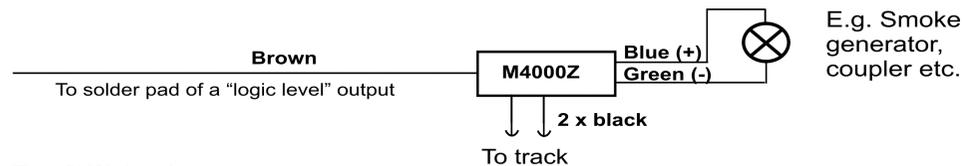
Using LED or logic level outputs:

Besides the normal function outputs (Headlights, FO1, FO2, FO3 and FO4), the MX640 decoders also have so called “LED or logic level” outputs (FO5, FO6, FO7, FO8 and FO9), to which current consuming devices may not be connected directly due to the low-load logic power available (0V, 5V).

However, **one LED** can be connected directly to each of these outputs (the required LED resistor is built into the decoder); each output provides a maximum of 10mA, see schematic on previous page.

NOTE: Connecting an LED to “logic level” outputs is allowed on MX640 decoders but on many other ZIMO decoders it is not (MX620, MX63, MX64...) and would lead to overheating!

If an “LED or logic level” output is to be used with a “normal” load, a M4000Z amplifier module or similar has to be used between the output and the load.



The “SUSI” interface:

The SUSI interface developed by Dietz is an NMRA standard and defines the connection between sound modules or other add-on components and loco decoders, provided they are also equipped with such an interface.

Speed and load information (e.g. to change sound intensity when going uphill, downhill, start up etc.) are sent from the decoder to the SUSI device.

Accessing SUSI CV's: These CV's are in the 890 range, according to the standard (NMRA DCC Draft RP), which is not accessible with many DCC systems. For this reason, ZIMO decoders allow access to these CV's with numbers in the 190's!

Connecting an electric uncoupler (System “Krois”):

In order to prevent damage from excess power to the delicate core of an uncoupler, appropriate adjustments can be made with special CV's for one or several function outputs (up to FO6).

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

Next define the uncoupler activation time limit 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 coupler detachment”, see CV #116, chapter 4.

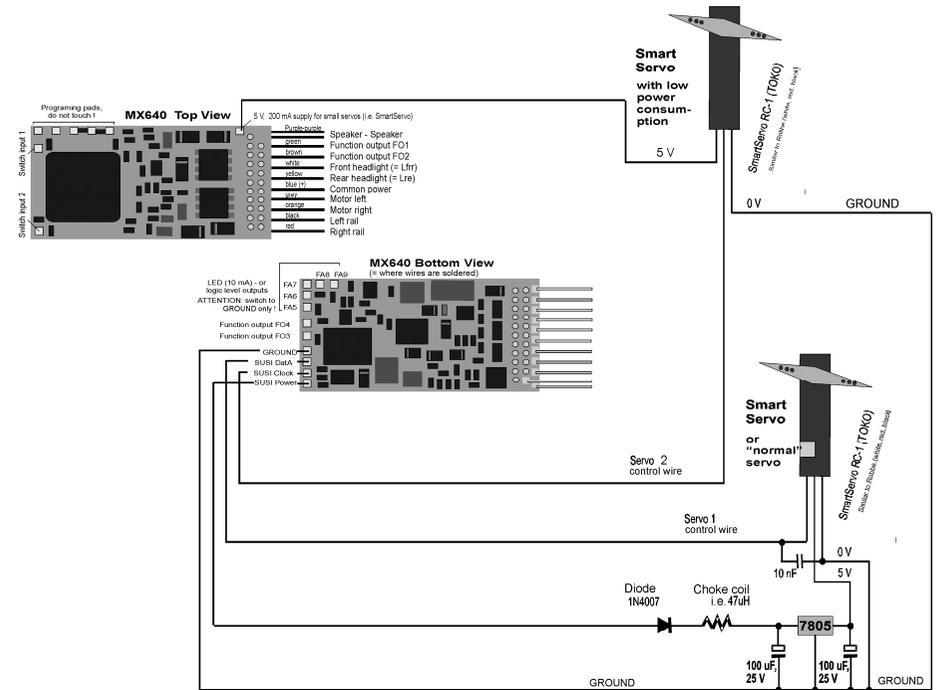
MX640 – Connecting servo and smart servo motors:

2 servo control outputs are available at the MX640 (solder pads or part of the 21-pin socket) for the control of commercially available servo motors or SmartServo RC-1 (Manufactured by TOKO Corp. Japan).

This is actually an **alternative use of the SUSI outputs** (which may be solder pads or part of the 21-pin connector; each output can be connected to a control input of a servo).

Low current servos (up to 200 mA) can be powered directly from the MX640! For all others, the 5V operating voltage must be supplied by an external voltage regulator such as the readily available LM7805 as shown in the drawing.

NOTE: ZIMO plans to introduce its own brand of a 5V regulator. Compared to the LM7805, it will be easier to install and produce less heat!



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.

CV #161 is also used to select the appropriate protocol. "Normal" for most servos are 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 can be changed by mechanical influences. In any case, Bit 1 in CV #161 must be set for **SmartServo's**, which is CV #161 = 2!

Connection and control of an external energy source (capacitor) for uninterrupted driving on dead track sections:

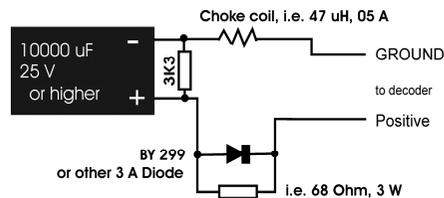
With the help of an electrolytic capacitor or a battery the

- driving performance on dirty track sections (or wheels) can be improved
- flickering of lights is reduced
- and stalling of trains, especially when crawling, can be eliminated

In cases where power to the decoder is interrupted due to dirty rails, wheels or insulated frogs, the decoder automatically keeps the engine going even though a currently active brake application should bring the train to a stop. Only when power to the decoder is restored is the loco allowed to stop, with subsequent testing to ensure power to the decoder is still available after the engine stopped (if not, the engine is moved again a short distance).

The energy storage increases with the capacity of a condenser and from 100uF (Microfarad) onwards an effect will be noticed. 1000uF to 10'000uF are recommended if the necessary space is available. 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.

The capacitor is connected between ground (available on all ZIMO decoders as solder pad) and power (blue wire) of the decoder. Note polarity!



When building your own power module, use the schematic above. The condenser is recharged through the 100 ohm resistor. This is to prevent a shut down of the command station during start-up. If a large number of loco's so equipped are on the layout the command station could interpret the current flow to these capacitors as a short circuit. 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!

The purpose of the resistor 3K3 shown in the drawing above (not required in all cases) is: even though a large condenser supplies the motor and lights for just a few tenths of a second (1000uF) or a few seconds (e.g. 4700uF) the remaining power, although at a voltage level below what is required by the motor and lights, is sufficient power to keep the decoders memory alive for quite some time (several minutes). This is sometimes a rather undesired effect. For example: If a running loco is taken from the track and the speed then set to zero, the loco would briefly run at the previous speed when it is set back on the track after about a minute. Using the above-mentioned resistor would erase the memory after just a few seconds.

Connection and control of the external power module MXSPEIK:

A complete **power module (MXSPEIK)**, which includes above circuitry with extended possibilities, will be available from ZIMO in the course of 2008!

MORE INFORMATION TO FOLLOW

Connecting speaker, cam sensor:

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

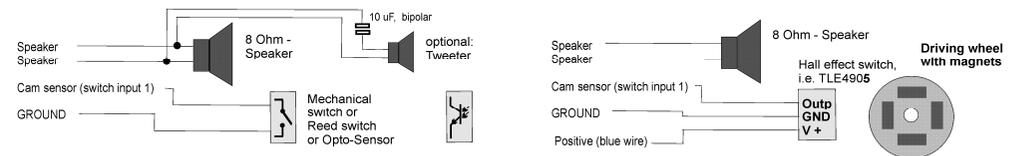
- mandatory – **SPEAKER** – Any 8-ohm speaker or two 4 Ohm speakers connected in series can be used. Speaker with higher impedance are also allowed but will result in reduced volume.

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).

Speaker installation – TO BE ADDED LATER

- optional – **CAM SENSOR** – Normally, ZIMO decoders are programmed for the "virtual cam sensor", which can be fine-tuned with CV #267. 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 and Hall Effect switches are suitable as cam sensors.



9. The MX640 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 also amperage). 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 of up to 24V from a Zimo command station.

If such problems arise or as preventive measure, it is recommended to:

- change **CV #57** (reference voltage) from "0" (where regulation is based on 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.

MX640 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 manual for the cab in question. 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 a Zimo system.

MX640 with ROCO Lokmouse-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!

MX640 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.

There have been some malfunctions in the past during system boot up. For example: locomotives would not start unless the power to the decoder was interrupted briefly (by tipping the locomotive off one rail). It is not quite clear whether the causes have ever been fully identified and eliminated; it may also depend on the command station model (year of manufacture) and the software version in the Digitrax command station.

10. Special - CV - Sets

This feature allows easy programming of a group of predefined values to the decoder's appropriate configuration variables. Such "CV sets" may be part of the decoder software at delivery (as listed and described in the table below) or defined by the user.

Typical applications are: Railroad specific lighting, motor specific data for perfect slow speed behavior, prototypical loco specific acceleration, easy switching between a passenger and goods train or single loco versus consist.

Installation of such CV-sets (either supplied or self defined) is accomplished by a pseudo-programming sequence of CV #8 (CV #8 contains "145", the manufacturer code for ZIMO and cannot really be overwritten, therefore the term pseudo-programming).

In contrast to the MX63 and MX64 HO decoders there are **no special CV sets available for the MX640 decoders up to SW version 4**. This is in part because the relevant CV's of the sound decoder are stored within the sound project.

The possibility of using self-defined CV sets is planned for future software versions.

Note to hard resets (are identical for CV-sets and sound projects):

CV #8 = 8 the common hard reset, will reset all configuration variables to default values according to the CV-table in chapter 3.

On the other hand, the hard reset procedure initiated by programming the decoder to address 0 with a ZIMO cab (MX2, MX21, MX31,...) will reset the decoder to the last defined special CV set. The Norwegian loco, in the above example, will remain just that.

CV #8 = 0 the "traditional" hard reset – a procedure known from ZIMO cabs (MX2, MX21, MX31...by programming an address to "0") – will on the other hand reset the decoder to the last defined "special CV set" or the lastly installed sound project!

11. 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 the others (1, 3, 6 and 7).

This results in a bit-set of 00110101 and 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).

12. MX640 with Märklin MOTOROLA systems

The only time it makes sense to use the MX640 in the MOTOROLA mode is when one is forced to use a system that is not capable of operating in DCC. DCC is much more efficient and is therefore the preferred mode in multi-protocol systems.

The MOTOROLA format is automatically recognized by the decoder.

Address and CV programming is possible with a Märklin system although very tedious (little support from the system):

PROVISIONAL INSTRUCTIONS:

Programming MX640 CV's with 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
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 1 – 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 to 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 power to the track off.

Long mode:

Remember to enter 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 of 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 power to the track off.

13. Software Update with MXDECUP

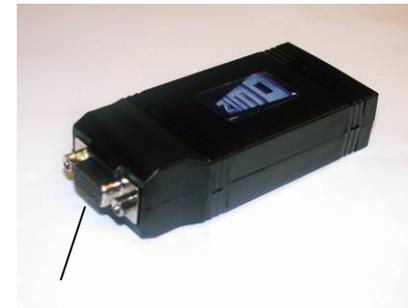
All MX62, MX63, MX64, MX64H, MX69/MX690, MX82 as well as all future decoders can be updated with new software by the end user with the help of the update module MXDECUP or MXDECUP_U (with USB converter).

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.

The ZIMO Service Tool (ZST from version 1.4) is also required for the update procedure. This software can also be downloaded at no charge from www.zimo.at.

Note that the decoder update page of the current ZST program (Version 1.7.1) is still in German. Until a new ZST version is released, a program extension can be downloaded with this page translated to English. Please download both, the original ZST mentioned above and the ZST extension from www.zimo.at

Once both are installed on your PC, the extension can be started as a stand-alone program for decoder updates.



RS-232 – DSUB-9-socket



Connect to "update track",
control-LED's
behind socket

Connect to
power supply

The update module comes with a power supply, an RS-232 connecting cable and a USB converter (in case of MXDECUP_U).

Power supplies (12V DC, 300mA minimum, unregulated), serial cable with two 9-pin sub-D connectors (1:1) and commercially available USB converters (USB to serial) can also be acquired locally if necessary.

Implementation and operation:

A **section of track** is used as "update track" and connected to the 2-pin screw terminal of the MXDECUP. Set the engine with the decoder that is to be updated on the track. The decoder can of course be connected 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).

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 ZST that operates without acknowledgements, its use is not really recommended.

First, 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).

The actual update process is started and controlled with the **“ZIMO Service Tool” (ZST)**, always use the latest version. For English applications use the **ZST extension**, see explanation on previous page):

We can't offer a detailed description here regarding the update process; since ZST will often be modified and expanded (this software performs a number of other tasks within the ZIMO system). In any case, there is a button on the original ZST main page named: “start with MXDECUP online”. English speaking users should start the ZST extension, which opens the COM PORT selection page. All further steps, such as selecting the right COM port, the update software file (one file contains all current software versions for all ZIMO decoders), starting, control and terminating the update process are self-explanatory on screen or can be obtained from the help file.

The two LED's at the MXDECUP are flickering very rapidly during the update process (red and green). This indicates that data packets are sent to and acknowledgments received from the decoder. The LED's remain dark once the update process is finished. If for any reason the update is unsuccessful (indicated by ZST), another update can be started after a waiting period of 5 seconds!

