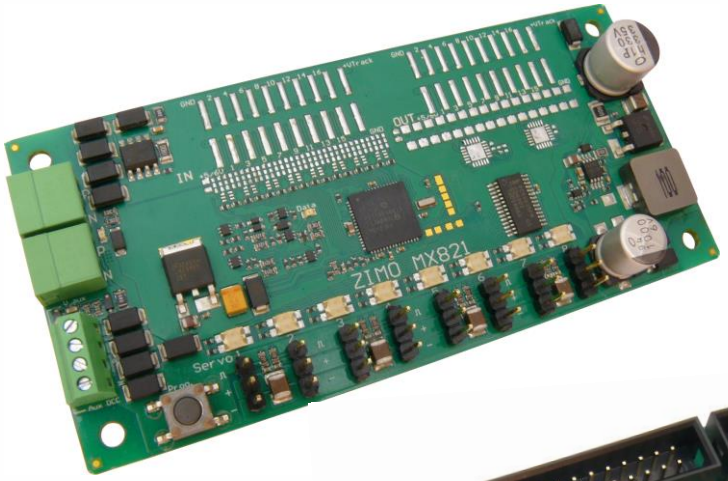
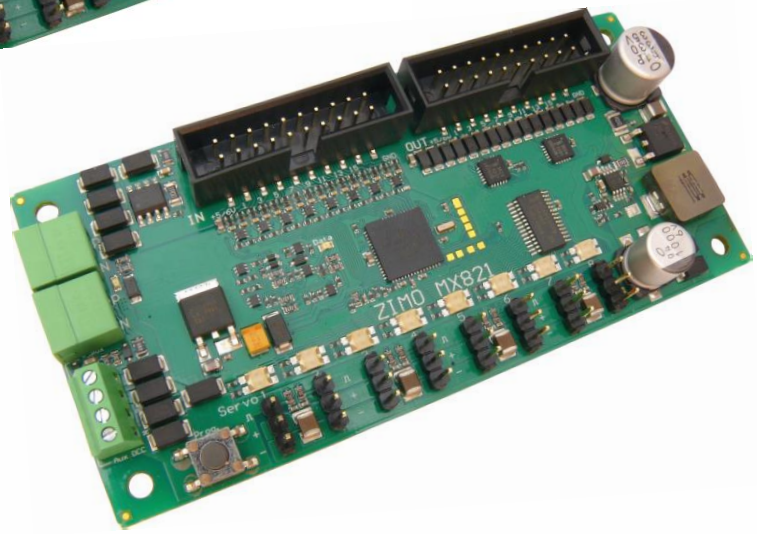
OPERATING MANUAL



MX821S



MX821V

ACCESSORY-DECODER (SERVO-DECODER)

EDITION

Initial MX821 manual --- 2015 12 10
2016 02 20
2020 08 01
2024 03 07

Content

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 "Software Update"! Software updates are available at no charge if performed by the end user (except for the purchase of a programming module); Updates and/or upgrades performed by ZIMO are not considered a warranty repair and are at the expense of the customer. The warranty covers hardware damage exclusively, provided such damage is not caused by the user or other equipment connected to the decoder. For update versions, see www.zimo.at!

1. Overview

The MX821 family of accessory decoders are designed to operate **8 Servos** (usually for turnouts, crossing gates or similar); they contain the 3-pin socket for the usual servo plugs; the necessary 5 V supply voltage is also provided by the MX821.

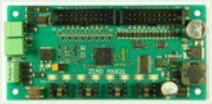
The 821V version can also drive **signals** in addition to the servos with up to 16 lights (LEDs or bulbs with up to 100 mA); Incidentally, in the same way as the accessory decoder MX820X, MX820Y or MX820Z. The difference: The MX820 has only solder pads while the MX821 features 20-pin ribbon cable connector.

ZIMO accessory decoders operate according to the **standardized NMRA DCC data format,** which specifies that such decoders are accessed through accessory addresses.

105 x 50 x 15 mm

MX821 *Family*	***Accessory Decoder*** for turnout and semaphore signals or other servo-driven devices, for light signlas and other lighting with bulbs or LEDs, but NOT for accessories with solenoid, motor, EPL drives and NOT for multi-aspect signals.

MX821 variants:

MX821S 	8 complete (three pin) servo sockets; 5 - 6 V (selectable) supply, ground, control line
MX821V 	8 complete (three pin) servo sockets; 5 - 6 V (selectable) supply, ground, control line 16 inputs for forced switching (via track, buttons etc.) 16 outputs for "frog" polarisation and/or signals

2. Technical Data, Schematics

Allowable track voltage	12 - 24 V
Maximum output current at 5 V / 6 V (Sum of all servos and relays/signals)	3 A
Maximum output current on track output for relays/signals)	1.6 A
Maximum switching capacity (Signal/Relays outputs)	Open Drain (max. 32 V), 16 x 0.1 A
Servo rotation speed	0.1 to 25 sec
Idle current (Outputs deactivated)	max. 85 mA
Operating temperature	- 20 bis 70 °C
Dimensions (L x W x H)	105 x 50 x 15 mm

16 Inputs for forced switching, manual control, feedback contacts, GROUND, 5 V, 20 V (= track) voltage.

16 Outputs for frog polarisation relays or signal lights (Control mode 0 - 4, GROUND, 5 V, 20 V (= track) voltage.

TRACK socket, from command station's "Schiene" output.

P -

Second socket (parallel) for daisy chaining

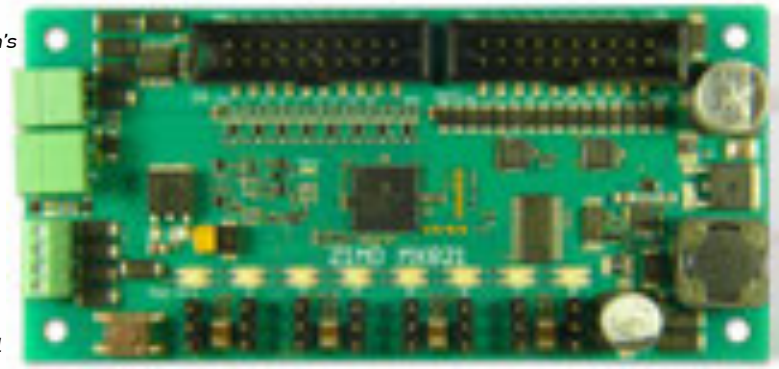
N -

P -

N -

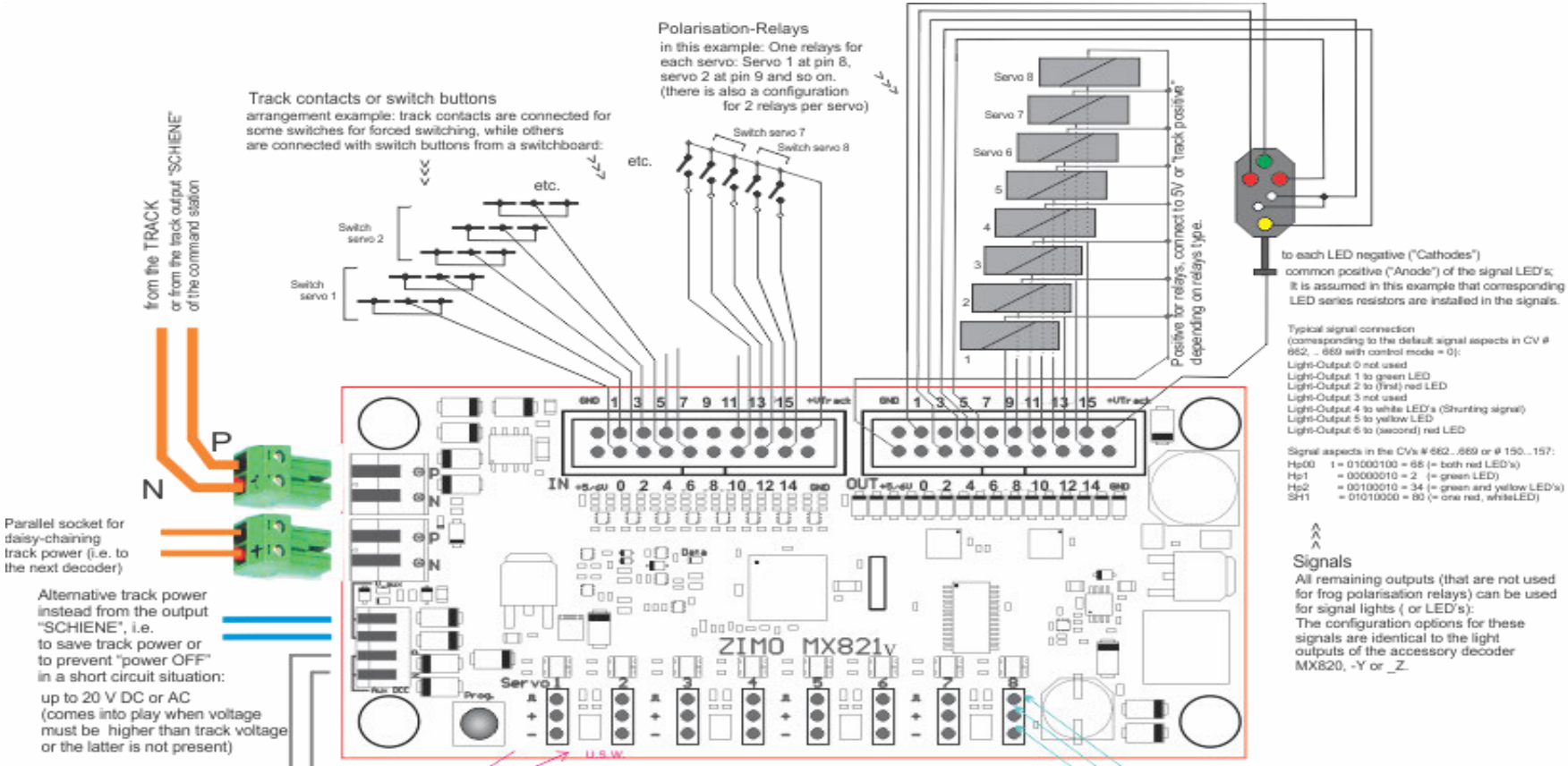
Alternate supply (instead of SCHIENE), = or ~, 12 - 20 V

Alternate DCC Signal, without power drain (i.e. as booster control signal) together with alternate power supply.



Programming button; press >1 sec. → MX821 is ready for the next command to accept the address.

Servo position indicatior LEDs Servo-Outputs 1 - 8 (Control, 5 V, GROUND)


Polarisation-Relays
in this example: One relays for each servo: Servo 1 at pin 8, servo 2 at pin 9 and so on. (there is also a configuration for 2 relays per servo)
Track contacts or switch buttons
arrangement example: track contacts are connected for some switches for forced switching, while others are connected with switch buttons from a switchboard:
etc.
Switch servo 1
Switch servo 2
Switch servo 7
Switch servo 8
Servo 8
Servo 7
Servo 6
Positive for relays, connect to 5V or track positive depending on relays type.
from the TRACK or from the track output "SCHIENE" of the command station
P
N
Parallel socket for daisy-chaining track power (i.e. to the next decoder)
Alternative track power instead from the output "SCHIENE", i.e. to save track power or to prevent "power OFF" in a short circuit situation:
up to 20 V DC or AC (comes into play when voltage must be higher than track voltage or the latter is not present)
Alternative DCC signal instead of the track output "SCHIENE"
ZIMO MX821V
Servo 1 2 3 4 5 6 7 8
Prog.
Control Signal
+ 5V (+) 5V
GROUND (-) GND
to each LED negative ("Cathodes") common positive ("Anode") of the signal LED's; It is assumed in this example that corresponding LED series resistors are installed in the signals.
Typical signal connection (corresponding to the default signal aspects in CV # 662, .. 669 with control mode = 0):
Light-Output 0 not used
Light-Output 1 to green LED
Light-Output 2 to (first) red LED
Light-Output 3 not used
Light-Output 4 to white LED's (Shunting signal)
Light-Output 5 to yellow LED
Light-Output 6 to (second) red LED
Signal aspects in the CVs # 662...669 or # 150...157:
Hp00 1 = 01000100 = 68 (= both red LED's)
Hp1 = 00000010 = 2 (= green LED)
Hp2 = 00100010 = 34 (= green and yellow LED's)
SH1 = 01010000 = 80 (= one red, whiteLED)
Signals
All remaining outputs (that are not used for frog polarisation relays) can be used for signal lights (or LED's):
The configuration options for these signals are identical to the light outputs of the accessory decoder MX820, -Y or _Z.
Control wire
+ 5V
GROUND
The pin arrangement of the MX821 sockets matches the plugs of most RC Servos.
(but there are also servo brands with different order)
Servo plug of Graupner, Futaba, Robbe, Conrad, Hitec and others.
ATTENTION: Pin assignment is different with Multiplex, Airtronic and possibly others.

3. Address and CV Programing

Accessory decoders MX821 require an **accessory address,** sometimes even several addresses.

According to NMRA DCC standards, such addresses are intended for 4 turnouts (or 8 single functions). A **sub-address** identifies the 4 turnouts (or 8 single functions), it determines with which **function key (F0, F1, F2, or F3)** the switch in question is operated with. By default, the MX821 (because it is used for 8 turnouts) uses 2 consecutive addresses with 4 subaddresses each.

Of particular importance is the main address of the decoder, since all subaddresses (for example, for light outputs) can be programmed via this address. In order to access the decoders individually, it is important that each decoder is programmed with its own unique main address. This is best done before the decoder is installed in the layout.

3.1. The "normal" address programming in "Service mode"

The address programming (= allocating the desired accessory address 1 - 511) is normally done with **"service mode"** programming at the command station's programming track output, which allows only one decoder to be connected at the time!

Prerequisite for programming an address in "service mode":

Accessory decoders (MX820, MX821 etc.) must be programmed with an address before they are installed in the layout and connected to the track or power bus (where several accessory decoders will be connected in parallel). This is the only way that each accessory decoder receives its unique address and can be operated individually.

*Alternatively, the method **"Search and program decoder in Operations Mode"** can be used: in this case, the decoders can be connected to the layout even though they all have the same (delivery) address. The assignment of the final unique address takes place with a specific procedure (see below, chapter 1.2).*

RECOMMENDATION: Activate the "Service mode" programming lock CV #611 = 1 to protect the decoder from accidental address reprogramming!

The exact programming procedure depends on the DCC system used. There may be a special address programming procedure available (i.e. ZIMO cabs automatically determine and enter the values for the two address CVs – see below) or the addressing is carried out using simple programming steps (the user must calculate and enter each CV value).

The address (1 - 511) divided in 6 low bits and 3 high bits is, depending on the system, either automatically or manually entered to the CVs #513 (6 bit) and #521 (3 bit); alternatively accessible with CV #1 and #9. Addresses 1 - 63 require only the 6 bits in CV #513 (or #1) while CV #513 (or #9) can remain at zero.

3.2. Programming address with button

If the decoder is not yet installed in the layout, or is at least easily accessible, it can also be programmed with a new address using the button on the MX821.

After the decoder is connected and powered up by the command station, press the button until the servo LEDs change from red (or green) to orange. The decoder is now in the "address learn" mode. The address of the next switch command it receives from the command station is going to be used from now on as the new main address is stored in CV #513 (#1) and CV #521 (#9).

The decoder remains in the "address learn" mode if no switch command is received, until the decoder is powered down or the button on the decoder is pressed again.

3.3. Search and program address in "Operations mode"

This is a new feature of ZIMO accessory decoders introduced in 2013 (which includes the MX820, MX821,...with software versions from September 2013).

The searching and programming of an address in Operations Mode ("OP MODE") helps to eliminate a long-standing problem, namely the problem of multiple used addresses. Until now, decoders with the same address had to be removed from the layout or worse from switch motors (if mounted inside) and reprogrammed individually. This is typical when decoders get installed without first changing the delivery address 3 to a unique address, which happens quite frequently.

"Decoder search" and "address programming" procedure:

1. First, start a pseudo-programming (won't save the programmed value)

   for the repeatedly used (undesired) address (i.e. address 3) with

   CV #81 = 0

   followed immediately by an additional pseudo-programming with

   CV #81 = x,

   where the value x is supposed to be about two to three times as large as the approximate number of decoders with the same address. All decoders now enter a special "address search mode" and calculate internal random numbers, which are of no interest to the user, but will be needed in the following steps to "separate" the decoders.

2. Now (still on the undesired address) send repeated

   switch commands with F0 (#1 key on ZIMO cabs, other system may call this "turnout 1"),

   that is, operate a turnout (or similar) back and forth, whereupon in the "ideal case" only one single decoder operates a turnout based on the calculated random number (namely when the number of sent switch commands coincides with the random number). This is an indication to the user that only this decoder is now ready for CV programming; all other decoders that did not switch will ignore the CV programming commands that follow.

   In regards to "non-ideal" cases that cause an **address conflict** (i.e. when multiple decoders switch simultaneously or, if you are not sure whether it was actually just one decoder): see below, about sending switch commands by pressing F1, F2, etc.!

3. A new address can now be programmed (still on the undesired address) into this decoder with operations mode CV programming, in this order:

   f i r s t: if applicable, enter a new sub-address or sub-address combination in CV #545,
   and t h e n: the actual address in CV #513 **and** (in conclusion) 0 in CV #521 (!).

ATTENTION
in **this** manner (with CV #521 = 0), only addresses 1 to 63 can be used (but NOT 64 - 511),
"DCC experts" may first write the high bits into CV #521 and thereby use the full address range.

4. The decoder now exits the special "address search" mode and is now fully functioning with the newly assigned address (according to the CV #513 programming).

Corrective measures in "non-ideal cases", especially with "**address conflicts**",

when the procedure described above causes several decoders to respond instead of only one (because they generated the same random number), or when you are not sure if only one decoder responded, try the following:

Switch commands with F1 (other systems may call this "Turnout 2") instead of F0 with the undesired address active: This repeats the last switch event (as was the case with F0) but won't advance to the next step in order for you to verify (look more closely!) whether one, two (or even more) turnouts are thrown.

Switch commands with F2 (other systems may call this "Turnout 3"):
After an address conflict, when two or more turnouts operated: Splits the previously generated random number into individual numbers by applying a 25 – 50% random decision.

Switch commands with F3 (other systems may call this "Turnout 4"):

ATTENTION: only one step is possible.

Go back one step in the switching sequence ("undo");
Cancelling the procedure is possible at any time with **CV #81 = 0.**

Example: 5 decoders with the same address 3 should receive their own unique address, 37 and 38 for the first two and sub-addresses for functions F2, F3 or F1:

1. Activate accessory address 3 in OP MODE (Operations mode) programming and enter

CV #81 = 0 followed by **CV #81 = 10**,

the 5 decoders now enter the "address search" mode and each calculates an internal random number between 1 - 10 (For example, the first MX821 may generate random number 5, the second MX821 the number 8 etc., which are not visible to the user).

2. Send repeated switch commands on address 3 with function key F0 (ZIMO cab: #1 key):
the first MX821 reacts after the fifth command sent (because of random number 5). At the same time, the decoder enters a special sub-state within the address search mode where it can receive programming commands on the multiple-used address (3), while all other decoders (the remaining 4 decoder) are being locked in this regard.

3. A new address can now be programmed into this decoder (the cab is already active on address 3 and all that is needed is to switch to operations mode programming), by entering
CV #545 = 32 for the new sub-addresses (F2 and F3) and
CV #513 = 37 for the new main address and
CV #521 = 0 is set for the higher byte of the address.

4. This decoder now exits the "address search" mode and is ready for operation at address 37.

5. Continue to send switch commands with F0 on address 3; after the third time the next MX821 reacts (because of random number 8) and operates its turnout.

6. Program this second decoder with the new address, by entering
CV #545 = 01 for the new sub-address (F1 – for a MX821E for example) and
CV #513 = 38 for the new main address and
CV #521 = 0 is set for the higher byte of the address.

7. and so on for decoders 3 – 5.

… in cases where **several decoders** reacted **simultaneously** (because they generated the same random number):

1. …

2. … after the fifth command sent: two MX821 react at the same time (conflict!) by throwing their respective turnouts. The following steps (address-programming under point 3) can therefore NOT proceed as described above.

2a. Continue sending switch commands on address 3 but use the F2 key, which causes these two decoders to enter a special "search mode to resolve address collision". With a certain probability, only one of the two decoders in conflict will respond and operate its turnout.

2b. but if not, continue pressing F2 on address 3 until only one decoder reacts by operating its turnout and entering into the special state where it can receive programming commands on the common address 3.

3. Enter a new address (as above with CV #545 ...., CV #513 ...),

3a. Continue sending switch commands on address 3 (with F2 key), change the address on single-responding decoders until all "collided" decoders have their unique address.

4. Each affected decoder will exit the "address search" mode after this step (as above with F0 commands).

5. Continue sending switch commands on address 3, with F0 key…

6 …

The procedure described above can be applied with any digital system but there could be differences in numbering and terminology.

NOTE to the *Synchronous-Update:*
This has actually nothing to do with "addressing and programming" (that is, with this chapter), but has certain similarities: the installed decoder should be able to remain on the layout if a new software version is being uploaded. The decoder update device MXULF is connected in place of the DCC command station and sends the new software to all accessory decoders simultaneously.
See separate chapter "Software Update" in this manual!

The ZIMO devices (especially the MX32 cab) will of course support the "decoder search and address procedure in operations mode" with a user-friendly interface.

3.4. Table of Configuration Variables (CVs)

The meaning of Configuration Variables (CVs) is in part standardized by the NMRA DCC RECOMMENDED PRACTICES, RP-9.2.2. There are however certain CVs 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 CVs; in this case use the table below.

CV-Numbers: the CVs for accessory decoders can either be programmed with high numbers from #513 on (according to the old NMRA rules) or low numbers from #1 and up. For this reason you'll find both high and low numbers in the CV column in the tables below.

The total number of CVs is divided into two blocks (one table for each block):

1) the CVs for the **Servo-Outputs**; these outputs and CVs correspond in part with the MX82 accessory decoder (Predecessor to the MX820 / MX821).
2) the CVs for the ***"light outputs",*** these outputs and CVs largely correspond to those of the accessory and signal decoders MX820 (Types -X, -Y, -Z).

*The CVs for the **Servo-Outputs** (consult the other table for light outputs):*

CV	Designation	Range	Default	Description
#1 and #9 or #513 and #521	Decoder **"Main Address"** **The first 4 servos (1 - 4)** are controlled with this address, and the other **4 servos (5 - 8)** with the "**Next address"** (assigned automatically).	1 - 511	3 = CV #1 = 3, CV #9 = 0.	The main address for accessory decoders is 9 Bits long and spreads over two CVs. The calculation of these two CVs is performed automatically by the ZIMO cab; the user only sees the complete address as a value between 1 - 511. A sub-address (see CV #33 - #36) is also required to fully identify which servo output is to be controlled and how. **Two addresses** ("main" and "next") are required to operate **8** servos; that's why the "**next address"** following the "main address" is automatically assigned. The **CVs** are accessible with the **main address**!
#2 or #514	Turnout actuated by switch inputs	0 - 255	0	Each bit determines whether the corresponding servo (1 - 8) can be operated by inputs. Bit 0 = 0: Inputs 0 and 1 are not active. = 1: Input 0 is active for "Servo 1 left" and input 1 is active for "Servo 1 right". Bit 1 = 0: Inputs 2 and 3 are not active. =1: Input 2 is active for "Servo 2 left" and input 3 is active for "Servo 2 right". and so on to Bit 7 = 0: Input 14 and 15 are not active. = 1: Input 14 is active for "Servo 8 left" and input 15 is active for "Servo 8 right".
#7 or #519	Version number	Read only		Lists the currently installed decoder software.
#8 or #520	Manufacturer ID and HARD RESET with CV #8 = 8	Read only (The content remains the same even after programming CV #8 = 8 for a Hard Reset)	145	The NMRA issues a specific number to each registered manufacturer; for ZIMO it is "145". A HARD RESET is performed by a "Pseudo-Programming" (that is, the entered value is not saved) of CV #8 = "8": All CVs will be set back to default, which is identical to the values at time of delivery.
#28 or #540	RailCom Configuration	0 - 3	2	Use of RailCom channels (only active if RailCom is selected with CV #29, Bit 3): Bit 0 = 1: Channel 1 (broadcast channel for "service request") Bit 1 = 1: Channel 2 for RailCom Data
#29 or #541	Basic Decoder Configurations	Only Bit 3 can be overwritten	136 (Bit 3 + 7 = 1)	Bit 7 = 1: this bit identifies the MX821 as an accessory decoder. The value of this bit cannot be changed. Bit 3 - RailCom ("bidirectional communication") = 0: OFF = 1: ON Bit 5 - Extended address mode (11 Bit instead of 9)
#33 or #545	This CV is the sub-address for **servo outputs 1 and 2** as part of the **"main address"**. For servos 3 – 8 use CV #34 – 36!!	ONES- and TENS digit for **Servo 1 / Servo 2** 0 - 7 / 0 - 7 sample settings: 10, 20, 30, 40, 50, 60, 70, 01, 21, 31, 41, 51, 61, 71, 02, 12, 32, 42, 52, 62, 72, 03, 13, 23, 43, 53, 63, 73, etc.	10	Sub-address(es); determine which function key, F0 - F3, operates a servo with the main address given in CV #1 and #9. **Default:** **on the "main address": Servo 1...Servo 4** **on the "next address": Servo 5...Servo 8** **Function key** assignment for **"main address"**: **ONES DIGIT** = function key (F0...F3) for **servo 1**, **TENS DIGIT** = function key (F0...F3) for **servo 2**: The ONES DIGIT in CV #33 contains the function key number (F0...F3) for servo 1, the TENS DIGIT the one for servo 2: CV #33 = 0: Function F0 (key 1 on ZIMO cabs) CV #33 = 1: Function F1 (key 2 on ZIMO cabs) CV #33 = 2: Function F2 (key 3 on ZIMO cabs) CV #33 = 3: Function F3 (key 4 on ZIMO cabs) Example 1: CV #33 = 10 (Default) = F0 (on main address) controls servo 1, F1 servo 2. Example 2: CV #33 = 32: F2 (on main address) controls servo 1, F3 servo 2. **NOTE**: ZIMO cabs can be set so that 8 accessory functions on "main" and "next" addresses can be operated together with function keys F0 - F7.

CV	Designation	Range	Default	Description
#34 or #546	This CV is the sub-address for servo outputs 3 and 4 as part of the "main address".	ONES and TENS digit: 0-7	32	Function key assignment for servos 3 and 4 on the main address: ONES DIGIT = function key (F0...F3) for servo 3, TENS DIGIT = function key (F0...F3) for servo 4: The ONES DIGIT in CV #34 contains the function key number (F0...F3) for servo 3, the TENS DIGIT the one for servo 4: CV #34 = 0: Function F0 (key 1 on ZIMO cabs) CV #34 = 1: Function F1 (key 2 on ZIMO cabs) CV #34 = 2: Function F2 (key 3 on ZIMO cabs) CV #34 = 3: Function F3 (key 4 on ZIMO cabs) Example: CV #34 = 32 (Default) = F2 controls servo 3, F3 servo 4. **NOTE**: ZIMO cabs can be set so that 8 accessory functions on "main" and "next" addresses can be operated together with function keys F0...F7.
#35 or #547	This CV is the sub-address for **servo outputs 5 and 6** as part of the "**next address**". (the next address is assigned automatically and is always main address +1 (Default addr. 4)	ONES and TENS digit: 0-7	54	Function key assignment for servo 5 and 6 on the **"next address"** (= decoder main address +1 (Default addr. 4). **ONES DIGIT** = function key (F0...F3) for **servo 5**, **TENS DIGIT** = function key (F0...F3) for **servo 6**: = 4: Function F0 on the "next address" (key 1) = 5: Function F1 on the "next address" (key 2) = 6: Function F2 on the "next address" (key 3) = 7: Function F3 on the "next address" (key 4) Example Default: CV #35 = 56: F2 (on next address) controls servo 5, F1 controls servo 6. **NOTE**: ZIMO cabs can be set so that 8 accessory functions on "main" and "next" addresses can be operated together with function keys F0...F7.
#36 or #548	This CV is the sub-address for **servo outputs 7 and 8** as part of the "**next address**". (the next address is assigned automatically and is always main address +1 (Default addr. 4)	ONES and TENS digit: 0-7	76	Function key assignment for servo 7 and 8 on the **"next address"** (= decoder main address +1 (Default addr. 4). **ONES DIGIT** = function key (F0...F3) for **servo 7**, **TENS DIGIT** = function key (F0...F3) for **servo 8**: = 4: Function F0 on the "next address" (key 1) = 5: Function F1 on the "next address" (key 2) = 6: Function F2 on the "next address" (key 3) = 7: Function F3 on the "next address" (key 4) Example Default: CV #36 = 76: F2 (on next address) controls servo 7, F3 controls servo 8. **NOTE**: ZIMO cabs can be set so that 8 accessory functions on "main" and "next" addresses can be operated together with function keys F0 - F7.
#37 or #549	Servo and Relays Voltage	0, 1	0	Power supply for servos and relays (at the servo connections and the 20-pin plugs) = 0: 5 V (for standard servos) = 1: 6 V (for high-preformance 6 V servos)
#38 or #550	Reverse direction	0 - 255	0	One bit for each servo output (Bit 0 for servo 1, bit 1 for servo 2 etc.): Bit = 0: no change = 1: Direction reversed (Left/Right switched)
#39 or #551	Servos powered/unpowered at stand still	0 - 255	0	One bit for each servo output (Bit 0 for servo 1, bit 1 for servo 2 etc.): Bit = 0: Servo turns off after reaching end (to avoid jitter). = 1: Servo remains powered (necessary with strong mechanical counterforce).
#40 or #552	Servo control polarity	0 - 255	0	One bit for each servo output (Bit 0 for servo 1, bit 1 for servo 2 etc.): Bit = 0: Servo protocol with positive pulses, = 1: Servo protocol with negative pulses.
#41 #553	Frog polarity	0 - 255	255	One bit for each servo output (Bit 0 for servo 1, bit 1 for servo 2 etc.): One or two realys can be employed for frog polarisation with each servo output. These relays are connected to the outputs of the 20-pin connector, as an alternative to their use as light outputs for signals. CV #41 defines which servo-turnouts should be equipped with frog polarity relays, CV #42 determines whether one or two relays are accosiated. Default configuration: the first 8 outputs (0 – 7) of the 20-pin connector are used for light outputs; the other 8 outputs (8 – 15) are defined for frog polarity relays for the 8 servo outputs. Bit = 0: No frog polarisation for this servo = 1: Frog polarisation for this servo
#42 or #554	Frog polarisation with one or two relays	0 - 255	0	One bit for each servo output (Bit 0 for servo 1, bit 1 for servo 2 etc.): Effective only if corresponding bit in CV #41 is set. Here, a frog polarisation with two relays per servo output can be activated. For the second relay, use the corresponding "lower" outputs (0 – 7) of the 20-pin connector. Bit: = 0: Frog polarisation with a single relay (the relay switches in the center servo position). Servo 1 -> Light output 8 etc. = 1: Frog polarisation with two relays (the first relay switches at the start of the servo movement, the second realy when reaching the end position. Both relays are turned off while the servo is moving, after that only one is active depending on switching direction).

CV	Designation	Range	Default	Description
				Servo 1 -> Light output 0 and 8 ... ... Servo 8 -> Light output 7 and 15
#43 or #555	Inverted frog polarisation Invert 0 - 7	0 - 255	0	One bit for each relay output (Bit 0 for output 0 etc.): Bit = 0: not inverted = 1: Relays control inverted
#44 or #556	Inverted frog polarisation Invert 8 - 15	0 - 255	0	One bit for each relay output (Bit 0 for output 8 etc.): Bit = 0: not inverted = 1: Relays control inverted
#45 or #557	Servo rebound	0 – 255	0	One bit for each servo output (Bit 0 for servo 1 etc.): Bit = 0: no rebound = 1: rebound after reaching end position This function is useful for realistic movements of crossing gates or semaphore signals for example. It is not recommended to use this function for servo operated turnouts.
#46 or #558	Rebound intensity	0 - 255	0	Rebound intensity: = 0: no rebound = 255: maximum rebound
#47 or #559	Rebound duration	0 – 255	0	Rebound duration: = 0: no rebound = 255: maximum rebound duration
#50 or #562	Servo 1 Left stop	0 - 255	0	Servo end position for "Turnout left" = 0: maximum left = 255: maximum right
#51 or #563	Servo 1 Right stop	0-255	255	Servo end position for "Turnout right" = 0: maximum left = 255: maximum right
#52 or #564	Servo 1 Speed	0-255 corre- sponds to 0 – 25.5 sec	30	Time it takes the servo to move from one end point to the other. = 30 (Default): 3 sec Acceleration and deceleration times as per CV #53 are added to the travel time above.
#53 or #565	Servo 1 Accel / Decel	0-255 corre- sponds to 0 - 25.5 sec	20	Slow acceleration and deceleration of servo = 20 (Default): 2 sec

Servo 2	Servo 3	Servo 4	Servo 5	Servo 6	Servo 7	Servo 8	
#54, #55, #56, #57 or	#58, #59, #60, #61 or	#62, #63, #64, #65 or	#112, #113, #114, #115 or	#116, #117, #118, #119 or	#120, #121, #122, #123 or	#124, #125, #126, #127 or	Servo 2 to 8 Left stop Right stop Speed Accel. / Deceleration

CV	Designation	Range	Default	Description
#566, #567, #568, #569	#570, #571, #572, #573	#574, #575, #576, #577	#624, #625, #626, #627	#628, #629, #630, #631	#632, #633, #634, #635	#636, #637, #638, #639	Same as above but with high CV numbers
#75 or #587	Limitation of succes-sive forced switchings	0 - 9 / 0 - 9	0	Ones digit: max. number of forced switch pulses = 0: no limit (in the same direction) Tens digit: Min. time between pulses (.5 s each)
#76 or #588	Input effects for forced switching of servos 1 and 2 if activated with CV #2	ONES and TENS digit for Servo 1 / Servo 2 0, 1, 2 / 0, 1, 2	0	The switch inputs for turnout control can be used in different ways, depending on application (i.e. forced switching by approaching train): = 0 (same as MX82): Turnout will be held in forced position as long as the input is active. = 1: a positive pulse operates the turnout; after that, the decoder is again ready to accept all DCC commands. = 2: on positive pulse; the turnout remains locked until confirmed by the operator by repeating the same switch command (= unlock) with the cab.
#77, #78, #79 or #588, #589, #590	Input effects for forced switching of servos 3 and 4, 5 and 6, 7 and 8 if activated with CV #2	0, 1, 2 / 0, 1, 2	0 0 0	As with CV #76 or #588 CV #77 Ones digit configures servo 3 CV #77 Tens digit configures servo 4 CV #78 Ones digit configures servo 5 CV #78 Tens digit configures servo 6 CV #79 Ones digit configures servo 7 CV #79 Tens digit configures servo 8
#80 or #592	Decoder-Type	83, 86	-	Decoder type can be read out with this CV: = 83 (ASCII 'S'): MX821S = 86 (ASCII 'V'): MX821V
#81 or #593	Adress search mode	0 - 255	-	Activates address surch mode (see section "Search and program address in "Operations mode")

*The CVs for the (additional) **"Light outputs"**:*

NOTE: programming of these CVs is carried out on the decoder's "main address" (see CVs #513, #521 or #1, #9), just like the CVs for the main outputs.

NOTE: In order to use outputs 8 – 15, CV #553 (#41) must have a value of 0.

Light outputs are controlled in two groups: 0 – 7 and 8 – 15 in one of 5 possible "control modes", which is set up individually for each group in CV #70 or CV #582 (with ones and tens digits, see the following table).

Control mode = 0 (according to the ones or tens digit setting in CV #70 or #582):

The 8 light outputs of one group (0-7 or 8-15) form a signal light, for which the possible signal aspects are stored in the associated 8 CVs (#150 - #157 or #158 - #165). Therefore, an MX821 decoder can accept one signal with up to 8 bulbs and 8 aspects.

Typical signals are stored by default in some signal aspect CVs (#150...); see table. For schematics go to chapter 4 "Application examples".

The signals are turned ON/OFF with the corresponding accessory commands at the relevant supplementary address (as per CV #578 etc.), the respective sub address and left/right bits:

Command with sub address 0, left: signal aspect 1 (as per CV #150),

Command with sub address 0, right: signal aspect 2 (as per CV #151),

Command with sub address 1, left: signal aspect 3 (as per CV #152), and so on.

On a ZIMO cab MX31 or MX32 (also MX2 and MX21), the "supplementary address" of the MX821 (see the following table) is activated and after setting the cab up for "8 single functions" and "momentary action" select the desired signal aspect with the 8 number keys.

Control mode = 1 (according to the ones or tens digit setting in CV #70 or #582):

The light outputs in this mode are arranged in pairs that is, up to 8 red-green signals can be connected. Changes to the signal aspect CVs are not required. Each signal is controlled with its "supplementary address" and sub address (same as a turnout).

Control mode = 2 (according to the ones or tens digit setting in CV #70 or #582):

Predefined signals or signal aspects are not available in this case. Each output is controlled with a corresponding accessory command at the relevant supplementary address (as per CV #578 etc.), the respective sub address and left/right bits.

With a ZIMO cab MX31 or MX32 (also MX2 and MX21), activate the "supplementary address" of the MX821 (see the following table) and after setting the cab up for "8 single functions" and "momentary action" switch the bulbs/LEDs ON/OFF individually with the 8 number keys.

Control mode = 3 (according to the ones or tens digit setting in CV #70 or #582):
(for the "extended" accessory command format as per NMRA)

32 signal aspects are available (in CVs #150 – #213) for the 8 light outputs of each group (0 – 7 or 8 – 15). They are controlled with the "extended" accessory commands.

Control mode = 4 → NOT part of the following table. See description AFTER this table!

*THIS table describes the **control mode 0 and 3;** Modes 1 and 2 do not need special CVs and mode 4 is covered by its own separate table.*

CV	Designation	Range	Default	Description
#66, #67 or #578, #579	Supplementary address for light outputs 0 - 7	1 - 511	5 (a new MX821 therefore comes with main address 3, "next address" 4 and supplementary addresses 5 and 6)	This supplementary address (9-bits long) is spread over two CVs; the ZIMO cab calculates the necessary values. The user sees the address as one number between 1 and 511. The 8 light outputs (0 – 7) are switched with this address (each bit = one output) **Or:** If it is an "extended" address, then there are no sub-addresses, but the main address controls 8 signal bulbs/LEDs or 32 signal aspects.
#68, #69 or #580, #581	Supplementary address for light outputs 8 - 15	1 - 511	6	This supplementary address (9-bits long) is spread over two CVs; the ZIMO cab calculates the necessary values. The user sees the address as one number between 1 and 511. The 8 light outputs (8 – 15) are switched with this address (each bit = one output) **Or:** If it is an "extended" address, then there are no sub-addresses, but the main address controls 8 signal bulbs/LEDs or 32 signal aspects.
#70 or #582	Light output control mode	0 - 3 / 0 - 3, (44)	0	Ones digit 0 - 3: Controls light outputs 0 - 7 Tens digit 0 - 3: Controls light outputs 8 – 15 Mode 4 controls either all 16 outputs (i.e. ones and tens digit = 4) or none (therefore settings other than 44, such as 04, 40 or 42 ... are not valid).
#72, #73 or #584, #585	Day/Night Address	1 - 511	0	Signals can be dimmed according to the settings in CV #586 (#74), by sending switch-over commands to the Day / Night address (Sub-address 0). The same address can be used on any number of decoders (collective dimming).
#74 or #586	Day/Night dimming	0 - 255	63	Dimming factor "at night". =**63** (Default): for LEDs @ 50% of normal.
#128 ... ... #143 or #640 ... ... #655	Brightness settings for light outputs 0 - 15	0 - 255	255 (full)	To compensate for the different efficiency of the connected lights (LEDs or bulbs), mostly color-dependent efficiency, the intensity can be reduced here for each light output (PWM - pulse width modulation). CV #128: Light output 0 #129: Light output 1 and so forth.

CV	Designation	Range	Default	Description
#144 or #656	Programming and Update Lock **NOTE**: the programming lock does not lock CV #144 and cancelling the programming lock is therefore possible.	Bits 6, 7	0	= 0: Programming or updating is not locked Bit 6 = 1: the decoder cannot be programmed in "Service mode" as a protection against unintentional programming or deletion. **NOTE**: Programming in "Operations Mode" is not locked because this is done during layout operation and only a specific address is affected. Bit 7 = 1: Locks software updates via MXULF, MX10 or other devices.
#145, #146 or #657, #658	LED / Bulb selection for Light outputs 0 - 15	0 - 255	0	If a signal contains bulbs instead of the now usual LEDs, the appropriate bits should be set to adapt the brightness according to the CVs 128 - 143. Bit value = 0: LED = 1: Light bulbs
#147 or #659	Light-up time	0 - 255 equals 0 - 25 sec	4	Only valid for the decoder's "light outputs". (controlled by the supplementary addresses) For prototypical signal control: Time in tenth of a second until the bulb reaches full brightness. = 0: Full brightness reached instantly. = 4: Default – short light-up time (@ 0.4 sec)
#148 or #660	Light-up delay	0 - 255 equals 0 - 25 sec	1	Only valid for the decoders "light outputs". (controlled by the supplementary addresses) For prototypical signal control: Time delay in tenth of a second until the bulb gets turned on. Together with CV #661 a harmonious transition between lighting aspects can be achieved. = 0: No delay. = 1: Short light-up delay (0.1 sec).
#149 or #661	Dimming time	0 - 255 equals 0 - 25 sec	4	Only valid for the decoder's "light outputs". (controlled by the supplementary addresses) Time in tenth of a second until the bulb is completely dark. = 0: Full darkness reached instantly. = 4: Default – short dim time (@ 0.4 sec)
#150 ... ...#157 or #662 ... ... #669	Signal aspects No. 1 - 8 for light outputs 0 - 7	0 - 255	CV #150 = 01000100=68 (HP00/Stop) CV #151 =0000010=2 (HP1/Go) CV #152 =0010010=34 HP2/Slow) CV #153 =0101000=80 (SH1/Shun.)	In control mode 0 or 3 (as per CV #70): Each CV stores a possible signal aspect, that is the on / off state of the 8 light outputs (one bit for each output), which can be activated with a corresponding accessory command. ← This is a typical main signal (default setting) with 4 possible aspects using 5 light outputs: 0 -, 1 green, 2 red, 3 -, 4 white, 5 yellow, 6 red, 7 -

CV	Designation	Range	Default	Description
#158 ... ...#165 or #670 ... ... #667	Signal aspects No. 1 -8 for light outputs 8 - 15	0 - 255	CV #159 =00000101=5 (VR0/Stop) CV #160 =0001010=10 (VR1/Go) CV #161 =0000110= 6 VR2/Slow) CV #162 =0000000=0 (dark)	In control mode 0 or 3: Each CV stores a possible signal aspect, that is the on / off state of the 8 light outputs (one bit for each output), which can be activated with a corresponding accessory command. ← This is a typical main signal (default setting) with 4 possible aspects using 4 light outputs: 0 yellow, 1 green, 2 yellow2, 3 green2, 4 -, 5 -, 6 -, 7 –
#166 ... ...#173 or #668 ... ... #675	Signal aspects No. 9 -16 for light outputs 0 - 7	0 - 255	0	In control mode 0: not used In control mode 3: Each CV stores a possible signal aspect, that is the on / off state of the 8 light outputs (one bit for each output), which can be activated with an "extended" accessory command.
#174 ... ...#181 or #676 ... ... #683	Signal aspects No. 9 -16 for light outputs 8 - 15	0 - 255	0	In control mode 0: not used In control mode 3: Each CV stores a possible signal aspect, that is the on / off state of the 8 light outputs (one bit for each output), which can be activated with an "extended" accessory command.
#182 ... ...#189 or #684 ... ... #691	Signal aspects No. 17 -24 for light outputs 0 - 7	0 - 255	0	In control mode 0: not used In control mode 3: Each CV stores a possible signal aspect, that is the on / off state of the 8 light outputs (one bit for each output), which can be activated with an "extended" accessory command.
#190 ... ... #197 or #692 ... ...#699	Signal aspects No. 17 -24 for light outputs 8 - 15	0 - 255	0	In control mode 0: not used In control mode 3: Each CV stores a possible signal aspect, that is the on / off state of the 8 light outputs (one bit for each output), which can be activated with an "extended" accessory command.
#198... ... #205 or #700 ... ...#707	Signal aspects No. 25 -32 for light outputs 0 - 7	0 - 255	0	In control mode 0: not used In control mode 3: Each CV stores a possible signal aspect, that is the on / off state of the 8 light outputs (one bit for each output), which can be activated with an "extended" accessory command.
#206 ... ... #213 or #708 ... ...#715	Signal aspects No. 25 -32 for light outputs 8 - 15	0 - 255	0	In control mode 0: not used In control mode 3: Each CV stores a possible signal aspect, that is the on / off state of the 8 light outputs (one bit for each output), which can be activated with an "extended" accessory command.

Control mode = 4:

Only in this mode (which the NMRA or VHDM standards have nothing similar, it is a ZIMO specialty) the available light outputs are utilized particularly well by defining how many light outputs are used for each signal. Depending on requirements, it is possible to define 2 to 8 signals, each with 1 – 8 light outputs ("1" defines a single light) and up to 8 signal aspects.

The configuration is not address-oriented (as usual), but rather object-oriented: a quota of 12 CVs is available for each signal object, see the following table. There, each signal is defined for the following: the accessory address for THIS signal (the decoder can in this way have up to 8 "object addresses"), the number of light outputs, a possible dependence to a distant signal, and a maximum of up to 8 signal aspects.

Signals defined that way are controlled with switch commands ("left", "right") to the four sub-addresses of their object address (and therefore up to 8 signal aspects).

A distant signal dependence can be activatet for each signal object that is, a signal object can be declared as a distant signal and is then dimmed automatically when the specified associated main signal displays "Stop".
The signal objects 1 - 4 control light output 0 - 7, the objects 5-8 on output 8-15.

If a signal object is to control outputs from two output areas, to better utilize the available outputs (or a signal object with more than 8 outputs), two signal objects can be created (one each from the area 1 - 4 and 5-8) that are programmed with the same object address and combined in this way.

NOTE: To use output 8-15, CV #553 (#41) must have a value of 0.

THIS table deals exclusively with the control mode 4 (CV #70 = 44):

CV	Designation	Range	Default	Description
#70 or #582	Light output control mode	(0-3 / 0-3) **44**	(0)	THIS table deals exclusively with the **control mode 4.** It **always applies** to **BOTH groups** of light outputs (i.e. 0 – 15), therefore "44"; a combination with other modes is not allowed.
#72, #73 or #584, #585	Day/Night Address	1 - 511	0	Signals can be dimmed according to the settings in CV #586 (#74), by sending switch-over commands to the Day / Night address (Sub-address 0). The same address can be used on any number of decoders (collective dimming).
#74 or #586	Day/Night dimming	0 - 255	63	Dimming factor "at night". =63 (Default): for LEDs @ 50% of normal.
#128, ... #143 or #640, ... #655	Brightness settings for light outputs 0 - 15	0 - 255	255 (full)	To compensate for the different efficiency of the connected lights (LEDs or bulbs), mostly color-dependent efficiency, the intensity can be reduced here for each light output (PWM - pulse width modulation). CV #128: Light output 0 #129: Light output 1 and so forth.

CV	Designation	Range	Default	Description
#147 or #659	Light-up time	0 - 255 equals 0 - 25 sec	4	Only valid for the decoder's "light outputs". (controlled by the supplementary addresses) For prototypical signal control: Time in tenth of a second until the bulb reaches full brightness. = 0: Full brightness reached instantly. = 4: Default – short light-up time (@ 0.4 sec)
#148 or #660	Light-up delay	0 - 255 equals 0 - 25 sec	1	Only valid for the decoders "light outputs". (controlled by the supplementary addresses) For prototypical signal control: Time delay in tenth of a second until the bulb gets turned on. Together with CV #576 a harmonious transition between lighting aspects can be achieved. = 0: No delay. = 1: Short light-up delay (0.1 sec).
#149 or #661	Dimming time	0 - 255 equals 0 - 25 sec	4	Only valid for the decoder's "light outputs". (controlled by the supplementary addresses) Time in tenth of a second until the bulb is completely dark. = 0: Full darkness reached instantly. = 4: Default – short dim time (@ 0.4 sec)
#150 & #151 or #662 & #663	Object address for Signal 1 ("first CV": #150, "second CV": #151) This address is valid for this signal object.	0 - 511		The object address is 9 bits long and spread over the two CVs (same coding scheme as all accessory addresses, i.e. a main address in CVs #1 and #9) that is, the lowest 6 bits in the first CV and 3 bits in the second CV. If the first signal aspect (No.1) should not be driven by the sub-address 0 (because several signals are on the same object address), the correct sub-address must be specified for controlling the first signal aspect in Bit 7 and 6 of the second CV.
#152 or #664	Bit mask for signal 1	0 - 255		The bit mask stores the bits valid for the signal aspects of this signal: Bit = "1": the corresponding light output (0-7) is used in the signal aspect. The number of "1-bits" defines those light outputs that are used by this signal aspect. The remaining light outputs can be used by another signal, if necessary.
#153 or #665	Number of signal aspects for signal 1 and distant signal dependency	0 - 255		Ones digit: Number of signal aspects = 1: this signal contains a single light = 2 - 8: up to 8 aspects possible Tens digit: = 0: this signal is not a distant signal = 1 - 8: this signal is a distant signal mounted on the mast of the main signal 1 - 8 and shall remain dark if main signal shows "Stop" ("Stop" is always the first aspect!) Hundreds digit: approach signal warning, valid if tens digit >0: = 0: dimmed at main signal "stop"

CV	Designation	Range	Default	Description
				= 1: not dimmed at main signal "Stop", but instead, signal aspect 0 ("warning") display
#154 ... ... #161 or #666 ... ... #673	Signal aspects Nr. 1 - 8 for signal 1	0 - 255		Each CV contains a possible signal aspect, that is the On / Off state of the 8 light outputs (one bit for each output, as provided in the above bit mask), which can be activated by an appropriate accessory command. The signal aspect No.1 should ALWAYS show "Stop"
#162 ... ... #173 or #674 ... ... #685	Object address, bit mask, number/distant signal and signal aspects for signal 2			These 12 CVs contain the information for the Signal 2 (in control mode 4) in the same sequence as described above for Signal 1
#174 ... or #686 ... for signal aspect 3 #186 ... or #698 ... for signal aspect 4 #198 ... or #710 ... for signal aspect 5 #210 ... or #722 ... for signal aspect 6 #222 ... or #734 ... for signal aspect 7				12 CVs for each of the signals 3, 4, 5... (Starting with the specified address) **ATTENTION**: For the signals 5, 6, 7and 8, the bit mask for light outputs 8 – 15 is valid (not for 0-7) **NOTE**: CV #533 (#41) must have a value of 0 for outputs 8 – 15 to work.
#234 ... ... #245 or #746 ... ... #757	Object address, bit mask, number/distant signal and signal aspects for signal 8		0	These 12 CVs contain the information for the Signal 8 (in control mode 4) in the same sequence as described above for Signal 1

3.5. Flashing:

The following CVs can be used to define whether and which stop signals should flash.

CV	Designation			Description
#47	Flashing speed			Upper 4 Bit=dimming time on 0 to 15 = 0,1 to 1,6s, lower 4 Bit= time off 0 to 15 = 0,1 to 1,6 seconds so #47 = (dimming time on [0,1s] - 1) * 16 + (time off [0,1s] - 1)
#257 to #288	Flashing mask			Defines which outputs should flash. #257=output 0-7 Signal aspect 1 or mode 1, 2 #258=output 8-15 Signal aspect 1 or mode 1, 2 #259=output 0-7 Signal aspect 2 #260=output 8-15 Signal aspect 2 ... #287=output 0-7 Signal aspect 16 #288=output 8-15 Signal aspect 16

In control modes 1 and 2, there are no signal aspects, so only CVs #257 and #258 are needed there.

In control modes 0 and 4, there are up to 8 signal aspects, so CVs #257 to #272 are required there.

In control mode 3, there are up to 32 signal aspects, but only the first 16 signal aspects support flashing outputs.

General:
Bits 7 to 0 = Outputs 7 to 0 or outputs 15 to 8
Bit value 0=Output permanently on, 1=Output flashing on

4. Application notes and examples

Application for servo operated TURNOUTS

(on the servo outputs of an MX821S or MX821V)

The CVs **as delivered** (or after a hard reset with CV #8 = 8) are set for normal operation of up to **8 servo operated turnouts** on two consecutive addresses (see illustration) on **accessory address 3** (F0 - F3) and **accessory address 4** (F0 - F3).

This means that

the turnout on servo output 1 can be operated with the function key F0 (number 1 key on ZIMO cabs) on accessory address 3, and

the turnouts on the servo outputs 2 to 4 with the funct. keys F1 (number 2 key) to F3 (number 4 key) on accessory address 3,

and the turnouts on the servo outputs 5 to 8 with the function keys F0 to F3 (number keys 1 to 4) on accessory address 4.

Changing the MX821 **main address** (CVs #1 and #9, using the ZIMO cab to calculate the values for the desired address 1 - 511), changes both accessory addresses (for the first servo outputs 1 - 4 and the second servo outputs 5..8), because the second automatically accepts the next higher address of the first.

The turnaround time is set at 3 sec, plus acceleration and deceleration times of 2 sec each, which results in prototypical movements for most turnout models.

Forced turnout switching (rail contacts or switch buttons) using the MX821 inputs *(MX821V only)*:

The switch inputs of the MX821 can be used to automatically switch the turnout to the appropriate position using switch contacts (or reed switches etc.) to prevent a short circuit situation by an approaching train. They can also be used to operate the turnout with facia mounted push-button switches.

This function is activated by default but can be turned off, by changing CV #2 (#514) where each bit is assigned to a servo output (see CV table).

If left in default activation, two inputs are assigned with one servo output. Inputs 1/2 operate servo 1, inputs 3/4 operate servo 2 and so on.

DEFAULT: With CV #2 (#514) = 255 (Default value) all inputs are activated and all 8 servo outputs can be operated with the inputs 1 & 2 for servo output 1, input 3 & 4 for servo output 2 etc.

ANOTHER EXAMPLE: With CV #2 (#514) = 1 only the inputs 1 & 2 are active (for servo 1), all other inputs are not activated and won't operate turnouts through their respective inputs.

NOTE: For the switch inputs to work, they must be "pulled up" towards a positive voltage (from 5 V to track voltage), NOT to ground.

LIGHT SIGNAL application

Supply and alternate supply of the MX821 and alternate DCC input

(also see wiring schematic in chapter 2)

The MX821 is normally supplied with power and the DCC signal through the **track input** ("SCHIENE", Phoenix plug on upper left), just like any other decoder. An LED next to the track input lights up when power is applied.
This track inp. is duplicated (intern. parallel) for a simple daisy-chain hook-up to other decoders.

1) In order to save "valuable" track current, the MX821 can also be supplied with power via the **alternate supply input** ("Ersatzversorung") using the 4-pin screw terminal (upper two pins). This input has its own rectifier so that the polarity of the supply is not relevant; the power can be supplied by a

   NOTE: The voltage at the alternate input is only used by the MX821, if it is higher than the voltage on the track (or if the track voltage has failed).

   (floating) power supply or a DC output of a ZIMO MX10 command station, ideally the "other" DC output than the one that powers the track. The voltage at the alternate input is indicated by its own LED.

If turnout operation should be maintained in the event of a short circuit on the rails (or track power failure), the **two alternate DCC inputs** on the 4-pin screw terminal (lower two pins) must be used. Here, a DCC input signal (even a low current signal, in the range if 12-24 V) can be applied, such as from a MX10 booster output for example. It should be noted that no feedback to the command station is possible on this input; this is only possible through the track. This applies, among other things, to the position feedback through Railcom or the decoder SW update.

Power supply of signals and relays on the MX821 *(MX821V only)*

There are three options to supply signals and relays connected to the 16 light ouputs with power:

- using the 5 V output of the MX821; this output supplies 5 V or 6 V (as per CV #37) with sufficient capacity, but must be shared with the other servos.
- using the +V –Track output of the MX821; that is the decoder's rectified track voltage (or the alternate supply voltage).
- using an external DC voltage:
  The positive side of the loads (relays, signals...) is connected to the external power supply, but the ground of this device must be connected with the ground of the MX821.

Turnout frog polarisation *(MX821V only)*

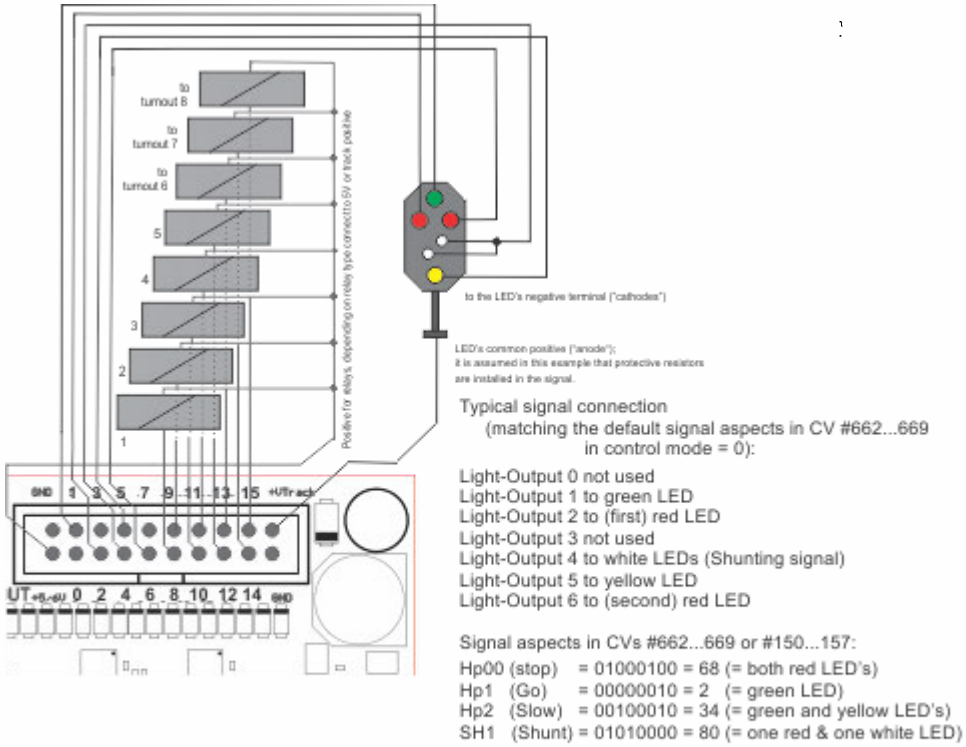
The 16 MX821 outputs can be configured in CVs #41/#42 for external relays that switch the polarity of turnout frogs.

The properly configured ouputs can drive relays directly, but the maximum current per output should not exceed 100mA.

The 16 open collector outputs are pulled low that is, the realy's coil is connected between a decoder output and a positive supply voltage (see paragraph above and wiring diagram in chapter 2).

If external relay modules are used that require a logic signal at its input, this can be generated with the aid of pull-up resistor (about 10K) at the outputs.

(MX821V only) *(at the "light outputs",* ***Control mode = 0***



LIGHT SIGNAL application

(MX821V only) *(at the "light outputs",* ***Control mode = 4***

The following tables show the necessary CVs for the example signals above:
for both examples:

CV-Number	CV-Function	Value	Explanation
CV69	Supplementary addresses	--- (not relevant in mode 44)	These addresses are not used in mode 4, each signal object has its own address
CV70	Mode	44 (decimal)	Mode 4 must always be activated for both banks of outputs
CV150..161, CV162..173, CV174..185, CV186..197, CV198..209, CV210..221, CV222..233, CV234..245	Signal objects	0 (decimal), if object is not needed	The CVs of unused signal objects should be set to '0' (this is the default value after a reset, except for signal object 1), to prevent an unintended activation and unexpected behavior due to possible overlapping of other signal objects. This can also be achieved by setting the number of signal aspects to zero for every unused signal (CV153, 165, 177, 189, 201, 213, 225, 237 = 0). The signal objects are so effectively disabled.

Example 1: **DB Entry signal (Hp 0 = stop, Hp 1 = clear, Hp 2 = approach) and distant signal (Vr 0 = expect stop, Vr 1 = expect clear, Vr 2 = expect approach)**

Allocation: Entry signal 3 outputs -> Output 1 - 3, Distant signal 4 outputs -> Output 4 - 7

Assignment: 0 = free, 1 = Main signal red, 2 = Main signal green, 3 = Main signal yellow, 4 = Distant signal yellow 1 (top), 5 = Distant signal yellow 2 (bottom), 6 = Distant signal green 1 (top), 7 = Distant signal green 2 (bottom) Controlled with: Main signal with address 5, Distant signal with address 100

***Example 2*: Two block signals (Hp 0/Hp 1 = stop/clear) and one DB Entry signal (Hp 0 = stop, Hp 1 = clear, Hp 2 = approach)**

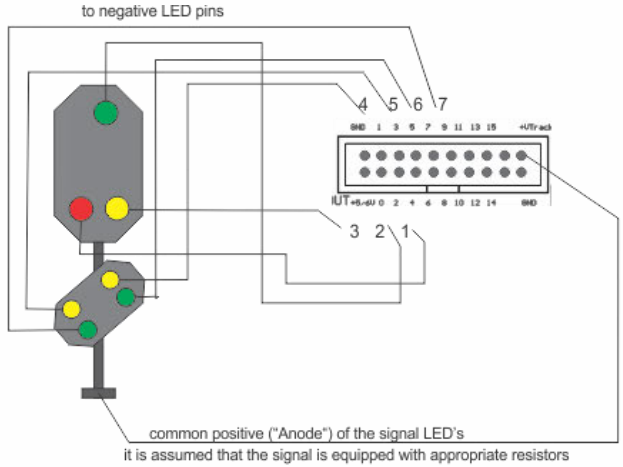
Allocation: First block signal 2 outputs -> Output 0..1, Entry signal 3 outputs -> Output 2..4, Second block signal 2 outputs -> Output 5..6

Assignment: 0 = *First block signal red*, 1 = *First block signal green*, 2 = *Entry signal red*, 3 = *Entry signal green*, 4 = *Entry signal yellow*, 5 = *Second block signal red*, 6 = *Second block signal green*, 7 = free

Controlled with: *First block signal with address* 4 (*Subaddress* 0 = F0), *Entry signal with address* 20, *second block signal with address* 4 (*Subaddress* 1 = F1)

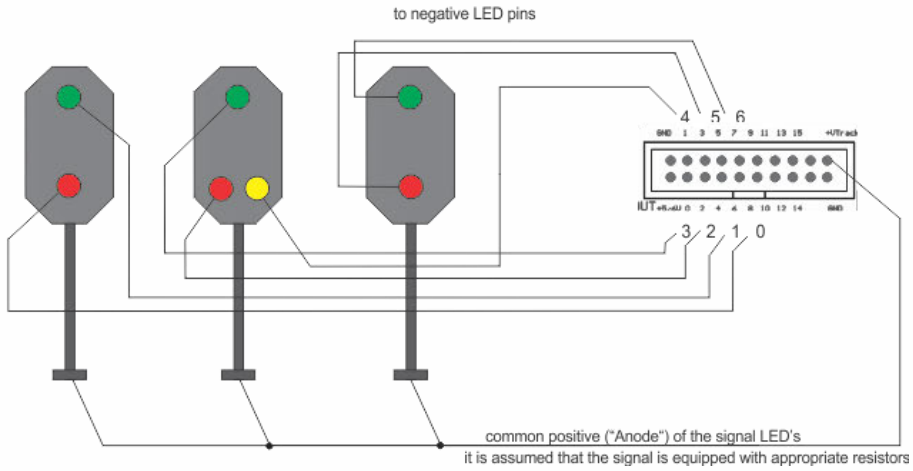
Typical connection of a main signal AND a distant signal mounted to the mast of a main signal (Control mode = 4):

Light output 0: not used
Light output 1: main signal, red LED
Light output 2: main signal, green LED
Light output 3: main signal, yellow LED
Light output 4: distant signal, top yellow LED
Light output 5: distant signal, bottom yellow LED
Light output 6: distant signal, top green LED
Light output 7: distant signal, bottom green LED



Typical connection of a main signal AND an entry signal AND another block signal (Control mode = 4):

Light output 0: First block signal, red
Light output 1: First block signal, green
Light output 2: Entry signal, red
Light output 3: Entry signal, green
Light output 4: Entry signal, yellow
Light output 5: Second block signal, red
Light output 6: Second block signal, green
Light output 7: not used



1. ***Example 1*: DB Entry signal (Hp 0 = stop, Hp 1 = clear, Hp 2 = approach) and distant signal (Vr 0 = expect stop, Vr 1 = expect clear, Vr 2 = expect approach)**

CV-Number	CV-Function	Value	Explanation
Main signal:			
CV #150	Signal object 1, Address Part 1	5 (decimal)	Address 5 (decimal) = binary 0 0000 0101 (9 Bit address range), therefore part 1 = lowest 6 Bits = 000101 binary = 5 decimal
CV #151	Signal object 1, Address Part 2	0 (decimal)	Address 5 (decimal) = binary 0 0000 0101 (9 Bit address range), therefore part 2 = highest 3 Bits = 000 binary = 0 decimal
CV #152	Bit mask for signal 1	14 (decimal)	Outputs 1..3 are used for Signal 1 = Bits 1..3 set = binary 00001110 = 14 decimal
CV #153	Number of signal aspects for Signal 1 and distant signal de-	3 (decimal)	Ones digit: Number of signal aspects used for this signal = 3, tens digit: distance signal depend-ence = none = 0 (This signal is always displayed and never dimmed in dependence of another)
CV #154	Signal aspect 1 for signal 1	2 (decimal)	The first signal aspect of any main signal must always be STOP. Hp 0 (Stop) = red, therefore only output 1 active: binary 00000010 = 2
CV #155	Signal aspect 2 for signal 1	4 (decimal)	Hp 1 (Clear) = green, therefore only output 2 active: binary 00000100 = 4 decimal
CV #156	Signal aspect 3 for signal 1	12 (decimal)	Hp 2 (Approach) = green + yellow, therefore output 2 + 3 active: binary 00001100 = 12 decimal
CV #157 – CV #161	Signal aspects 4 … 8 for signal 1	--- (content is not relevant)	
Distant signal:			
CV #162	Signal object 2 Address Part 1	36 (decimal)	Address 100 (decimal) = binary 0 0110 0100 (9 Bit address range), therefore part 1 = lowest 6 Bits = 100100 binary = 36 decimal
CV #163	Signal object 2 Address Part 2	1 (decimal)	Address 100 (decimal) = binary 0 0110 0100 (9 Bit address range), therefore part 2 = highest 3 Bits = 001 binary = 1 decimal
CV #164	Bit mask for signal 2	240 (decimal)	Outputs 4..7 are used for Signal 2 = Bits 4..7 set = binary 11110000 = 240 decimal
CV #165	Number of signal aspects for Signal 2 and distant signal de-	13 (decimal)	Ones digit: Number of signal aspects used for this signal = 3, tens digit: distance signal dependence = Depends on signal object 1 = 1 (this distance signal will be dimmed when main signal 1 shows STOP (Hp 0))
CV #166	Signal aspect 1 for signal 2	48 (decimal)	Vr 0 (expect STOP) = yellow + yellow, therefore output 4 + 5 active: binary 00110000 = 48 decimal
CV #167	Signal aspect 2 for signal 2	192 (decimal)	Vr 1 (Clear) = green + green, therefore output 6 + 7 active: binary 11000000 = 192 decimal
CV #168	Signal aspect 3 for signal 2	96 (decimal)	Vr 2 (expect approach) = green top + yellow bottom, therefore output 5 + 6 active: binary 01100000 = 96 decimal
CV #169 – CV #173	Signal aspects 4 … 8 for signal 2	--- (content is not relevant)	

***Example 2*: Two block signals (Hp 0/Hp 1 = stop/clear) and one DB Entry signal (Hp 0 = stop, Hp 1 = clear, Hp 2 = approach)**

CV-Number	CV-Function	Value	Explanation
First block signal:			
CV #150	Signal object 1, Address Part 1	4 (decimal)	Address 4 (decimal) = binary 0 0000 0100 (9 Bit address range), therefore part 1 = lowest 6 Bits = 000100 binary = 4 decimal
CV #151	Signal object 1, Address Part 2	0 (decimal)	Address 4 (decimal) = binary 0 0000 0100 (9 Bit address range), therefore part 2 = highest 3 Bits = 000 binary = 0 decimal
CV #152	Bit mask for Signal 1	3 (decimal)	Outputs 0..1 are used for Signal 1 = Bits 0..1 set = binary 00000011 = 3 decimal
CV #153	Number of signal aspects for Signal 1 and distant signal de-	2 (decimal)	Ones digit: Number of signal aspects used for this signal = 2, tens digit: distance signal dependence = none = 0 (This signal is always displayed and never dimmed in dependence of another)
CV #154	Signal aspect 1 for signal 1	1 (decimal)	The first signal aspect of any main signal must always be STOP. Hp 0 (Stop) = red, therefore only output 0 active: binary 00000001 = 1
CV #155	Signal aspect 2 for signal 1	2 (decimal)	Hp 1 (Clear) = green, therefore output 1 active: binary 00000010 = 2 decimal
CV #156 – CV #161	Signal aspects 3 … 8 for signal 1	--- (content is not relevant)	
Entry signal:			
CV #162	Signal object 2 Address Part 1	20 (decimal)	Address 20 (decimal) = binary 0 0001 0100 (9 Bit address range), therefore part 1 = lowest 6 Bits = 010100 binary = 20 decimal
CV #163	Signal object 2 Address Part 2	0 (decimal)	Address 20 (decimal) = binary 0 0001 0100 (9 Bit address range), therefore part 2 = highest 3 Bits = 000 binary = 0 decimal
CV #164	Bit mask for Signal 2	28 (decimal)	Outputs 2..4 are used for Signal 2 = Bits 2..4 set = binary 00011100 = 28 decimal
CV #165	Number of signal aspects for Signal 2 and distant signal de-	3 (decimal)	Ones digit: Number of signal aspects used for this signal = 3, tens digit: distance signal dependence = none = 0 (This signal is always displayed and never dimmed in dependence of another)
CV #166	Signal aspect 1 for signal 2	4 (decimal)	The first signal aspect of any main signal must always be STOP. Hp 0 (Stop) = red, therefore only output 2 active: binary 00000100 = 4
CV #167	Signal aspect 2 for signal 2	8 (decimal)	Hp 1 (Clear) = green, therefore output 3 active: binary 00001000 = 8 decimal
CV #168	Signal aspect 3 for signal 2	24 (decimal)	Hp 2 (Approach) = green + yellow, therefore output 3 + 4 active: binary 00011000 = 24 decimal
CV #169 – CV #173	Signal aspects 4 … 8 for signal 2	--- (content is not relevant)	
Second block signal:			
CV #174	Signal object 3 Address Part 1	4 (decimal)	Address 4 (decimal) = binary 0 0000 0100 (9 Bit address range), therefore part 1 = lowest 6 Bits = 000100 binary = 4 decimal
CV #175	Signal object 3 Address Part 2	64 (decimal)	Address 4 (decimal) = binary 0 0000 0100 (9 Bit address range), therefore part 2 = highest 3 Bits = 000 binary, additionally Bit 6 is set for sub-address 1: 01000000 binary = 64 decimal
CV #176	Bit mask for Signal 3	96 (decimal)	Outputs 5..6 are used for Signal 3 = Bits 5..6 set = binary 01100000 = 96 decimal
CV #177	Number of signal aspects for Signal 3 and distant signal de-	2 (decimal)	Ones digit: Number of signal aspects used for this signal = 2, tens digit: distance signal dependence = none = 0 (This signal is always displayed and never dimmed in dependence of another)
CV #178	Signal aspect 1 for signal 3	32 (decimal)	The first signal aspect of any main signal must always be STOP. Hp 0 (Stop) = red, therefore only output 5 active: binary 00100000 = 32
CV #179	Signal aspect 2 for signal 3	64 (decimal)	Hp 1 (Clear) = green, therefore output 6 active: binary 01000000 = 64 decimal
CV #180 – CV #185	Signal aspects 3 … 8 for signal 3	--- (content is not relevant)	

5. MX821 with other DCC systems

MX821 accessory decoders operate according to the NMRA-DCC standard and can therefore be used with other DCC systems adhering to the same standard.

However, instead of using addresses and sub addresses to reach individual turnouts, other systems (i.e. Lenz, LGB, Uhlenbrock...) often number them consecutively. The following allocation table can be used with such systems:

Turnout 1	program the MX821 to	Address CV #1 = 1, Sub Address CV #33 = 0
Turnout 2	program the MX821 to	Address CV #1 = 1, Sub Address CV #33 = 1
Turnout 3	program the MX821 to	Address CV #1 = 1, Sub Address CV #33 = 2
Turnout 4	program the MX821 to	Address CV #1 = 1, Sub Address CV #33 = 3
Turnout 5	program the MX821 to	Address CV #1 = 2, Sub Address CV #33 = 0
Turnout 6	program the MX821 to	Address CV #1 = 2, Sub Address CV #33 = 1
and so on		
Turnout 9	program the MX821 to Default (!)	Addr CV #1 = 3, Sub Address CV #33 = 0
Turnout 10	program the MX821 to	Addr CV #1 = 3, Sub Address CV #33 = 1
and so on.		

6. Software-Update (and Synchronuous-Update)

As is the case with all ZIMO decoders, the accessory decoder too can be updated with new firmware by the end user. This is accomplished with decoder update modules such as the MXDECUP, MX31ZL, MXULF(A) or a DCC command station MX10; see the respective operating manual.

However, a distinctive feature of the accessory decoder is the ***synchronous update***, which takes into account that accessory decoders are usually installed permanently in the layout and should preferably remain there during the update. The problem is that there is no direct connection to a single decoder, instead, all decoders are connected in parallel to the track (power bus), and the software update would be sent to all decoders simultaneously.

For the synchronous (simultaneous) update of all decoders, connect the decoder update module MXULFA to the track (power bus) in place of the DCC command station and start the special synchronous software update procedure. Vehicles may remain on the track but higher and longer inrush currents caused by energy storage devices (capacitors etc.) may cause problems...

Check the MXULF operating manual for detailed description; the following is a short excerpt:

At first, the update module searches for any accessory decoders (suitable for the synchronous update) and displays them all organized by decoder family.

Decoder-Family search in progress	→	MX821 SEARCH 3
Search completed	→	■ MX821 FOUND 7
Update progress is shown	→	■ MX821 SY-UP 68%
Update successful (Updated decoders; total numbers of decoders FOUND) Of course, all decoders should normally update successfully.	→	MX821 OK 6(7)