

# Massoth<sup>®</sup>



## eMOTION XL

Loco Decoder

Nr. 8150001  
Version 1.2



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## **General and Safety Details**

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Congratulations on your purchase of an eMOTION XL Decoder. The eMOTION XL Decoder is an exceptional high-performance Digital Decoder designed for G-Scale by Massoth Electronics, Germany. We highly recommend reading this manual and the documentation carefully and thoroughly before operating your eMOTION XL Decoder.

Massoth Electronics used the latest in technology in designing and manufacturing the eMOTION XL Decoder. Excellent operation at all times is assured by the high safety standard in data processing and by delivering an exceptional power output and performance. Future alterations in the DCC Standards are easily implemented in the eMOTION XL Decoder by updating. The latest Flash-Technology is utilized in the eMOTION XL Decoder to provide a safe and consumer-friendly operation during updating.



This Decoder conforms to the CE Standards

**RoHS**

This Decoder is manufactured according to the latest EG-Standards for lead free manufacturing conforming to RoHS Standards.



Please dispose of according to your State regulations.



Do not dispose of in open fire.

## **Important information for the operation**

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Install your Decoder in compliance with the connecting diagram in this manual. The Decoder is protected against shorts and excessive loads. However, in case of a connection error e.g. a short between a light and the motor, this safety feature cannot work and the Decoder will be destroyed subsequently.

The Decoder is originally programmed on address #3 with 14 speed steps. In case you want to use a high address, you have to program CV17, CV18 and CV29 accordingly. If you want to use 28 speed steps you need to set CV29-Bit1 to "2". Otherwise the lights might not work or flicker.

## Summary of the XL Decoder Properties

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- 14, 28 and 128 speed steps
- 10239 addresses
- 256 internal speed steps
- Programmable driving characteristics
- Starting speed, medium speed and maximum speed (with acceleration/deceleration time)
- Serial and parallel control of all light and function outputs, incl. LGB P-Sound updates
- Digital and analog operation with automatic recognition
- Compatible with NMRA DCC and LGB MTS (all generations)
- Latest technology of load control (digital and analog)
- Adjustable motor frequency
- 3 light outputs (front, aft, interior) max 0.3 Amps each
- 6 function outputs (each programmable with special functions) max 0.6 Amps each
- Light and function outputs may be dimmed and activated in analog mode
- Programmable blinking light, short-time function, and pulse generator function
- 2 additional contact inputs (for future functions)
- Switching speed (with free function mapping)
- Easy to use function mapping
- Free command allocation of all function outputs
- Maximum total load 4 Amps
- 3 Amps motor power amplifier (usable for 2 motors with 1.5 Amps each)
- Connector for power buffer (accessory) for smooth running integrated
- Overload and temperature protection for motor and function outputs
- Reset function for all CV values
- Software easy to be updated

## Supported Programming Procedures

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- Read Cvs
- Write Cvs
- Write CVs bit by bit
- Write CVs indirectly (by register programming)
- Direct register programming (CV1-CV4)
- PoM – program on main

## Brief Introduction into Digital Control

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The prominent benefit of digital controlling is your choice of operating all your locomotives individually at the same time. Traction current is on the track at all times, for G-Scale it is generally 22V -24V AC. Each locomotive is equipped with a digital Decoder which is programmed with the locomotive's individual properties, e.g. address, maximum speed, voltage of the light bulbs etc. Controlling is achieved by a digital central station in conjunction with a handheld controller. The controller converts the users' commands into digital signals which the central station, after processing sends onto the track. Every Decoder which is connected to the track receives these signals and decides based on the addresses, for which Decoder the commands are sent for. Several safety features in the transmitting protocol make sure that there are no malfunctions or disturbances. Eventually only the selected locomotive responds to the inputs of the handheld controller.

To ensure the proper operation of the Decoders, the Decoders need to be individually programmed according to the CV-table. CV stands for configuration variables and the table holds the individual data for the properties of a Decoder. CV1 holds the address of the Decoder; others define the maximum speed, the brightness of a light bulb or the braking characteristics.

Please find the explicit list of all CVs at the end of this manual.

## **LGB MTS I, II, III Information**

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The basic setting of the eMOTION XL Decoder is set to 14 speed steps to accommodate the LGB MTS digital systems run that run with 14 speed steps. In case you use the eMOTION XL Decoder in connection with the DiMAX System or any other system that supports 28 speed steps the CV29 setting must be changed. A 128 speed step demand is recognized by the eMOTION XL Decoder automatically. In this case a CV programming is not necessary.

## **Basic Settings**

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- **Address #3**
- **14 speed steps** (compatible to MTS I, II and III)
- **Light outputs** delivering full voltage (for 19/24 V bulbs)
- **Switching speed F8**
- **Function outputs F1 to F6 corresponding to keys F1 to F6**

## Contact Assignment

All electrical connections to the eMOTION XL Decoder are done via two rugged terminal blocks, positioned symmetrically on each side. Each terminal block holds 9 contacts. Please find the contact assignment in Illustration #1 below:

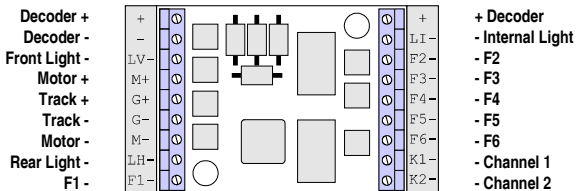


Illustration 1: Contact Assignment

## Light- and Function Outputs

All Light- and Function Outputs of the eMOTION XL loco Decoder are illustrated in the following picture including a schematic design of the required wiring.

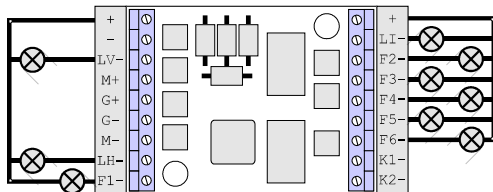


Illustration 2: Light- and Function Outputs

## Installation (schematically)

To connect your eMOTION XL Decoder to a motor or LGB gear box you need four color coded wires that are equipped with crimp terminals. Two wires (white, brown) connect the eMOTION XL Decoder to the track; two wires (yellow, green) connect the eMOTION XL Decoder to the motor. In case you want to connect two motors to the Decoder you need a second set of wires. Two sets of wires are provided. See illustration #3:

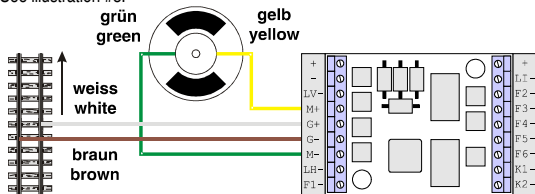


Illustration 3: Connection Diagram Track / Motor

## Installation without Interface

Installation into a locomotive without an interface can be easily done. Generally all LGB gear boxes provide four color coded contacts, two for the tracks and two for the motor. Connect the provided wires according to the color code to the gear box and the eMOTION XL Decoder.

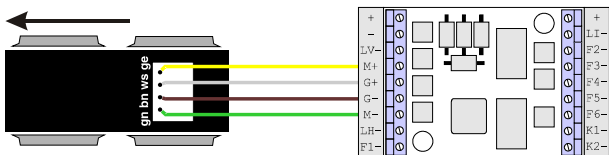


Illustration 4: Connection Diagram Track / Motor

## Installation with LGB Decoder-Interface

The eMOTION XL Decoder can be installed using the LGB Interface Cable. These cables control light functions and sound functions. The LGB Interface cable may be purchased as LGB item 55026. Remove the crimp connectors and strip the insulation for 1/8 in and twist the wires before connecting the wires to the eMOTION XL Decoder. See Illustration #5:

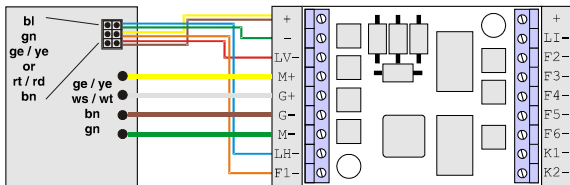
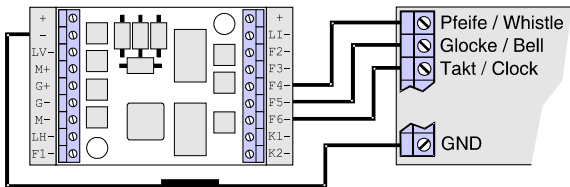


Illustration 5: Installation with LGB Decoder Interface

## Installation in Locos with Sound (non LGB Sound)

The eMOTION XL Decoder can be installed using the LGB Interface Cable. These cables control light functions and sound functions. The LGB Interface cable may be purchased as LGB item 55026. Remove the crimp connectors and strip the insulation for 1/8 in and twist the wires before connecting the wires to the eMOTION XL Decoder. See Illustration #6:



Widerstand / Resistor 10 Ohm

Illustration 6: Installation in Locos with Sound

## Installation with LGB DCC Interface

The installation with a LGB DCC Interface is self explanatory, please see illustration.

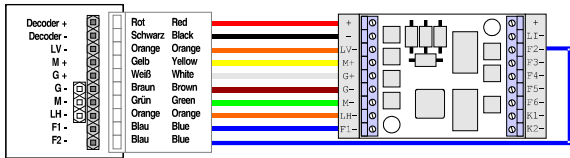


Illustration 7: Installation with LGB DCC Interface

## Installation with Aristocraft DCC Interface

For installation please refer to the wiring diagram. The maximum output of the eMOTION XL Decoder is 3 Amps which is generally sufficient for two motors. If you want to equip an Aristocraft locomotive that has four motors, you need to use two separate eMOTION XL Decoders.

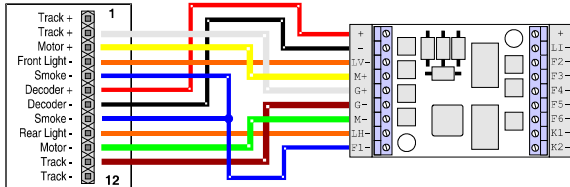


Illustration 8: Installation with Aristocraft DCC Interface

## **Programming the Decoder**

The eMOTION XL Decoder supports all programming methods according to NMRA/DCC standards. Please note that not all of the DCC systems currently available can be programmed according to this standard. The manufacturer of your DCC system should give you in-depth information.

## **Reading Configuration Variables (CVs)**

The readout of CV parameters is essential for checking the programmed settings and it is not to be mistaken for programming. The eMOTION XL Decoder provides this function and the readout can be easily accomplished with the DiMAX Navigator or any other handheld controller. After inserting the requested CV No. the controller will display the value of the respective parameter.

## **Writing Configuration Variables (Cvs)**

Programming (writing) the CV values is the easiest way of programming the Decoder. This method is utilized by most of the DCC systems. Using your DiMAX Navigator or any other hand held controller, you select the desired CV parameter and insert your desired value. Programming is done on a separate programming track or a piece of track that is used as programming track. Please check the manual of your central station.

## **Writing the Configuration Variables (CVs) Bit by Bit**

Some of the CV parameters consist of multiple binary values. This means that several values are combined in one value (e.g. CV 29). Programming a CV of this kind requires that all values of all functions controlled by this CV need to be summed up. A deactivated function always is "0", an active function must be programmed with the respective value. The sum represents the value is the CV and must be written into the CV parameter.

## **Register Programming / Writing CVs indirectly**

Register programming was the first method of CV programming. The CV value is to be entered into an intermediate variable. The Decoder thereafter does the real programming. This method is supported by the eMOTION XL Decoder too. The input into register 5 and 6 is accomplished with the DiMAX Navigator or any other hand held controller. The CVs 1 to 4 are entered directly; all other CVs with higher numbers are programmed per register programming.

## **PoM Programming on Main (Main Track)**

The PoM Method is the only procedure to accomplish programming on the main track. All of the CV programming can be done except CV1 (address) with the eMOTION XL Decoder.

## Explanation of important CV parameters

Current digital systems like the DiMAX System provide a comfortable way to program addresses. All CVs including CV29 are calculated automatically and programmed at the same time. The original address setting of the eMOTION XL Decoder is "3". In case of a Decoder reset, the address will be reset to this value.

### **Loco Address**

- Each locomotive running in a digital system needs a digital address.
- The NMRA Standard provides two kinds of addresses:  
Low (short) addresses (1...127) and high (long) addresses (128...10239)  
An address must be stored in the Decoder to enable the Decoder to recognize the commands that are meant for it.
- The low address is stored in CV 1. The maximum value is "127". In addition bit 5 in CV 2 must be "off" (value 0)
- The high address is divided into two values and is stored in CV17 and CV18.  
In addition bit5 in CV29 must be set to "on" (value 1)

**The long address must be calculated and stored into CV17 and CV18:**

**CV17 = address / 256 (store only the whole-numbered value)**

**CV18 = address – (CV17x256)**

### **Motor Control**

- The direction of driving (including the direction related functions) can be defined by setting CV29 bit0 accordingly.
- Three settings of speed control are available:
  - 14 speed steps (CV29 – bit1 = Off)
  - 28 speed steps (CV29 – bit1 = On)
  - 128 speed steps (is detected automatically) MTS I and II require a 14 speed step setting

- The acceleration/deceleration characteristic is controlled by 2 Cvs:
  - acceleration delay (CV3)
  - deceleration delay (CV4)

Time lag between speed 0 and the maximum speed (or reverse) is 0.5sec if the setting is "1", maximum possible is 128sec (setting "255"). Simply divide your desired time delay by "2" to acquire the respective CV setting.
- The linearity of the driving characteristic is defined by three CVs or by a individually programmed driving curve:
  - The start voltage defines the driving voltage of step1. The smaller the voltage the slower the locomotive drives. If, the back EMF in "off", the loco does not move in step 1, the voltage should be increased.
  - The maximum speed (CV5) may be reduced by inserting smaller values.
  - The mid-speed (CV6) defines how many speed steps are available. In the case CV6 is half of the value of CV5, all speed steps are distributed equally. In case CV6 is smaller than half the value of CV5 the lower speed steps are stretched. The locomotive will drive slower at mid-speed; the slow speed range will be extended.
  - As an alternative you may program the driving curve individually in 28 speed steps (CV67 - CV94). This driving curve is activated by CV29- bit4. In this case the CVs 2, 5, and 6 are deactivated!
- The motor control frequency is defined in 4 steps by CV9. At 16 kHz the motor is operated at its optimum and runs very quiet. A few types of motor may require a lower setting if they do not run smoothly or get hot. The integrated back EMF works only with 16 kHz. The eMOTION XL Decoder is usable with all kinds of DC motors.
- The eMOTION XL Decoder is equipped with an integrated PI-Back EMF that can be programmed by 3CVs. The eMOTION XL Decoder is delivered with a "fast" setting. This facilitates fast speed changes which however may result in over controlling and subsequently in bucking. For optimizing CV60 (Back EMF adjusting factor) and CV61 (Back EMF adjustment speed) may be changed. A reduction of CV60 results in a reduction of the regulating steps per time unit. The eMOTION XL Decoder regulates less and does not tend to over regulate. The

increase CV61 results in an increase of time between two regulating steps. The eMOTION XL Decoder regulates less per time unit. Depending on the motor type used a change of CV60 or CV61 may be advisable. In addition the eMOTION XL Decoder may limit the back EMF automatically depending on the situation.

CV62 is the back EMF adjustment strength. It defines if the Decoder is enabled to regulate up to full load or only to a certain limit. If this value is set to "128" the back EMF is limited to 50%. The Decoder will not continue regulating if this limit is reached thus resulting in a slower speed if the locomotive is put on a strain. The back EMF may be switched off by CV49.

### **Programmable Special Functions**

- Switching speed: The maximum speed is reduced by half to facilitate a more effective driving characteristic during switching. This feature may be set on any programmable function key. With CV59 = 0 the function is "off". Values between 1...16 define the number of the function key.
- Disabling acceleration value and braking value: the programmed values of CV3 and CV4 may be reduced to a minimum by a keystroke. With CV64 = 0 the function is "off". Values between 1...16 define the number of the function key.
- Pause time during shuttle operation: You may utilize a simple shuttle operation by defining a pause time in digital operation as well as in analog. With CV58 = 0 the function is "off", values between 1...255 define the pausing time in seconds. This only works if the driving direction is reversed. The pause time is disregarded if the locomotive is stopped and started again in the same direction.

### **Light and Function outputs**

- The light and function outputs are freely programmable. (Assignment of function keys, direction controlled functions, blinking and short-time-functions, impulse generator for sound).
- Outputs may be programmed for NMRA-DCC-Commands or serial LGB pulses
- All light outputs and the F1 – F4 outlets are dimmable
- Attention: The light function depends on the programmed speed step setting. In case the CV29 setting is not matching with the setting of the DCC system, the lights blink or are not working.

## **Contact Inputs**

- The two contact inputs are not activated yet. E.g. a shuttle service will be utilized in the near future.

## **Analog Operation**

- The operation in analog mode may be prohibited by setting CV29 – Bit2 accordingly.
- The eMOTION XL Decoder is programmed with an internal motor characteristic curve which enables a soft start in analog mode by measuring the track voltage. An analog back EMF may be switched on with CV49-Bit2.
- All three light outputs are on in analog operation regardless of the driving direction. All six function outputs may be activated. Features like dimming and blinking are available in analog operation. The pulse generator (F6) cannot be used in analog.

## **Reset Mode + Software (Firmware) Update**

- CV7 provides a feature to reset the basic functions (Value 55), motor data (value 66) and Light and Function Output (Value 77) to the original values. This works only with the function “write CV”.
- See attachment 7 for CV assignment.
- By means of a PC Program the internal software (Firmware) of the eMOTION XL Decoder can be updated.

## **Programming of Binary Values**

- Some of the CVs consist of binary values. This means that several values are combined in one value. Each function has a position and a value. A deactivated function generally has the value “0”, an active function the respective value according to the list. For programming all values of the functions have to be summed up and then stored as the final CV value.

CV	Description	Default	A	Value	Note
1	Loco Address (standard short)	3		1.. 127	If CV29-Bit5 = 0
2	Starting Voltage	2		1.. 255	CV2 x (1/255 Track Voltage)
3	Acceleration time	3	x	1.. 255	CV3 x 2ms x (1/255 Tr. Voltage)
4	Braking time	3	x	1.. 255	CV4 x 2ms x (1/255 Tr. Voltage)
5	Top Speed	255	x	1.. 255	CV5 x (1/255 Track Voltage)
6	Mid-Speed	64		1.. 255	CV6 x (1/255 Track Voltage)
5+6	Programming in Register Mode: Register 6 = CV- Number Register 5 = value	---		---	CV5 and CV6 are not affected
7	Software Version	(1.2)		---	Read only
7	Decoder Reset Function 3 ranges are available	---		55 66 77	Basic CV Reset Motor CV Reset Light CV Reset
8	Manufacturer ID	123		---	Read only
9	Motor Frequency	0	x	0.. 3	0 = 16 kHz / 1 = 2 kHz 2 = 250 Hz / 3 = 60 Hz
13	Function Outputs in Analog Mode (On if value set)	0	x	0.. 63	F1 = 1, F2 = 2, F3 = 4, F4 = 8, F5 = 16, F6 = 32
17	Long Loco Address (High Byte)	128		128 .. 10239	If CV29-Bit5 = 1
18	Long Loco Address (Low Byte)				
29	Configuration Table NMRA	4	x		See Attachment 1
49	Configuration Table Massoth	2	x		See Attachment 2
50	Light: Dimming Value (PWM)	32	x	1 .. 32	32 = Track Voltage
51	Front Light: Command Allocation	128			See Attachment 3
52	Rear Light: Command Allocation	64			See Attachment 3
53	F F1 + F2: Dimming Value	32	x		See Attachment 4
54	F1: Command Allocation	1			See Attachment 3
55	F1: Special Function	0	x		See Attachment 4

CV	Description	Default	A	Value	Note
56	F2: Command Allocation	2			See Attachment 3
57	F2: Special Function	0	x		See Attachment 5 + 5a
58	Pause Time for Stop and Reversing	0	x	0.. 255	0.5 sec per Value
59	Switching Speed Command Allocation (Half Speed)	8		0.. 16	0=Off, 1.. 16 = F-Key
60	Back EMF Adjustment Factor	4	x	1.. 15	Big Value = Fast Regulation
61	Back EMF Adjustment Speed	60	x	1.. 255	Big Value = Slow Regulation
62	Back EMF Adjustment Strength	255	x	1.. 255	255 = max. Strength
64	Engage/Disengage acceleration / Deceleration Value, Command Alloc.	9		0.. 16	0 = off, 1.. 16: No. Of Function Key
67- 94	Freely Programmable Driving Curves In 28 Steps	1.. 255		1.. 255	See Attachment 8
106	ID for Decoder Type (Only needed for Software Update)	193		---	Read Only
112	F3 + F4 Dimming Value	32	x		See Attachment 4
113	F3: Command Allocation	3			See Attachment 3
114	F3: Special Function	0	x		See Attachment 5
115	F4: Command Allocation	4			See Attachment 3
116	F4: Special Function	0	x		See Attachment 5 + 5a
117	F5: Command Allocation	5			See Attachment 3
118	F5: Special Function	0	x		See Attachment 5 + 5a
119	F6: Command Allocation	6			See Attachment 3
120	F6: Special Function	0			See Attachment 6

**Attachment 1: (CV 29) – NMRA Configuration**

Bit	Value	Off (0)	Assignment	On (Value)	Note
0	1	Driving Direction Standard	Reverse Driving	Reverse	
1	2	14 Speed Steps	28 Speed Steps		Automatic Recognition of 128 Speed Steps
2	4	Digital Operation Only	Digital + Analog Operation		
4	16	Internal Driving Curve	Programmable Driving Curve		CV 67-94
5	32	Short Address (CV1)	Long Address (CV17+18)		

**Attachment 2: (CV49) – Massoth Configuration**

Bit	Value	Off (0)	Assignment	On (Value)	Note
0	1	Parallel Data Processing Only	Serial + Parallel Data Processing		Automatic Detection of Serial/Parallel
1	2	Digital Load Control Off	Digital Load Control On		
2	4	Analog Load Cont. Off	Analog Load Cont. On		
3	8	F1-Ouput Standard	Fast Pulse String (P-Update) on F1		Bit3="On" only with Bit0="On"

**Attachment 3: (CV51, 52, 54, 56, 113, 115, 117, 119) Switching Output Commands**

Value	Assignment	Note
0 - 16	0=Switch Function with Light Key 1-16 = Switch Function with F-Key No. 1-16	
+ 64	Switching Output "On" in Reverse only	Additional Value is to be Added
+ 128	Switching Output "On" in Standard Driving Direction only	Additional Value is to be Added

**Attachment 4: (CV53, 112) – Dimming Values**

Value	Assignment	Note
1 - 32	Voltage on Output (32=full Voltage)	
+ 64	F1 (F3) is dimmed only	*F1 in CV53, F3 in CV112
+ 128	F2 (F4) is dimmed only	*F2 in CV53, F4 in CV112
+ 192	Both Outputs are dimmed	

\*Command Allocation Value must be added to Voltage Value

**Attachment 5: (CV55, 57, 114, 116, 118) – Special Functions F1 + F2 + F3 + F4 + F5**

Value	Assignment	Note
0	0=Steady "On" (Standard Operation)	
1..15	Blinking Steadily (Time Base 0.25sec / value)	Symmetric Blinking
(1..15) +64	Short Term Function (Monoflop) (Time Base 0.25sec / value)	Output is switched "off" automatically after timeout
(1..15) + 128	Asymmetric Blinking (Short)	Output blinks 1/3 "On"
(1..15) + 192	Asymmetric Blinking (Long)	Output blinks 2/3 "On"

**Attachment 5a: (CV57, 116, 118) – Expanded Special Functions F2 + F4 + F5**

Value	Assignment	Note
16	Inverse Coupling with Output F1 resp. F3 (Alternating Blinking)	Only in CV57 (F2 with F1) and CV116 (F4 with F3)
31	Charging Control of Voltage Buffer in Programming Mode	Only in CV118 (Buffer controlled by F5)

**Attachment 6: (CV120) – Special function F6**

Value	Assignment	Note
0	Steady "On" (Standard Operation)	
1 .. 15	Time Base for Sound Pulse Generator	1 =slow pulse, 15=fast pulse

**Attachment 7: Default CV-Settings for Reset**

CV7 = 55	1=3 , 17=0 , 18=128 , 29=4 , 49=2 , 58=0 , 59=8
CV7 = 66	2=2 , 3=3 , 4=3 , 5=255 , 6=64 , 9=0 , 60=4 , 61=60 , 62=255 , 64=9
CV7 = 77	13=3 , 50=32 , 51=128 , 52=64 , 53=32 , 54=1 , 55=0 , 56=2 , 57=0 , 112=32 , 113=3 , 114=0 , 115=4 , 116=0 , 117=5 , 118=0 , 119=6 , 120=0

## **Attachment 8: Basic Values of Freely Programmable Driving Curve (CV67...CV94)**

6, 8, 10, 13, 16, 19, 22, 26, 31, 36, 42, 48, 54, 60, 68, 76, 84, 92, 102, 112, 124, 136, 152, 168, 188, 208, 228, 232

### **Warranty:**

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Massoth warrants this product for one full year from the original date of purchase. This product is warranted against defects in materials and workmanship. Peripheral component damage is not covered by this warranty. Wearing parts are not included in the warranty since these items wear out while time passes. On top of this, you might have additional requirements from country to country. Normal wear and tear, consumer modifications as well as improper use or installation are not covered.

Valid Warranty Claims will be serviced without charge within the warranty period. To initiate a warranty claim, please contact your dealer or Massoth directly for an RMA (Return Merchandise Authorization). Massoth cannot be responsible for return shipping charges to our repair facility. Please include your Proof of Purchase with the returned goods.

### **Customer Support:**

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For support and technical questions contact: [hotline@massoth.com](mailto:hotline@massoth.com)

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