Simple USB / DMX512 Interface with Arduino Micro or Arduino Leonardo

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The circuit described here provides an easy to build USB controller for the DMX512 lighting bus.

Three different command sets are selectable, the command set is selected by a jumper, which may be replaced by a switch:

--- When the **ASCII text based command set** is selected, the USB interface gets configured as "USB Communication Device" (CDC/ACM class). It provides a virtual RS-232 port.

--- The **MiniDMX protocol is implemented** – formally as ASCII text command 'Z', so it works configured as "USB Communication Device", too

--- When the **MIDI channel based command set** is selected, the USB interface is configured conforming to the "USB MIDI Streaming Class", i.e. is seen as a virtual MIDI port.

Due to limited SRAM of the ATmega32U4 processor, max. 256 DMX channels are supported.

An **alternative firmware** is available, which supports the **MiniDMX protocol for 512 DMX channels** instead of the MIDI command set.

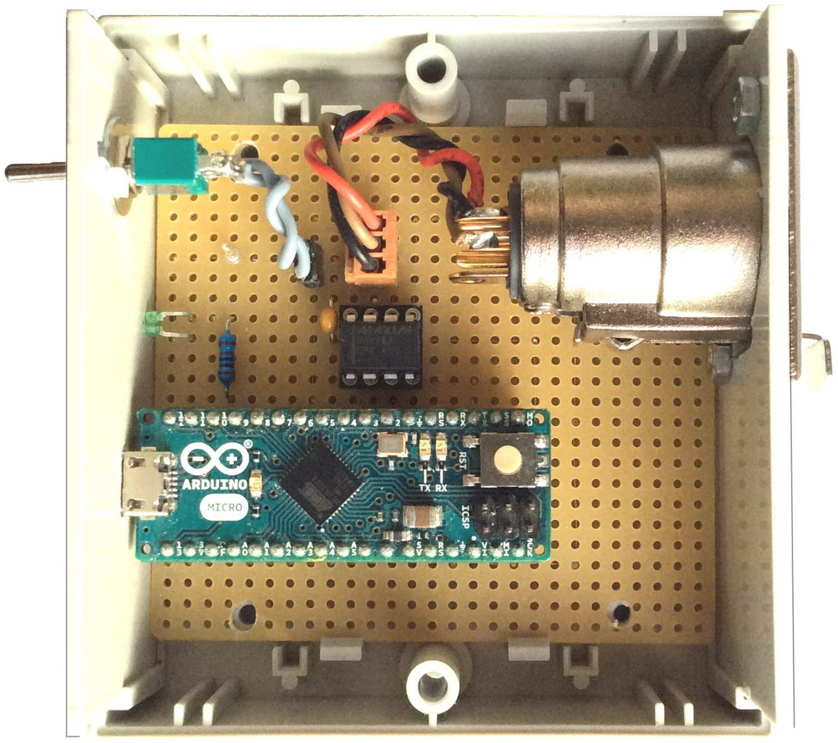
In contrast to Arduino IDE compatible DMX libraries, **special DMX features** like soft fading between lighting scenes, permanent storage of líghting scenes and chaser effect are offered.

Unfortunately the downloadable hex code cannot be programmed with the Arduino IDE (flash programming at runtime needs Boot Section) **you will need an external ISP programmer**

It is **NOT allowed to use this device together with any safety critical applications**, where misfunction could result in personal injury oder noticeable material damage !

All information about this project is provided 'as is' – without any warranty

Hardware for Arduino Micro

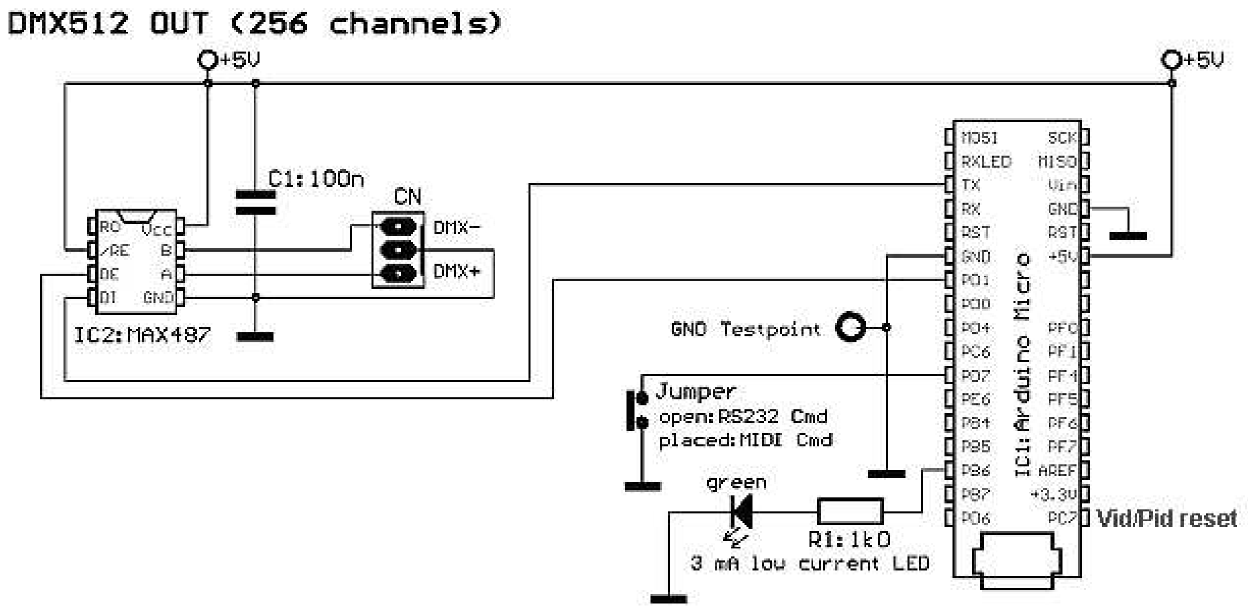


For easy reproduction with simple tools,**the hardware is designed to be built on a Veroboard around an Arduino Micro module** using a minimum of additional parts.

The USB interface is "full speed" grade, the device is **USB bus powered**. The supply current is less than 100mA. A green LED signals presence of power and data flow.

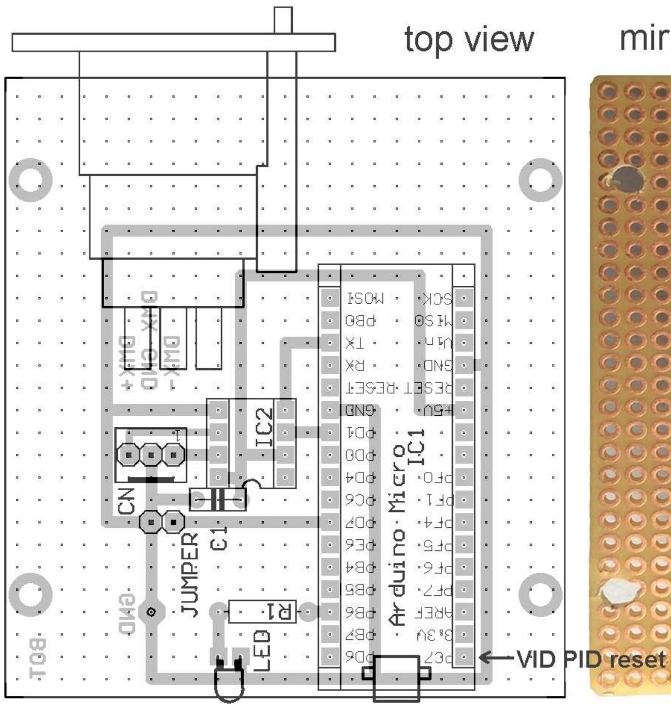
Schematic diagram:

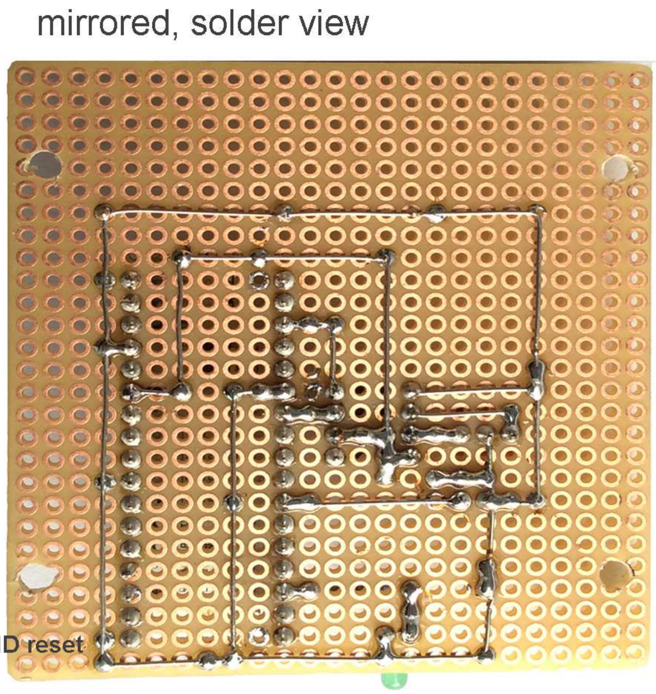
Differing from previous releases, the circuit layout is changed: **PB5 (IO9)** should **not** be connected with Ground.



Assembly:

To build an etched PCB instead of the Veroboard, a 1:1 TIF file is provided for download at the website <www.midi-and.more.de/armicdmx.htm>.



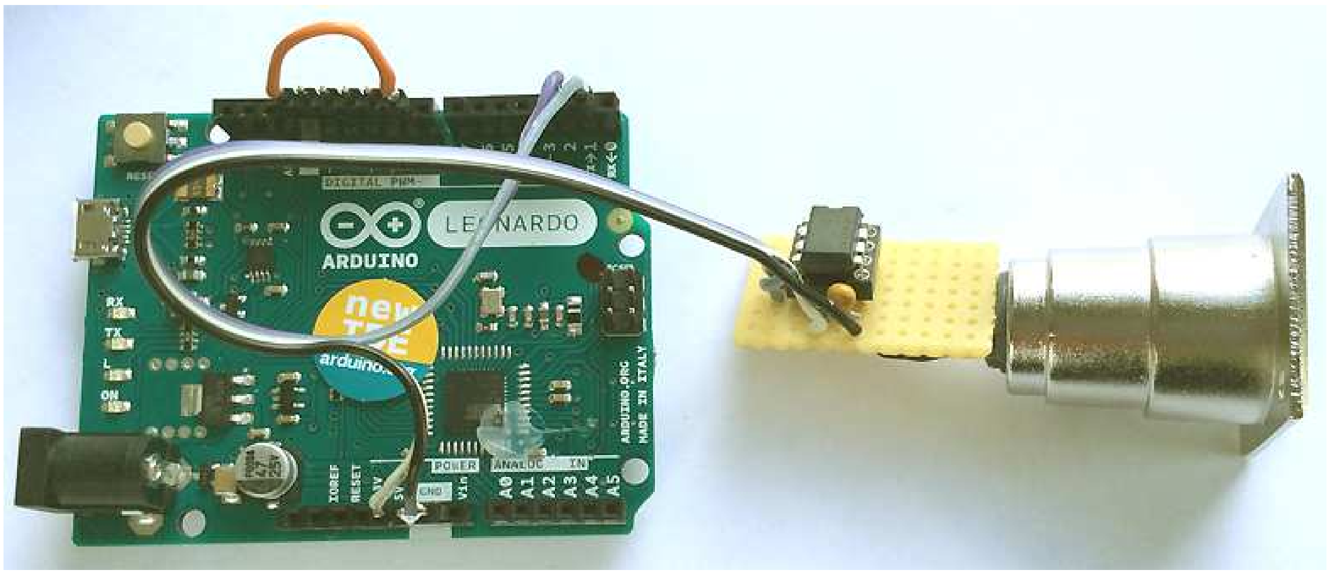


The PCB is designed to fit into a "Bopla Unimas85" enclosure, source Reichelt (BOPLA U 85) or Conrad 540803
With slightly deplaced holes it fits into an "Eurobox" enclosure, Reichelt (EUROBOX) or Conrad part no. 523132
Resistor R1 should be carbon or metal film type, min 0.1W. The optimum value may be chosen higher or lower than 1 kiloOhm depending on efficiency of the used LED. For blue or white LED: R1 ca. 4.7-10kOhm
Capacitor C1 should be multilayer ceramic 5.08mm raster, 50V

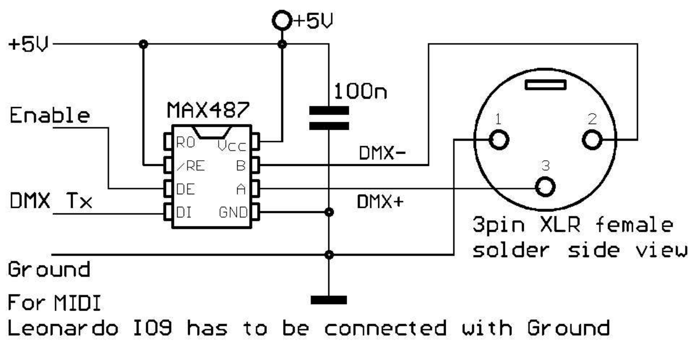
IC1: Arduino Micro module
IC2:MAX487 8pDIL or equivalent (also useable MAX485, MAX3085)
LED: green,   preferably 3mm low current type (2-4mA).
CN: source Reichelt (PS 25/3G BR) or Conrad. Wires to the XLR connector may be soldered directly, too.

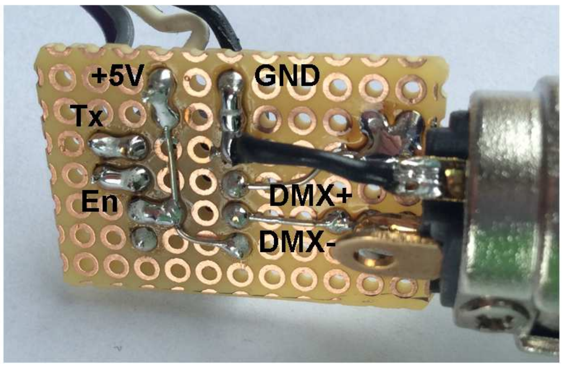
Hardware for Arduino Leonardo

The DMX transmitter is mounted on a small PCB, which is directly fitted at the XLR connector. For better solder fitness on Veroboard, a 3 pin socket was chosen . **Pin numbers are the same for 5 pin connector.** If the XLR connector is a type which is mounted through the hole, it is essential that the Veroboard is slim enough to fit through the hole too.



In this wiring example, the black wire is connected with Ground, the white wire with +5V. The grey wire transports DMX data from Leoanardo TX (D1) to the MAX487. The violet wire enables/disables the MAX487. It is switched low during USB enumeration to minimize supply current. It is connected with Leonardo D2. **Leonardo IO9(PB5) is ground shoreted with an orange jumper** (or switch). This configures the Leonardo seen by the PC as **MIDI interface** and activates the MIDI command set. Without jumper (default), USB is configured as virtual COM port and the ASCII/MiniDMX commands are active (assignment exchanged new rev1.13).
All connections to the Leonardo are made unsoldered with 2.54 mm pinheads.





In the following text only Arduino Micro is referred. But commands and firmware features are the same for Arduino Leonardo

Installation and Operation

Depending on the setting of the jumper JP (or switch), the device behaviour is different:

--- If the jumper is open or not installed, the firmware is automatically configured as a USB Communication Device (CDC/ACM class), i.e. will be installed as a vitual RS-232 compatible COM port.
When the microcontroller is programmed new, the default USB VID/PID for the RS-232 compatible mode is the same as for Arduino Micro (VID=2341,PID=0037).

When you start the new programmed Arduino Micro in RS-232 compatible mode first time, the LED initially is dark and the Windows Device manager shows "Unkown Device".Then install "Arduino Micro.inf" manually as guided by Windows navigation.

For this purpose **additionally the appropriate "Arduino Micro.inf" file has to be available**. This is found best the following way: Download the Arduino Software package and install it. Open folder "Drivers". The actual file "Arduino.inf" does work less well, so it is proposed to unzip "Old_Arduino_Drivers.zip" into new folder named "Old_Arduino_Drivers". File "Arduino Micro.inf" is contained there, it is even compatible with Windows2000

--- If the jumper is set or a connected switch is closed, **the firmware is automatically configured as a USB MIDIStream device**, i.e. most operating systems will recognize it as a virtual MIDI device. In Windows Device Manager (XP and newer only, Windows98/2000 has no built-in USB/MIDI support) it will be listed under "Audio-Video-Game Controller" as "USB-SimpleDmx" or simply as "USB Audio Device". If you open any MIDI software, it will be seen as MIDI port "USB-SimpleDmx" or simply as "USB Audio Device".
If the microcontroller is programmed new, the default USB VID for the MIDI mode is the same as for Arduino Micro (VID=2341) but the PID is =8236 (changed rev1.13).
Else the MIDI PID is always user configured PID +1.
When the interface is connected first time to a PC, it may take some time to install the driver.

Please note that the default values for VID and PID are licensed for device test and evaluation only! For external use, you have to enter your own VID and PID as follows:
It is assumed that you already have some experience with the RS-232 interface.
Type 'U', follow the text messages, enter your new VID (as sequence of 4 hex digits. Enter hex words without 0x. Case independent. Leading zeroes of the VID/PID MUST be entered, no spaces between the nibbles) . When this is ok, enter your new PID (as sequence of 4 hex digits). The input will be echoed. It is automatically stored in EEProm and will get active after next reset/power cycle.
Fill your own VID/PID in a ("proven" e.g.Arduino) **template .inf file** with an ASCII text editor, change the file name, if wanted change manufacturer name etc. Select this file when the PC asks for a driver.
The MIDI PID is always one higher (exept default value, which is always 8236 for better compatibility)**.**
With ASCII command '?' the actual sytem configuration incl. VID/PID setting is returned.

To reset VID/PID to default values, connect Arduino PC7 (=IO13) with GROUND during power up! See marker at the assembly figure above.

<u>Hints for operation with the MiniDMX protocol are found below at page 11.</u>
<u>Description of the MIDI command set is found below starting from page 12.</u>

ASCII command set

is active when NO jumper JP is placed or a switch attached there is open. The associated COM port may be set in the Device Manager. Baud rate selection of your control software does not matter, communication is baud rate independent. Handshake is not supported.

Short reference of all ASCII commands

Sn	address DMX channel **(write SLOT register)** for subseqent action (n=1 - 256)	p.5
Vn	set DMX level at DMX channel=SLOT (n=0 - 255)	p.6
,n (comma)	increment SLOT first then set level at new DMX channel (n=0 - 255)	p.6
=n	fill block of n DMX channels starting from SLOT+1 with level of SLOT (n=1-256)	p.6
#n	set DMX channel no. n (n=1-256) to DMX level entered by previous command	p.6
+	increase transmit buffer level DMX channel=SLOT by one	p.7
-	decrease transmit buffer level DMX channel=SLOT by one	p.7
^n	add n to transmit buffer level DMX channel=SLOT (n=0 - 255)	p.7
_n	subtract n from transmit buffer level DMX channel=SLOT (n=0 - 255)	p.7
$	from now DMX level in HEX (only V , comma , ^- , _- , R and Q- command)	p.7
&	from now DMX level DECIMAL (only V , comma , ^ , _ , R and Q-command)	p7
Hn	set hue (spectral color) for RGB lamp	p.8
Wn	set color saturation for RGB lamp	p.8
Bn	set brightness (luminance) for RGB lamp	p.8
Ts.t	set FADETIME in 1/10s raster (0 – 12.7s)	p.8
X	stop fade processes and freeze them at actual DMX level	p.8
Rn	read n bytes starting at DMX channel=SLOT from transmit buffer	p.9
Mn	set the masterfader: n=0 to 200 (in percent, see detailled description below)	p.9
Gn	enter start scene (preset no.) of chaser cycle . See detailled description	p.9
An	set length of chaser cycle (n=2 to 89) and start the chaser	p.9
Pt	set duration of chaser step in 1/10 s units	p.9
N	forward chaser immediately by one step	p.10
D	set output of all DMX channels immediately to 0 (Panic function)	p.10
Q	show content of all DMX registers at DMX channel=SLOT	p.10
~n	save transmit buffer a as preset no. n	p.10
@n	load preset Nr. n into buffers	p.10
|	reset all buffers and configuration to default state (presets kept unchanged)	p.10
Cn	change MIDI channel (1-16)	p.11
?	return system version, USB VID/PID and MIDI channel	p.11

MiniDMX protocol p.11

Detailled description of all ASCII commands:

Every control command and every state message is assigned with a single characteristic letter. If a command expects a parameter, it is listed after the command letter in acute angular brackets <..:>, to be entered as ASCII text (decimal (default) or – if activated - hex without 0x.This compact format is suitable to enter commands manually as well as for automatic generation and parsing with an application software.

Address the DMX channel ("slot") to be operated with following commands:

S <channel number>

The **parameter addresses a DMX channel**, on which many of the subsequently described commands have an effect. Internally the parameter value is stored in the SLOT register.

In DMX slang many times the word 'slot' is used as synononym for 'DMXchannel' because during DMX transmission every DMX channel is represented by a specific time slot in the transmission cycle. In this manual, most times "DMX channel" is used.

Parameter: slot number (range 1 to 256) is the number of the DMX channel to be manipulated with subsequent commands

Comment: No action is started immediately. But the SLOT register content will be applied to subsequently given commands.

Example: S123 writes 123 into register SLOT

Transmit buffer manipulation:

V <level>

Write parameter into the transmit buffer of DMX channel = "SLOT".

Parameter: level (range 0 to 255) is the value (lamp intensity, e.g.) which will be transmitted at the DMX channel addressed by SLOT.

Comment: Changes the transmitted DMX packet sequence in accordance with previously entered values in the SLOT and FADETIME register. **It depends on the selected merge method of the addressed DMX channel if this new level gets actually transmitted.**

If FADETIME is equal to zero, the value of the addressed DMX channel is immediately set to <level >

If FADETIME is nonzero, a fade process is started, which begins at the actual value of the adressed DMX channel and finishes, when the value of the addressed DMX slot is equal to <level>.

Example: V34 sets the DMX level to 34 at the DMX channel which is actually addressed by SLOT (i.e. seleceted before with the "S" command). The parameter is interpreted in the active number base .

, (comma) <level>

First this command increases the SLOT register automatically, then it writes the parameter into the transmit buffer for the new DMX channel = 'SLOT'.

Parameter: level (range 0 to 255) is the value or intensity which will be transmitted at the DMX slot addressed by the new, incremented SLOT.

Comment: except the fact that the SLOT register is pre-incremented, the ',' (comma) command does the **same as the V command**.

= <block length>

This command writes the final level of the DMX channel addressed by SLOT into the number of <block length> DMX channels starting from (SLOT+1). Starting from the actual level of each of these channels a new fade to this final level is started. The fade time is given by the actual content of the FADETIME register.

Parameter: <block length> (1 to 256) is the number of DMX channels into which the same level is copied. Independent of the value of <block length> DMX channel no.256 is not exceeded.

# <channel number>

The **parameter** (range 1 to 256) **addresses the DMX channel**, where the same DMX level is set which was entered by any previous command.

If the fade time is nonzero, a fade process is started, which begins at the actual level of the addressed DMX channel and finishes, when the level is equal to the previously entered level.

Example: S1v35 #5 first sets DMX channel no 1 to level 35 and next channel no 5 to level 35, too.

+ (no parameter)

Increase (add 1 to the) level of the DMX channel addressed by SLOT

> **Comment:** The byte cannot be made greater than decimal 255. If it is already equal to 255, the + command is ignored. If a fade process is active at this DMX channel, only the final value is increased.

- (minus, no parameter)

Decrease (subtract 1 from the) level of the DMX channel addressed by SLOT

> **Comment:** The byte cannot be made less than 0. If it is already zero, the - command is ignored. If a fade process is active at this DMX channel, only the final value is decreased.

---

^ <summand>

Add summand to the transmit buffer addressed by SLOT (and start a fade process)

> **Comment:** The final value cannot be made greater than decimal 255. If the addition would make an overflow, the result is fixed to 255.
> The effect is similar to the V command. But instead of an absolute DMX level the sum of (previous entry of VALUE plus <summand>) is restored in the VALUE register and taken as the final level of a new triggered fade proces. Any active fade process of this DMX channel is overwritten with the new final level and the actual fade time and restarted.

_ <subtrahend>

subtract subtrahend from the transmit buffer addressed by SLOT (and start a fade process)

> **Comment:** The final value cannot be made less than 0. If the subtraction would make a borrow, the result is fixed to 0.
> The effect is similar to the V command. But instead of an absolute DMX level the difference of (previous entry of VALUE minus <subtrahend>) is restored in the VALUE register and taken as the final level of a new triggered fade proces. Any active fade process of this DMX channel is overwritten with the new final level and the actual fade time and restarted.

$ (no parameter)

Set number base for input/output of VALUE as **hexadecimal**

> **Comment:** All following parameter values of the commands V, '.' (comma), ^ and _ are interpreted as hexadecimal numbers (0 to FF without leading 0x).
>
> This behavious remains active until the decimal number base is set. Because the number base is stored in preset no. 0, loading of this preset may change the active number base. All messaged DMX level values are coded as hexadecimal numbers with a prefix "$".

& (no parameter)

Set number base for input/output of DMX levels as **decimal**

> **Comment:** All following parameter values of the commands V, '.' (comma), ^ and _ are interpreted as decimal numbers (0 to 255).
>
> This behavious remains active until the hex number base is set. Because the number base is stored in preset no. 0, loading of this preset may change the active number base. All messaged DMX level values are coded as decimal numbers without specifier symbol.

H <hue>

Sets the spectral color (hue) for a group of 3 subsequent DMX channels (RGB lamp)

Comment: The hue may be entered in the range 0 to 255. This will approximately result in following colors. Intermediate hue values will result in intermediate colors:
H0:red, H43:yellow, H85:green, H128:cyan, H170:blue, H213:magenta, H255:red again.
In correspondence with the model of the driven lamp and setting of saturation and brightness the resulting color tone may differ somewhat.

The H command influences the actually addressed DMX channel (actual entry to the SLOT register, for example set with command S) and the two next higher neighbours. It is provided that the RGB setting of the respective lamp is done on these 3 successive DMX channels. All features else of a complex lamp ("fixture") may be used independently.

Every new setting of RGB-hue, color saturation and luminance is applied immediately to the 3 DMX channels addressed by SLOT, furthermore each is stored in a global register (not individuall per DMX channel). During every new setting of hue, saturation and luminance, the stored global values ot the other color components are applied, too.

If set, the fade time gets also also applied in combination with the H command. But the fade transition from the previous color tone to the new one is performed along a straight line through the color space, not along the spectral color circle. So, if is faded between very different colors, disagreable desaturated color tones may appear. To get a perfect color transition, up tp 6 subsequent fade steps between neighboured colors have to be performed.The technical handling can be simplified by use of the chaser.

W <saturation>

Sets the color saturation for a group of 3 subsequent DMX channels (RGB lamp).

Comment: The parameter of <saturation> may take values between 0 and 255. The maximum value 255 sets a pure spectral color, at lower parameter values other color components are partially added which results in a pastel light. When the saturation is set to 0, independently of the hue setting a white or grey light is composed.

B <brightness>

Sets the resulting brightness for a group of 3 subsequent DMX channels (RGB lamp).

Comment: the <brightness> parameter may take values between 0 and 255. The value 255 sets maximum light intensity, the value 0 switches the light intensity off. Fading down is performed linear, without taking the gamma characteristics of the driven lamp into account. Specially when high performance LEDs are driven most times very strong changes of light intensity are observed at low brightness. So in this range small parameter steps may result heavy changes of the RGB composition.

T <seconds.tenths>

Enter parameter into FADETIME. No action is started directly.

Parameter: FADETIME is always entered in 1/10seconds raster. Maximum fadetime is 319 tenths of a second (=31.9s). Higher input will be limited to this value

Example: T134 sets FADETIME to 13.4 seconds

X (no parameter)

All fade processes are stopped immediately and all DMX channels are freezed on their present levels

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Poll the transmit buffer:

R <number of bytes>

Poll <number of bytes> of the DMX transmit buffer starting from the DMX level = SLOT and send them via MIDI OUT.

Parameter: number of polled bytes (1 to max. 128)

Syntax of the resulting state message:

s <1st channel no.> v [$]DMX level [**,**[$]DMX level] <CR >

M <percent>

Enter parameter for the masterfader. All DMX levels are modulated immediately

Parameter: The masterfader is always entered in decimal percentage scale (without postponed % sign and independent of the number base for DMX levels).
Default =100, maximum = 200, minimum = 0.

Comment: The masterfader works like a digital signal processor when the **transmit buffer is written into the DMX transmitter hardware**. It is useful for global adjustment of lighting scenes. **It does not change or influence any internal data of the DMX device.**

The **actually transmitted level of every DMX channel** is the transmit buffer value multiplied by the masterfader factor, i.e. up to 200%. Due to internal fast integer arithmetics, the transmitted level may be slightly lower than exactly calculated (intermediate fractionals lost). Changes of the parameter are applied immediately, not influenced by FADETIME. The masterfader parameter is not stored in presets.

G <chaser start>

Enter start scene (preset no.) of the chaser cycle

Accepted start values: 0 to 89. Default at power on:50. If the chaser would access a preset beyond 89, the sequence continues with loading preset no. 0 etc..

A <cycle length>

Set the length of the chaser cycle (n=2 to 127) **and start the chaser**

<cycle length> = 0 switches the chaser OFF

The chaser works as follows: a sequence of presets (=lighting scenes) is loaded in a cyclic manner to DMX channels 1 to 128.

DMX channels 129 to 256 are not modified by the chaser and may be used for chaser indepent steady lighting.

Before the chaser can be started, the **step duration** (command P) as well as the **start scene** (command G) has to be adjusted. **Start at scene 50 and step duration 20 is loaded by default. The actual settings of the fade time and master fader are applied by the chaser.**

Example: if the chaser cycle is set to 4 and the the chaser start is set to 64, then presets no. 64,65,66,67 are loaded partially, then preset no. 64 again and so on

---

P <chaser step duration>

Set duration of chaser step in 1/10 s units (step duration = 0 to 25.5 seconds)

Comment: Default at power on: 20 (= 2 seconds). After the duration of a chaser step is over, the chaser automatically loads the next preset in the cycl. After <cycle length> presets were loaded in sequence, the procedure is repeated form <chaser start> .
Step duration 0 only virtually stops the chaser. It can be forwarded by one step with command "N".

N (no parameter)

Forward the chaser immediately (asynchronously) by one step

D (no parameter)

Set output of all DMX channels immediately to 0 (Panic function). Must be entered twice.

Q (no parameter)

Returns actual settings of all registers of the DMX channel addressed by SLOT. The response is sent as readable ASCII text

Example of a typical message: CH=1 Fin=80 TX=27 R=13 G=0 B=0 MF=50% CS=50/0/20 T=3.2

Comment about example: at the channel addressed by CH= SLOT: Fin sends the final DMX level when fade is finished, TX reports the present level of the DMX transmit buffer, R shows the actually transmitted level, modified by the Master Fader, G and B show the levels of the next 2 subsequent DMX channels (i.e. RGB show the output of a RGB fixture with DMX start address= SLOT). MF reflects the acual setting of the masterfader. To explain possible differences you are referred to the description of commands H,W,L,+,-,^,_,T,M, (,). CS describes the actual setting of the chaser in the order: start scene, cycle length, step duration. T reports the fade time.

~ <preset#>

save current content of the transmit buffer preset (=lighting scene) number <preset#>.

Parameter: preset # (range 0 to 89)

Comment: The parameter value of FADETIME and the number base is exclusively stored in preset no. 0. Because this preset is automatically loaded when the device is powered on, this way a "soft start" may be configured. With all presets else only the actual lighting scene of the transmit buffer is saved, so these may be reloaded universally without change of system parameters.

@ <preset#>

Recalls and activates preset (= lighting scene) number <preset#>

Parameter: preset# (range 0 to 89)

Comment: After switching power on or after a reset automatically preset no. 0 is loaded. When the fade time is set different from 0, the actual lighting scene is faded over into the loading one with this time constant. **Exception:** when preset no. 0 is loaded (switching the device on, for example), the permanently stored value of the fade time and the number base are updated.

Lighting scenes no.84 to 89 are preprogrammed by firmware for test of chaser and fade. May be overweritten by user. The original scenes can only be recovered then by reprogramming the processor.

| (no parameter)

"clear all memory": all buffers and modes of operation are reset to default

<u>This command has to be entered twice to protect the ligting scene against lapse of command entry</u>

Comment: this is a kind of warm start, not a reset!

All DMX levels of the transmit buffer are reset to "0".
Number base = "decimal", Masterfader = 100%, Fade time = 0.0.
The chaser is switched OFF and parameters are reset to their default values
Presets are not deleted or changed otherwise.

C <MIDI channel>

Parameter: MIDI channel 1-16 (internally in status bytes transformed to 0-15)

Parameter must be entered twice. This MIDI channel is stored in flash, but active immediately when changed to MIDI mode of operation. New RevNum. 1.13.

? (no parameter)

A text message is returned with: Rev.Num, VID/PID, MIDI channel (actual and new entered)

Operation with MiniDMX protocol

The MiniDMX protocol is formally implemented as ASCII command 'Z' here.

The practical reason is that each MiniDMX data packet starts with the character hex5A='Z'. This way, **no switch or other configuration is necessary to start or terminate operation of the MiniDMX protocol.**Upon receipt of this command code, the microcontroller jumps into an endless loop: receives MiniDmx data, transfers and transmits them to DMX out, waits for the next 'Z', receives, transmits etc.

If no MiniDMX compatible data byte is received within max. 100 milliseconds, processing of this data packet is cancelled, the firmware jumps back to the main ASCII command interpreter and waits for the next 'Z'.

Once active in MiniDMX mode, this mode is locked for about 1/2 sec as safety against faulty ASCII commands released by incomplete packets. After this timeout, MiniDMX terminates, the complete ASCII command is active again. This way, the 'Z' command and MiniDMX constitutes a distinct mode of operation, though it is embedded in the ASCII protocol.

When MiniDMX data packets are received, each active fade process is terminated immediately, the chaser is stopped. Because MiniDMX permanently transmits all DMX channels, these effects don’t make sense and are not supported then.

Unfortunately the original website with MiniDMX specification is not available anymore.

MiniDMX packets for 256 DMX channels (type A1) and for 512 DMX channels (type A2) are accepted, but when A2 packets are received, the data for DMX channels 257 to 512 are discarded.

The MiniDMX protocol is supported by a number PC based DMX software products like preferably 'DMXControl 3'. It is supported by 'Freestyler' too, but the operation is less smooth then. While such a software is active, it occupies the corresponding COM port. Parallel data input by terminal software. is impossible then.

While the MiniDMX mode is active, the **LED is blinking** permanently

If the alternative firmware is installed and the jumper is set (or switch is closed) **exclusively the MiniDMX protocol is active supporting 512 DMX channels**. All MiniDMX features else are the same as described above.
Without jumper the complete ASCII command set and related additional features are available - like smooth fade transitions and user predefined lighting scenes. Only 256 DMX channels are supported due to limited SRAM resources of the microcontroller.

The MIDI command set is not available with the alternative firmware.

MIDI Channel Message protocol of the DMX512 transmitter

By default MIDI channel no. 1 is the base channel for command input. This may be changed at any time by sending a MIDI CONTROL CHANGE message to controller no.124 (hex7C) with controller value equal to the new MIDI base channel (1 to 16 (hex10)) **twice in immediate sequence**: Not to cut the current session, this new channel will become **active not before the next power cycle** or microcontroller reset else. Details see page 14.

Quick start and basic commands:

The most frequently used application is **lighting control with NOTE ON messages from a sequencer**.

To address any of the DMX channels 1 to 127, control data have to be sent on the selected MIDI base channel. How to access DMX channels 128 to 256 see below.

The 1st data byte of the MIDI command defines the DMX channel to be addressed.
The 2nd data byte of the command describes the DMX level (light intensity) to be set.
the 2nd MIDI data byte is multiplied by 2 inside the USB/DMX Interface.
As an exception, 2nd MIDI data byte 127(0x7F) sets DMX level to max. value 255

Or described in the opposite way of thinking: **to set a certain DMX level (0 to 255) with a simple MIDI command, HALF OF the intended DMX level has to be entered in the 2nd MIDI data byte.**

Example: To set DMX channel no. 35 to level 200 send NOTE ON, note 35, velocity 100.

To write data into DMX channels 128 to 256 with Note On commands, the MIDI commands are sent on the **next higher MIDI channel** as described in the table:

coded MIDI channel	**1st data byte**	**sets SLOT address to-**	**calculation of 1st data byte**
as selectred base channel	1 to 127	1 to 127	= DMX channel
as base channel + 1	0 to 127	128 to 255	= DMX channel minus 128
as base channel	**0 special case !**	**256**	**= 0**

This means: on a sequencer program you have to **reserve a block of 2 MIDI channels** for full control of the USB / DMX Interface and the corresponding edit tracks have to be initialized. **Attention:** data which are meant for other MIDI equipment which works on these channels may be misinterpreted.

All supported MIDI message types else (Control Change, Program Change, Pitch Wheel Change) eclusively use the preset MIDI channel.

With these MIDI messages, somewhat **more complex commands are implemented, which allow to adjust any DMX channel 1 to 256 with full 8 bit accuracy**. See description of the appropriate CONTROL CHANGE and PITCH WHEEL CHANGE commands below.

The response of the USB/DMX Interface to NOTE ON messages with **velocity=0** or to any **NOTE OFF** messages is prevented with PROGRAM CHANGE command 121. This way you can "play in" DMX level timing for a sequencer or similar with NOTE ON on a keyboard without care about note ends. In this case, velocity=1 sets DMX level = 0.

Survey of all MIDI Channel Commands (MIDI Implementation Chart)

Abbreviations:
DB means "data byte", DB1 means "1st data byte" (note value, controller number), DB2 means "2nd data byte" (velocity, controller value)

When using PROGRAM CHANGE commands you should take into account, that most MIDI devices and software send the data byte value "0" when "program no.1" is selected! **In the table "DB" denotes the physically transferred data byte.**

MIDI message and coded MIDI channel	**special data values**	**function /effect**	**p.**
NOTE OFF	see detailled description	DMX level --> 0. May be blocked with PROGRAM CHANGE 121	14
NOTE ON MIDI channel = base channel.+ next channel	**DB1** = DMX channel **DB2** = DMX level ./. 2	set DMX channel and level (only 1 MIDI message / 7bit resolution) **DMX level = DB2 * 2.** DB2=127-->DMX level 255	14
CONTROL CHANGE MIDI channel = base ch.	**DB1**= 1 **DB2**= tenth sec.0-127	set fade time 0 to 12.7 seconds fade time = DB2 ./.10	17
!	**DB1**= 2 **DB2**= seconds 0-32	set fade time in whole seconds. DB2 = seconds (0 to 31,9 seconds)	17
	DB1 = 7 **DB2 =** masterfader %	set masterfader in the range 0 – 127 %	17
	DB1 = 8 **DB2 =** masterfader-100	set masterfader in the range 100-200 %	17
	DB1 = 16 (hex 10) **DB2 =** step in 1/10 sec	set step duration of the chaser. 0 = chaser OFF. Controlled by an internal timer.	17
	DB1 = 18 (hex 12) **DB2 =** count of scenes per cycle	set cycle length of the chaser and start it: display any preset (scene) 'step duration' long, then next preset is loaded. Repeat cycle after 'count' steps	17 /18
	DB1 = 19 (hex 13) **DB2 =** start preset	set start scene (preset no.) 0-89 of the chaser cycle. See detailled description	18
	DB1 = 37 (hex 25) **DB2 =** 0 to127	poll (entry of DB2) levels of DMX OUT starting from DMX channel=SLOT (DB2=0: poll 128 channels) Response is a SysEx message like ASCCI Cmd 'R'	18
	DB1 = 40 (hex 28)	fill a block of DB2 DMX channels starting from ch. SLOT+1 with the final level of DMX ch. "SLOT"	16
	DB1 = 64 (hex 40) **DB2** = 0 to 127	set hue (color tone) of an RGB lamp (3 consecutive DMX channels) see detailled description !	16
	DB1 = 65 (hex 41) **DB2** = 0 to 127	set color saturation of an RGB lamp i.e.add grey- or white component (3 consecutive DMX channels)	16
	DB1 = 66 (hex42) **DB2** = 0 to 127	set brightness/luminance of an RGB lamp (3 consecutive DMX channels) see detailled description !	16
	DB1= 80 – 81 (hex 50 – 51)	address DMX channel(SLOT) using only one single MIDI channel. For loading data see "pitch change"	14
C	**DB1** = 84 (hex 54)	set DMX level (@SLOT) to **DB2** *2 adjust DMX level with 8 bit resolution to **even** value	15
	DB1 = 85 (hex 55)	set DMX level (@SLOT)to **DB2** *2 **+ 1** adjust DMX level with 8 bit resolution to **odd** value	15
	DB1 = 86 (hex 56)	First **increase DMX channel** (SLOT reg.) there set DMX level (@SLOT)to **DB2** *2**.** adjust DMX level with 8 bit resolution to **even** value	15
	DB1 = 87 (hex 57)	First **increase DMX channel** (SLOT reg.) there set DMX level (@SLOT)to **DB2** *2 **+ 1** adjust DMX level with 8 bit resolution to **odd** value	15

MIDI message and coded MIDI channel	**special data values**	**function /effect**	**p.**
CONTROL CHANGE MIDI channel = base ch.	**DB1** = 96 (hex 60) **DB2 =** preset no.	load preset no. 0 – 89. The fade time is exclusively loaded with preset no. 0	19
	DB1 = 112 (hex 70) **DB2 =** preset no.	save preset no. 0 - 89. The fade time is exclusively saved with preset no. 0	18
	DB1 = 119 (hex 77)	**DB2** has the same meaning as the data byte of the corresponding PROGRAM CHANGE command.	
PROGRAM CHANGE	DB = 1	Stop all fade processes, freeze at momentary level	15
MIDI channel = base ch.	DB = 8	decrease DMX level (minus 1) at channel "SLOT"	15
	DB = 9	increase DMX level (plus 1) at channel "SLOT"	15
	DB = 16 (hex 10)	forward chaser immediately by 1 step	18
	DB = 37 (hex25)	poll actual channel configuration Response is a SysEx message like ASCCI Cmd 'Q'	18
	DB = 120 (hex78)	NOTE ON sets the level of a DMX channel Velocity=0 and NOTE OFF are accepted (default)	19
	DB = 121 (hex79)	NOTE ON sets the level of a DMX channel Velocity=0 is ignored	19
	DB = 127 (hex7F)	Clear All Memory	19
PITCH CHANGE MIDI channel = base ch.	**DB1** = less than 64 ? **DB2** = DMX level ./. 2	set DMX level at position SLOT (8bit resolution) **If DB1 >= 64, then DMX level = DB2*2 + 1**	15

Easy setting of DMX channel (="SLOT") and DMX level with a single MIDI message:

NOTE ON or NOTE OFF

The first MIDI data byte (controller number or note value/pitch) **sets the DMX channel.**
The 2nd data byte (note velocity) **describes the light intensity to be set.**

The DMX level is **twice of** the second MIDI databyte.
Exception: velocity=127 (0x7F) sets DMX level to 255=max.
Or vice versa: the **the 2nd MIDI data byte is HALF OF the intended DMX level (0 to 255).**

This simple method works only for DMX channels 1 to 127.
To address DMX slots 128 to 256, the USB / DMX Interface expects control commands on a higher MIDI channel corresponding with following table (only valid for MIDI base channels 1 - 15):

coded MIDI channel	**1st data byte**	**addresses DMX channel-**	**calculation of 1st data byte**
as selected base channel	1 to 127	1 to 127	= DMX channel
as base channel + 1	0 to 127	128 to 255	= DMX channel minus 128
as base channel	**0 special case !**	**256**	**= 0**

Address the active DMX channel (= "SLOT" register) with:

CONTROL CHANGE

This alternative command version is used, **when all MIDI messages shall be sent on the MIDI channel = selected base channel**.

The coarse range is selected by the first data byte, which has to be chosen according to this table:

1st data byte	**addresses DMX chan.= SLOT**	**2nd data byte**	**calculation of 2nd data byte**
80 (hex50)	1 to 127	1 to 127	= DMX channel
81 (hex51)	128 to 255	0 to 127	= DMX channel minus 128
80 (hex50)	**256**	**0 (special case!)**	**= 0**

Comment: This command does not directly trigger any action. But the updated content of the SLOT register will be executed together with subsequent commands. In DMX slang a DMX channel is called a "SLOT" (physically it denotes a time slot in the DMX transmit cycle, therefore this strange name)

Set DMX level with 8 bit resolution at DMX channel = SLOT with:

Method 1:

PITCH WHEEL CHANGE

MIDI channel as selected base channel

1st data byte: if equal or greater than 64, "1" is added to the DMX level
if less than 64 (hex40), nothing is added to the DMX level

2nd data byte: desired DMX level divided by 2
inside the USB / DMX Interface, this data is multiplied by 2 before it is written into the DMX transmit buffer

Comment: This coding scheme looks strange at first glance. But it is compatible with the standard MIDI method to put the 7 "most significant bits" of 14bit data into the second data byte zu. So it can be used together with simple MIDI equipment, which has only 7 bit capability of PITCH WHEEL CHANGE operation.

Method 2:

CONTROL CHANGE

MIDI channel as selected base channel

1st data byte = 84 (hex54) adjusts to an **even** DMX level
2nd data byte: desired DMX level divided by 2
i.e vice versa: DMX level= 2nd data byte * 2

1st data byte = 85 (hex55) adjusts to **next odd** DMX level
2nd data byte: desired DMX level divided by 2
i.e vice versa: DMX level= 2nd data byte * 2 **plus 1**

1st data byte = 86 (hex56) **first increases the addressed DMX channel**
and adjusts this one to an **even** DMX level
2nd data byte: desired DMX level divided by 2
i.e vice versa: DMX level= 2nd data byte * 2

1st data byte = 87 (hex57) **first increases the addressed DMX channel**
and adjusts this one to **next odd** DMX level
2nd data byte: desired DMX level divided by 2
i.e vice versa: DMX level= 2nd data byte * 2 **plus 1**

Simple modifications of the DMX level with:

PROGRAM CHANGE

MIDI channel as selected base channel

data byte = 1 **Stop all fade processes** immediately.
Freeze all DMX levels at their present state.

data byte = 8 decrease (subtract 1 from) the level of DMX channel "SLOT"

data byte = 9 increase (add 1 to) the level of DMX channel "SLOT"

Comment: With these comands the disadvantage of lower accuray of 7 bit MIDI data can be compensated. Furthermore it is useful to perform extremely slow fade transitions. If a fade process is active at the addressed DMX channel, only the final DMX level is decreased or increased

---

Set hue (color tone) of a RGB lamp with :

CONTROL CHANGE

MIDI channel as selected base channel

1st data byte = 64 (hex 40): set hue at the addressed DMX channel + next 2

2nd databyte = hue (color tone) 0 - 127

This will approximately result in following colors. Intermediate hue values will result in intermediate colors:
2nd databyte= 0:red, 22:yellow, 43:green, 64:cyan, 85:blue, 106:magenta, 127:red again.
In correspondence with the model of the driven lamp and setting of saturation and brightness the resulting color tone may differ somewhat.

Comment: The command to controller number 64 influences the actually addressed DMX channel (actual entry to the SLOT register set first by a NOTE ON or CONTROL CHANGE message) and the two next higher DMX channels. It is provided that the RGB setting of the respective lamp is done on these 3 subsequent DMX channels. All features else of a complex lamp ("fixture") may be used independently.

If set, the fade time gets also also applied in combination with these commands. But the fade transition from the previous color tone to the new one is performed along a straight line through the color space, not along the color circle. So, if is faded between very different colors, disagreable intermediate color tones may appear. To get a perfect color transition, up tp 6 subsequent fade steps between neighboured colors have to be performed.The technical handling can be simplified by use of the chaser effect.

Set color saturation of a RGB lamp with :

CONTROL CHANGE

MIDI channel as selected base channel

1st data byte = 65 (hex 41): set saturation at the addressed DMX channel + next 2

2nd databyte = color saturation 0 - 127

Comment: "Saturation" describes the amount of white or grey in a color tone (pastel shade). Saturation=127 gets a pure color, saturation=0 gets white or grey without specific color tone.

Set brightness/luminance of a RGB lamp with :

CONTROL CHANGE

MIDI channel as selected base channel

1st data byte = 66 (hex 42): set luminance at the addressed DMX channel + next 2

2nd databyte = brightness/luminance 0 - 127

Fill block of DMX channels starting from "SLOT+1" with the final level of DMX channel "SLOT" with:

CONTROL CHANGE

MIDI channel as selected base channel

1st data byte = 40 (hex28)

2nd data byte: block length (1 to 127)

Comment: Every DMX channel in the commanded range is faded or switched from its present level to the final state of the DMX channel wich is preselected by the SLOT register. The fade duration is given by the actual setting of the FADETIME register.

Set the Fade Time with:

CONTROL CHANGE

MIDI channel as selected base channel
1st data byte = **1**, then
  2nd data byte = 0 – 127: fade time in 1/10 second units
    (setting range 0 –12.7 seconds).
1st data byte = **2**, then
  2nd data byte = 0 – 32: fade time in **whole seconds**
    if the 2nd data byte >= 32, it is internally limited to 31.9 sec

Comment: The actual value of the fade time is copied into the respective resource when the fade process is started. Immediately after then the fade time can be modified without retroactivity on running fade processes. Any number of fade processes can be active simultaneously.

Set the MASTERFADER with:

CONTROL CHANGE

MIDI channel as selected base channel
1st data byte = 7
  then 2nd data byte = 0-127 (hex 7F) masterfader setting in %
1st data byte = 8
  then 2nd data byte = 0-100 (hex 64) masterfader setting 100-200%
    (internally 100 is added to the data byte)

Comment: The masterfader works like a digital signal processor when the **transmit buffer is written into the DMX transmitter hardware**. It is useful for global adjustment of lighting scenes. **It does not change or influence any internal buffer of the DMX interface.**

Set chaser step duration with :

CONTROL CHANGE

MIDI channel as selected base channel
1st data byte = 16 (hex 10)
2nd data byte = (1 - 127) chaser step duration in 1/10 second units
  or = 0 switches the chaser **OFF**
    by default step duration of 2 seconds is active
    to provide an easy start

Comment: After the duration of any chaser step is over, the chaser automatically loads the next preset in the cycle.
Step duration 0 only virtually stops the chaser. It can be forwarded by one step with PROGRAM CHANGE 16

Set chaser cycle length and start it with :

CONTROL CHANGE

MIDI channel as selected base channel
1st data byte = 18 (hex12)
2nd data byte = 2 - 127 (hex 7F) set chaser cycle length 2-89
  or = 0: switches the chaser **OFF**

Comment: before the chaser can be started, the **step duration** (CONTROL CHANGE, 1st data byte= 16) as well as the **start scene** (CONTROL CHANGE 1st data byte= 19) has to be adjusted – **Details see description of these commands**.
As soon as <cycle length> presets are loaded in sequence, the procedure repeats form <chaser start>**.**
If the chaser would access a preset beyond 89, the sequence continues with loading preset no. 0 etc..

Example: if the chaser cycle is set to 4 and the the chaser start is set to 64, then presets no. 64,65,66,67 are loaded partially, then preset no. 64 again and so on

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Set chaser start preset (lighting scene) with :
CONTROL CHANGE

MIDI channel as selected base channel
1st data byte = 19 (hex13) ,
2nd data byte: = chaser cylcle start preset (0 - 89)

Comment: For an easy start, start at scene 50 and step duration 20 (= 2 seconds) is preset as default. **The chaser loads only the first 128 DMX channels of the preset**. The remaining upper DMX channels can be used for chaser-independent steady light.

Forward chaser immediately (asynchronously) by 1 step with :
PROGRAM CHANGE

MIDI channel as selected base channel
data byte = 16 (hex 10) forward chaser immediately (asynchronously) by 1 step

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Poll DMX transmit buffer at DMX channel ="SLOT" and subsequent ones with :
CONTROL CHANGE

MIDI channel as selected base channel
1st data byte = 37 (hex 25)

2nd data byte = (0 bis 127) count of DMX channels to be polled.
= 0: poll 128 DMX channels

This command is essentially used for tests. For better readability, the response comes as a SysEx message which reports the actual DMX levels in ASCII text format.
The content of the SysEx message is idential with the response to the ASCII command 'R', which has the following syntax:

s <1st channel no.> v [$]DMX level, [$]DMX level, ……, [$]DMX level <CR >

Save, store presets (= lighting scenes) with:
CONTROL CHANGE

MIDI channel as selected base channel
1st data byte = 112 (hex70)
2nd data byte = 0 to 89 (hex5A): preset number to be saved

Comment: Together with preset no.0, the actual fade time, special behaviour of NOTE ON and NOTE OFF messages (see PROGRAM CHANGE 120,121) and the ASCII number base (see ASCII commands) is stored permanently.

Load presets (= lighting scenes) with:
CONTROL CHANGE

MIDI channel as selected base channel

1st data byte = 96 (hex60)

2nd data byte = 0 to 127 (hex7F): preset number to be loaded

Comment: After the USB / DMX Interface is powered on or the jumper setting was changed, generally preset no.0 is loaded. Together with this preset the permanently stored fade time, special behaviour of NOTE ON and NOTE OFF messages (see PROGRAM CHANGE 120,121) and the ASCII number base is updated.

Lighting scenes no.84 to 89 are preprogrammed by firmware for test of chaser and fade. May be overweritten by user. The original scenes can only be recovered then by reprogramming the processor.

Change mode of operation with :
PROGRAM CHANGE

MIDI channel as selected base channel

data byte = 37 (hex 25) ask configuration of DMX channel= "SLOT"

A System Exclusive message will be returned with typically following ASCII content:

<0xF0, 0x7D> CH=1 Fin=80 TX=27 R=13 G=0 B=0 MF=50% CS=50/0/20 T=3.2 <EOX=0xF7>

Comment about example: at the channel addressed by CH= SLOT: Fin sends the final DMX level when fade is finished, TX reports the present level of the DMX transmit buffer, R shows the actually transmitted level, modified by the Master Fader, G and B show the levels of the next 2 subsequent DMX channels (i.e. RGB show the output of a RGB fixture with DMX start address= SLOT). MF reflects the acual setting of the masterfader. To explain possible differences you are referred to the description of commands H,W,L,+,-,^,_,T,M, (,). CS describes the actual setting of the chaser in the order: start scene, cycle length, step duration. T reports the fade time.

data byte = 120 (hex 78**)** **NOTE ON messages set DMX channel and level.**
velocity = 0 is accepted and sets the DMX level to 0 (=default)
Any NOTE OFF message (with arbitrary velocity) sets the DMX level to 0

data byte = 121 (hex 79) **NOTE ON messages set DMX channel and level.**
NOTE ON messages with 2nd data byte (velocity) = 0 are ignored
and all NOTE OFF messages are ignored
but: NOTE ON messages with velocity = 1 set the DMX level to 0.

data byte = 127 (hex 7F) **Panic:** sets all transmitted DMX levels **immediately to 0**
This command has to be entered twice to avoid unwanted effects

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