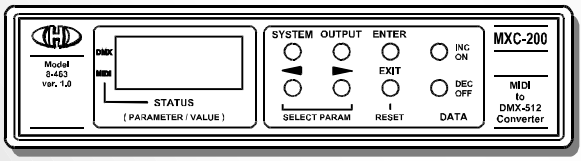
MXC-200

MIDI to DMX-512 Converter

Model 8-463
ver. 1.0



SYSTEM EXCLUSIVE COMMUNICATION

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Manufacturer :

CHD Elektroservis
Nad kundratkou 27, 19000 Praha 9
Czech Republic

info@chd-el.cz
www.chd-el.cz

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1. SYSTEM EXCLUSIVE COMMUNICATION

MXC-200 converter disposes with system of System Exclusive communication which enables to receive and to transmit SysEx Messages for remote setting of all parameters. Also, it is possible to list actual values of parameters. These data can be archived in PC for example.

Special MIDI System Exclusive messages allows to control the device's display – it is possible to show own texts on the device's LCD.

2. SYSEX MESSAGES STRUCTURE

MXC-200 receives / transmits own specific messages with the following structure:

[hex]	[bin]	byte
F0	11110000	Start SysEx
00	00000000	Manufacturer ID (always 3 byte)
20	00100000	
21	00100001	
ii	0iiiiiii	Device ID
16	00010110	Model ID
cc	0ccccccc	Command
aa	0000000a	Address MSB
aa	0aaaaaaa	Address LSB
dd	0ddddddd	Datablock (0 ~ 16 byte in dependence on the SysEx message type)
..	....	
dd	0ddddddd	
xx	0xxxxxxx	Checksum
F7	11110111	End SysEx

2.1. "DEVICE ID" BYTE

The device ID byte identifies the MIDI device exactly. It is equal to a number of an active MIDI channel (00h for channel Nr. 1, 01h for channel Nr. 2 etc. up to 0Fh for channel Nr. 16). The next possible value of the Device ID is 7Fh – universal Device ID always accepted by the converter regardless on active MIDI channel number.

For all other values of the Device ID (from 10h to 7Eh) the message is considered to be invalid and it is ignored by the interface.

2.2. "COMMAND" BYTE

The command "**cc**" specifies the message type i.e. the converter function type (see chapter 3).

2.3. "ADDRESS" BYTES

The two-byte address "**aa aa**" (MSB and LSB) specifies the memory area or selects the system function accordingly to a type of the SysEx Msg (see below).

2.4. "DATA" BYTE(S)

The block of databytes "**dd…dd**" contains the values of a parameters or a functions defined by the SysEx Msg type. The number of bytes in the datablock "**dd…dd**" is a different accordingly to a type of the SysEx message. It can consists from 0 to 16 databytes.

2.5. "CHECKSUM" BYTE

The checksum byte "**xx**" confirms the validity of System Exclusive message. It must be calculated as 7-bit complement of the sum of bytes from 'Model ID' to 'Data' (by other words, seven-bit sum of bytes from the "Model ID" to "Checksum" must be equal to zero). If the checksum byte is invalid, the whole message is invalid too and it is ignored by the interface.

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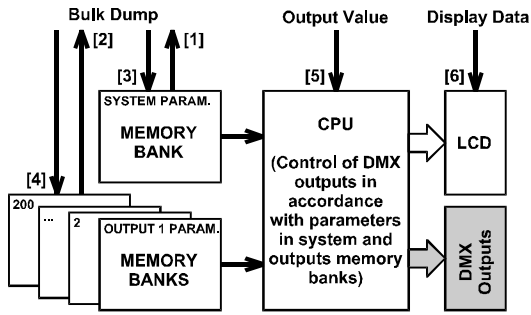
3. COMMAND TYPES OVERVIEW

Pic. 1 – Principle of SysEx communication



The "**cc**" command defines the converter activity after the whole message is received. The valid values of "**cc**" are:

"**cc**"=10h - **Bulk Dump Data Request** – request for a content of an user memory bank in the internal interface's memory ([3] and [4] on pic. 1).

"**cc**"=20h - **Bulk Dump Data Save / Load** – response to the "Bulk Dump Data Request" or the change of content of an user memory bank in the internal interface's memory ([1] and [2] on pic. 1).

"**cc**"=30h - **Change Output Value** – sets value of an output ([5] on pic. 1).

"**cc**"=40h - **Display Data** – shows user data on device's display ([6] on pic. 1).

"**cc**"=50h - **Service** – launches the testing functions for the interface's hardware checking.

3.1. "BULK DUMP DATA REQUEST" COMMAND

The "Bulk Dump Data Request" command ("**cc**" is 10h) launches the listing of the data from an output or from system memory banks in user memory.

The address "**aa aa**" defines requested memory bank for data transfer. Valid range is from 00h 00h to 01h 48h (i.e. 0 to 200). For all other addresses, the message is invalid and it is ignored.

This type of SysEx message doesn't use the data bytes.

Immediately after the "Bulk Dump Data Request" message reception, the device sends the "Bulk Dump Data Save / Load" message (see below) as a reply. All parameters data of requested memory bank are included in that message.

3.1.1. "BULK DUMP DATA REQUEST" FOR SYSTEM MEMORY BANK

If the address "**aa aa**" is 01h 48h, the message is request for the content of the system memory bank.

Form of the message:

[hex]	[bin]	Byte	Value range
F0	11110000	Start SysEx	
00	00000000	Manufacturer ID (3 byte)	
20	00100000		
21	00100001		
ii	0iiiiiii	Device ID	0 ~ 15 / 127
16	00010110	Model ID	
10	00010000	Command (Data Request)	
01	00000001	Address MSB	200
48	01001000	Address LSB	
xx	0xxxxxxx	Checksum	
F7	11110111	End SysEx	

3.1.2. "BULK DUMP DATA REQUEST" FOR OUTPUT MEMORY BANK

If the address "**aa aa**" is from 00h 00h to 01h 47h, the message is request for the content of an output memory bank. The address corresponds to the number from 1 to 200 of requested output.

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Form of the message:

[hex]	[bin]	Byte	Value range
F0	11110000	Start SysEx	
00	00000000	Manufacturer ID (3 byte)	
20	00100000		
21	00100001		
ii	0iiiiiii	Device ID	0 ~ 15 / 127
16	00010110	Model ID	
10	00010000	Command (Data Request)	
aa	0000000a	Address MSB	0 ~ 199
aa	0aaaaaaa	Address LSB	
xx	0xxxxxxx	Checksum	
F7	11110111	End SysEx	

3.2. "BULK DUMP DATA SAVE / LOAD" COMMAND

The "Bulk Dump Data Save / Load" command ("**cc**" is 20h) changes the content of a memory bank in the device's memory. This SysEx Msg message is also sent from the MXC-200 as reply to the "Bulk Dump Data Request" message (see above).

The address "**aa aa**" defines requested memory bank for data transfer. Valid range is from 00h 00h to 01h 48h (i.e. 0 to 200). For all other addresses, the message is invalid and it is ignored.

The datablock "**dd ... dd**" always contains 14 or 5 bytes for the system or output memory bank.

3.2.1. "BULK DUMP DATA SAVE / LOAD" FOR SYSTEM MEMORY BANK

If the address "**aa aa**" is 01h 48h, the message includes the content of the system memory bank.

Form of the message:

[hex]	[bin]	Byte	Value range
F0	11110000	Start SysEx	
00	00000000	Manufacturer ID (3 byte)	
20	00100000		
21	00100001		
ii	0iiiiiii	Device ID	0 ~ 15 / 127
16	00010110	Model ID	
20	00100000	Command (Data Save / Load)	
01	00000001	Address MSB	200
48	01001000	Address LSB	
d1	0000000d	DMX Channels Used MSB parameter	24 ~ 200 *)
d2	0ddddddd	DMX Channels Used LSB parameter	
d3	000000dd	DMX Channels Shift MSB parameter	1 ~ 489 *)
d4	0ddddddd	DMX Channels Shift LSB parameter	
d5	0000dddd	MIDI Channel parameter	0 ~15
d6	000000dd	MIDI Mode parameter	0 : Note / 1 : Note+After / 2 : CC / 3 : NRPN
d7	0000000d	MIDI Shift MSB parameter	0 ~176 *)
d8	0ddddddd	MIDI Shift LSB parameter	
d9	0ddddddd	MIDI Master CC Nr. parameter	0 ~127
d10	0ddddddd	MIDI Blackout CC Nr. parameter	0 ~127
d11	0000rbma	bit parameters: a – Autoreset	0 : Off / 1 : On
		m – Master CC Enabled	0 : Disabled / 1 : Enabled
		b – Blackout CC Enabled	0 : Disabled / 1 : Enabled
		r – RAC CC Enabled	0 : Disabled / 1 : Enabled
d12	00dddddd	LCD Contrast parameter	0 ~32
xx	0xxxxxxx	Checksum	
F7	11110111	End SysEx	

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Note *): Valid range of value of these parameters depends on setting of another system parameters. If entered value is out of possible range, the device corrects it to acceptable range automatically.

3.2.2. "BULK DUMP DATA SAVE / LOAD" FOR OUTPUT MEMORY BANK

If the address "**aa aa**" is from 00h 00h to 01h 47h, the content of an output memory bank is included in the message. The address corresponds to the number from 1 to 200 of requested output.

Form of the message:

[hex]	[bin]	Byte	Value range
F0	11110000	Start SysEx	
00	00000000	Manufacturer ID (3 byte)	
20	00100000		
21	00100001		
ii	0iiiiiii	Device ID	0 ~ 15 / 127
16	00010110	Model ID	
20	00100000	Command (Data Save / Load)	
aa	0000000a	Address MSB	0 ~ 199
aa	0aaaaaaa	Address LSB	
d1	0000000d	Default Value MSB parameter	0 ~ 255
d2	0ddddddd	Default Value LSB parameter	
d3	0mbccccc	bit parameters: c – Curve	0 : Lin 1 : Off/On 2 ~ 7 : Log1 ~ Log6 8 ~ 13 : Exp1 ~ Exp6 14 ~ 19 : "Z"1 ~ "Z"6 20 ~ 25 : "S"1 ~ "S"6
		b – Accept Blackout	0 : Off / 1 : On
		m – Accept Master	0 : Off / 1 : On
d4	0ddddddd	Preheat parameter	0 ~127
d5	0ddddddd	Limit parameter	0 ~ 127 : 127 ~ 255
xx	0xxxxxxx	Checksum	
F7	11110111	End SysEx	

3.3. "OUTPUT VALUE SETTING" COMMAND

The "Output Value Setting" command ("**cc**" is 30h) sets the value of an output of the device.

The address "**aa aa**" defines type of the command (see below). Valid range is from 00h 00h to 01h 48h (i.e. 0 to 200). For all other addresses, the message is invalid and it is ignored. For all other addresses, the message is invalid and it is ignored.

The datablock "**dd ... dd**" contains none or two bytes in dependence on the command type.

3.3.1. "OUTPUT VALUE SETTING" – SET ONE OUTPUT VALUE

If the address "**aa aa**" is from 00h 00h to 01h 47h (i.e. 0 to 199), the message is command for value of one output setting. The address corresponds to the number from 1 to 200 of requested output.

The datablock "**dd ... dd**" always contains 2 bytes (MSB and LSB) whose define the output value in range 0 to 255.

Form of the message:

[hex]	[bin]	Byte	Value range
F0	11110000	Start SysEx	
00	00000000	Manufacturer ID (3 byte)	
20	00100000		
21	00100001		
ii	0iiiiiii	Device ID	0 ~ 15 / 127

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16	00010110	Model ID	
30	00110000	Command (Output Value Setting)	
aa	0000000a	Address MSB	0 ~ 199
aa	0aaaaaaa	Address LSB	
d1	0000000d	Output Value MSB	0 ~ 255
d2	0ddddddd	Output Value LSB	
xx	0xxxxxxx	Checksum	
F7	11110111	End SysEx	

3.3.2. "OUTPUT VALUE SETTING" – SET DEFAULT VALUES

If the address "**aa aa**" is 01h 48h (i.e. 200), the message is command for setting of all outputs to their default values. The message is convenient to use as security command for return of all DMX devices to their original status.

This type of SysEx message doesn't use the data bytes.

Form of the message:

[hex]	[bin]	Byte	Value range
F0	11110000	Start SysEx	
00	00000000	Manufacturer ID (3 byte)	
20	00100000		
21	00100001		
ii	0iiiiiii	Device ID	0 ~ 15 / 127
16	00010110	Model ID	
30	00110000	Command (Output Value Setting)	
01	00000001	Address MSB	200
48	01001000	Address LSB	
xx	0xxxxxxx	Checksum	
F7	11110111	End SysEx	

3.4. "DISPLAY DATA" COMMAND

The "Display Data" command ("**cc**" = 40h) allows to change actual content of device's display – the user can write any own text. Any ASCII characters can be shown on the display.

The address "**aa aa**" defines type of the command (see below). Valid range is from 00h 00h to 00h 02h (i.e. 0 to 2). For all other addresses, the message is invalid and it is ignored.

The datablock "**dd ... dd**" contains none or 16 bytes in dependence on the command type.

Attention! It is possible to write a data to display only if the device operates in normal working mode. "Display Data" command is ignored in all editing modes.

3.4.1. "DISPLAY DATA" – SHOW DATA

If Address "**aa aa**" is 00h 02h (i.e. 2), the message is command for displaying of own data on device's display.

Datablock always contains 16 databytes which specify ASCII characters shown on individual positions of the display. Order is: upper row from the left to the right (8 databytes) and then lower row from the left to the right (8 databytes). Values of all databytes must be in valid range (i.e. 20h to 7Dh - see table 1). Values out of range are automatically corrected to nearest possible values.

Form of the message:

[hex]	[bin]	Byte	Value range
F0	11110000	Start SysEx	
00	00000000	Manufacturer ID (3 byte)	
20	00100000		
21	00100001		

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ii	0iiiiiii	Device ID	0 ~ 15 / 127
16	00010110	Model ID	
40	01000000	Command (Display Data)	
00	00000000	Address MSB	2
02	00000010	Address LSB	
d1	0ddddddd	Data for row 1 / column 1	32 ~ 125
d2	0ddddddd	Data for row 1 / column 2	32 ~ 125
..	....		
d16	0ddddddd	Data for row 2 / column 8	32 ~ 125
xx	0xxxxxxx	Checksum	
F7	11110111	End SysEx	

Table 1 – Valid characters for display (ASCII)

Data	Chr	Data	Chr	Data	Chr	Data	Chr	Data	Chr	Data	Chr	Data	Chr
20h	space	2Eh	.	3Ch	=	4Ah	J	58h	X	66h	f	74h	T
21h	!	2Fh	/	3Dh	<	4Bh	K	59h	Y	67h	g	75h	U
22h	“	30h	0	3Eh	>	4Ch	L	5Ah	Z	68h	h	76h	V
23h	#	31h	1	3Fh	?	4Dh	M	5Bh	[	69h	i	77h	W
24h	$	32h	2	40h	@	4Eh	N	5Ch	\	6Ah	j	78h	X
25h	%	33h	3	41h	A	4Fh	O	5Dh	]	6Bh	k	79h	Y
26h	&	34h	4	42h	B	50h	P	5Eh	^	6Ch	l	7Ah	Z
27h	‘	35h	5	43h	C	51h	Q	5Fh	_	6Dh	m	7Bh	{
28h	(	36h	6	44h	D	52h	R	60h	‘	6Eh	n	7Ch	|
29h	)	37h	7	45h	E	53h	S	61h	a	6Fh	o	7Dh	}
2Ah	*	38h	8	46h	F	54h	T	62h	B	70h	P		
2Bh	+	39h	9	47h	G	55h	U	63h	C	71h	Q		
2Ch	,	3Ah	:	48h	H	56h	V	64h	D	72h	R		
2Dh	-	3Bh	;	49h	I	57h	W	65h	E	73h	S		

3.4.2. "DISPLAY DATA" – CLEAR DATA

If Address "**aa aa**" is 00h 01h (i.e. 1), the message is command for clearing of the display – spaces will be shown on all positions of the display.

This type of “Display Data” command doesn’t use the data bytes

Form of the message:

[hex]	[bin]	Byte	Value range
F0	11110000	Start SysEx	
00	00000000	Manufacturer ID (3 byte)	
20	00100000		
21	00100001		
ii	0iiiiiii	Device ID	0 ~ 15 / 127
16	00010110	Model ID	
40	01000000	Command (Display Data)	
00	00000000	Address MSB	1
01	00000001	Address LSB	
xx	0xxxxxxx	Checksum	
F7	11110111	End SysEx	

3.4.3. "DISPLAY DATA" – CANCEL

If Address "**aa aa**" is 00h 00h (i.e. 0), the message is command for canceling of displaying of own data on device’s display. After the message is received, own data on display are cleared and the display returns to normal displaying of working status of the device.

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This type of “Display Data” command doesn’t use the data bytes

Form of the message:

[hex]	[bin]	Byte	Value range
F0	11110000	Start SysEx	
00	00000000	Manufacturer ID (3 byte)	
20	00100000		
21	00100001		
ii	0iiiiiii	Device ID	0 ~ 15 / 127
16	00010110	Model ID	
40	01000000	Command (Display Data)	
00	00000000	Address MSB	0
00	00000000	Address LSB	
xx	0xxxxxxx	Checksum	
F7	11110111	End SysEx	

3.5. "SERVICE" COMMAND

The "Service" commands ("**cc**" = 50h) are assigned only for tests and debugging in production and for the service procedures of the converter. They are not expected to be used during regular operation.

4. EXAMPLES OF SYSEX MESSAGE CREATION

Task 1:

Set the system parameters of the device to these values:

DMX Channels Used	200
DMX Channels Shift	1
MIDI Channel	8
MIDI Mode	3
MIDI Shift	0
MIDI Master CC Nr.	119
MIDI Blackout CC Nr.	0
Autoreset	1
Master CC Enabled	1
Blackout CC Enabled	0
RAC CC Enabled	0
LCD Contrast	16

Solution:

- I don’t know what number of the MIDI channel is actually active so the universal Device ID (**7Fh**) will be used.
- The command to be used is the “**Bulk Dump Data Save / Load**“, the command byte will be **20h**.
- Data will be stored to a system memory bank, the address bytes will be **01h 48h**.

Start of SysEx Msg will be then:

Start SysEx : **F0h**
Mfr ID : **00h 20h 21h**
Device ID : **7Fh**
Model ID : **16h**
Command : **20h**
Address : **01h 48h**

- DMX Channels Used, DMX Channels Shift and MIDI Shift numbers must be divided to two bytes:
  200d → 01h 48h
  1d → 00h 01h

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0d → 00h 00h

- RAC CC Enabled, Blackout CC Enabled, Master CC Enabled, and Autoreset bits must be combined to one byte:
  $(2^3$ x 0d) + (2^2 x 0d) + (2^1 x 1d) + (2^0 x 1d) → 00000011b → 03h
- All twelve bytes of the datablock will then be:
  01h 48h 00h 01h 08h 03h 00h 00h 77h 00h 03h 10h
- Now, the checksum must be calculated as 7-bit complement of the sum of bytes from 'Model ID' to 'Data', i.e.:
  00h – (16h+20h+01h+48h+01h+48h+00h+01h+08h+03h+00h+00h+77h+00h+03h+10h) = 22h
- The form of the whole required System Exclusive message is after the checksum and End SysEx byte refilling:
  F0h 00h 20h 21h 7Fh 16h 01h 48h 01h 48h 00h 01h 08h 03h 00h 00h 77h 00h 03h 10h 22h 10h

When the message is received, the values of all system parameters in a system memory bank will be set accordingly to the SysEx message data.

Task 2:

Set the output parameters of output memory bank Nr. 200 to the following values:

Default Value	255
Curve	25
Preheat	64
Limit	192
Accept Blackout	1
Accept Master	0

Solution:

- I don't know what number of the MIDI channel is actually active so the universal Device ID (**7Fh**) will be used.
- The command to be used is the "**Bulk Dump Data Save / Load**", the command byte will be **20h**.
- Data will be stored to output memory bank Nr. 200, the address bytes will be **01h 47h**.

Start of SysEx Msg will be then:

Start SysEx : **F0h**
Mfr ID : **00h 20h 21h**
Device ID : **7Fh**
Model ID : **16h**
Command : **20h**
Address : **01h 47h**

- Default Value must be divided to two bytes:
  255d → 01h 7Fh
- Accept Master, Accept Blackout and Curve bits must be combined to one byte:
  (2^6 x 1d) + (2^5 x 0d) + (2^0 x 25d) → 01011001b → 59h
- Limit must be converted from range 128~255 to 0~127 (i.e. subtract 128):
  192d - 128d = 64d → 40h
- All five bytes of the datablock will then be:
  01h 7Fh 59h 40h 40h
- Now, the checksum must be calculated as 7-bit complement of the sum of bytes from 'Model ID' to 'Data', i.e.:
  00h – (16h + 20h + 01h + 47h + 01h + 7Fh + 59h + 40h + 40h) = 69h
- The form of the whole required System Exclusive message is after the checksum and End SysEx byte refilling:
  F0h 00h 20h 21h 7Fh 16h 20h 01h 47h 01h 7Fh 59h 40h 40h 69h F7h

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When the message is received, the values of all output parameters in output memory bank Nr. 200 will be set accordingly to the SysEx message data.

Task 3:

Show "`Test of display`" text on device's display!

Solution:

- I don't know what number of the MIDI channel is active so the universal Device ID (**7Fh**) will be used.
- The command to be used is the "**Display Data** ", the command byte will be **40h**
- The function is **"Show Data"**, the address byte will be **02h**

Start of SysEx Msg will be then:

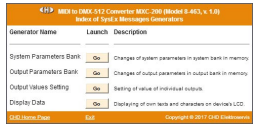
Start SysEx : **F0h**
Mfr ID : **00h 20h 21h**
Device ID : **7Fh**
Model ID : **16h**
Command : **40h**
Address : **00h 02h**

- Databytes for upper row of the display will be:
  54h 65h 73h 74h 20h 6Fh 66h 20h
- Databytes for lower row of the display will be:
  64h 69h 73h 70h 6Ch 61h 79h 20h
- Now, the checksum must be calculated as 7-bit complement of the sum of bytes from 'Model ID' to 'Data', i.e.:
  00h – (16h+40h+00h+02h+54h+65h+73h+74h+20h+6Fh+66h+20h+64h+69h+73h+70h+6Ch+61h +79h+20h) = 5Dh
- The form of the whole required System Exclusive message is after the checksum and End SysEx byte refilling:
  F0h 00h 20h 21h 7Fh 16h 40h 00h 02h 54h 65h 73h 74h 20h 6Fh 66h 20h 64h 69h 73h 70h 6Ch 61h 79h 20h 5Dh F7h

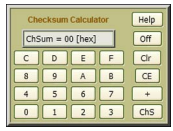
When the message is received in normal working mode of the device, requested text will be shown on the display.

5. SUPPORT SOFTWARE

Special software generators can be used for an easy creation of SysEx messages for control and programming of the device. These generators don't require any knowledge of calculating with hexadecimal numbers so any musician can use them without a problems if some of SysEx message is necessary to be created.



For easy calculation of the checksum byte necessary in all SysEx messages, a special software calculator can be used. It calculates the checksum byte in hexadecimal form directly so no next conversion of numbers is necessary.



Both these software tools are based on Java script so they can be launched under any computer's operation system which includes a web browser. The generator and the calculator are available at the manufacturer web pages.

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