USER MANUAL

for

MRG1 rev. A – MIDI controller

firmware version 4.3

www.midi-hardware.com

Roman Sowa 2008

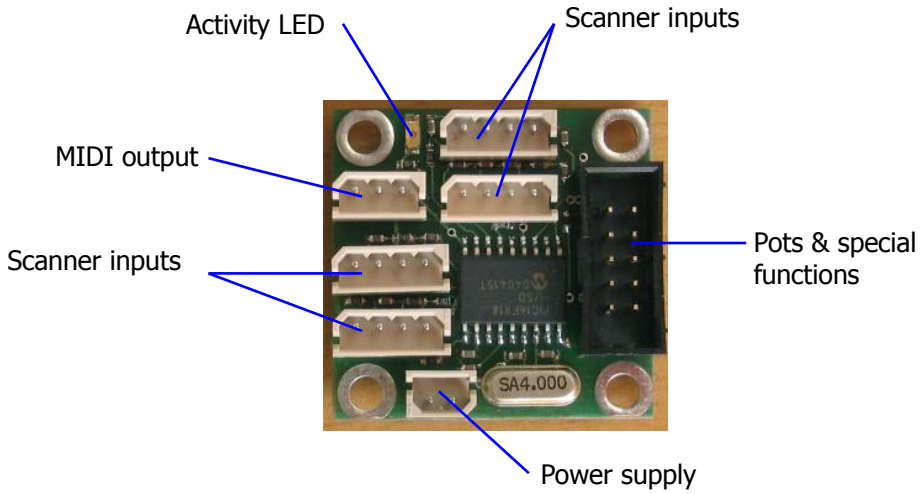
Overview

This little board is the heart of medium to large scale consoles with multiple keyboards and various additional functions. By itself it scans only 8 potentiometers and translates their movement into MIDI. But the main function of this board is to combine external scanners and merge them into single MIDI stream adding many useful features. There are 4 universal scanner inputs on-board. Any of those can take up to 128 keys if keyboard scanner is connected, or up to 32 potentiometers if pot scanner is used. Up to 4 keyboard scanners can work together, but only one input at a time can work with a chain of potentiometer scanners. It is possible to merge keyboard and potentiometer scanners on one input, thus 512 keys and 32 additional pots can be connected.

Features

- 8 on board inputs for potentiometers or switches or CV (control voltage)
- 4 scanner inputs, each for up to 128 contacts in 2 keyboards
- each keyboard can be split in 2 parts in any point
- one of the inputs can be used for potentiometer scanner (up to 32 pots)
- independent transposition for all keyboards/splits
- user defined MIDI channel separately for each keyboard/split and pot
- user defined MIDI event separately for each pot and keyboard split
- available MIDI events: Control Change, Pitch Bend, Channel After Touch, Program Change, notes
- a knob can be assigned as Velocity adjust for all notes, as well as transposer of up to +/-8 semitones, or MIDI channel change for all controls.
- select patch (MIDI Program Change) directly from keyboard.
- store 10 favorite patches and recall them with just 2 keystrokes
- all settings stored in non volatile memory, meaning they remain after disconnecting power
- the board can be used with DC power supply (5V-12V DC, max 10mA) or without any external power supply if connected to PC sound card Game Port by special cable.
- optional auto-power-off feature in battery version – on request

Layout



Power supply

Recommended power supply range is between 5.2 and 12V DC. It is possible to run this board even from as low voltage as 3V battery, but its operation is not guaranteed then. Current consumption is about 3mA with 2 scanners connected, and 5mA with all 4 scanners. So it can be used with single 9v battery (6LF22). This figure doesn't include the load caused by potentiometers if they are used for CCs. If e.g. those are 10k pots, current consumption will rise by 0.5mA per pot. The board comes with wires on special connector for applying power. Make sure you use proper polarity of power supply. **Blue cable to (-) and red to (+)**. Connecting power in reverse will cause permanent damage to the board, and is not covered by guarantee.

Connecting keyboards

Keyboard switches are connected with keyboard scanner, or in another words - expander board. There are several scanners available: for 16, 32, 48, 64, 128 keys, with switches organized in 8x8 matrix and single-rod bus-bar. Type of the scanner needed is determined by keyboard size and the way how switches are organized. Connection between keyboard scanner and MRG1 main board is always the same, regardless of the type of scanner, whether it is 32 or 128 keys, or potentiometers. MIDI settings of those keyboards can be changed by the user after all connections are in place. All available scanners are described at the end of this manual.

8x8 scanner driver can be used if the keyboard has "scanning diode matrix", that's special kind of very simple circuit, made of diodes forming electric XY array of 8 rows and 8 columns. Usually all modern keyboards are equipped with it. In fact it is integral part of the contacts board found beneath the keys. Those kind of keyboards can work directly with MIDI128X scanner. Its advantage is that it can cover 2 such keyboards, and also 8 additional potentiometer inputs. Older keyboards, and especially those used in old analog organs, usually don't have such a thing, so in order to use 8x8 scanner, the DMTX64 board is needed in between the keyboard and MIDI128X. This is actually a diode matrix itself and it can be treated as a split board bridging MIDI128X and individual keys of the keyboard. There is also AMTX64X, which is 8x8 type of scanner with built-in diode matrix. It is single board solution for keyboards which have independent contacts without any circuitry on them.

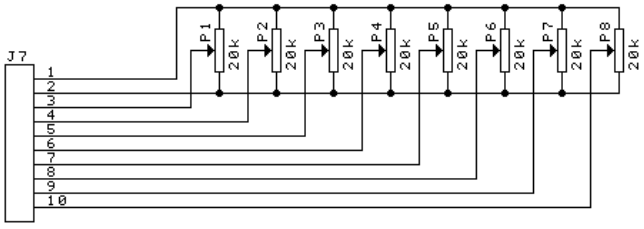
Below is a short table showing which scanner can be used with different keyboards:

Keyboard type	MIDI128X	AMTX64X	BBS64X	MIDI4D
Independent switches, no connection to any circuitry	◇	●	●	◇
Switches organized in 8x8 matrix, with diodes	●	‡	‡	●
Switches organized in 8x8 matrix, no diodes	◇	●	‡	◇
Switches organized in 5x12 and other (Yamaha, Casio)			‡	
One common rail for all switches			●	

● - can be used directly
◇ - with additional DMTX board
‡ - some rewiring of original contacts circuit may be required

Connecting potentiometers

Pot inputs can be used as continuous controllers for things like volume, modulation etc. Usually those inputs would be connected to potentiometers, but it's possible to use them as analog inputs with range of 0..+5V. Applying voltage of 0V causes generation of CC with lowest value, while +5V makes highest possible value of assigned MIDI parameter. There are 8 available inputs, all user configurable in terms of controller type and MIDI channel. Potentiometers are connected to bigger black 10-pin connector (IDC10) at the side of the board. Following is schematic of potentiometers connections.



The pinout description:

1 Vcc, connect to upper terminal of all pots
2 GND, connect to lower terminal of all pots
3-10 CC inputs, connect wiper terminals of CC pots

if you don't use all 8 potentiometers it is recommended to connect unused inputs to VCC (pin 1 of J1). Keeping any, or all inputs open is quite safe, but in some rare cases may result in unwanted MIDI messages. Potentiometers must be linear taper (not audio) in range 10-50k, preferably 20k.

Settings and special functions

All settings are accessible from a keyboard connected to MRG1 with any type of compatible scanner. The last key of each scanner, usually the 64th one, is typically not used to connect to actual key contact. Instead, it's the most important input for feature assignment. There's also another one – the 63th, its function is described later. To make the settings more ergonomic and easier, there's optional numeric keypad available, similar to phone keypad. It is connected the same way as any keyboard scanner, and works like actual keyboard, meaning it is possible to play notes with it. But the advantage of using it lays in „#" key, which is simply the 64th key. And „*" is equivalent of 63th key.

To change any settings, you have to enter new value of given parameter. To do so, use lowest 10 keys of the keyboard as numeric entry. Lowest key is digit „0", while 10th key is digit „9". This looks obvious when using mentioned numeric keypad. As a general rule, any change on a controller requires selecting this controller first before making change. For example, if you want to change MIDI channel of certain potentiometer, move it a bit, and go into MIDI channel settings mode. Or to change the split point – first play any note on the keyboard to be split, and enter split-point change mode.

In this chapter, describing how to set some parameters, whenever „#" sign is mentioned, it means the „#" key on numeric keypad, or 64th contact of any other scanner. Likewise, „*" means „*" key, or 63th contact. Numeric entries are provided with the assumption that numeric keypad is used, but the same can be achieved with lowest 10 keys of any keyboard connected to MRG1. It helps to add a sticker over lowest 10 keys with numbers from 0 to 9 if only musical keyboard is used.

Transposition of keyboards

Transposition of keyboards connected to MRG1 is unlimited, that means any key can generate any MIDI note from range of over 12 octaves. There are two ways of using it. Typical one is by selecting "new middle C" position. First you have to select the keyboard you want to edit by playing any note on it. Enter „**#**" then „**1**" on the keypad. Now, whatever key you press, it will be the new position of the middle C MIDI note afterwards. You can select new position of middle C note anywhere between 3rd and top key of the keyboard. Another option is to use lowest 2 keys of the keyboard, or numbers "**0**" and "**1**" of the keypad. It doesn't matter if keyboard starts with key C or F or whatever, those are always two lowest keys. The 1st one shifts the keyboard one semitone down with each sequence (**#10**), the 2nd shifts the keyboard one semitone up (**#11**). This is useful when you want to shift the keyboard in range not available by the first method, for example very low bass, or high treble.
Both methods require first selecting the keyboard to be changed by playing a note, then entering "# 1" on the keypad, and selecting transposition.

MIDI event assignment for keyboards and analog inputs

MIDI event assigned to given potentiometer or keyboard split can be easily changed. To perform this, turn a bit the knob, or play a key on the split you want to assign, and then select the controller type by entering keys **#** then **2** and then appropriate number from table in Appendix A. You need to enter 2 or 3 digits for each input controller depending on entered number. To assign another one, again you must turn the pot it a bit, or play the key on another split, and then start from "**#2**" sequence followed by event type number.
Possible MIDI event codes are from number 000 to 139. **Standard setting for a keyboard is "# 2 131" - single notes, and for analog input "# 2 007" - Channel Volume**. This is factory default.
Possible settings are:

Control Change

Select the pot (or keyboard) to be edited, enter "**# 2**", and Control Change number in range from "000" till "127". Numbers above 127 are used to generate MIDI events other than *Control Change*, or turn them into other functions, what is described next.

Pitch Bend

Select the pot to be edited, enter "**# 2 128**". The pot will work then as pitch bender. If assigned to a keyboard, each key will set pitch bender in 1/128 steps across the keyboard. Range can be adjusted with transposition settings.

Program Change

Select the pot (or keyboard) to be edited, enter "**# 2 129**". Although this is rather unusual usage, this pot will then generate MIDI Program Change messages with its every move. Program Change can be also generated from the keyboard, by using sequence "**# 4** <number>" – this is described later. If assigned to a keyboard, pressing each key will generate MIDI Program Change message with different patch number. Starting number can be adjusted with transposition setting. This is useful for organ emulators, where bank of Program Change buttons can be used to work as pistons (sets of registers)

Channel After Touch

Select the pot to be edited, enter "**# 2 130**". Turning such pot will cause Channel After Touch messages to be sent out. If assigned to a keyboard, each key will set After Touch in 1/128 steps across the keyboard. Range can be adjusted with transposition settings.

Standard keyboard action – single notes

Whenever MIDI event 131 is assigned to a keyboard, it works as typical MIDI keyboard, playing MIDI notes. It is also possible to generate notes played in glissando, when this event is assigned to a pot. Select the pot to be edited, enter "**# 2 131**". This knob becomes then a note generator resembling quantized Theremin. Move the knob and a series of notes will be played. There's only one note played at a time (with velocity set like described later) and it is released just before new note is about to play. Whole knob slow rotation plays 128 notes from entire MIDI range.

Note on

Select the pot to be edited, enter "**# 2 132**". This mode is somehow similar to Glissando described above, but only "note-on" messages are generated, that means whenever you move this pot, new notes will be played, and they will stay on forever unless proper note-off message will be issued by another means. If assigned to a keyboard, only note-on messages will be sent. It will work like with constantly depressed sustain pedal.

Note off

Select the pot to be edited, enter "**# 2 133**". This is like "note-on" mode described above, but instead it sends out only note-off messages. It can be used to mute part of notes already played, or as some kind of panic button – slow full rotation mutes all notes in assigned channel. If assigned to a keyboard, it will send only note-offs, so it may be used to quiet some notes played earlier.

CC keyboard

This feature has no effect on a pot, i.e. the pot will generate no MIDI event if it has this feature assigned. Select the keyboard to be edited, enter "**# 2 135**". In this mode you can use keyboard as toggle switches selecting min/max values of range of CCs. All keys have increasing MIDI Continuous Controller assigned. Pressed key sends CC with max value (127), while key release generates the same CC but with minimum value (0). CCs are ordered just like there would be MIDI notes, i.e. typically they start from CC#36 at the lowest key, next key is CC#37 etc. Use transposition settings to set different starting CC.

MIDI channel shift for all controls

Select the pot to be edited, enter "**# 2 136**". Turning such pot will change the MIDI channel of all pots and keyboards by one. Turning to the most counterclockwise (minimum) position leaves all controls on the channels as set individually for each control. Turning to the most clockwise position adds „1” to the channel number of each control. If one pot was initially programmed to be on channel 16, activating this function will change it to channel 1. This one is better used when a switch is used instead of a pot. Assigning this to a keyboard is also possible, although its usefulness is doubtful then.

Small Transposer

Select the pot to be edited, enter "**# 2 137**". Turning such pot will shift all notes played on all connected keyboard scanners by number of semitones determined by pot position. In the middle it gives no shift, and full rotation has range from -4 to +4 semitones. It's most useful when pot is replaced by 9-position switch with 8 resistors of equal value connected between switch leads. Assigning this to a keyboard is also possible, but you cannot reach full range of transposition with 5-octave keyboard.

Big Transposer

Select the pot to be edited, enter "**# 2 138**". Turning such pot will shift all notes played on all connected keyboard scanners by number of semitones determined by pot position. In the middle it gives no shift, and full rotation has range from -8 to +8 semitones. Assigning this to a keyboard is also possible, but you cannot reach full range of transposition with 5-octave keyboard.

Velocity

Select the pot to be edited, enter "**# 2 139**". Position of this pot will then determine velocity parameter of all MIDI notes generated by this board, and all connected expanders/scanners. If assigned to a keyboard, each key will set velocity of all notes in 1/128 steps across the keyboard. Range can be adjusted with transposition settings.

MIDI Channel

Channel of each potentiometer and keyboard can be set individually. To change MIDI channel of certain potentiometer select the pot by simply turning it a bit. Then select the MIDI channel with the following sequence: "**# 3** <channel number>". The channel number must be in range 1-16. Channels from 2 to 9 require only 1 key stroke, while 1 needs to be entered as 2 digits – namely "01". Channel 10 and above of course need 2 keystrokes too. Then turn another potentiometer and select its channel the same way. To change MIDI channel of the keyboard, first select it by playing a note, and enter mentioned sequence with channel number.

Program Change

MRG1 allows you to send Program Change MIDI messages, or in another words – change patches. Three ways are available. Two were mentioned in Knob Assignment chapter, where you could program the potentiometer to act like 128-position patch rotary switch, or use keyboard assigned to Program Change to act like array of single touch patch select buttons. To change the patch on selected keyboard directly to specific number, play a note on this keyboard and enter the sequence: "**# 4** <program number>". The Program Change MIDI message is sent directly after last digit of entered patch number. This may happen after 2nd or 3rd digit. You only need to enter 2 digit, when the patch number is in range 13-99. Programs lower than 13 require 3 digits, with 0s in front, for example 012, or 003. Obviously, programs with numbers higher than 99 also need 3 digits. The range of Program Change is from 000 to 127.

Keyboard split

It is possible to split each keyboard into 2 independent parts. The split point can be anywhere on the keyboard, and both parts can work with independently adjusted MIDI channel, type of event and starting note (transposition) or range of other controllers if something else than notes is assigned to a keyboard. Assuming that all 4 inputs of MRG1 are equipped with MIDI128X dual keyboard scanner, it is possible to make a system with 8 individual splits making of 16 independent parts. To set up the split point, you have to select the keyboard to be split by playing a note in it, and then enter sequence „**# 5**" followed by stroke of the key that you want to be the last one of the lower part. Since then lower part remains on the same channel that was used for whole keyboard, while upper part takes settings of upper part, which by default is 8 MIDI channels higher. To change MIDI channel, type of event, transposition, or send a Program Change for split part, follow directions described above, regarding non-split keyboard, but now changes are made to this split part, which was selected by playing a note prior entering the edit mode (pressing „**#**").

Favorite patches

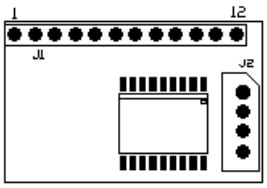
Whenever a program/patch/instrument selected from MRG1 is often used, or interesting, it is worth to memorize for fast recall in the future. There can be 10 such favorite patches, selected for last played keyboard, split, or turned pot by just 2 key strokes. First you play on a keyboard, and to change a patch for this keyboard, simply press „*****" and then a single digit with memorized patch. MRG1 will send the patch number in channel of last played keyboard, or last turned pot. To memorize any patch for recall in this way, you have to first select this patch by one of the 3 ways – either by entering „**# 4** <patch number>", or by turning „Program Change" knob if one is assigned, or by using one of the keys in keyboard assigned to Program Change event. Then simply press „**# 6** <favorite digit>" and it's done. Next time whenever you press „*****" followed by that digit you just programmed, the MIDI Program Change message will be issued, setting the patch that was programmed into that digit.

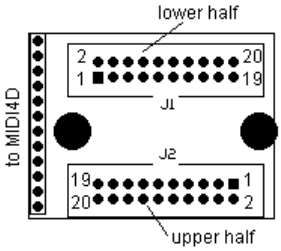
Scanners

MRG1 board by itself scans only 8 potentiometers, but it can be expanded by keyboard and pot scanners. Depending on their sizes, the whole system can cover up to 8 keyboards or 496 keys over single MIDI socket together with 48 potentiometers at the same time. Currently available sizes are: 16, 32, 48, 64 and 128 keys, the last one has the 128 keys split into 2 keyboards.

32-keys scanner - MIDI4D

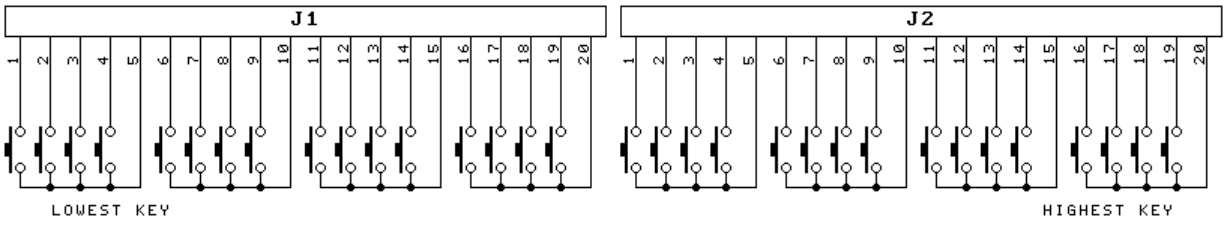
Pedal board controller takes care of 32 keys, usually used as pedals or small keyboard. It's a small board that can be fitted inside pedal board, and it connects to the main board via supplied 4-wire cable. This board can be connected and disconnected anytime during operation.





J1 usually connects to small diode matrix board shown at the right, above

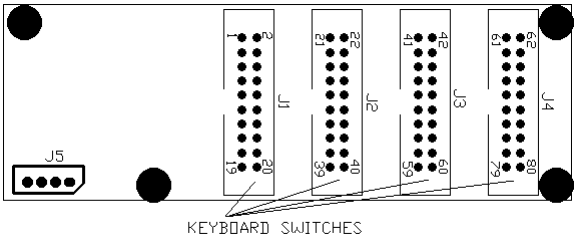
There are 2 20-pin headers, each connects to 16 keys in the way shown in diagram below.
When standard IDC connectors with flat cables are used to connect keyboard switches, the wires are organized in groups of 5: first four wires go to individual keys, while 5th connects common of those 4 switches. This is shown in details here:



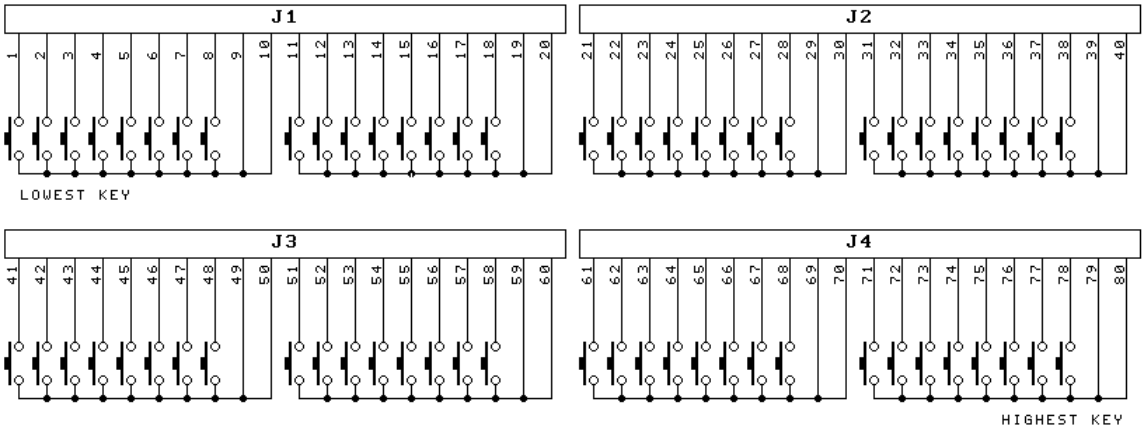
The groups of 4 switches must be separate. In case of keyboard with 1 common bus bar going through entire keyboard, you have to cut the bar every 4th key.
It's best to place the matrix board in the middle of the pedal board. Then one flat cable goes left, the other goes right. The flat cables should be kept as short as possible for reliable performance and interference-free operation.

64-keys scanner - AMTX64X

Bigger scanner has inputs for 64 keys. Its layout is shown below. There are four 20-way connectors, marked as J1-J4, that are used to connect the keys, and one smaller – J5, which via supplied cable connects to MRG1 board.



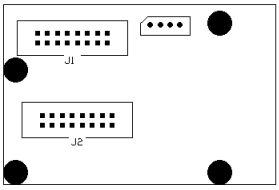
20-pin connectors correspond with individual keys in a manner shown in diagram below. Best is to use 4 IDC connectors and 20-wire flat computer grade cable. Each group of 8 adjacent keys connects with half of such cable. First 8 wires go to the individual keys' contacts, while 9th or 10th, or both are connected to the common poles of those 8 contacts. Then wires 11-18 go to next 8 switches, and 19-20 connect to common of those 8 switches. This is shown in detail in the following schematic:
The groups of 8 switches must be separate. In case of keyboard with 1 common bus bar going through entire keyboard, you have to cut the bar every 8th key.



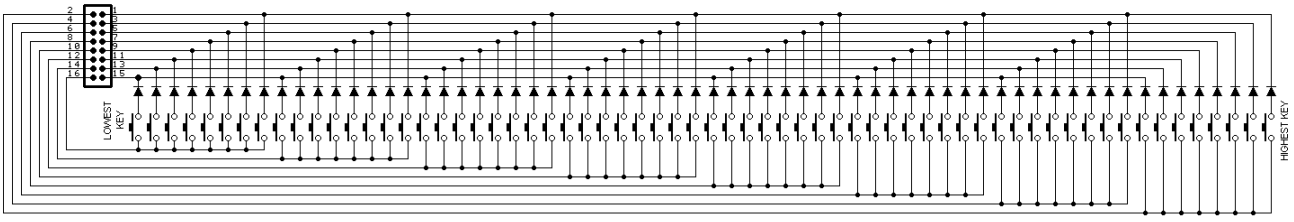
It's best to place the matrix board in the middle of the keyboard. Keep the flat cables going to the switches as short as possible for reliable performance and interference-free operation.

128-keys scanner - MIDI128X

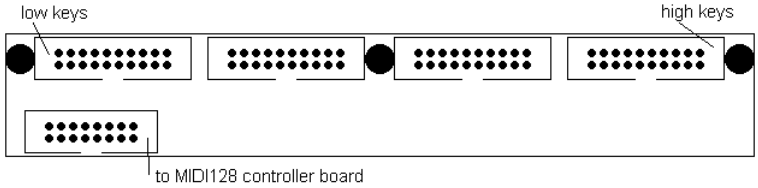
There can be another optional board connected, adding 128 inputs. This can be described as "diode matrix driver" for 2 keyboards. It is useful when you want to connect 2 modern keyboards, that usually have 8x8 diode matrix built in together with switches. The layout is shown below. There are two 16-way connectors, that usually are used to connect diode-matrix keyboards. Smaller connector marked as J5 is used to connect it with main controller board - MRG1.



J2 – connector of 1st group of keys (1 to 64)
J1 – connector of 2nd group of keys (65 to 128)
J3 – connector linking this board with the main board
Each 16-way connector covers one keyboard. The keyboards must have "8x8 scanning diode matrix", that's special kind of very simple circuit, made of diodes forming electric XY matrix. Usually all modern keyboards are equipped with it although sometimes the matrix is organized differently, say 5x12 or 6x11. In fact it is integral part of the contacts board usually found beneath the keys.
Schematic below shows example of diode matrix compatible with MIDI128X board.



Older keyboards, and especially those used in old analog organs, usually don't have such a thing, so in order to use MIDI128X scanner, the DMTX64 board is needed in between. This is actually a diode matrix itself and it can be treated as a split board bridging 16-pin connector of MIDI128X and individual keys of old keyboard.

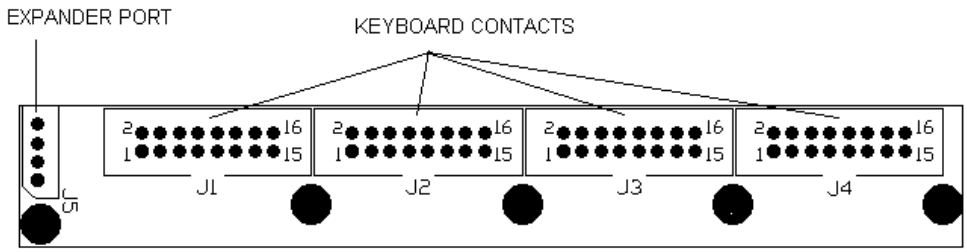


16-pin connector needs to be connected via proper flat cable to J1 or J2 of MIDI128X scanner. With cable included, mating connectors will ensure proper polarity. 20-pin ones go to individual keys exactly like in diagram in AMTX64X section before. Same remarks apply.

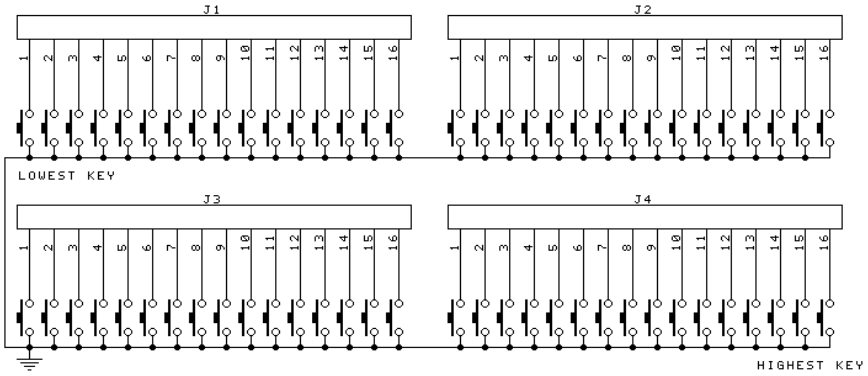
16, 32, 48 or 64 keys scanner - BBS64X

There's another family of keyboard scanners, especially suitable for keyboards with single rod used as common bus for all switches in entire keyboard. This one does not use diode matrix, and can be used with almost any type of switch arrangement, it can also be TTL controlled.
In case of biggest, 64-keys version, keyboard is connected to four 16-pin connectors - J1, J2, J3 and J4 shown below. Each of them covers 16 keys. The key contacts can have one common buss bar (with GND), or it can be driven from logic IC outputs. 0V at an input means "key pressed", +5V at input or left open means "key released". The BBS board can be also ordered with reversed logic, i.e. positive voltage at input means "key pressed", 0V - "key released"

LAYOUT



Keyboard should be connected to four 16-pin headers according to the following diagram. Best is to use 4 IDC connectors and 16-wire flat computer grade cable. Each cable connects to 16 consecutive keys. Connection of all keys to pins in BBS64 in shown in diagram below.



The BBS64X board comes in different variants, or lengths. It can work with either positive or negative keying, which means that key pressed is represented by 0V, or +5V. The board can be shorter, covering 48, 32 or 16 keys. It's then called BBS48X, BBS32X and BBS16X respectively

Appendix A – numbers for assigning MIDI event type to potentiometers. For up to date assignment of CC numbers to controllers go to www.midi.org. Note that features described in *italic* with numbers above 127 don't represent a CC, but other MIDI events or parameters.

digits	Controller name	digits	Controller name
000	Bank Select	73	Sound Controller 4 (Attack Time)
001	Modulation Wheel or Lever	74	Sound Controller 5 (Brightness)
002	Breath Controller	75	Sound Controller 6 (Decay Time)
004	Foot Controller	76	Sound Controller 7 (Vibrato Rate)
005	Portamento Time	77	Sound Controller 8 (Vibrato Depth)
006	Data Entry MSB	78	Sound Controller 9 (Vibrato Delay)
007	Channel Volume	79	Sound Controller 10 (default undefined)
008	Balance	80	General Purpose Controller 5
010	Pan	81	General Purpose Controller 6
011	Expression Controller	82	General Purpose Controller 7
012	Effect Control 1	83	General Purpose Controller 8
013	Effect Control 2	84	Portamento Control
16	General Purpose Controller 1	91	Effects 1 Depth (Reverb Send Level)
17	General Purpose Controller 2	92	Effects 2 Depth
18	General Purpose Controller 3	93	Effects 3 Depth (Chorus Send Level)
19	General Purpose Controller 4	94	Effects 4 Depth
32	LSB for Control 0 (Bank Select)	95	Effects 5 Depth
33	LSB for Control 1 (Modulation Wheel or Lever)	96	Data Increment (Data Entry +1)
34	LSB for Control 2 (Breath Controller)	97	Data Decrement (Data Entry -1)
36	LSB for Control 4 (Foot Controller)	98	Non-Registered Parameter Number (NRPN) - LSB
37	LSB for Control 5 (Portamento Time)	99	Non-Registered Parameter Number (NRPN) - MSB
38	LSB for Control 6 (Data Entry)	100	Registered Parameter Number (RPN) - LSB
39	LSB for Control 7 (Channel Volume)	101	Registered Parameter Number (RPN) - MSB
40	LSB for Control 8 (Balance)	120	[Channel Mode Message] All Sound Off
42	LSB for Control 10 (Pan)	121	[Channel Mode Message] Reset All Controllers
43	LSB for Control 11 (Expression Controller)	122	[Channel Mode Message] Local Control On/Off
44	LSB for Control 12 (Effect control 1)	123	[Channel Mode Message] All Notes Off
45	LSB for Control 13 (Effect control 2)	124	[Channel Mode Message] Omni Mode Off
48	LSB for Control 16 (General Purpose Controller 1)	125	[Channel Mode Message] Omni Mode On
49	LSB for Control 17 (General Purpose Controller 2)	126	[Channel Mode Message] Poly Mode On/Off
50	LSB for Control 18 (General Purpose Controller 3)	127	[Channel Mode Message] Poly Mode On
51	LSB for Control 19 (General Purpose Controller 4)	128	*Pitch Bend*
64	Damper Pedal on/off (Sustain)	129	*Program Change*
65	Portamento On/Off	130	*Channel After Touch*
66	Sostenuto On/Off	131	*Standard keyboard action, glissando for pot*
67	Soft Pedal On/Off	132	*Note-on*
68	Legato Footswitch	133	*Note-off*
69	Hold 2	135	*CC keyboard*
70	Sound Controller 1 (Sound Variation)	136	*MIDI channel change for all*
71	Sound Controller 2 (Timbre/Harmonic Intens.)	137	*Transpose by +/-4*
72	Sound Controller 3 (Release Time)	138	*Transpose by +/-8*
		139	*Velocity of all notes played*