KBD02

Keyboard Interface for Encoders and Switches

Rev 1.0

Contents

1. General

The keyboard interface KBD02 translates switch actions to key presses - a switch which is closed or opened sends a keystroke to the PC, freely selectable from the characters on a standard keyboard, optional with the *Shift*, *Ctrl*, and *Alt* keys combined. The length of the keypress is usually 10 ms, but it is adjustable in a wide range (1 to 250 ms). Also the (minimum) break between successive keystrokes is adjustable in this range (default is 5 ms).

Both, encoders and switches can be connected to the interface. Up to 96 different switching events can be associated with selectable key combinations. With the encoders, these are a sequence of key presses when turning clockwise and a different one when turning counter-clockwise. With the switches, the *ON* and *OFF* events are issued separately. All switching actions are software debounced, that is to say, even inexpensive switches can be used reliably.

It is possible, to connect up to 16 encoders with push-button switch (or separate switch) and/or up to 48 pushbutton or toggle switches. Inputs are gouped into 16 channels with 3 inputs each.

2. Rotary Encoders

Mechanical rotary encoders usually have three terminals, a central (*C*), which cyclically contact the second (*A*) and the third port (*B*) when spinning. Through constructive skillful change of *contact* and *non-contact* the direction of rotation can be found and a separate keystroke for the clockwise and counter-clockwise rotation is issued. Dual encoders with concentric axis‘, logically have three additional connections (*C´*, *A´* und *B´*), which work independent of the first - like two separate encoders. A push button is often installed as well, with two additional connections.

Optical encoders also need a power supply (usually 5 volts) and have commonly 4 connections: *A* and *B* (as with the mechanical counterparts) as well as *+5V* and *GND* (no *C* terminal). The wiring can vary from type to type and must be taken from the respective data sheet.

An encoder input on the KBD02 has four ports, three for *C*, *A* and *B*, plus one for a pushbutton or separate switch (*D*). In the case of a dual encoder a second input for *C´*, *A´* und *B´* must be used.

Each encoder can be virtually doubled in its function, which means that an additional pair of clockwise and counter-clockwise keycodes is available. The switchover then happens by the pushbutton with the appropriate configuration of the KBD02.

If a high-resolution encoder is cranked faster as the keypresses can follow, an overrun feature can be turned on, to continue the still missing key presses even after end of the rotation. This is with short keystrokes (~10ms) hardly noticeable. With longer keystrokes it is recommended, however, to turn the overrun off. Then keystrokes of the given length will be issued only as long as the encoder is moved, regardless how many pulses the shaft encoder has actually made.

3. Switches

Simple switches have two connectors. Depending on the position of the switch they are electrically separated (*OFF*) or shorted (*ON*). Any change from *OFF* to *ON* and from *ON* to *OFF* is associated with a virtual press of a key. Through the appropriate configuration of the interface this can be restricted to the change from OFF to ON only, if, for example, a pushbutton shall only trigger a signal when pushed, but not when it is released.

Change-over switches (toggle switches) are in principle two single switches, which are mechanically coupled, such that one switches *ON* when the other switches *OFF* and vice versa. Since these switches have also two positions, there is effectively no difference to the simple switch.

A switch with center position can be seen as two separate switches. However, they cannot be turned on at the same time, but turned off. The three positions can be allocated to three different keystrokes, if for the respective transition from *ON* to *OFF* the *same* key combination is selected. Otherwise you have two different keystrokes for the center position, depending on which direction the switch is placed in the center position.

Multi-switches, mostly rotary switches, can be used also. However, the special features of the switch matrix is to take into account (see *Technical Appendix*).

4. Switch matrix

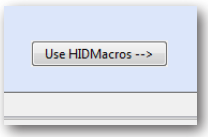
To bring in line the large number of connections with the lower number of microprocessor pins, a switch matrix is used. That is, the switches are arranged at the intersections of a grid formed from 16 rows by 3 columns. This means on the other hand, only those switch terminals are electrically connected together, which are wired to the same row or column line. Therefore it is to make sure that no shorts between individual rows or columns are made in the wiring. Usually, this is not a problem, if every switch and each encoder is connected with the appropriate terminals on the interface. It is a different with multiple switches where mostly a common pole for multiple switch positions is provided. This pole then has to be wired to one of the three column lines and the others to the corresponding row lines (see example in the *Technical Appendix*).

5. HIDMacros

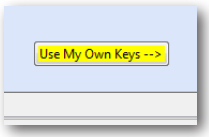
Each of several keyboards connected to a PC is equivalent, that is to say, it makes no difference whether the F6 key is pressed on one keyboard or the other, the effect is the same. This applies to the KBD02 also. Shortcuts already assigned for the default keyboard from a program can be run by the interface as well, however not as an extension to the standard keyboard but in parallel. A second and a third interface makes no difference.

Different with the very good program *HIDMacros* of Petr Medek (www.hidmacros.eu). Here, each of the connected keyboards is independent of all other seen. For example, if the *F6* key on the standard keyboard triggers event ***A***, the *F6* key on the KBD02 may trigger an event ***B*** and on a further interface starts action ***C***, etc.

The KBD02 usually assigns each switch event a key, being modifiable with the *Shift*, *Ctrl*, and *Alt* keys. *HIDMacros,* however, only accepts unmodified keycodes, but at the time of transfer it can be modified with *Shift*, *Ctrl* and *Alt* (or even more complex macros, see there). When using *HIDMacros* the KBD02 can be switched to a simple mode where each switch input maps to a fixed key, without the need for an individual configuration. A possibly already existing configuration is retained and can be re-enabled at any time.



The *HIDMacros* feature is enabled by clicking on the button in the bottom right corner. It turns yellow. To use your own key definitions you click the button again.



AutoHotkey (www.autohotkey.com) is another very useful program to combine keystrokes with a powerful scripting language.

6. *Configuration*

The configuration, so the assignment of a shortcut to a switching event, and the way in which the switches are processed, is stored in the KBD02 and will be preserved even without power supply. A change is done via an easy-to-use program which automatically recognizes all of the connected interface cards. The existing configuration can be read, changed and written back. A configuration can be archived in a file and read back again if necessary. The archive file is in XML-format, and can therefore be read and edited with a simple text editor.

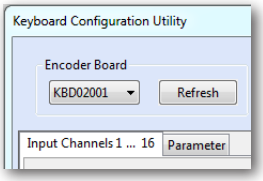
The key mapping for the *HIDMacros* mode is permanently stored in the KBD02 and can not be altered.

7. *Configuration Program*

The *Keyboard Configuration Utility* program displays the current configuration of each of the KBD02 connected to the USB. Changes can be made easily here and the results are stored back into the device. Each configuration can be also saved as an XML-file on disk and read back from there.

After starting the program it searches for all interface cards connected and lists them. The configuration of the last found will be read and displayed in the program window.

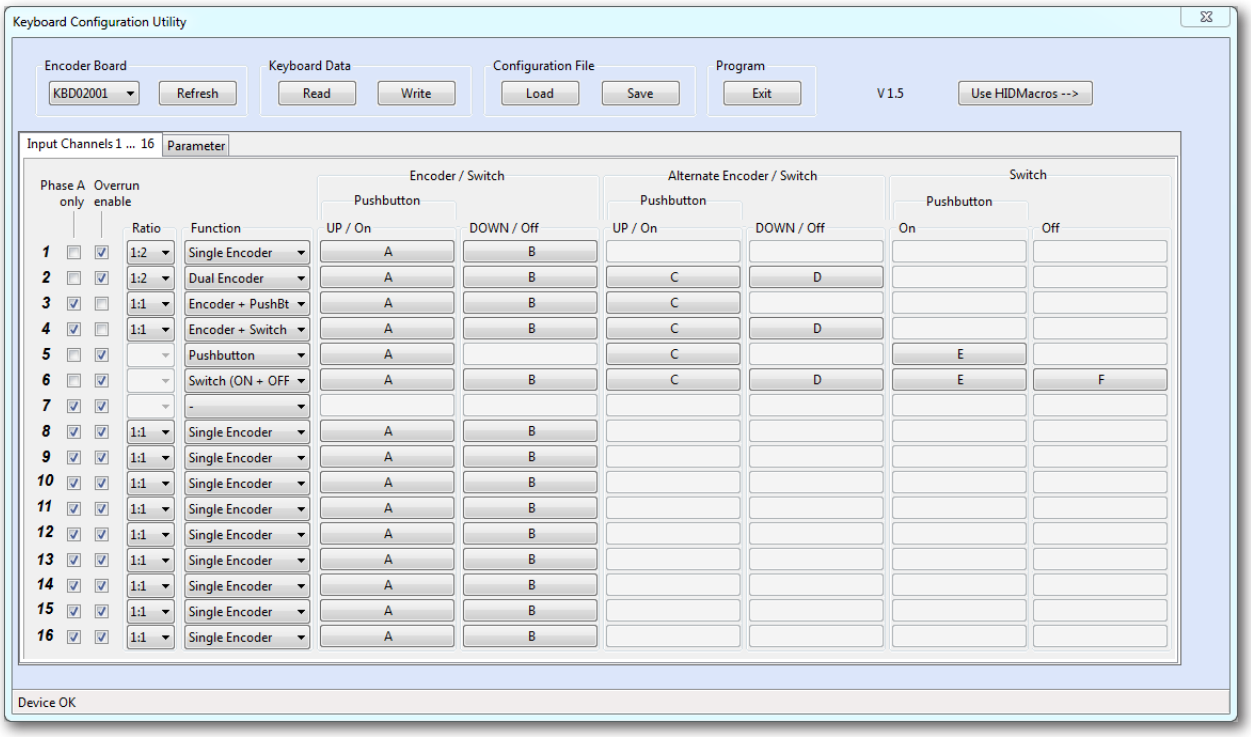
In the ***status bar*** the number of interface cards found is shown.



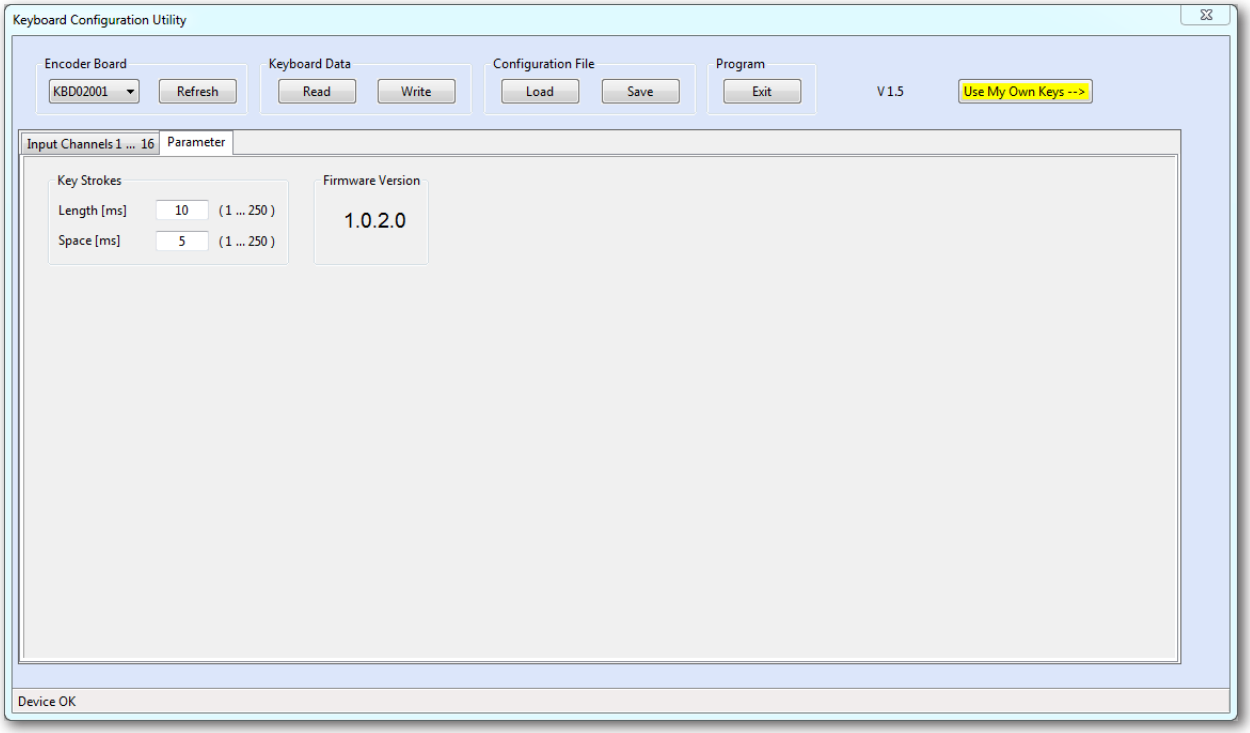
In the selection field on the top left of the program window the desired board can be selected and subsequently edited.

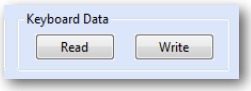
If boards will be removed or new ones attached, the status is updated with the **Refresh** button.

The startup screen shows the configuration of the 16 channels:



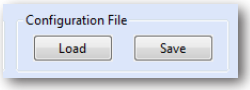
On the second page you will find additional parameters:





With the **Read** button, the configuration of the selected interface card is re-read and in the appropriate input fields are displayed. .

Vice versa, with the button **Write** the currently displayed configuration is written back into the interface.

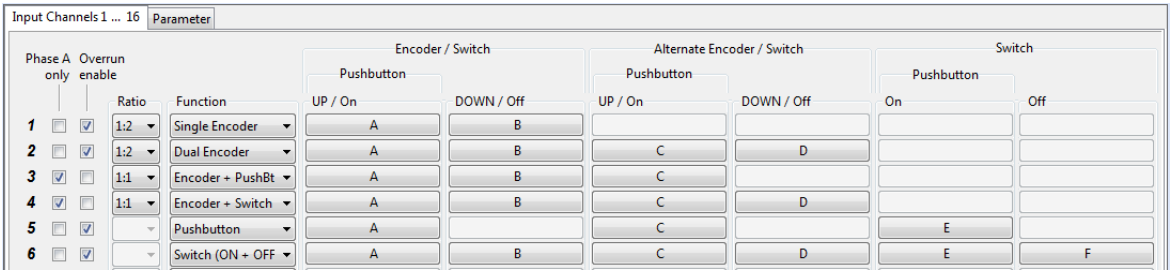


With the **Load** button, a configuration which has been saved on a storage medium can be restored and the input fields will be updated.

Accordingly, with the **Save** button the currently displayed configuration will be stored as an XML file on any storage medium.

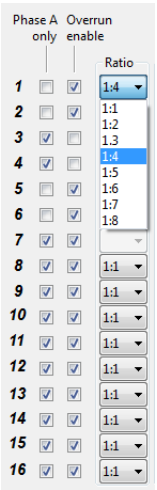
8. Input Channels 1 ... 16

This page contains individual settings for the 16 input channels. Encoder inputs can send 2 to 4 keycodes, switches up to 6, depending on the configuration:



Available options:

Funktion	UP / On	DOWN / Off	UP / On	DOWN / Off	On	Off
Encoder A simple encoder is connected	Keycode for UP (cw rotation)	Keycode for DOWN (ccw rotation)				
Dual Encoder An encoder with pushbutton is connected	First keycode for UP (cw rotation)	First keycode for DOWN (ccw rotation)	Second keycode for UP (cw rotation)	Second keycode for DOWN (ccw rotation)		
Encoder + Pushbutton An encoder with pushbutton is connected	Keycode for UP (cw rotation)	Keycode for DOWN (ccw rotation)	Keycode for pushbutton ON			
Encoder + Switch An encoder and a switch is connected	Keycode for UP (cwrotation)	Keycode for DOWN (ccw rotation)	Keycode for switch ON	Keycode for switch OFF		
Pushbutton 1, 2 or 3 Pushbuttons are connected	Keycode for ON pushbutton #1		Keycode for ON pushbutton #2		Keycode for ON pushbutton #3	
Switch (On + Off) 1, 2 or 3 switches are connected	Keycode for ON switch #1	Keycode for OFF switch #1	Keycode for ON switch #2	Keycode for OFF switch #2	Keycode for ON switch #3	Keycode for OFF switch #3
- Input is unused						



When checked, the checkbox **Phase A only** disables the evaluation of phase B of an encoder. This addresses an issue with some encoders which have their detent (click) exactly at the position where phase B changes (see *Hints*).

The checkbox **Overrun enable** turns the overrun feature on or off. When enabled, encoder pulses are gathered and all captured keystrokes are output with no missing pulses. The time for sending the keystrokes might be significant longer than the encoder is actually turned. When disabled, keystrokes are sent only as long as the encoder is turned.

The input field **Ratio** selects the reduction of the encoder pulses by the given ratio. For example, in a setting of 4:1 each fourth electrical pulse of the encoder leads to a keycode output. Thus high-resolution encoders may be adjusted as necessary, or encoders with more than one (electrical) pulses per detent can be adapted.

Each line represents one channel with 6 configuration fields for the desired key combinations:

For Encoders, there are the two possible events, ***UP*** (turning clockwise) and ***DOWN*** (turning anti-clockwise). For switches these are ***ON*** and ***OFF***, and for Pushbuttons there is only one event ***ON***. Depending on the selected function, configuration fields not required are grayed and cannot be edited. For example, the function **Rotary Encoder** has only two options, ***UP*** and ***DOWN***, the function **Encoder + Switch** but four, ***UP*** and ***DOWN***, as well as ***ON*** and ***OFF***.

By a single mouse-click on a configuration field it changes its color to red then and the next key press is captured and displayed. Each key on the keyboard is allowed and you can modify it with the *Shift*, *Ctrl* and *Alt* keys. The displayed key corresponds to an American keyboard: instead of a German «**ö**» therefore a «**`@key**» appears and instead of a «**ß**» a «**[key**». I. e., when «**ü**» is pressed with all three modifiers, then the configuration field shows „**Alt+Ctl+Shft+;key**“.

After a click with the mouse (the field is red now), but no change is to be made, then a second mouse click aborts this action.

«Additional Parameters» (on the second page) include the length (duration) of a keystroke and the gap (pause) between successive keystrokes. They can be adjusted independently in milliseconds.

9. LEDs

A special I/O device allows for up to 16 LEDs being connected. By default, The I/O device is programmed to indicate the output of the alternative keycode when the function **Dual Encoder** is selected and the encoder‘s pushbutton was pressed (LED is on). A second press toggles back to the primary set of keycodes of the associated encoder channel (LED is off). LEDs can be connected to the port pins directly, for each LED there is a 180 Ω pull-up resistor on the board. The Anode must be connected to a port pin, while the Cathode connects to ground.

As the I/O device is programmable, it will be possible, on request, to use the 16 I/O lines as inputs or outputs for other purposes.

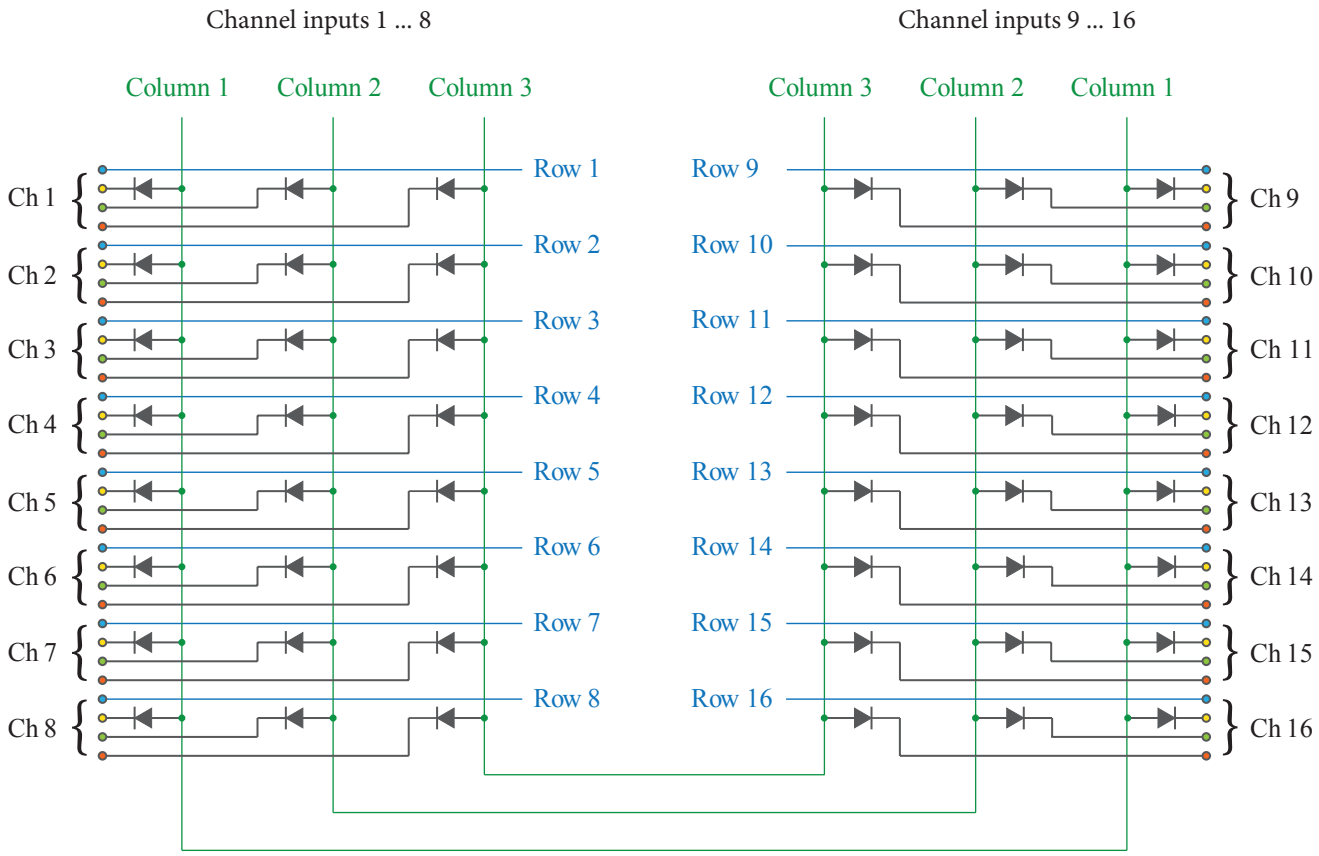
10. Expansion port (I^2C)

The KBD02 has the capability of being expanded by means of an expansion port with serial communication. This port provides GND and +5V in addition to the two serial lines SDA and SCL for I^2C devices like general purpose I/O, analog input/output, memory, and many more. There is no firmware support for this, yet.

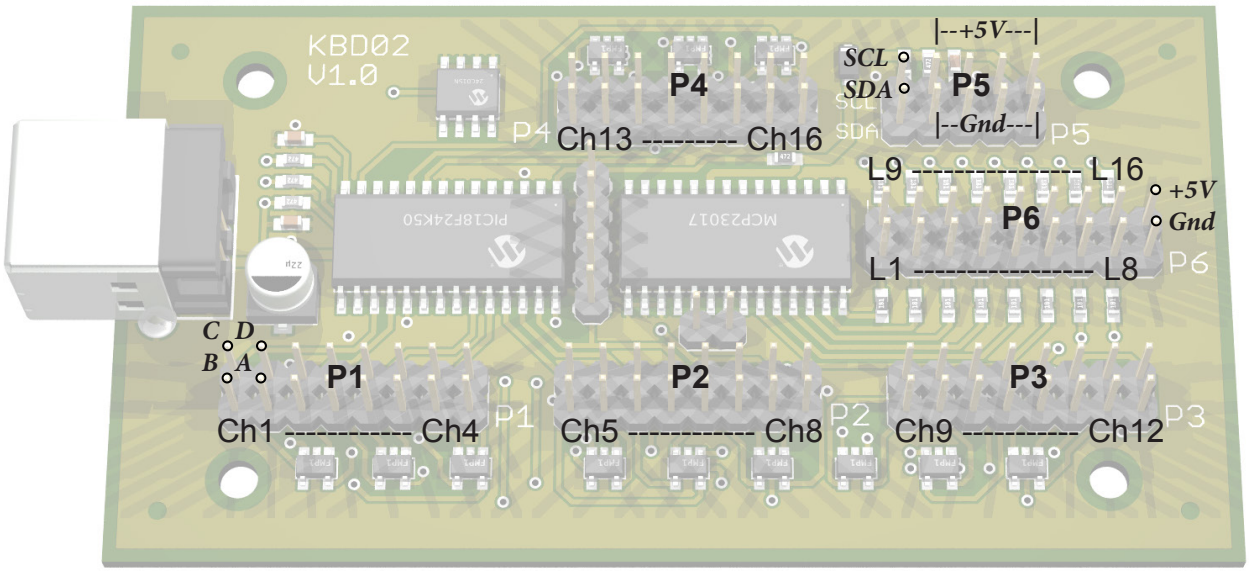
The USB specification (USB 2.0) does not allow for more current from the +5V line than 500mA. The board itself draws about 10mA and when all LEDs are lit at the same time they consume another 256mA. Hence, there are ~230mA left for additional circuitry, if not powered externally.

Technical Appendix

11. Switch Matrix



12. Interface Layout



P.. - Pin header ***Ch..*** - Input channels ***L..*** - LED outputs

13. Pin Descriptions

P1		P2		P3		P4		P5		P6	
B1	C1	B5	C5	B9	C9	B13	C13	SDA	SCL	L1	L9
A1	D1	A5	D5	A9	D9	A13	D13	Gnd	+5V	L2	L10
B2	C2	B6	C6	B10	C10	B14	C14	Gnd	+5V	L3	L11
A2	D2	A6	D6	A10	D10	A14	D14	Gnd	+5V	L4	L12
B3	C3	B7	C7	B11	C11	B15	C15	Gnd	+5V	L5	L13
A3	D3	A7	D7	A11	D11	A15	D15			L6	L14
B4	C4	B8	C8	B12	C12	B16	C16			L7	L15
A4	D4	A8	D8	A12	D12	A16	D16			L8	L16
										Gnd	+5V

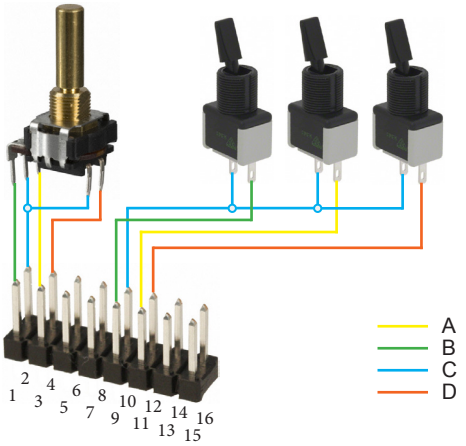
C = Common, B = PhaseB/Terminal 1, A = Phase A/Terminal 2, D = Pushbutton/Terminal 3

Channel pins do not have an electrical connection to other channels and may not be connected externally. Multi-switches with more than 3 (4) positions must be equipped with two or more levels/poles (see below).

14. Wiring Examples

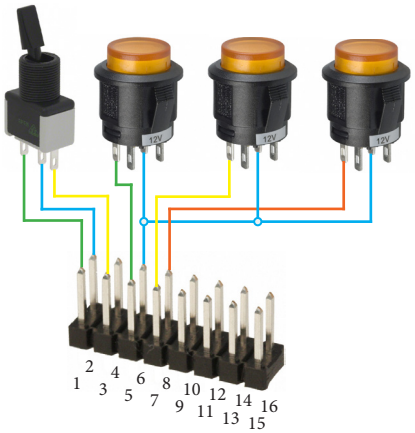
Rotary encoder with pushbutton

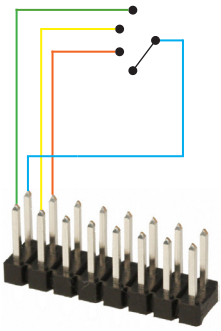
3 x ON-OFF



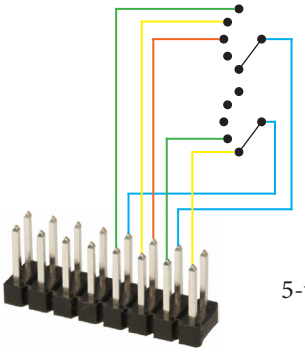
ON - OFF - ON

3 x Pushbutton





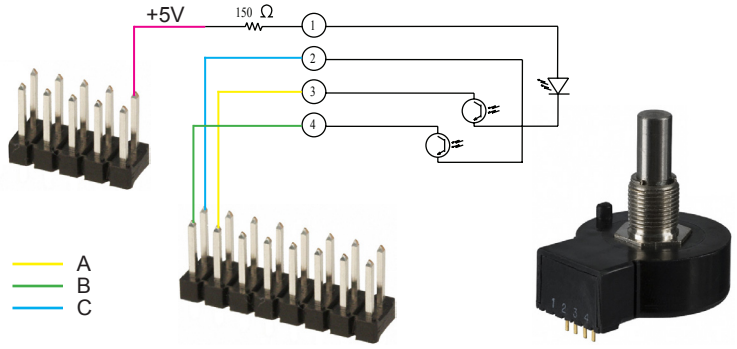
4-throw key switch
1 pole



5-throw rotary switch
2 poles

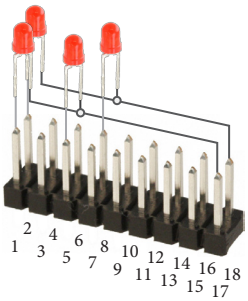
Wiring Examples (continued)

Optical Rotary Encoder



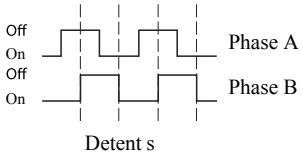
Dual Encoder LEDs

1 ... 16 = Anode
17 , 18 = Gnd

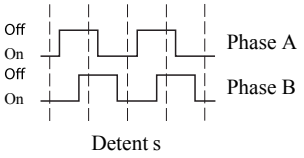


15. Hints

Mechanical encoders with detents are available in two variants, depending on where the snap-in positions in relation to the output signals are:

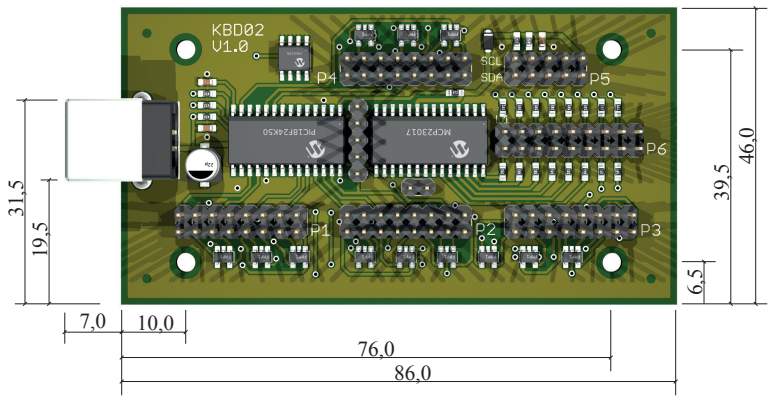


Variant 1



Variant 2

In the case of variant 1 it should be ensured that terminal *A* (*Phase A*) is correctly wired to the pin designated as «*A*». For variant 2, *A* and *B* can be interchanged - it only then changes the direction of rotation.



Dimensions [mm]