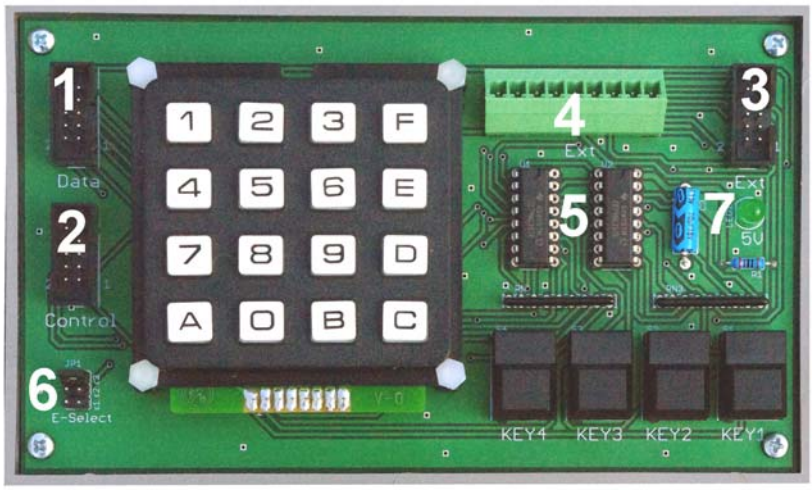
Keypad / Input Module 10b
Hardware Reference

Release 1.4a (October 11, 2017)

Purpose:
Platform to carry a keypad and four additional keys and to facilitate attachment of up to eight input signals from outside.

- PCB dimensions: approx. 92 by 156 mm (approx. 4" by 6 6,3").
- PCB fits on a sloped enclosure TEKO 362 and on frames for DIN rail mounting.
- PCB can be stacked upon other modules having the same dimensions.
- Microcontroller interface: two 8-bit ports. One port data bus (bidirectional), one port control signals (outputs).
- Supply voltage: up to 5 V, depending on the multiplexer ICs inserted.

Principles of Operation
The interface comprises two 8-bit ports. One port is an 8-bit data bus, the other carries five selection and three enable signals. Input signal selection is done via two multiplexers with three-state outputs. The interfaces of the keypad/input module 10b and the LCD module 10a are matched together. Each of these modules allows for selecting one of the three enable signals by appropriately setting a jumper. A typical configuration comprises two LCD modules (one with a dot-matrix, one with a graphic LCD) and one keypad/input module.



1 Data bus header
2 Selection and enable signals header
3 External inputs header
4 External inputs terminal strip
5 Multiplexers
6 Enable-signal select jumper
7 Power LED

Fig. 1 The Keypad / Input Module 10b.

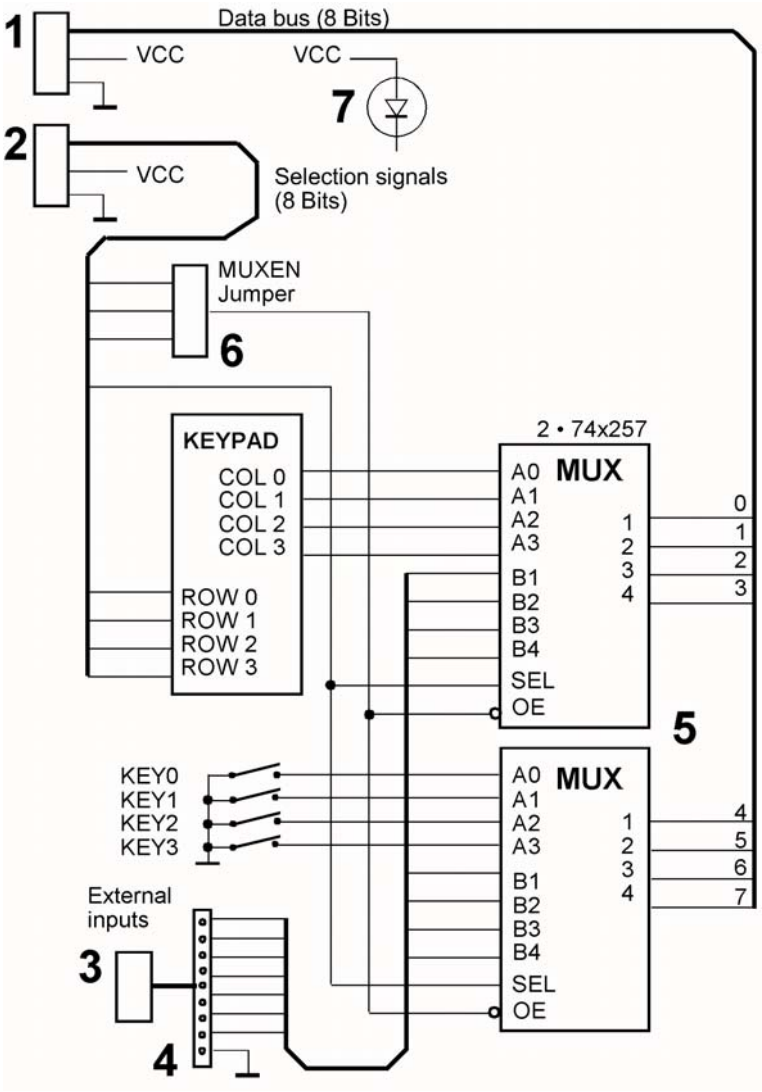


Fig. 2 Keypad / Input Module 10b block diagram.

Power Supply

Power must be supplied from outside. The board has no voltage regulator. The nominal maximum supply voltage is 5 V. The module can be operated with 3.3 V, provided the multiplexers belong to an appropriate CMOS family (for example, SN74HC or 74AC). Power is fed to the module via the I/O connectors.

I/O connectors (1), (2), (3)

The I/O connectors are pin headers with 10 pins in two rows and a pin pitch of 2,54 mm (100 mil). Various types can be inserted (horizontal or vertical, on the component side or on the soldering side, shrouded or not and so on). The assignment of the I/O signals, GND and VCC corresponds to the industry standard of the Atmel starter kits and the like (Fig. 3). The GND and VCC contacts may be used to supply the module.

2	**4**	**6**	**8**	**10**
Bit 1	Bit 3	Bit 5	Bit 7	VCC
Bit 0	Bit 2	Bit 4	Bit 6	GND
1	**3**	**5**	**7**	**9**

Fig. 3 I/O port header pin assignment.

I/O port connectors (1), (2)
The upper port (1) is the data bus, the port (2) below comprises the selection and enable signals.

External Inputs (3), (4)
Up to eight external inputs (Fig. 4) may be connected via header (3) or terminal strip (4). The terminal strip has 9 pins with a pin pitch of 3,81 mm (150 mil). External input connectors may be omitted, if not required. The multiplexers (5) and the corresponding pull-up resistor SIPs must be inserted, however.
The external input signals must be contacts, which connect the signal to ground, or they must be digital signals complying to the level specification of the multiplexers (5).
In Fig. 1, a somewhat luxury type of terminal strip is shown, manufactured by Phoenix Contact. Fig. 5 and Table 1 show appropriate connector types. The application wiring ends in pluggable screw terminals. Hence the wires can be disconnected with little effort.

7	6	5	4	3	2	1	0
EXT7	EXT6	EXT5	EXT4	EXT3	EXT2	EXT1	EXT0

Fig. 4 The external inputs.

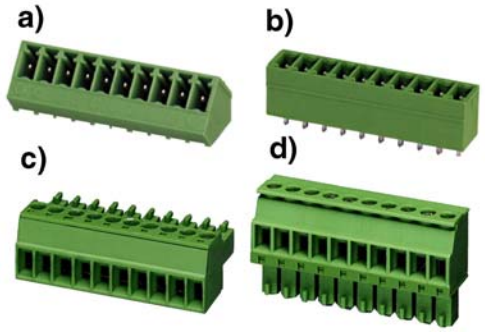


Fig. 5 Phoenix Contact connectors. a), b) base strips; c), d) pluggable screw terminals.

To be soldered in	Base strip SMC 1,5/9-G-3,81 - 1827347 sloped (Fig. 5a) Base strip MCV 1,5/9-G-3,81 - 1860715 vertical (Fig. 5b)
Removable screw terminals	Printed-circuit board connector MC 1,5/9-ST-3,81 - 1803646 (Fig. 5c) Printed-circuit board connector MCVR 1,5/9-ST-3,81 - 1827198 vertical (Fig. 5d)

Table 1 Phoenix Contact connectors (9-pole).

Multiplexers (5)
The multiplexers are used to select the input signals and to act as tri-state drivers on the data bus. The basic type is 74x257 (quadruple 2-line to 1-line, tri-state outputs). The logic family (LS, ALS, HC, AC) is to be selected according to the power supply voltage of the application (5 V or less). Speed (propagation delay) does not matter.

Enable-signal select jumper (6)
The OE-inputs of the multiplexers must be connected to an external enable signal (E-signal). Three of the eight control signals of the //O port (2) can be used as E-signals. One of these signals is to be selected by appropriately inserting a jumper. A maximum of three modules can be operated at one bus attached to two microcontroller ports. Each module must have its jumper inserted in a different position.
The LCD Module 10a has the same selection provisions. Beyond that, these modules have double I/O connectors, allowing for daisy-chaining. The keypad / input module must be the last module of such a a daisy-chain.

Caution:
The keypad / input module requires the E-signal active Low, the LCD module active High.

Power LED (7)
One of the most basic troubleshooting aids is an indication, whether a device is powered or not.

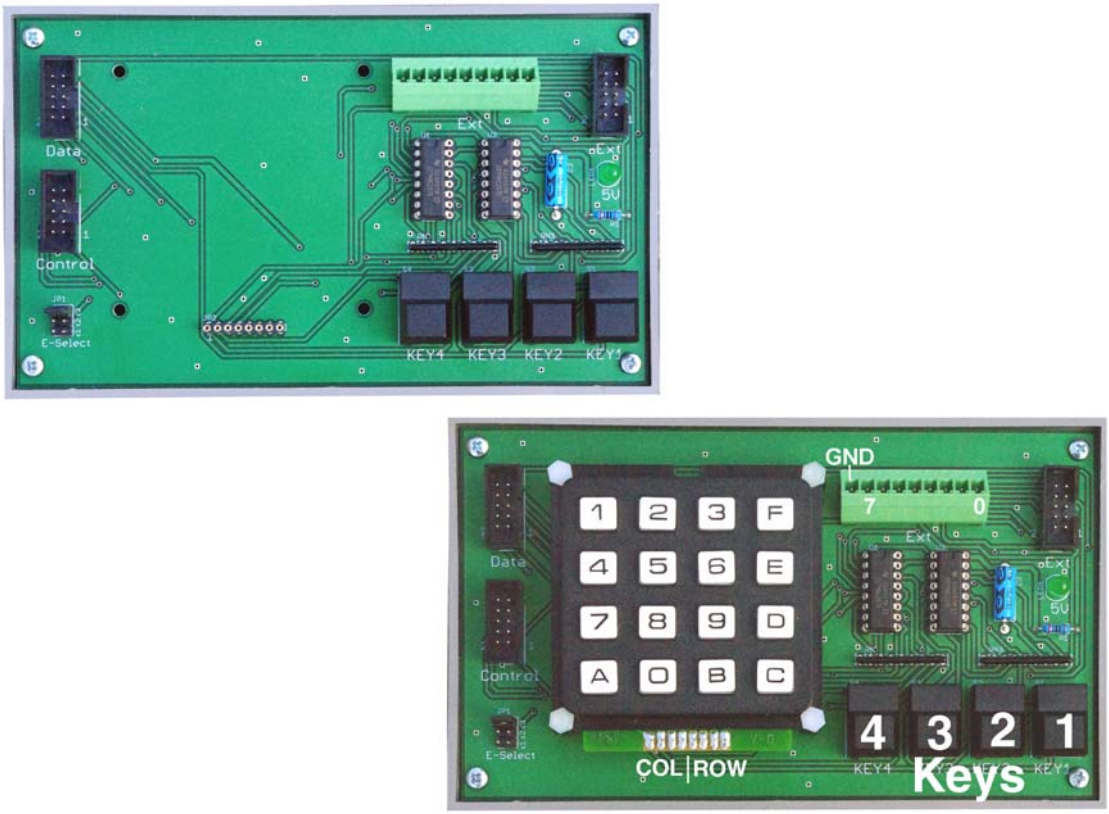


Fig. 6 The Keypad / Input Module 10b.

The Programming Interface

7	6	5	4	3	2	1	0
KEY4#	KEY3#	KEY2#	KEY1#	COL3#	COL2#	COL1#	COL0#
EXT7	EXT6	EXT5	EXT4	EXT3	EXT2	EXT1	EXT0
Inputs							

Fig. 7 The data bus. If SEL = 0, then the internal signals KEY4#...COL0# are selected. If SEL = 1, then the external inputs EXT7...EXT0 are selected.

KEY4#...0#: Signals of the four keys (low-active).
COL3#...0#: Keypad column signals to be sanned (low-active).
EXT7...0: External input signals. High-level, if not connected.

7	6	5	4	3	2	1	0
E3#	E2#	ROW3#	ROW2#	ROW1#	E1#	ROW0#	SEL
Outputs							

Fig. 8 The selection and enable signals. One of the E-signals is to be selected by jumper. It must be programmed as active-low.

E3, E2, E1: Enable signals.
ROW3...0: Keypad row signals to select a particular row (low-active).
SEL: Select inputs via the multiplexers. 0 = internal, 1 = external signals.

Data bus, if SEL = 0:

7	6	5	4	3	2	1	0
KEY4#	KEY3#	KEY2#	KEY1#	COL3#	COL2#	COL1#	COL0#

Data bus, if SEL = 1:

7	6	5	4	3	2	1	0
EXT7	EXT6	EXT5	EXT4	EXT3	EXT2	EXT1	EXT0

Unconnected external inputs are held on a high level by pull-up resistors.

Notes:

1. To each module, a particular enable-signal (E) must be assigned. Pay attention to the level at which the signal is active. The E-signal of the keypad/input module is active low. To hold the display in the idle state, E = 0 shall be programmed. A counterexample is the LCD module 10a. The E-input of a typical LCD display is active high. Hence the idle state requires E = 0 to be programmed.

2. The data bus should not float too long. An inactive bus should be programmed for output (parking the bus) or programmed for input with pull-up resistors active.
3. Th data bus should be parked at High level (FFH bit pattern). So no current will be drawn over pull-up resistors.
4. A preferred configuration: the keypad/input module configured to E3, LCD displays to E1 and E2, respectively.

Scanning the keypad:

1. Pull down a row select signal.
2. Sense the column signals. A depressed key will cause its column line to be pulled low, too.
3. Repeat 1. and 2. for all rows.
4. Keep care of intricacies, like contact bounce and phantom keys (ghosting). Generate an appropriate scan code to be returned to the application program.

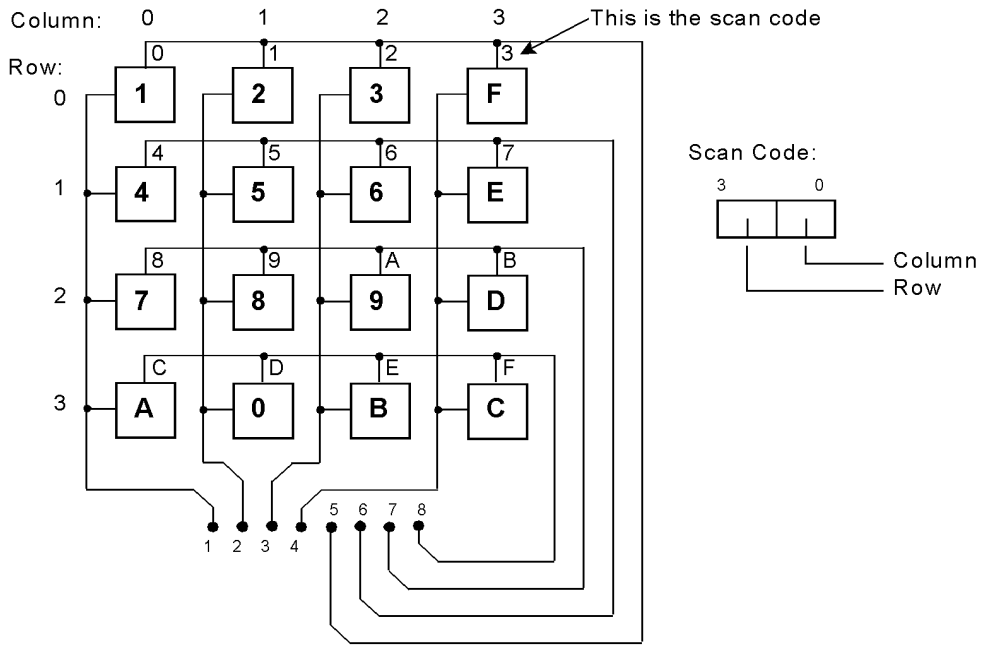


Fig. 9 Scanning the keypad.

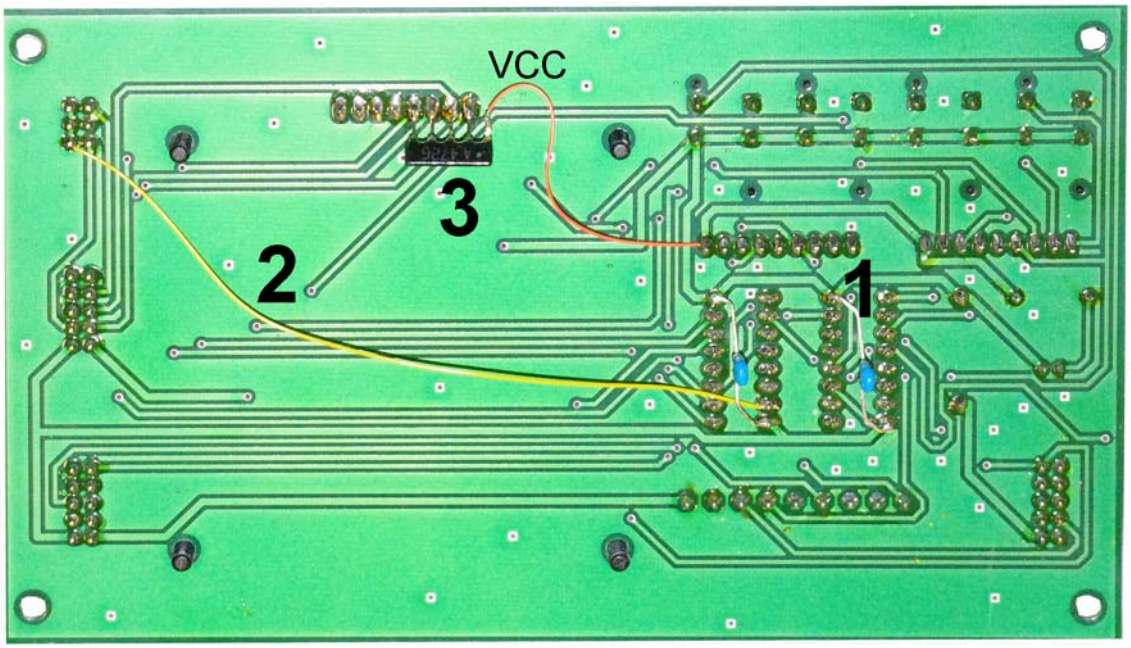
Note: It is always to be expected, that two or more keys are depressed simultaneously. To avoid short circuit currents between row select signals, these signals must be driven from open drain output stages. The I/O ports of Atmel AVR microcontrollers can be programmed appropriately. However, the built-in pull-up resistors have quite high values of resistance. Thus the rise time of the signals will be considerably long. Hence the row select signals are to be connected to additional pull-up resistors.

Engineering Change Order (ECO)
Boards with release number 1.3 or less need rework:

1. Add the missing decoupling capacitors.

2. Add the missing MUX enable signal connection.

3. Add the pull-up resistors of the row select signals.



Keypad / Input Module 10b in Action

– A Photo Gallery –