Serial keyboard with LCD display

2. Short description

TKL-020-LCD is a compact keyboard with LCD-display and status indicator LED with the following features:

- Keyboard with 20 keys and LCD in ergonomical plastic housing
- Serial, bidirectional communication from/to the host PC
- Connecting cable ca. 180 cm with 9-pin female Sub-D-connector
- V24-level
- 20 keys, (19 programmable and 1 shift key)
- Output of up to 16 character per key click (8 characters when pressing and 8 characters when releasing the key)
- Operating voltage 5 V DC
- 2 character layers programmable on each physical existing key
- Build-in switchable acoustic signal generator (key "click")
- 1 LED (controlled by PC)
- LCD-displays with 2 lines with 20 characters (letter height 5,6 mm)
- LCD with permanent backgrount lighting
- Display controller 44780 with transparent control
- Character download function
- Transmission rate: 9600 baud; alternative transmission rate 1200 baud adjustable by jumper SL8
- Range of operating temperature from 0 °C to 50 °C
- Low dimensions: 108 x 166 x 52 mm
- Weight only 450 g
- Key matrix programming in the EPROM of the build-in terminal decoder by GETT or by customer by using programming device

3. Data interface

The Data interface is a serial connection to the host (4-wire-connection) with the following configuration:

Interface: RS 232-C;V 24; #
                          RxD; TxD; Gnd; +5 VDC

Operating mode: Full Duplex, no Handshake

Transmission rate: 9600 baud (others on request)
                          Switchable to 1200 baud by jumper

Data format: 1 Start bit / 8 Data bits / 1 Stopp bit

Error handling: no parity bit and therefore no error handling in the controller

There´s no handshake, because all serial incomming informations are processed directly and the additional controller jobs are done within the transmission time of each byte.

An input filter is rating all incomming characters of control-bytes (all characters that cannot be shown at the display; 01 ... 31 [01h ... 1Fh]). If such a character is detected, the following byte executes the belonging function (see "Display" ff.).

Connect the data interface to the power supply:

The serial connection is done by a 9-pin female Sub-D-connector.
The external power supply of the keyboard is realized by the same connector.

9-pin female Sub-D-connector:			
Pin:	allocation:	Pin:	allocation:
1	Vcc (+5V external)	2	RxD (PC)
3	TxD (PC)	5	Gnd (external and PC)

4. Keyboard

The pressed key is detected by a matrix in TWO-KEY-LOCKOUT method.
All keyboard informations to the host are registered into a cache memory and sended thence by the serial interface in a 10ms-grid.
The keyboard has 19 programmable keys, they can be allocated in 2 layers, and a shift key. So 38 key entries (maxímum) in 2 layers can be programmed.
For each key can be placed different ASCII-characters in both layers. 8 characters (maximum) can be programmed at the pressing and 8 characters (maximum) at the releasing every single key in each of the 2 layers

The shift key doesn´t generate any ASCII-character.
It is used to display the codes of the corresponding key layer – depending on the operation mode of this key.

The key matrix is decoupled by diodes. So that no phantom keys can be detected when more than 1 key is pressed.

Keyboard output:

In dependence of the operating mode of the SHIFT-key is switched to the corresponding key layer.
The key code (max. 8 ASCII characters) is sent when pressing the button.
When letting the button off another max. 8 ASCII characters can be sent.
An autorepeat function isn't implemented.
The output of a key "click" is carried out per default after every button activity.

Programming instruction for changing the keys codes

The programming of the individual ASCII characters to the key positions is carried out in the EPROM of the built-in terminal decoder.
This programming can already be available in the delivering state from GETT, is, however, feasible also from the customer even by means of EPROM programmer.

For opening the keyboard the bottom plate should be removed by a screw driver. The terminal decoder is mounted at the bottom and should not be removed. For simple editing of the basic layer key coding (Shift-key is not pressed) it is mapped in the EPROM. Following the addresses are named according to the key positions:

1480/1488	1490/1498	14A0/14A8	2./1. Ebene
1380/1388	1390/1398	13A0/13A8	13B0/13B8
1280/1288	1290/1298	12A0/12A8	12B0/12B8
1180/1188	1190/1198	11A0/11A8	11B0/11B8
1080/1088	1090/1098	10A0/10A8	10B0/10B8

For changing the coding it´s necessary to:
- pick out the EPROM
- edit the memory area
- save the edited ptogram to the EPROM again.

e.g. address 1480h to 1487h contains the ASCII-characters when pressing the left upper key, the address 1488h to 148Fh contains the ASCII- characters when releasing the left upper key.
If less then 8 ASCII-characters are needed, there must be entry 00h in the according memory cell. The further memory areas of the other keys are shown in the table above.

E.g. the left upper key should put out the string "GETT" when pressing and "Indukey" when releasing the key:
From memory cell 1480h: 47h   45h   54h   54h   00h   00h   00h   00h
From memory cell 1488h: 49h   6Eh   64h   75h   6Bh   65h   79h   00h
The programming of the 2nd key layer is done like shown above, the memory area is dedicated as following:

2480/2488	2490/2498	24A0/24A8	2./1. Ebene
2380/2388	2390/2398	23A0/23A8	23B0/23B8
2280/2288	2290/2298	22A0/22A8	22B0/22B8
2180/2188	2190/2198	21A0/21A8	21B0/21B8
2080/2088	2090/2098	20A0/20A8	20B0/20B8

5. Display

A 2-line-display (20 char./line) with a controller Hitachi 44780 is integrated in the keyboard. The display is background lighted permanently. The display is activated by PC.

Preliminary remark to activate the display:

The keyboard firmware ist provided for activation of various display types.
To plot charcters at the display at first the used display must be selected.
This is done once by the 2-byte-control-character 12h 01h.
The prefixed control-byte 12h initializes the switching of the LCD, the 2nd byte 01h defines the LCD control line. All characters now are plotted at the integrated LCD. It´s non-permissible to control a display that´s not integrated here.

Control instructions (e.g. clear display od input of an user-defined character) are also realised by 2-byte-transmission. The prefixed control-byte 13h prepares the transmission of a control character, the following byte complies the desired control character (e.g. 01h for clear display).

The necessary waiting times of the control instructions are guaranteed by the assignment with 9600 bauds. The handing over of the signs to be represented at the display is made by "pushing thru" of the bytes. The represented signs comply with the ASCII font, the signs 0 to 7 are reserved for download signs.
Special signs not contained in the ASCII font or inverse representation of signs can be loaded into the display controller and be called from there with help the download function. Up to 8 different signs (5 x7 matrix) can be stored.

Example:

select of display , delete of display and representation of a text

12h	01h	13h	01h	47h	45h	54h	54h
display	**select**	**display**	**delete**	G	E	T	T

The download of a special sign in the controller and the calling up by the display is also possible and complies with the specification of the Hitachi 44780 controller.

Generally, a picking out the memory contents of the display controller isn't possible!
the display contents must be inscribed in the driver software.

After a reset the integrated display is mentioned by the controller and the following basic setup carried out:
* display off, cursor off
* flash cursor on, display on
* write to the right
* display delete, cursor home position

Steuer-anweisung	Funktion	Beschreibung
01d/01h	Clear Display	Display löschen; Cursor Home (links in 1. Zeile)
02d/02h	Return Home	Cursor Home (links in 1. Zeile)
04d/04h	schreiben nach links	Zeichen von rechts -> links schreiben Cursor wandert mit
05d/05h	schieben nach rechts	Displayinhalt beim Schreiben von links -> rechts schieben Cursor bleibt
06d/06h	schreiben nach rechts	Zeichen von links -> rechts schreiben; Cursor wandert mit
07d/07h	schieben nach links	Displayinhalt beim Schreiben von rechts -> links schieben Cursor bleibt
08d/08h	Display & Cursor aus	Display abschalten, Daten und Einstellungen bleiben
12d/0Ch	Display ein Cursor aus	Display einschalten, Cursor nicht aktiv
13d/0Dh	Blinkcursor & Display ein	Cursor rechteckig und blinkt
14d/0Eh	Cursor '_' & Display ein	Cursor als Balken unter Zeichen
15d/0Fh	Blinkcursor & Cursor '_' & Display ein	Cursor rechteckig blinkend & Balken unter Zeichen
16d/10h	Cursor links verschieben	Cursor eine Stelle nach links verschieben
20d/14h	Cursor rechts verschieben	Cursor eine Stelle nach rechts verschieben
24d/18h	Inhalt links schieben	Displayinhalt eine Stelle nach links schieben
28d/1Ch	Inhalt rechts schieben	Displayinhalt eine Stelle nach rechts schieben
64d+n*8 40h+n*8	Character download auf Adresse n	Zeichen zeilenweise (5 Pixel/Zeile) auf Adresse des Zwischenspeichers laden 8 Zeilen eingebbar (8:=Cursor)
128d+n 80h+n	Cursor setzen in 1. Zeile	Cursorposition (Pos des nächsten Zeichens) auf Position n (n=0 -> linker Rand, n=20 -> Mitte) in Zeile 1 festlegen
192d+n C0h+n	Cursor setzen in 2. Zeile	Cursorposition (Pos des nächsten Zeichens) auf Position n (n=0 -> linker Rand, n=20 -> Mitte) in Zeile 2 festlegen

6. Acoustic key-click

The keyboard has a beeper, which is integrated on the circuit board and beeps at every keystroke for approx. 100 ms.

The button click also can be activated by the primary system. To this the control value 07 has to be sent to H to the terminal keyboard. After that the keyboard outputs a 100 ms button beep.

By unpicking the bridge BR1 on the leader side of the keyboard decoder the button beep can be switched off.

7. LED

A light-emitting diode (LED) is integrated In the keyboard, which can be turned on and off by the serial interface.

Control the light-emitting diode

The control of the light-emitting diodes is also made by a 2 byte assignment.
If the light-emitting diodes shall be switched on, then the preceding control byte is 14H and in the following byte 11H the LED becomes switched on.
If the LED shall be turned off, then the following byte 01H has to be sent from the PC to the keyboard after the control byte.

8. Eingebauter Terminaldekoder
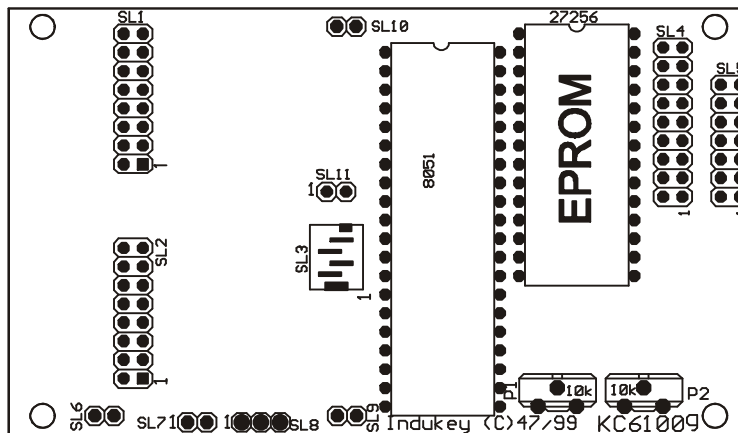
SL9: (Baudrateneinstellung)
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offen         = 9600        SL11 (Piepser):
geschlossen = 1200          1 = Piepser (+)  2 = +5V
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9. Operating parameters

Operating voltage: 5V (DC)
Power consumption: ca. 120 mA
Operating temperature range: 0°C ... 70°C
Storage temperature: -15°C ... 80°C
Dimensions (WxHxD):   108 x 166 x 52 mm
Weight: apr. 450 g

10. Summary of the control commands for activation

07h   Activating the button beep for apr. 100 ms
12h   LCD-controlling (+ 01h)
13h   Activating control instructions for LCD (+ control code)
14h   Activating LED (+ turn-on or turn-off code)

11. Matrix tables

Keyboard layer 1

Spalte	Reihe	1 Adr	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	1 Adr	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	1 Adr	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	1 Adr	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8
1	Make (HEX)	1480									1490									14A0									Umschalttaste nicht gedrückt								
	Break (HEX)	1488									1498									14A8																	
2	Make (HEX)	1380									1390									13A0									13B0								
	Break (HEX)	1388									1398									13A8									13B8								
3	Make (HEX)	1280									1290									12A0									12B0								
	Break (HEX)	1288									1298									12A8									12B8								
4	Make (HEX)	1180									1190									11A0									11B0								
	Break (HEX)	1188									1198									11A8									11B8								
5	Make (HEX)	1080									1090									10A0									10B0								
	Break (HEX)	1088									1098									10A8									10B8								

Keyboard layer 2

Reihe / Spalte		1 Adr	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	1 Adr	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	1 Adr	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	1 Adr	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8
1	Make (HEX)	2480									2490									24A0									Umschalttaste gedrückt								
1	Break (HEX)	2488									2498									24A8																	
2	Make (HEX)	2380									2390									23A0									23B0								
2	Break (HEX)	2388									2398									23A8									23B8								
3	Make (HEX)	2280									2290									22A0									22B0								
3	Break (HEX)	2288									2298									22A8									22B8								
4	Make (HEX)	2180									2190									21A0									21B0								
4	Break (HEX)	2188									2198									21A8									21B8								
5	Make (HEX)	2080									2090									20A0									20B0								
5	Break (HEX)	2088									2098									20A8									20B8								

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