Keyboard Controller

Series GCK-978

Elektronik und
Feinwerktechnik GmbH

Module und Geräte zum Eingeben, Auswerten, Anzeigen und Ausdrucken analoger und digitaler Daten.

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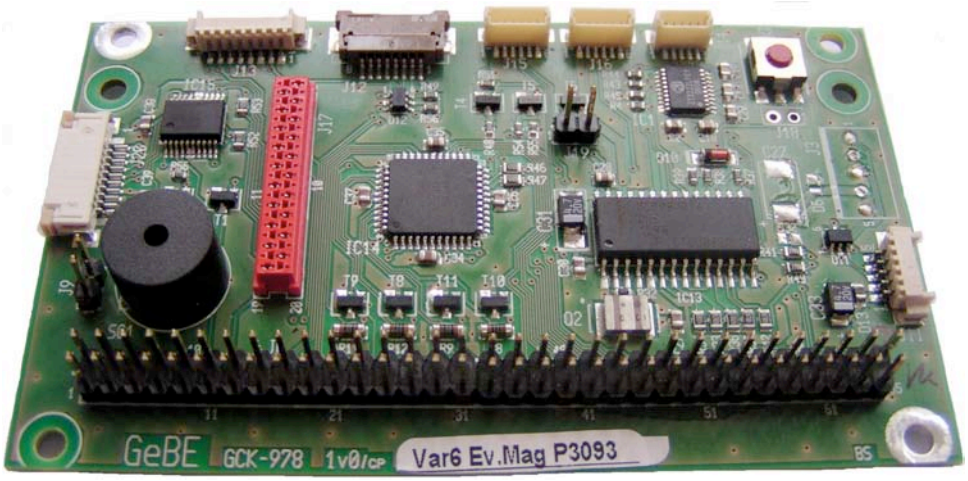

User Manual

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Contents

1 Fundamental Safety Instructions

1.1 Symbols

The following names and tags are used to label hazards and special information throughout this user manual:

Info

Text passages labeled “Info” contain user tips and particularly useful information that will help you to utilize all functions optimally.

Important

Text passages labeled “Important” contain information on proper device handling.
Failure to comply with these instructions may cause damage to the keyboard controller GCK-978 or something in its proximity.

Attention

Text passages labeled “Attention“ point at a potentially dangerous situation.
Failure to comply with this information may cause small injuries or damage of property.

Warning

Text passages labeled “Warning“ alert the user of a potentially imminent danger.
Failure to comply with these alerts may result in severe health threats and even fatal injuries.

2 Short Description

2.1 Operation and Use of the Keyboard

Between one and 160 keys can be connected to the matrix (special versions with 16x20 keys are possible). Practically all current keyboards with a contact resistance of less than 200 Ω that have diodes at the cross points of the matrix can be used (such as membrane, contact, and rubber keyboards). The keyboard program has “full N-key rollover” and “typematic“ features. The key matrix has a function key (Fn) producing an alternative assignment for up to 159 keys whenever it is held down. Four LEDs signaling the functions of POWER, CAPS-LOCK, NUM-LOCK, SCROLL-LOCK can be connected on the controller board. The keyboard functions are freely programmable through the USB interface or the “download mode” from a PC file. String programming (max. 30 characters plus defined breaks) to support batch commands is also possible. Other features are a disengagable signal generator and the support of Windows95 keys.

2.2 Hardware Configuration

Host controller:
Single-chip micro processor with 16 Kbytes in system-programmable flash EEPROM and 1 Kbyte RAM

SCAN engine:
Single-chip micro processor with 32 Kbytes in system-programmable flash EEPROM and 2 Kbyte RAM

Magnetic Card Controller:
Single-chip micro processor with 2 Kbytes in system-programmable flash EEPROM and 128 byte RAM

TTL-LED outputs through driver
(capacity:max. 40 mA in countercurrent with GND)

Acoustic signal generator (click of key), connecting internally or externally

- 1 connector 5 pins for system interface PS/2 or USB
- 1 connector for keyboard matrix 8x20, populated depending on matrix size, 64 PINs by default, double-row connector in 2.54 row
- 1 connector 5 pin SH connector
  for serial interface RS232
- 2 connector 6 pin
  for interface extension (I^2C)
- 1 connector 8 pin
  for connecting a 2-button mouse (touchpad)
- 1 connector 8 pin
  for connecting a 3-button mouse (touchpad)
- 1 connector 10 pin
  for connecting a card reader
- 1 connector 5 pin
  for system interface AT
- 1 connector 2 pol.
  for power supply during RS232 operation
- 1 screwed fastening 2 pin
  for power supply during RS232 operation

2.3 The Interface

The keyboard controller has a PS/2–USB “double function” interface consisting of a CLOCK/ DATA-line at the PS/2 port or a D+/D- line at the USB port plus power supply lines. The interface automatically recognizes, whether a PS/2 or a USB is being plugged in.
In USB mode, the controller/keyboard acts as a BUS powered, low-speed, low-power USB 1.1 compatible device in accordance with the “Device Class Definition for Human Interface Devices (HID) version 1.1 (4/7/99). The keyboard is USB 2.0 compatible. The HID reports of the standard keys as boot devices according to HID specification have been implemented. The power management features “suspend”, “resume”, and “remote wakeup” are supported.
In PS/2 mode, scan code2 is supported, and so is scan code3 upon request.
The system is prepared for support from “Multimedia” and “Power Management” keys. In USB mode, this is made possible through an additional Endpoint2, and in PS/2 mode through special scan codes.

3 Description of the Controller Functions

3.1 Operation Principles of the Controller

3.1.1 Full N-Key Rollover

The function "Full N-Key Rollover" is programmed in. This function lets the program recognize all pressed keys in the matrix, even if multiple keys are pressed simultaneously. The auto-repeat function, however, will always affect the key that was pressed last.
The simultaneous pressing of multiple keys in a keyboard matrix may generate additional, unwanted key codes (ghost keys).
The use of decoupling diodes at the cross points is the most effective protection against the so-called ghost keys.
These diodes may only generate a maximum flow voltage of 0.3 V. Their negative electrode has to be connected to the appropriate row of the key.

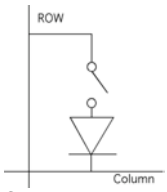


fig. 4-1 Decoupling Diode

Sophisticated “ghost key detection” is part of the software for the GCK-978, so the use of decoupling diodes is not mandatory.
The existence of a ghost key is recognized by the software, which then replaces all keystrokes with an error message.
This means that the PC will start beeping, when such a situation arises.
Important key combinations that are used often (such as ALT / STRG / ENTF) must be placed in different rows, so they will not generate any ghost keys and error codes
The GeBE standard matrix follows this rule optimally.

3.1.2 Additional Keyboard Plane Function (Fn)

In order to create a multitude of scan codes with keyboards that have a low number of matrix dots and, therefore, only a few keys, the controller features an additional keyboard plane “FUNCTION”. A “FUNCTION” shift key switches between the two. The additional keyboard “FUNCTION” will be active as long as the “FUNCTION” shift key is held down.
The “FUNCTION” shift key creates a code inside the keyboard that is recognized as the shift identifier to the additional plane (code table). The “FUNCTION” shift code itself is not transferred to the PS/2 or USB system. Code 130 (dec) has been defined as the “FUNCTION” shift code in the PS/2 table, and code AC (hex) in the USB table.

3.1.3 Typematic Rate of PS/2 Systems

The keyboard program includes an auto-repeat feature. Whenever a key is held down longer than a pre-defined DELAY time programmed in the flash, the character is put out repeatedly. The output speed is determined by the REPEAT time, which is also established in the flash.

The default DELAY time is 500 msec. The auto-repeat rate is about 10 characters per second.

The PS/2 system provides the option to reset the REPEAT and the DELAY time through a control command to the keyboard controller. With certain keyboard drivers, the default value will be changed and therefore, become ineffective. For this reason, the options of changing the auto-repeat timing by the user as described above only applies to applications, where these time constants are not being maintained by the PS/2 USB system.

3.1.4 Debounce Time

The key debounce time of the keyboard is about 40 milliseconds by default.

3.1.5 Key Memory

The controller has a FIFO memory (first in-first out) for 16 bytes that stores the key codes before their output.

If the keyboard is maintained by the system, this buffering is not happening.

If more than 16 codes have to be buffered before the first code is sent, a buffer overrun will occur, and a special FIFO overrun code is generated instead of the 17th code of the printed key. The following key strokes will be ignored.

Pin:	Signal Identification:	PIN:	Signal Identification:
1	NC	2	NC
3	NC	4	NC
5	NC	6	NC
7	PIEPSER	8	C16
9	MOUSE_M	10	C17
11	NC	12	C18
13	NC	14	C19
15	SCROLL	16	R7
17	MOUSE_L	18	R6
19	MOUSE_R	20	R5
21	GND	22	R4
23	BLOCK	24	R3
25	NUM	26	R2
27	CAPS	28	R1
29	VCC	30	R0
31	C8	32	C0
33	C9	34	C1
35	C10	36	C2
37	C11	38	C3
39	C12	40	C4
41	C13	42	C5
43	C14	44	C6
45	C15	46	C7
47	R0	48	C8
49	R1	50	C9
51	R2	52	C10
53	R3	54	C11
55	R4	56	C12
57	R5	58	C13
59	R6	60	C14
61	R7	62	C15
63	R0	64	C0

3.1.6 Power ON

The keyboard controller will become active about 400 ms after power is connected.

3.2 Connecting the Controller

Connecting the Controller GCK-978 to the Keyboard Matrix through Connector J6:

2-row strip, grid dimension 2.54 mm

4 Interfaces

4.1 The PS/2 Interface

Connecting the controller to the PS/2 system:
The connection with the PS/2 system is done through connector J11. The connection cable GKA-503 is available from GeBE®.
Connector type Molex strip-5p 90° RM1.25 mm-SMD Molex

Pin Assignment of Connector J11:

Pin:	Signal Identification
1	Supply Voltage + 5 V
2	GND
3	DATA
4	CLOCK
5	GND

Optional connector for PS/2 (AT) interface, 5 pin connector

Pin Assignment of Connector J3:

Pin:	Signal Identification
1	CLOCK
2	DATA
3	GND
4	Supply Voltage +5V
5	GND

4.2 General Description of the Interface

The interface that is used for data exchange is bidirectional. PS/2 USB system and keyboard controller are connected through a CLOCK and a DATA line with each other. The CLOCK impulses are generated for the operating mode SEND and for the operating mode RECEIVE.

4.2.1 Definition of the Signal Lines

CLOCK:	The keyboard controller generates the CLOCK line in the operating modes SEND and RECEIVE in order to synchronize data transfer in or out of the controller. The PS/2 USB system uses it to block the keyboard (CLOCK LOW). In idle state, CLOCK runs HIGH levels.
DATA:	When sending data to the PS/2 USB system, the controller puts data onto the data line synchronously to the CLOCK impulses generated by the keyboard. When the controller receives data from the PS/2 USB system, the PS/2 USB system puts data onto the data line synchronously to the CLOCK impulses generated by the controller. The PS/2 USB system also uses the data line to signal to the controller that data are ready to be transmitted to the controller (DATA LOW). In idle state, DATA runs HIGH levels.

4.2.2 Keyboard Controller Sending Data

When the controller has recognized at least one keystroke and is ready to send, it will first check, whether the keyboard is locked (CLOCK LOW), or the PS/2 USB system is requesting to send (DATA LOW). If the controller is blocked (CLOCK pulled to LOW by PS/2 USB system), the data will be stored in the output buffer. When the DATA line of the PS/2 USB system is pulled to LOW, the PS/2 USB system is requesting to send. The controller also buffers the recognized key strokes in the output buffer and prepares to receive data. Data is valid during the falling and the rising edge of the CLOCK signal during data transmission, the controller will survey the CLOCK line every 60 µs to see, if the PS/2 USB system is pulling the CLOCK line to LOW. If this is the case before the rising edge of the 10th CLOCK signal (parity bit), the controller will stop the transmission attempt releasing both lines (HIGH), and gets ready for data reception from the PS/2 USB system. The code of the character, at which the interruption of transmission occurred is buffered and put out at the next opportunity to send.

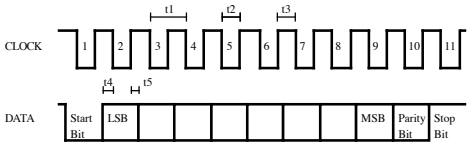


fig. 4-1 Time Diagram “Send Data“

Info

For associated characeristic times during transmission see 4.2.4

4.2.3 Keyboard Controller Receiving Data

Before the PS/2 USB system sends data to the controller, both lines are checked for HIGH levels. The PS/2 USB system can interrupt the transmission from the controller by pulling the CLOCK line to LOW level, thereby preparing the controller for data reception. If both lines are HIGH, the PS/2 USB system will signal to the controller by blocking the DATA line (DATA LOW) indicating that data is available. The controller will then read the data from the PS/2 USB system by applying CLOCK impulses. Data bits are read during CLOCK HIGH. After the 10th data bit (parity bit), the controller checks for a stop bit. If the data line is HIGH, the controller will pull the data line to LOW, signaling to the PS/2 USB system that data has been read. Otherwise, the reading is continued until DATA-HIGH is recognized. The controller has to respond to each command from the PS/2 USB system within 20 ms.

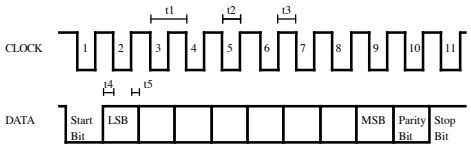


fig. 4-2 Time Diagram “Receive Data“

Info

For associated characeristic times during transmission see 4.2.4

4.2.4 Characteristic Times During Transmission

Signal:	Name	Min.	Max.	Unit
t1	Cycle time CLOCK	60	100	ms
t2	CLOCK-HIGH time	30	50	ms
t3	CLOCK-LOW time	30	50	ms
t4	Set-Up time DATA to CLOCK	0		ms
t5	Hold time, data valid after CLOCK-HIGH	10		ms
t6	Request to send / start bit		5	ms
t7	Set-up time DATA to CLOCK controller input	5		ms
t8	Hold time CLOCK to DATA controller input	0		ms
t9	Delay CLOCK DATA / stop bit	5	25	ms
t10	Delay CLOCK DATA HIGH / stop bit	5	25	ms

4.3 Command Codes of the PS/2 USB-System

All checked commands are supported.

Host to Keyboard Commands

Code	Description	Implemented	Note
$ED	Set status indicators	X	
$EE	Echo	X	
$F0	Set alternate Scan Code	X	
$F2	Get keyboard ID	X	
$F3	Set typematic repeat rate	X	
$F4	Enable Scan	X	
$F5	Disable Scan	X	
$F6	Set default values	X	
$FE	Resent the last command	X	
$FF	Reset	X	

Keyboard to Host Commands

Code	Description	Implemented
$00	Keyboard detection or overrun error	X
$AA	Basic assurance test passed	X
$FA	Acknowledge	X

4.4 Acoustic Signal Generator

2 pin connector 2.54 grid for jump plugs.

Pin:	Signal Identification
1	Trans. OC
2	Beeper

Comment: plugged in – signal generator enabled

4.5 The USB Interface

4.5.1 Connecting the Controller to the USB System

The USB system is connected through connector J11.
Connector type: Molex strip 5p 90° RM 1.25 mm-SMD Molex

Pin Assignment of Connector J11

Pin:	Signal Identification
1	Supply voltage + 5 V
2	GROUND
3	Data
4	CLOCK
5	NC

Connector type sockets FPC strip 10 pin 90°:

4.5.2 Connection to the USB-System

The firmware implements, as required for all multi-media keyboards, a USB composite device with two interfaces. For this reason, the hardware assistant will appear multiple times during the initial installation with Windows. This is normal, since a total of three HID drivers of the operating system have to be installed consecutively for the GCK-978. Three devices total will also appear in the device manager (see screen shot; here, GCK-978 is operated at a USB hub with Windows 98):

HID compatible keyboard
HID compatible control unit
HID compatible system control unit

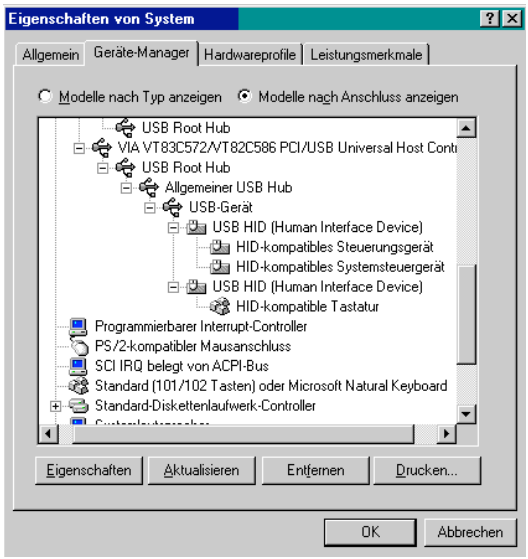


fig. 4-3 Device Manager

4.6 Serial Interface RS232

(optional)
Connector J14 connects the RS232.

Connector type 5 pin BM05B

Pin Assignment of Connector J14:

PIN	Signal Identification
1	GND
2	TXD
3	RXD
4	RTS
5	CTS

4.7 Magnetic Card Reader

4.7.1 Description

The magnetic card reader works with magnetic cards of the type ISO 3554.

Connection:
Through connector J20, a magnetic card reader with up to three tracks can be connected.

Pin Assignment of Connector J20

Pin:	Signal Identification
1	CLS
2	TR2 DATA
3	TR1 CLK
4	TR2 CLK
5	TR1 DATA
6	TR3 DATA
7	VCC CARD
8	GROUND
9	TR3 CLK
10	GROUND

The data on the card reader are transmitted through the PS/2 / USB interface as if these keys had been pressed.

The magnetic strip can contain up to three tracks with serial data. Recording density and number of bits per character vary from track to track in accordance with ISO 3554, resulting in a different maximum number of characters that can be stored on each track.
For track 1, this is 79 characters, for track 2 a maximum of 40, and for track 3 a maximum of 107 characters including start and stop characters.

Track	bpi	bit	Characters
1	210	7	79
2	75	5	40
3	210	5	107

According to the norm, just track 1 and 2 are read during operation. Only track 3 is also intended for writing.

The magnetic card reader can be combined with: USB, Bluetooth, RS232/TTL, and IrDA-9 wire; but not with: HP-Ir, GeBE-Ir, or IrDA IrLPT

Operation:
After sliding the card, the LED will light up for about two seconds to signal an accurate reading. In case of an error, the LED will flash three times very fast.
As long as the LED is lit, a new reading process is not possible. After the LED has gone out, the internal buffers are prepared for a new reading process, and the reader waits for a new card.

The printer prints the card data for each track with a header. The data set is completed with a check sum.

The card data for each track contain:
- the number of data on the track
- status byte (type of error if applicable)
- data

You will find an exact description in the software manual.

Applications:
Track 1 and 2 for credit cards
Track 2 and 3 for check cards
Track 2 for access control
Track 3 for time recording

EuroCheck Card		
Track	**Position**	**Content**
2	1-3	Identification 672
2	9-18	Account number
2	21-22	Year validity expires
2	23-24	Month validity expires
3	1-4	Identification (0159, EC card)
3	5-12	Bank identification number
3	14-23	Account number
3	37-40	Amount that can still be withdrawn
3	41	Last digit of year of last withdrawal
3	61-62	Year validity expires
3	63-64	Month validity expires

Check Card		
Track	**Position**	**Content**
2	x	Like EC card
3	1-4	Identification (0059, check card)
3	9-24	Like EC card

Credit Card		
Track	**Position**	**Content**
1	2-17	Credit card number
1	19-44	Family name of card owner
1	46-47	Year validity expires
1	48-49	Month validity expires
2	1-16	Credit card number
2	18-19	Year validity expires
2	20-21	Month validity expires

Track 1	Alpha Characters				
P 543210	**hex**			**hex**	
1 000000	00	space	0 100000	20	@
0 000001	01	!	1 100001	21	A
0 000010	02	,,	1 100010	22	B
1 000011	03	#	0 100011	23	C
0 000100	04	$	1 100100	24	D
1 000101	05	%(start)	0 100101	25	E
1 000110	06	&	0 100110	26	F
0 000111	07	'	1 100111	27	G
0 001000	08	(	0 101010	28	H
1 001001	09	)	1 101011	29	I
1 001010	0A	*	1 101000	2A	J
0 001011	0B	+	0 101001	2B	K
1 001100	0C	,	0 101100	2C	L
0 001101	0D	-	1 101101	2D	M
0 001110	0E	.	1 101110	2E	N
1 001111	0F	/	0 101111	2F	O
0 010000	10	0	1 110000	30	P
1 010001	11	1	0 110001	31	Q
1 010010	12	2	0 110010	32	R
0 010011	13	3	1 110011	33	S
1 010100	14	4	0 110100	34	T
0 010101	15	5	1 110101	35	U
0 010110	16	6	1 110110	36	V
1 010111	17	7	0 110111	37	W
1 011000	18	8	1 111010	38	X
0 011001	19	9	0 111011	39	Y
0 011010	1A	:	0 111000	3A	Z
1 011011	1B	;	1 111001	3B	[
0 011100	1C	<	1 111100	3C	\
1 011101	1D	=	0 111101	3D	]
0 011110	1E	>	0 111110	3E	^(field)
0 011111	1F	? (end)	1 111111	3F	_

Track 2 and 3	Numeric Characters	
P 3210	Equates to	Meaning
1 0000	0	
0 0001	1	
0 0010	2	
1 0011	3	
0 0100	4	
1 0101	5	
1 0110	6	
0 0111	7	
0 1000	8	
1 1001	9	
1 1010	:	control
0 1011	;	start sentinel
1 1100	<	control
0 1101	=	field seperator
0 1110		control
1 1111	?	end sentinel

4.8 I2C Bus

Controlling of a I2C display through the implemented bus is under way.

Parameter bytes:

Bit 7 is always 0

Bit 5 and bit 6 determine the delay time.

Bit 6	Bit 5	delay time
0	0	250 ms ± 2 %
0	1	500 ms ± 2 %
1	0	750 ms ± 2 %
1	1	1 s ± 2 %

Bit 0 to Bit 4 determine the repetition rate

Bits 4 to 0	frequency (Hz)
00000	30.0
00001	26.4
.	.
.	.
01111	8.0
10000	7.5
.	.
.	.
11110	2.1
11111	2.0

4.9 Power Connector

J1 and J2

J1 terminal screw RM 2.0

Pin:	Signal Identification
1	GND
2	Vcc

J2 Connector JST B02B-EH-A

Pin:	Signal Identification
1	GND
2	Vcc

5 Technical Data

5.1 Selected Operating Parameters in the Standard Flash

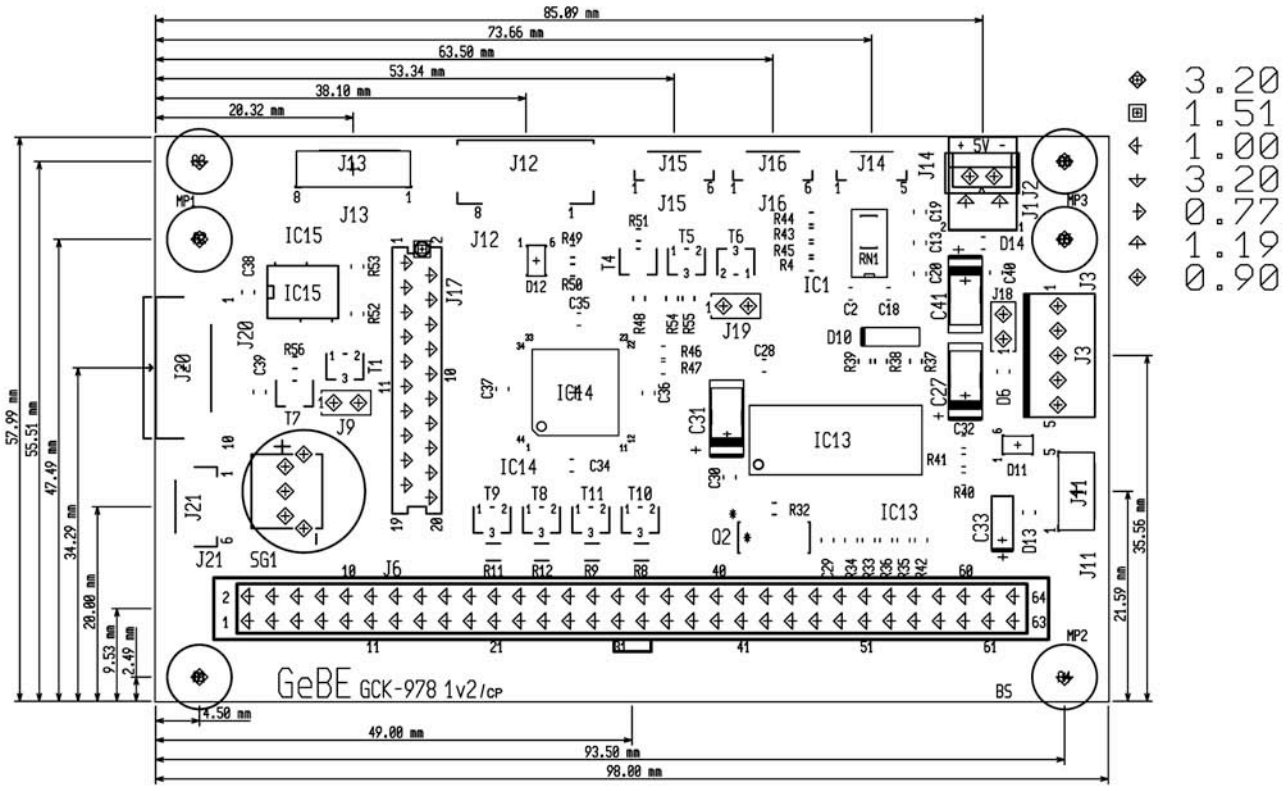
The following parameters are set during the initialization:

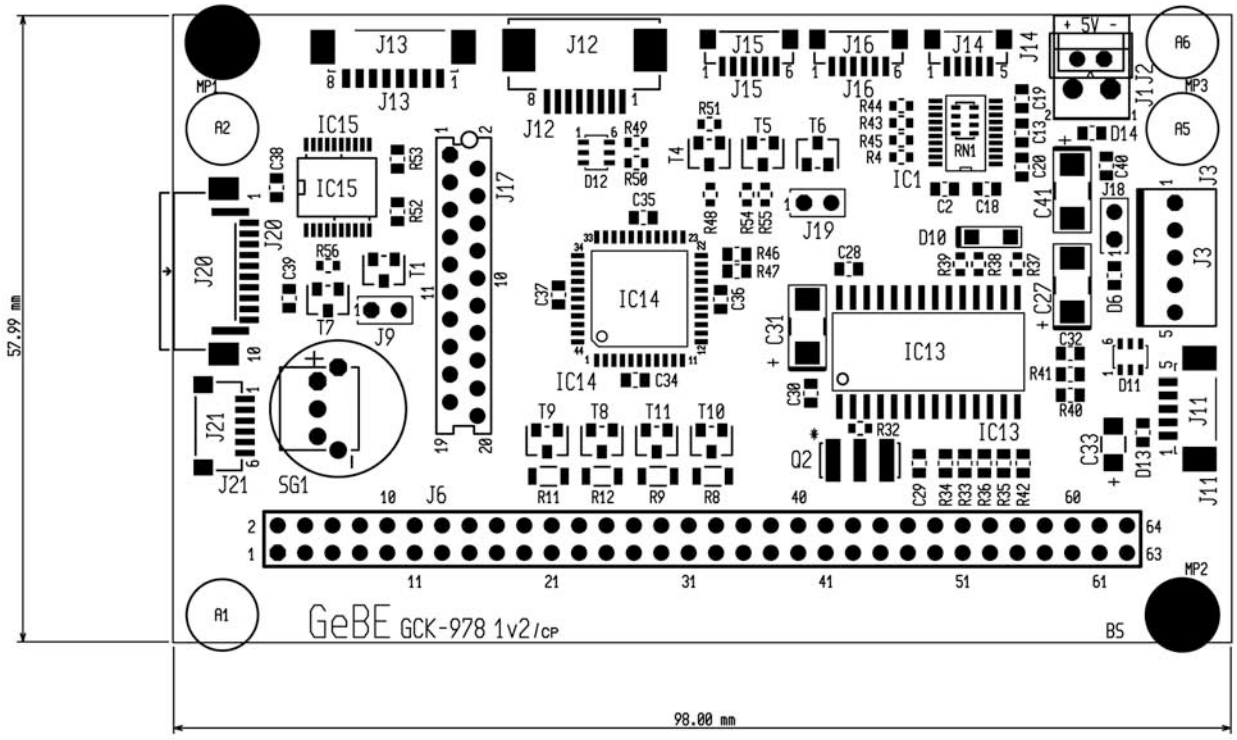
Debounce Time:	app. 40 ms
Standard waiting time for repetition begin:	app. 500 ms
Repetition rate:	app. 10 characters/s
Power-ON time:	app. 400 ms

5.2 Technical Specifications

Interface	PS/2 and USB low speed (USB2.0 compatible)	
Power Supply	+5 V ± 5 %, max. app. 12 mA	
Dimensions	98 x 60 x 11	(length x width x height in mm):
Weight	app. 60 g	(with all components)
Operating Temperature	0 … +70°C	
Storage Temperature	-15 … +70°C	

5.3 Arrangement of Connectors and Mechanical Dimensions





6 Standard Versions

Controller	Version	USB	PS/2	RS232	TTL	MCARD	I2C_1 J15	I2C_2 J16	Buzzer	Key S2	Touch J12/J13	Connector PS/2 J3	Connector USB/PS/2 J11
GCK-978	PS/2-USB	X	X	-	-	-	-	-	X	-	-	-	X
GCK-978	EVAL	X	X	X	-	X	X	-	X	-	X	-	X

6.1 Custom Programming

(in preparation)

6.1.1 Matrix Download of the GCK-978

The current version allows custom key assignments at the factory.
A matrix download through the USB interface with the help of a PC program is under way**.**

6.2 Standard Assignment of the GCK-978

The keys are assigned so that typical combinations of multiple keys don't create "ghost keys"**.**

	R0	R1	R2	R3	R4	R5	R6	R7
C0	ESC	1 !	w W	d D	b B	-		L mouse
C1	F1	2 "	e E	f F	n N	Left Arrow		M mouse
C2	F2	3 §	r R	g G	m M	Down Arrow		R mouse
C3	F3	4 $	t T	h H	, ;	Right Arrow		
C4	F4	5 %	z Z	j J	. :			
C5	F5	6 &	u U	k K	- _			
C6	F6	7 /	i I	l L	SPACE			
C7	F7	8 (	o O	ö Ö	INSERT			
C8	F8	9)	p P	ä Ä	POS1			
C9	F9	0 =	ü Ü	# ~	PAGE UP			
C10	F10	ß ?	+ *	< >	DELETE			
C11		´ `	RETURN	y Y	END		L GUI (Win)	L Shift
C12	R Shift	R CTRL	Application (WIN)	R GUI (WIN)	R ALT	L ALT	L CTRL	Function Shift1
C13	Print Screen	Back space	Caps Lock (not lock)	x X	PAGE DOWN			
C14	PAUSE	TAB	a A	c C	Keypad +			
C15	^ °	q Q	s S	v V	Up Arrow			

7 Appendix

7.1 Appendix W: Scan Codes of the PS/2 / USB Keyboard

USB Usage Code	USB Usage Code	Version US	Version GER	AT Keys No.	PS/2 Code Set 2 Make /Brake
4	$04	Keyboard a / A	Tastatur a / A	31	1C / F0 1C
5	$05	Keyboard b / B	Tastatur b / B	50	32 / F0 32
6	$06	Keyboard c / C	Tastatur c / C	48	21 / F0 21
7	$07	Keyboard d / D	Tastatur d / D	33	23 / F0 23
8	$08	Keyboard e / E	Tastatur e / E	19	24 / F0 24
9	$09	Keyboard f / F	Tastatur f / F	34	2B / F0 2B
10	$0A	Keyboard g / G	Tastatur g / G	35	34 / F0 34
11	$0B	Keyboard h / H	Tastatur h / H	36	33 / F0 33
12	$0C	Keyboard i / I	Tastatur i / I	24	43 / F0 43
13	$0D	Keyboard j / J	Tastatur j / J	37	3B / F0 3B
14	$0E	Keyboard k / K	Tastatur k / K	38	42 / F0 42
15	$0F	Keyboard l / L	Tastatur l / L	39	4B / F0 4B
16	$10	Keyboard m / M	Tastatur m / M	52	3A / F0 3A
17	$11	Keyboard n / N	Tastatur n / N	51	31 / F0 31
18	$12	Keyboard o / O	Tastatur o / O	25	44 / F0 44
19	$13	Keyboard p / P	Tastatur p / P	26	4D / F0 4D
20	$14	Keyboard q / Q	Tastatur q / Q	17	15 / F0 15
21	$15	Keyboard r / R	Tastatur r / R	20	2D / F0 2D
22	$16	Keyboard s / S	Tastatur s / S	32	1B / F0 1B
23	$17	Keyboard t / T	Tastatur t / T	21	2C / F0 2C
24	$18	Keyboard u / U	Tastatur u / U	23	3C / F0 3C
25	$19	Keyboard v / V	Tastatur v / V	49	2A / F0 2A
26	$1A	Keyboard w / W	Tastatur w / W	18	1D / F0 1D
27	$1B	Keyboard x / X	Tastatur x / X	47	22 / F0 22
28	$1C	Keyboard y / Y	Tastatur z / Z	22	35 / F0 35
29	$1D	Keyboard z / Z	Tastatur y / Y	46	1A / F0 1A
30	$1E	Keyboard 1 / !	Tastatur 1 / !	2	16 / F0 16
31	$1F	Keyboard 2 / @	Tastatur 2 / "	3	1E / F0 1E
32	$20	Keyboard 3 / #	Tastatur 3 / §	4	26 / F0 26
33	$21	Keyboard 4 / $	Tastatur 4 / $	5	25 / F0 25
34	$22	Keyboard 5 / %	Tastatur 5 / %	6	2E / F0 2E
35	$23	Keyboard 6 / ^	Tastatur 6 / &	7	36 / F0 36
36	$24	Keyboard 7 / &	Tastatur 7 / /	8	3D / F0 3D
37	$25	Keyboard 8 / C70*	Tastatur 8 / (	9	3E / F0 3E
38	$26	Keyboard 9 / (	Tastatur 9 /)	10	46 / F0 46
39	$27	Keyboard 0 /)	Tastatur 0 / =	11	45 / F0 45
40	$28	Keyboard RETURN	Tastatur EINGABE	43	5A / F0 5A
41	$29	Keyboard ESCAPE	Tastatur ESCAPE	110	76 / F0 76
42	$2A	Keyboard BACKSPACE	Tastatur BACKSPACE	15	66 / F0 66
43	$2B	Keyboard TAB	Tastatur TAB	16	0D / F0 0D
44	$2C	Keyboard SPACE	Tastatur LEER	61	29 / F0 29
45	$2D	Keyboard - / _	Tastatur ß / ?	12	4E / F0 4E
46	$2E	Keyboard = / +	Tastatur ´/ `	13	55 / F0 55
47	$2F	Keyboard [/ {	Tastatur ü / Ü	27	54 / F0 54
48	$30	Keyboard] / }	Tastatur + / *	28	5B / F0 5B
49	$31	Keyboard \ / |		29	5D / F0 5D

USB Usage Code	USB Usage Code	Version US	Version GER	AT Keys No.	PS/2 Code Set 2 Make /Brake
50	$32		Tastatur # / ~ 102 TASTEN	42	5D / F0 5D
51	$33	Keyboard ; / :	Tastatur ö / Ö	40	4C / F0 4C
52	$34	Keyboard ' / "	Tastatur ä / Ä	41	52 / F0 52
53	$35	Keyboard `/ ~	Tastatur ^ / °	1	0E / F0 0E
54	$36	Keyboard , / <	Tastatur , / ;	53	41 / F0 41
55	$37	Keyboard . / >	Tastatur . / :	54	49 / F0 49
56	$38	Keyboard / / ?	Tastatur - / _	55	35 / F0 35
57	$39	Keyboard CAPS LOCK	Tastatur CAPS	30	58 / F0 58
58	$3A	Keyboard F1	Tastatur F1	112	05 / F0 05
59	$3B	Keyboard F2	Tastatur F2	113	06 / F0 06
60	$3C	Keyboard F3	Tastatur F3	114	04 / F0 04
61	$3D	Keyboard F4	Tastatur F4	115	0C / F0 0C
62	$3E	Keyboard F5	Tastatur F5	116	03 / F0 03
63	$3F	Keyboard F6	Tastatur F6	117	0B / F0 0B
64	$40	Keyboard F7	Tastatur F7	118	83 / F0 83
65	$41	Keyboard F8	Tastatur F8	119	0A / F0 0A
66	$42	Keyboard F9	Tastatur F9	120	01 / F0 01
67	$43	Keyboard F10	Tastatur F10	121	09 / F0 09
68	$44	Keyboard F11	Tastatur F11	122	78 / F0 78
69	$45	Keyboard F12	Tastatur F12	123	07 / F0 07
70	$46	Keyboard PRINT SCREEN	Tastatur DRUCK	124	E0 12 E0 7C / EO F0 7C E0 F0 12
71	$47	Keyboard SCROLL LOCK	Tastatur ROLLEN	125	7E / F0 7E
72	$48	Keyboard PAUSE	Tastatur PAUSE	126	E1 14 77 / E1 F0 14 F0 77
73	$49	Keyboard INSERT	Tastatur EINFG	75	E0 70 / E0 F0 70
74	$4A	Keyboard HOME	Tastatur POS 1	80	E0 6C / E0 F0 6C
75	$4B	Keyboard PAGE UP	Tastatur BILD OBEN	85	E0 7D / E0 F0 7D
76	$4C	Keyboard DELETE	Tastatur ENTF	76	E0 71 / E0 F0 71
77	$4D	Keyboard END	Tastatur ENDE	81	E0 69 / E0 F0 69
78	$4E	Keyboard PAGE DOWN	Tastatur BILD UNTEN	86	E0 7A / E0 F0 7A
79	$4F	Keyboard RIGHT ARROW	Tastatur PFEIL RECHTS	89	E0 74 / E0 F0 74
80	$50	Keyboard LEFT ARROW	Tastatur PFEIL LINKS	79	E0 6B / E0 F0 6B
81	$51	Keyboard DOWN ARROW	Tastatur PFEIL UNTEN	84	E0 72 / E0 F0 72
82	$52	Keyboard UP ARROW	Tastatur PFEIL OBEN	83	E0 75 / E0 F0 75
83	$53	Keyboard NUM LOCK / CLEAR	Tastatur NUM	90	77 / F0 77
84	$54	Keypad /	num. Block /	95	E0 4A / E0 F0 4A
85	$55	Keypad *	num. Block *	100	7C / F0 7C
86	$56	Keypad -	num. Block -	105	7B / F0 7B
87	$57	Keypad +	num. Block +	106	79 / F0 79
88	$58	Keypad ENTER	num. Block EINGABE	108	E0 5A / E0 F0 5A
89	$59	Keypad 1 / END	num. Block 1 / ENDE	93	69 / F0 69
90	$5A	Keypad 2 / DOWN ARROW	num. Block 2 / PFEIL UNTEN	98	72 / F0 72
91	$5B	Keypad 3 / PAGE DOWN	num. Block 3 / BILD UNTEN	103	7A / F0 7A
92	$5C	Keypad 4 / LEFT ARROW	num. Block 4 / PFEIL LINKS	92	6B / F0 6B
93	$5D	Keypad 5	num. Block 5	97	73 / F0 73
94	$5E	Keypad 6 / RIGHT ARROW	num. Block 6 / PFEIL RECHTS	102	74 / F0 74
95	$5F	Keypad 7 / HOME	num. Block 7 / POS 1	91	6C / F0 6C
96	$60	Keypad 8 / UP ARROW	num. Block 8 / PFEIL OBEN	96	75 / F0 75
97	$61	Keypad 9 / PAGE UP	num. Block 9 / BILD OBEN	101	7D / F0 7D
98	$62	Keypad 0 / INSERT	num. Block 0 / EINFG	99	70 / F0 70
99	$63	Keypad . / DELETE	num. Block . / ENTF	104	71 / F0 71

USB Usage Code	USB Usage Code	Version US	Version GER	AT Keys No.	PS/2 Code Set 2 Make /Brake
100	$64	Keyboard \ / |	Tastatur < / > 102 KEYS	45	61 / F0 61
101	$65	Keyboard APPL MENU (Windows)	Tastatur MENU (Windows)	129	E0 2F / E0 F0 2F
		Special Keys			
224	$E0	Keyboard LEFT CONTROL		58	14 / F0 14
225	$E1	Keyboard LEFT SHIFT		44	12 / F0 12
226	$E2	Keyboard LEFT ALT (Option)		60	11 / F0 11
227	$E3	Keyboard LEFT GUI (Windows)	Tastatur GUI (Windows)	127	E0 1F / E0 F0 1F
228	$E4	Keyboard RIGHT CONTROL		64	E0 14 / E0 F0 14
229	$E5	Keyboard RIGHT SHIFT		57	59 / F0 59
230	$E6	Keyboard RIGHT ALT (Option)		62	E0 11 / E0 F0 11
231	$E7	Keyboard RIGHT GUI (Windows)	Tastatur GUI (Windows)	128	E0 27 / E0 F0 27

7.2 Appendix X:

Multimedia and Power Management Codes of the PS/2 Keyboard

Power	E0 37 / E0 F0 37	AL Email Reader	E0 48 / E0 F0 48
Sleep	E0 3F / E0 F0 3F	AC search	E0 10 / E0 F0 10
Wake	E0 5E / E0 F0 5E	AC Home	E0 3A / E0 F0 3A
Scan next Track	E0 4D / E0 F0 4D	AC Forward	E0 30 / E0 F0 30
Scan previous Track	E0 15 / E0 F0 15	AC Stop	E0 28 / E0 F0 28
Stop	E0 3B / E0 F0 3B	AC Refresh	E0 20 / E0 F0 20
Play Pause	E0 34 / E0 F0 34	AC Bookmarks	E0 18 / E0 F0 18
Mute	E0 23 / E0 F0 23	AC Calculator	E0 2B / E0 F0 2B
Volume increase	E0 32 / E0 F0 32	AC Local Browser	E0 40 / E0 F0 40
Volume decrease	E0 21 / E0 F0 21	AC Consumer Control Configuration	E0 50 / E0 F0 50

7.3 Appendix Y:

Multimedia and Power Management Codes of the USB Keyboard

102	$66	Power	139	$8B	Keyboard International 5	187	$BB	Keypad BS
103	$67	Keypad =	140	$8C	Keyboard International 6	188	$BC	Keypad A
104	$68	Keyboard F13	141	$8D	Keyboard International 7	189	$BD	Keypad B
105	$69	Keyboard F14	142	$8E	Keyboard International 8	190	$BE	Keypad C
106	$6A	Keyboard F15	143	$8F	Keyboard International 9	191	$BF	Keypad D
107	$6B	Keyboard F16	144	$90	Keyboard LANG 1	192	$C0	Keypad E
108	$6C	Keyboard F17	145	$91	Keyboard LANG 2	193	$C1	Keypad F
109	$6D	Keyboard F18	146	$92	Keyboard LANG 3	194	$C2	Keypad XOR
110	$6E	Keyboard F19	147	$93	Keyboard LANG 4	195	$C3	Keypad ^
111	$6F	Keyboard F20	148	$94	Keyboard LANG 5	196	$C4	Keypad %
112	$70	Keyboard F21	149	$95	Keyboard LANG 6	197	$C5	Keypad <
113	$71	Keyboard F22	150	$96	Keyboard LANG 7	198	$C6	Keypad >
114	$72	Keyboard F23	151	$97	Keyboard LANG 8	199	$C7	Keypad &
115	$73	Keyboard F24	152	$98	Keyboard LANG 9	200	$C8	Keypad &&
116	$74	Keyboard Execute	153	$99	Keyboard Alternate Erase	201	$C9	Keypad I
117	$75	Keyboard Help	154	$9A	Keyboard SysReq/Attention	202	$CA	Keypad II
118	$76	Keyboard Menu	155	$9B	Keyboard Cancel	203	$CB	Keypad :
119	$77	Keyboard Select	156	$9C	Keyboard Clear	204	$CC	Keypad #
120	$78	Keyboard Stop	157	$9D	Keyboard Prior	205	$CD	Keypad Space
121	$79	Keyboard Again	158	$9E	Keyboard Return	206	$CE	Keypad @
122	$7A	Keyboard Undo	159	$9F	Keyboard Separator	207	$CF	Keypad !
123	$7B	Keyboard Cut	160	$A0	Keyboard Out	208	$D0	Keypad Memory Store
124	$7C	Keyboard Copy	161	$A1	Keyboard Oper	209	$D1	Keypad Memory Recall
125	$7D	Keyboard Paste	162	$A2	Keyboard Clear Again	210	$D2	Keypad Memory Clear
126	$7E	Keyboard Find	163	$A3	Keyboard CrSel/Props	211	$D3	Keypad Memory Add
127	$7F	Keyboard Mute	164	$A4	Keyboard ExSel	212	$D4	Keypad Memory Subtract
128	$80	Keyboard Volume up	176	$B0	Keypad 00	213	$D5	Keypad Memory Multiply
129	$81	Keyboard Volume Down	177	$B1	Keypad 000	214	$D6	Keypad Memory Divide
130	$82	Keyboard Locking Caps Lock	178	$B2	Thousands Separator	215	$D7	Keypad ±
131	$83	Keyboard Locking Num Lock	179	$B3	Decimal Separator	216	$D8	Keypad Clear
132	$84	Keyboard Locking Scroll Lock	180	$B4	Currency Unit	217	$D9	Keypad Clear Entry
133	$85	Keypad Comma	181	$B5	Currency Sub-Unit	218	$DA	Keypad Binary
134	$86	Keypad Equal Sign	182	$B6	Keypad (	219	$DB	Keypad Octal
135	$87	Keyboard International 1	183	$B7	Keypad)	220	$DC	Keypad Decimal
136	$88	Keyboard International 2	184	$B8	Keypad {	221	$DD	Keypad Hexadecimal
137	$89	Keyboard International 3	185	$B9	Keypad }			
138	$8A	Keyboard International 4	186	$BA	Keypad Tab			

7.4 Appendix Z:

Sample of Code Table Form

Please enter the required key numbers in the appropriate fields.

	R0	R1	R2	R3	R4	R5	R6	R7
C0								
C1								
C2								
C3								
C4								
C5								
C6								
C7								
C8								
C9								
C10								
C11								
C12								
C13								
C14								
C15								
C16								
C17								
C18								
C19								