

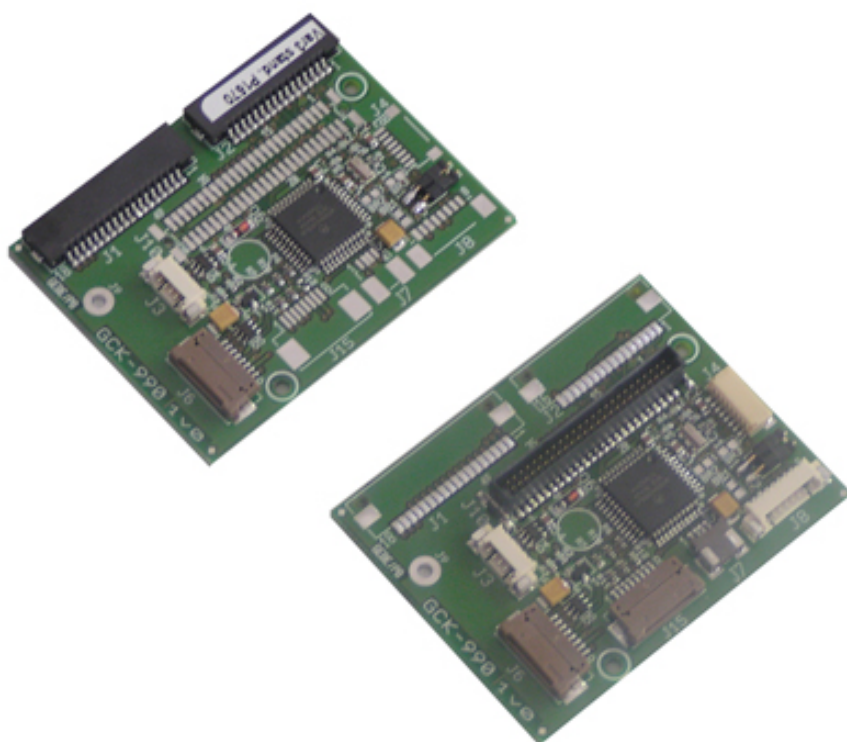
User Manual

## Series GCK-990

**PS/2 – USB COMPATIBLE  
Keyboard Controller  
Hardware and Software**

GeBE Document No.:

# Man-E-521



**Compact PS/2 - USB Keyboard Controller GCK-990**

**Industrial Keyboards**

**GFT-104** (GCK-990)

**KWD-85** (GCK-977)

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**GeBE Computer & Peripherie GmbH**

zur Heupresse 4 • D-82140 Olching • Germany  
Phone ++49+8142/ 669 58-0 • FAX: ++49+8142/ 669 58-11



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# CONTENTS

- 1. Short Description**
- 2. Description of the Controller Functions**
- 3. The PS/2 Interface**
- 4. The USB Interface**
- 5. The Mouse Slave Port**
- 6. Technical Data, Operating Parameters**
- 7. Custom Programming**

**APPENDIX A: Keyboard Membrane GFT-104**

**APPENDIX K: Silicone Industrial Keyboard KWD-85**

**Appendix W: Scan codes of the PS/2 / USB Keyboard**

**Appendix X: Multimedia and Power Management Codes of the PS/2 Keyboard**

**Appendix Y: Multimedia and Power Management Codes of the USB Keyboard**

**Appendix Z: Sample for Code Table Form**

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# 1. SHORT DESCRIPTION

## 1.1. Keyboard Function and Applications

In a matrix, between one and 144 keys can be connected. Practically any current keyboard with a transfer resistance of less than 500  $\Omega$  and diodes located at the points of intersection of the matrix can be used (such as membrane, contact, and rubber keyboards). The keyboard program has full N-key rollover and auto repeat features. A function key (Fn) can be put in the key matrix (Fn), creating an alternative assignment for 143 keys maximum as long as the Fn key is held down. An internal jumper allows the user to switch between US and German key assignment. Double assignment is available for up to three keys. For up to eight key positions, key sequences with ten keys or key combinations (e.g. CTRL F10) maximum can be programmed at the factory on request. Three LEDs to display the functions CAPS-LOCK, NUM-LOCK, SCROLL-LOCK are implemented on the controller. A power-on LED can be connected through a 1-KOhm resistance. In USB sleep mode, this is turned off.

## 1.2. Hardware Configuration

- \* single chip  $\mu$ P with 8 Kbyte in system programmable flash and 256 bytes RAM
- \* outputs for 3 low current LED's (capacity: pull max. 5 mA against GND)
- \* 1 individual connector for the PS/2 and USB interface
- \* 2 FPC connectors plus an optional 50 pin strip for the keyboard matrix
- \* 1 connector for the firmware download
- \* 4 connectors for PS/2 mouse devices
- \* 1 shield connection for a shield layer in the membrane keyboard

## 1.3. The Interface

The keyboard controller has a PS/2–USB double function interface consisting of a CLOCK/DATA line with PS/2 port or a D+/D- line with USB port plus power supply lines. The interface automatically recognizes the PS/2 or USB interface, when the device is plugged in.

In USB operating mode, the controller/keyboard acts as 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 (7/4/99). The keyboard is USB 2.0 compatible. The HID reports of the standard keys according to the HID specification as boot device have been implemented. The power management features "Suspend", "Resume", and "Remote Wakeup" are supported. In the PS/2 operating mode, scan code 2 is supported. The system is prepared for the support of "Multimedia" and "Power Management" keys. In the USB operating mode, this is enabled with an additional end point 2 in the PS/2 operating mode through special scan codes. An HID mouse that is connected to the GCK-990 as PS/2 mouse is available as an alternative to the "Multimedia" and "Power Management" device. See chapter 5.

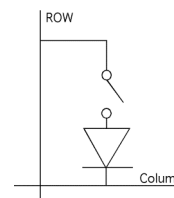
## 2. DESCRIPTION OF THE CONTROLLER FUNCTIONS

### 2.1. Controller Functionality

#### 2.1.1. Full-N-Key-Rollover

The function "Full-N-Key-Rollover" is programmed. With this function, the program can recognize all keys that are pressed in the matrix, even if several keys are pressed simultaneously. The auto-repeat function, however, always affects the key that was pressed last. If multiple keys of a key matrix are pressed simultaneously, additional key codes (ghost keys) that are not wanted in reality may be generated.

The use of decoupling diodes at the points of intersection is the most effective solution to prevent ghost keys in this case. The diodes may generate no more than 0.3 V flow voltage. They have to be connected to the particular row (row R0-R7) of the key.



The GCK-990 (GCK-977) software features sophisticated ghost key detection, so the use of decoupling diodes is not mandatory.

The existence of a ghost key is recognized by the software, and all keys that are pressed are replaced by an error message, meaning that in this situation, the PC will start beeping.

Important: often used key combinations (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.

#### 2.1.2. 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. In the PS/2 table, code 130 (dec) has been defined as the "FUNCTION" shift code, and code AC (hex) in the USB table.

### **2.1.3. Typematic Rate of the PS/2 System**

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 ms. The auto-repeat rate is app. 10 characters/s.

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, 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.

### **2.1.4. Debounce Time**

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

### **2.1.5. Key Memory**

The controller has a FIFO memory (First In - First Out) for 16 bytes that buffers the key codes before they are put out. 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 17<sup>th</sup> code of the printed key. The following key strokes will be ignored.

### **2.1.6. Power On**

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



J10 Pin:	J2 Pin	J1 Pin	Signal Name: GCK-990	Signal Direction:
1	1		LED PowerOn (1 KOhm at GND) turned off during sleep mode	output
2	2		center mouse key	input
3	3		LED scroll lock	output
4	4		LED NUM-LOCK	output
5	5		LED CAPS-LOCK	output
6	6		Vcc + 5V power	output
7	7		right mouse key	input
8	8		left mouse key	input
9	9		R 0	input
10	10		R 1	input
11	11		R 2	input
12	12		R 3	input
13	13		R 4	input
14	14		R 5	input
15	15		R 6	input
16	16		R 7	input
17		1	GND (for mouse keys), alternatively optional C17	output
18		2	C 0	output
19		3	C 1	output
20		4	C 2	output
21		5	C 3	output
22		6	C 4	output
23		7	C 5	output
24		8	C 6	output
25		9	C 7	output
26		10	C 8	output
27		11	C 9	output
28		12	C 10	output
29		13	C 11	output
30		14	C 12	output
31		15	C 13	output
32		16	C 14	output
33		17	C 15	output
34		18	C 16	output
35		-	C17	output
36		-	CODE: jumper J5 (switch GER / US )	input
37		-	GND	
38 - 50		-	NC	



## 3. THE PS/2 INTERFACE

### 3.1. Connecting the Controller to the PS/2 System

The connection to the PS/2 system is implemented through connector J3. Connecting cable GKA-503 is available from GeBE.

Pin Assignment of the Connector J3 Type Molex 53261-059

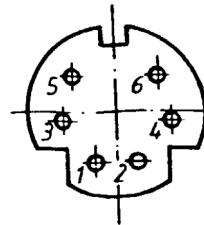
Pin:	Signal Name
1	Supply voltage + 5 V
2	GND
3	DATA
4	CLOCK
5	cable - frame conn. with GND

### 3.2. General Interface Description

This bidirectional interface is used for data exchange. The host system and keyboard controller are connected with each other through a CLOCK and a DATA line. The keyboard controller generates CLOCK pulses for the operating mode SEND, but also for the operating mode RECEIVE.

Data interface PS/2 formatted:

Pin	Connection at PS/2 Connector
1	Data
2	NC
3	GND
4	VCC
5	Clock
6	NC



#### 3.2.1. Definition of the Signal Lines

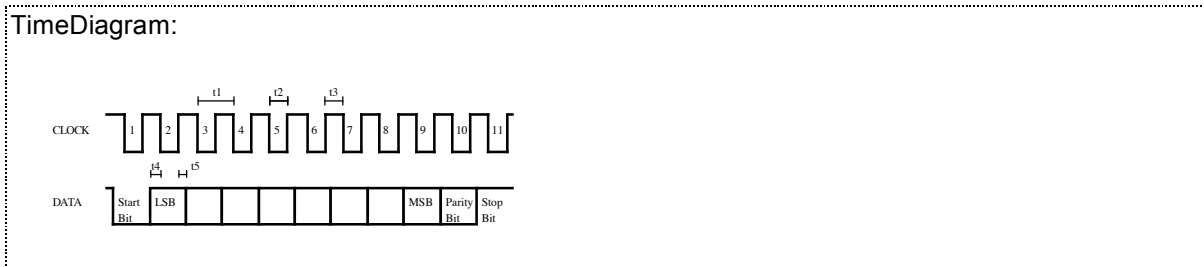
**CLOCK:** The keyboard controller generates the CLOCK line in the operating modes SEND and RECEIVE in order to synchronize data transfer in or out of the controller. The PS/2 system uses it to block the keyboard (CLOCK LOW). In idle state, CLOCK runs HIGH levels.

**DATA:** When sending data to the PS/2 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 system, the PS/2 system puts data onto the data line synchronously to the CLOCK impulses generated by the controller. The PS/2 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.

#### 3.2.2. Keyboard Controller Transmitting Data

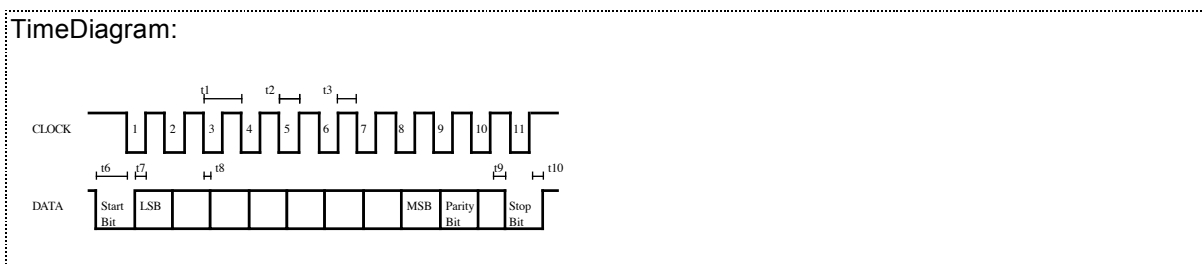
When the controller has recognized at least one key stroke and is ready to transmit, it will first check, if the keyboard is locked (CLOCK LOW), or if the PS/2 system (DATA LOW) requests to send. If the controller is locked (CLOCK of PS/2 system pulled to

LOW), data is buffered in the output buffer. When the DATA line of the PS/2 system is pulled to LOW, the PS/2 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  $\mu$ s to see, if the PS/2 system is pulling the CLOCK line to LOW. If this is the case before the rising edge of the 10<sup>th</sup> CLOCK signal (parity bit), the controller will stop the transmission attempt, release both lines (HIGH) and get ready for data reception from the PS/2 system. The code of the character, at which the interruption of transmission occurred, is buffered and put out at the next opportunity to send.



### 3.2.3. Keyboard Controller Receiving Data

Before the PS/2 system sends data to the controller, both lines are checked for HIGH levels. The PS/2 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 system will signal to the controller by blocking the DATA line (DATA LOW) that data is available. The controller will then read the data from the PS/2 system by applying CLOCK impulses. Data bits are read during CLOCK HIGH. After the 10<sup>th</sup> 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 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 system within 20 ms .



### 3.2.4. Characteristical Times during Transmission

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

### 3.4. 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	
\$F7	Set all keys typematic	—	Scan code set 3 only
\$F8	Set all keys make/break	—	Scan code set 3 only
\$F9	Set all keys make	—	Scan code set 3 only
\$FA	Set all keys typematic/make/break	—	Scan code set 3 only
\$FB	Set key type typematic	—	Scan code set 3 only
\$FC	Set key type make/break	—	Scan code set 3 only
\$FD	Set key type make	—	Scan code set 3 only
\$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
\$EE	Echo	X
\$FA	Acknowledge	X
\$FE	Resend	X

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## 4. THE USB INTERFACE

### 4.1. Connecting the Controller to the USB System

The USB system is connected through connector J3.  
Connecting cable GKA-504 is available from GeBE.

Pin Assignment of Connector J3 Type Molex 53261-0590

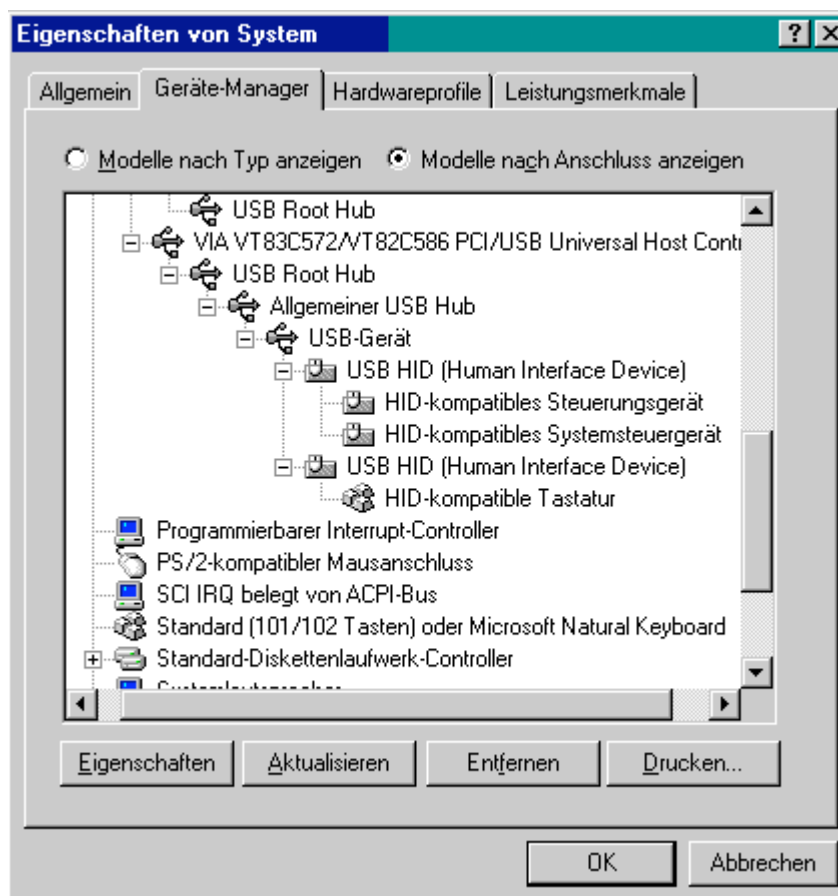
Pin:	Signal Name
1	Supply voltage + 5 V
2	GROUND
3	D -
4	D +
5	Frame

## 4.2. Installation at the USB Bus

As required for all multimedia keyboards, the firmware implements 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 are installed for the GCK-990. Three devices total will also appear in the device manager (see screen shot; here, GCK-990 is operated at a USB hub with Windows 98):

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

When a PS/2 mouse is connected, the device manager will show an HID compatible keyboard and a HID compatible mouse.



# 5. MOUSE SLAVE PORT

## 5.1. Description

A PS/2 mouse, a track ball, or a touchpad can be connected through connectors J6, 7, 8, and 15. With a PC, the mouse ONLY works in USB operation.

The mouse is connected as a USB device through the keyboard cable to the PC.

During mouse operation, the power management device and the multimedia device of the keyboard are not available, since this Endpoint is occupied by the mouse.

In the resume/suspend mode, the mouse is switched to dead-voltage.

Reactivation is only possible through the keyboard.

Pin Assignment of Connector J6 Type FFC-SMT-RM1.0, 8 pin  
To Connect a Synaptics Touchpad STP-1

Pin:	Signal Name
1	PS/2 Mouse DATA
2	NC
3	NC
4	Right mouse key
5	Left mouse key
6	GND
7	Supply voltage + 5 V
8	PS/2 mouse clock

Pin Assignment of Connector J15 Type FFC-SMT-RM1.0, 8 pin  
To Connect a GK16 Track Ball

Pin:	Signal Name
1	NC
2	Center mouse key
3	GND
4	Left mouse key
5	Right mouse key
6	PS/2 mouse clock
7	PS/2 mouse DATA
8	Supply voltage + 5 V

Pin Assignment of Connector J7 Type FFC-SMT-RM1.0, 4 pin  
To Connect Mouse Keys of a Cirque Touchpad

Pin:	Signal Name
1	Left mouse key
2	GND
3	GND
4	Right mouse key

Pin Assignment of Connector J8 Type Molex 53261-0890, 8 pin  
To Connect Different Mouse Devices

Pin J8	Signal Name	Cirque Touchpad TSM 9920 / 9925	Mini Joystick MB01 / MJ01	38 mm Track Ball GK-38 Con 1	38 mm Track Ball GK-38 Con 2
1	GND	1	NC	10	NC
2	Left mouse key	NC	NC	NC	1
3	GND	3	1	NC	4
4	Vcc	4	4	7	NC
5	PS/2 mouse DATA	5	8	8	NC
6	PS/2 mouse clock	6	3	9	NC
7	Center mouse key	NC	NC	NC	2
8	Right mouse key	NC	NC	NC	3

# 6. TECHNICAL DATA, OPERATING PARAMETERS

## 6.1. Set Operating Parameters in the Standard Flash

The following parameters are set during initialization:

- \* debounce time: app. 40 ms
- \* standard repeat start waiting time: app. 500 ms
- \* repeat rate app. 10 characters /s
- \* power-on time app. 400 ms

## 6.2. Technical Specifications

Interface:	PS/2 and USB low speed (USB2.0 compatible)
Power supply:	+5 V $\pm$ 5 %, max. app. 4 mA + max. 3 low current LEDs with app. 2.5 mA (max. app. 11.5 mA) USB suspend: app. 250 $\mu$ A
Dimensions (length x width x height in mm):	61 x 47 x 5.5 (standard type) 61 x 47 x 16 (EVAL type)
Weight:	app. 20 g (all components)
Operating temperature:	0 ... +70°C
Storage temperature:	-20 ... +80°C



## 6.3. Installation

### 6.3.1. Installation via Screw Fastening:

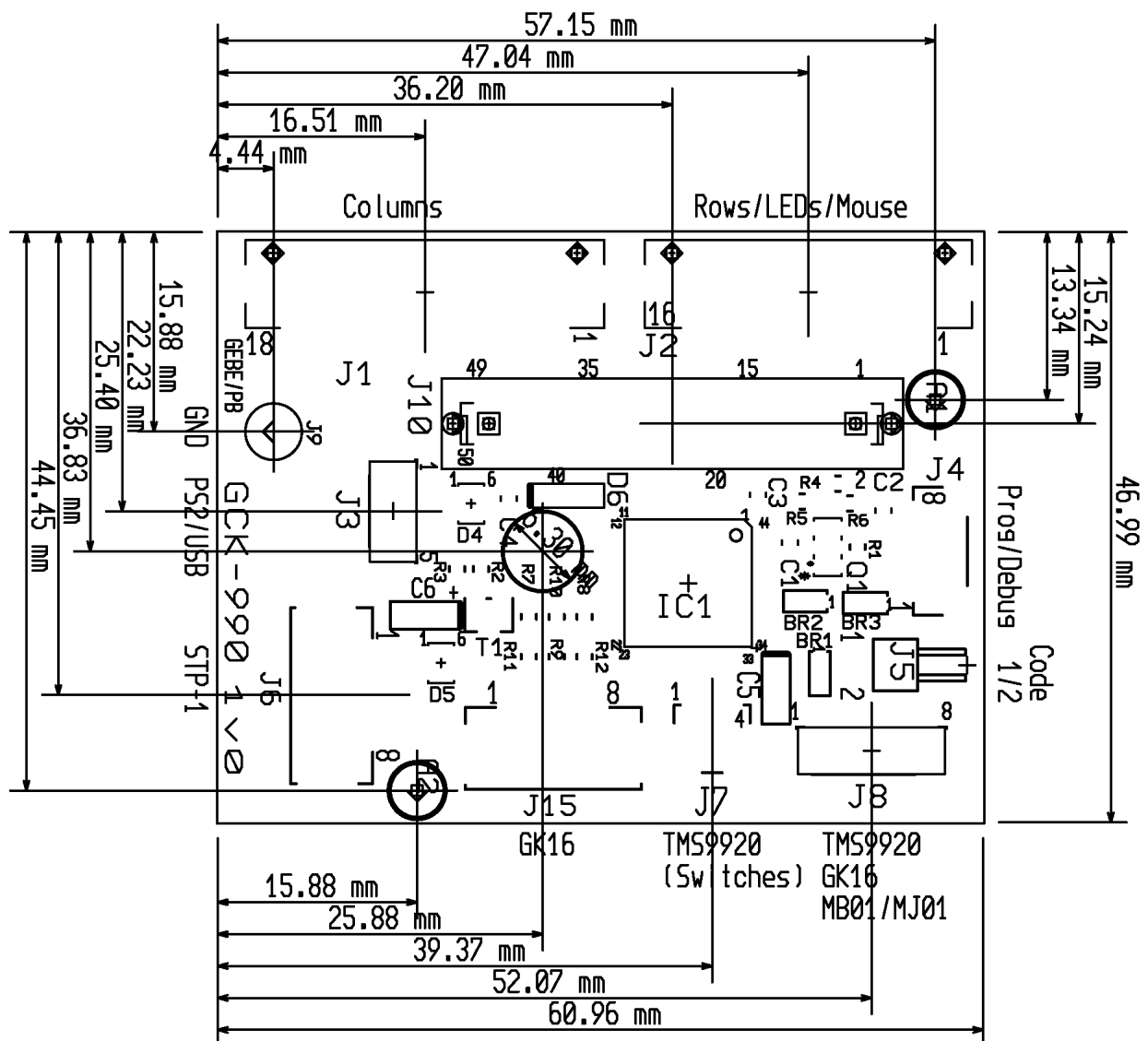
The GCK-990 can be mounted with three 3 screw holes each with a diameter of 2.2 mm for M2 screws. The hole at interface connector J9 is also connected to Frame. The frame shielding of a membrane keyboard can be connected here.

**Attention: Frame and GND are galvanically connected.**

### 6.3.2. Installation via Clamp Fastening:

The GCK-990 is completely flat on the bottom side of its circuit board.

Through the mechanical contact point with a 6.3 mm contact point in the center of the circuit board, the GCK-990 can be pressed against an inconductive surface.



# 7. CUSTOM PROGRAMMING

## 7.1. Firmware Download for the GCK-990

A firmware download can be done at the factory through the programming interface J4. This requires the programmer GCK-975-10. A firmware update at the customer site is only possible in connection with a licence agreement.

Pin Assignment of Connector J4, Type JST SH 8pin

Pin:	Signal Name
1	Supply voltage + 5 V
2	PTA 0
3	PTA 1
4	PTA 2
5	PTA 3
6	/IRQ
7	/RESET
8	GROUND

## 7.2. Selecting the Country Specific Code Table

In the German (102 keys) and the US keyboard layout (101 keys), the keys **#' \ |** and **< > nur Ger** are assigned differently.

J5 connected: 102 key assignment (**German**)

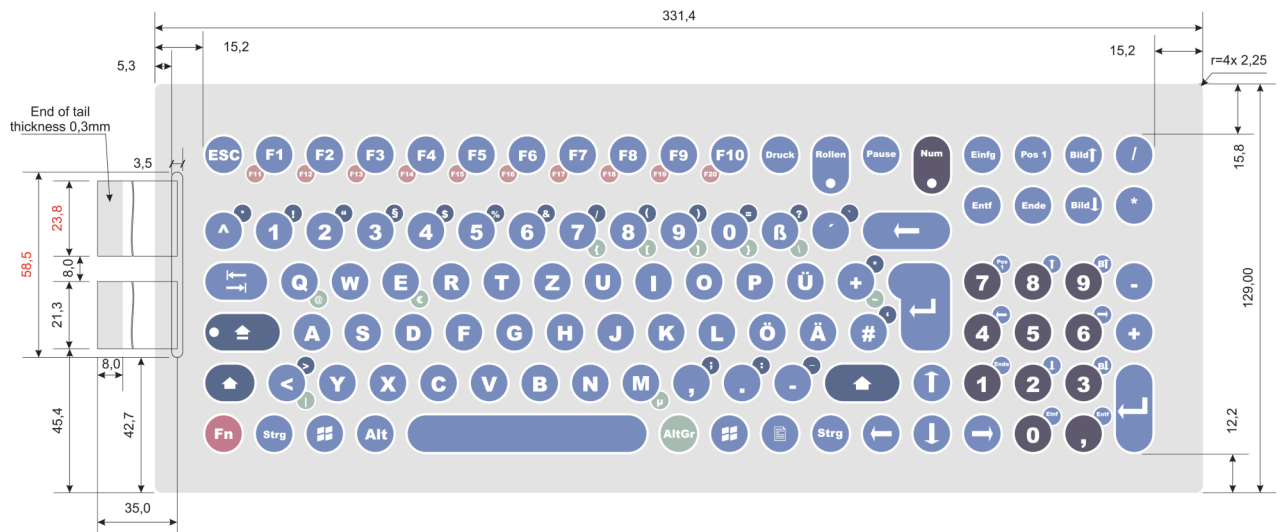
J5 unplugged: 101 key assignment (**US**)

Pin Assignment of Jumper J5

Pin:	Signal Name
1	CODE (also J10 pin 36)
2	GND

The jumper can also be connected through the 50 pin connector J10 through pin 36 and 37.

# APPENDIX A: KEYBOARD MEMBRANE GFT-104



## Matrix Configuration of the GFT-104 (Deviations in US Layout in red)

	R0	R1	R2	R3	R4	R5	R6	R7
C0	- - ?/	# ' \	P	5	R Ctrl		Ende	Home
C1		Up	Ü { [	R Shift	8	9	Pg dn	Pg up
C2	<b>Fn</b>	1	+ * ] }	Enter	Left	,	*	/
C3	, ; < ,	Ö : .	I		App	0	RGUI	F8
C4	C	G	R	2	Right	5	F5	LGUI
C5	X	F	E	3	0	Alt Gr	F4	F9
C6	Y Z	D	3			L Alt	F3	F10
C7	Caps Lock	4	Tab		L Ctrl	^ ° ~	ESC	
C8		A	Q	L Shift		1	F1	
C9	<> nur Ger	S	W		Enter	2	F2	Prnt Scr
C10	V	H	T	4	Down	6	F6	F7
C11	B	J	Z Y			7	? ß _ -	Scrl Lck
C12	N	K	Space			8	` ' = +	Pause
C13	M	L	U		+	9	BS	Num Lock
C14	. : . >	Ä “ ,	O	7	6	-	DEL	Insert
C15	F11	F12	F13				F14	F15
C16	F16	F17	F18				F19	F20
C17								

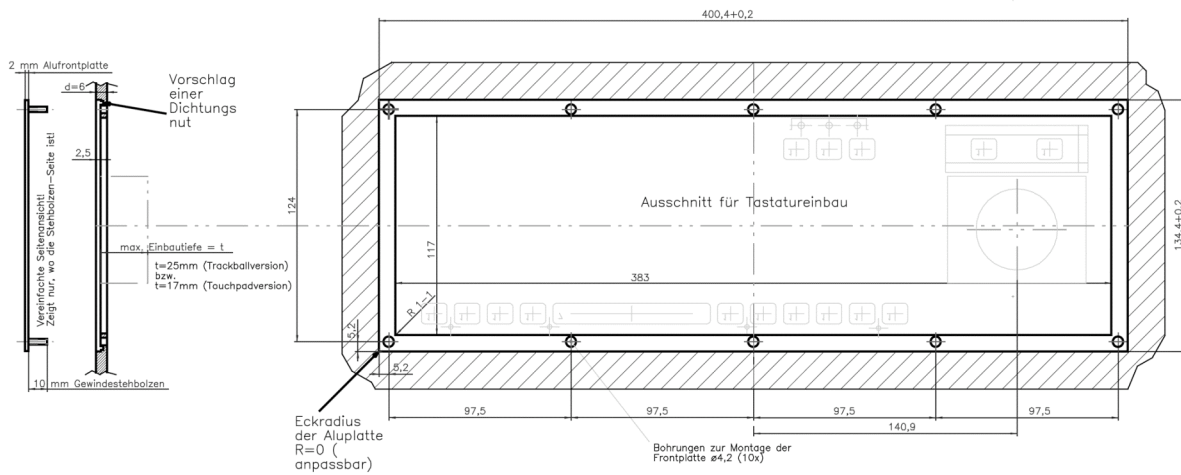
## Fn Level: Matrix Configuration of the GFT-104

	R0	R1	R2	R3	R4	R5	R6	R7
C3								F18
C4							F15	
C5							F14	F19
C6							F13	F20
C7								
C8							F11	
C9							F12	
C10							F16	F17

# APPENDIX K: KWD-85



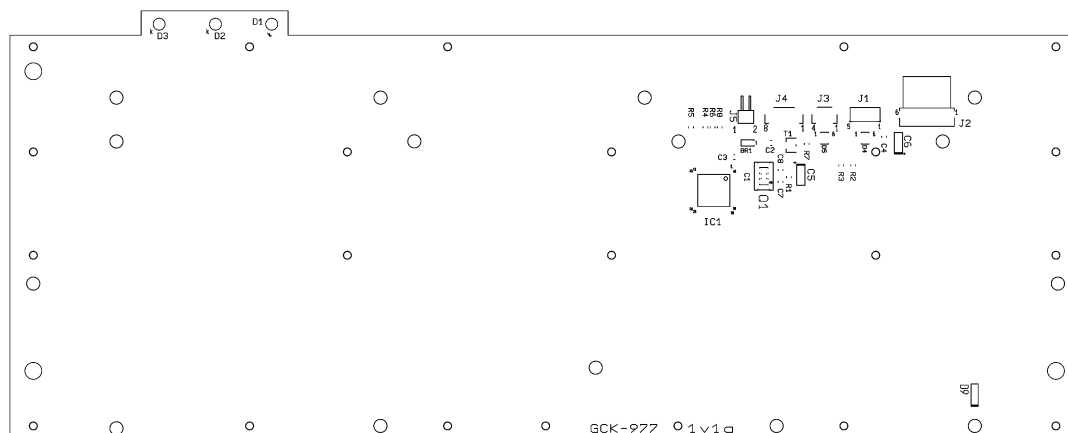
## K.1. Dimensions for Installation



KWD-85 Einbau-Lochbild  
GeBE, vp, 10.07.2001

## K.2. Pin Assignment for Controller GCK-977

The pin assignments are identical to those of the GCK-990.



### K.3. Selecting the Country Specific Code Table

In the German and the US keyboard layout, the keys **#' \ |** and **< > nur Ger** are assigned differently.

J5 connected: key assignment (German)

J5 unplugged: key assignment (US)

Pin Assignment of Jumper J5 (optionally also by closing solder bridge BR1)

Pin:	Signal Name
1	CODE
2	GND

# APPENDIX W: SCAN CODES OF THE PS/2 / USB KEYBOARD

USB Usage Code	USB Usage Code	Version US	Version GER	AT Tasten Nr.	PS/2 Codeset 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 & / ?	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
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 / E0 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
100	\$64	Keyboard \ /	Tastatur < / > 102 TASTEN	45	61 / F0 61
101	\$65	Keyboard APPL MENU (Windows)	Tastatur MENÜ (Windows)	129	E0 2F / E0 F0 2F
		<b>Special Keys</b>			
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
		<b>Additional Function Codes, not verified for PS/2</b>			
104	\$68	Keyboard F13	Tastatur F13		08 / F0 08
105	\$69	Keyboard F14	Tastatur F14		10 / F0 10
106	\$6A	Keyboard F15	Tastatur F15		18 / F0 18
107	\$6B	Keyboard F16	Tastatur F16		20 / F0 20
108	\$6C	Keyboard F17	Tastatur F17		28 / F0 28
109	\$6D	Keyboard F18	Tastatur F18		30 / F0 30
110	\$6E	Keyboard F19	Tastatur F19		38 / F0 38
111	\$6F	Keyboard F20	Tastatur F20		40 / F0 40
112	\$70	Keyboard F21	Tastatur F21		48 / F0 48
113	\$71	Keyboard F22	Tastatur F22		50 / F0 50
114	\$72	Keyboard F23	Tastatur F23		57 / F0 57
115	\$73	Keyboard F24	Tastatur F24		5F / F0 5F

## 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 previousTrack	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

## 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			



# APPENDIX Z: SAMPLE FOR CODE TABLE FORM

Please enter the required key numbers in the boxes.

	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								