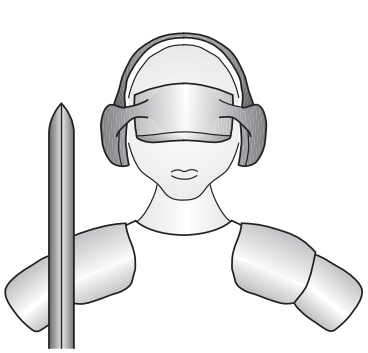
KeyWarrior28

8x8 Matrix USB Keyboard/Mouse Combo
Controller with advanced programming features
KeyWarrior II family



Code Mercenaries

1. Features

- USB full speed interface
- USB HID 1.1 compliant
- 64 keys in 8x8 matrix
- Custom keyboard layout programmable via USB
- Each key can be a modifier plus a typing key
- Mouse function with cursor control via keys
- 32 media control and application keys supported
- Two function shift keys (FN) to switch to a second and third key table
- Up to 19 macros with up to 31 keys each
- Macros can be static, typing, or cell phone like
- Security features prevent overwriting keyboard layout by users
- Unique serial number for definite identification
- 16 bytes of programmable customer data for version tracking and other purposes
- Support for Caps lock, Num lock and Scroll lock LEDs
- FN functions can be activated by the lock LEDs
- Single 3.3V power supply
- Low power consumption: 20mA max.
- Available in QFN28 package, DIL28 module, and SO24 module

1.1 Variants

KeyWarrior28 is currently available in a single variant.

KeyWarrior28

- Supports up to 64 keys in 8x8 matrix
- Preprogrammed with three layouts for general use
- Support for Caps lock, Num lock and Scroll lock LEDs
- Supports diodes in the key matrix
- Keyboard layout and macros programmable via USB
- Layout can be read and write protected
- Custom 64 bit PIN code can be set to prevent user tampering
- 16 bytes of customer defined data for any purpose
- Button mouse function

2. Functional Overview

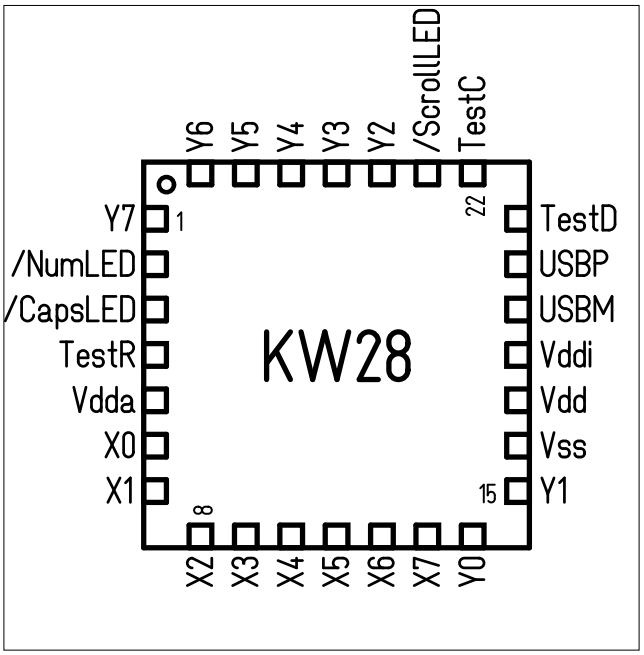
KeyWarrior28 is the successor of the KeyWarrior24 and KeyWarrior8 families. In the SO24 module it can replace KeyWarrior24-8-S or KeyWarrior24-8M-S in many aplications.
The ability to program the keyboard table in circuit, extended support of media, application and system control keys, and the mouse function make it a powerful addition to the KeyWarrior family.
KeyWarrior28 combines all programming options of the KeyWarrior family, that formerly have been available in separate chips (Flex, Operator, Commander, Cell), plus several features that formerly have been available only in custom designs.
Advanced programming and protection features allow to prevent end user tampering with the keyboard layout. The keyboard table can be protected against reading and writing. Additionally a custom 64 bit PIN code can even prevent erasing the controller by the end user.
16 bytes of customer data storage allow the keyboard manufacturer to store version and/or model information in the chip to better track the life cycle of the product. A factory programmed unique serial number does allow to definitely identify the individual KeyWarrior28.
Tampering can also be detected via a 16 bit erase counter, that counts how many times the keyboard table of the KeyWarrior28 has been erased.
Serial number and erase counter can not be changed by external manipulation.

2.1 Differences to KeyWarrior24-8/-8M

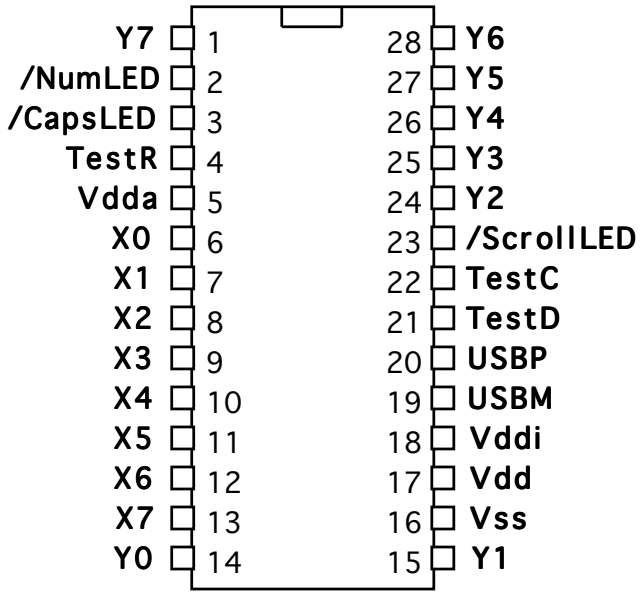
Since KeyWarrior28 is programmable and highly configurable there is only a single version and not multiple versions as with the KeyWarrior24 and KeyWarrior8.
KeyWarrior28 has a factory default keyboard layout that is similar to KW24-8 and KW24-8M.
KeyWarrior28 works with 3.3V. Any external connections must observe this.
The Caps, Num, Scroll LED outputs are no longer sharing pins with the X lines. On KeyWarrior28 LEDs can be driven directly by the outputs.
Due to the weaker internal pull up resistors of KeyWarrior28 it is recommended to add external pull ups, unless the key matrix is very close to the controller and rather small.

3. Pin Configuration

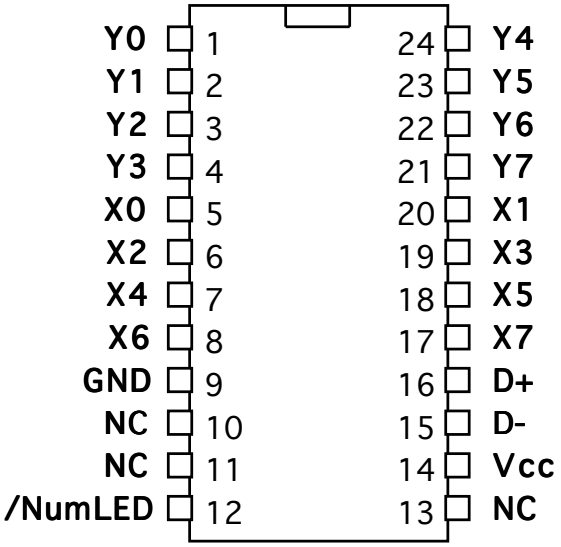
KeyWarrior28-Q28
QFN28



KeyWarrior28-DIL28
DIL28 module



KeyWarrior28-S24
SOIC24 replacement module



TOP VIEW!

4. Pin descriptions KeyWarrior28-Q28/-DIL28

Name	I/O	Type	Pins	Description
USBP, USBM	I/O	special	20, 19	USB differential data lines
Y0, Y1, Y2, Y3, Y4, Y5, Y6, Y7	O	open drain outputs	14, 15, 24, 25, 26, 27, 28, 1	Y lines for key matrix. These lines are periodically pulled low, between matrix scan they are high impedance.
X0, X1, X2, X3, X4, X5, X6, X7	I	inputs with internal pull ups	6, 7, 8, 9, 10, 11, 12, 13	X lines for key matrix.
TestR, TestD, TestC		special	4, 21, 22	Used during manufacturing, do not connect.
Vss		power supply	16	Ground
Vdd, Vddi, Vdda		power supply	17, 18, 5	Supply voltage, connect to 3.3 V
NumLED, CapsLED, ScrollLED	O	open drain outputs	2, 3, 23	Outputs for lock LEDs

4.1 Pin Ffunctions KeyWarrior28-Q28/DIL28

USBP, USBM
Differential data lines of USB. Connect these signals direct to the USB cable or type B plug.

X[0:7]
Matrix horizontal inputs. These eight lines are read by KeyWarrior to detect pressed keys.
Internal pull up resistors are activated on device reset. The addition of external pull up resistors in the range of 1kΩ to 4.7 kΩ is recommended.

Y[0:7]
Vertical matrix outputs. These open drain outputs are periodically pulled low to detect pressed keys. No internal or external pull up resistors.

TestR, TestD, TestC
These pins are used during production of the KeyWarrior chips, do not connect.

NumLED, CapsLED, ScrollLED
Outputs to drive the lock LEDs.
Open drain, can directly drive LEDs with up to 25 mA (a limit to the total current into all pins does apply!),

Vss
Power supply ground.

Vdd, Vddi, Vdda
Supply voltage, connect to 3.3 V

4.2 Pin descriptions KeyWarrior28-S24

Name	I/O	Type	Pins	Description
D+, D-	I/O	special	16, 15	USB differential data lines
Y0, Y1, Y2, Y3, Y4, Y5, Y6, Y7	O	open drain outputs	1, 2, 3, 4, 24, 23, 22, 21	Y lines for key matrix. These lines are periodically pulled low, between matrix scan they are high impedance.
X0, X1, X2, X3, X4, X5, X6, X7	I	inputs with internal pull ups	5, 20, 6, 19, 7, 18, 8, 17	X lines for key matrix.
NC			19, 11	Unused, do not connect.
GND		Power supply	9	Ground
Vcc		Power supply	14	Supply voltage, connect to 5 V
NumLED	O	open drain output	12	Output for Num lock LED

4.3 Pin functions KeyWarrior28-S24

D+, D-
Differential data lines of USB. Connect these signals direct to the USB cable or type B plug.

X[0:7]
Matrix horizontal inputs. These eight lines are read by KeyWarrior to detect pressed keys.
Internal pull up resistors are activated on device reset. The addition of external pull up resistors in the range of 1kΩ to 4.7 kΩ is recommended.

Y[0:7]
Vertical matrix outputs. These open drain outputs are periodically pulled low to detect pressed keys. No internal or external pull up resistors.

NumLED
Output to drive the Num lock LED.
Open drain, can directly drive a LED with up to 20 mA (a limit to the total current into all pins does apply!),

GND
Power supply ground.

Vcc
Supply voltage. Connect to 5 V. The module has an internal voltage regulator to produce the 3.3 V power supply for the chip.

5. Device operation

KeyWarrior28 registers as a standard HID keyboard and mouse and supports boot protocol. It does not need any special drivers to be installed, standard system drivers are sufficient.
The country code is 0 for not localized hardware, which allows to use a single version of the chip for all international keyboard layouts. Usage codes are defined for 0 to 221, which include the Power key and the = sign in the keypad, as well as the compose keys for Asian languages and several special keys that may or may not be supported by individual operating systems.
In addition the media control keys Mute, Play/ Pause, Eject, Fast Forward, Fast Backward, and several application control keys are supported via a separate function. The interface for programming the key table registers as a fourth function.

5.1 Power up

Every time the supply voltage is applied KeyWarrior28 executes an internal reset sequence. All internal pull up resistors are disabled upon power up and will be activated during the internal reset sequence.

5.2 Keyboard scanning

KeyWarrior28 scans the keyboard matrix every t_{scan} by sequentially pulling one of the Y lines low and then reading the status at the X lines. When the scan matrix changes status and then remains stable for $t_{debounce}$ KeyWarrior28 decodes the changes and generates scancodes.

5.3 Key rollover

KeyWarrior supports n-key rollover. All keys in the matrix may be pressed at the same time without KeyWarrior missing a code. However due to the phantom key effect it can not be guaranteed that combinations of many keys are properly reported (see 5.3.1).
USB has a limitation on how many keys can be reported at the same time. On USB any six keys plus all eight modifiers (GUI, Ctrl, Alt, Shift) may be pressed at the same time. If more than six standard keys are pressed an error state is reported. So USB has a 6-key plus modifiers rollover.

5.3.1 Phantom keys

Phantom keys do occur when the keys on three corners of an imaginary rectangle in the matrix are pressed, the fourth corner then appears to be pressed too.
To avoid phantom keys diodes may be added to the keys. The diodes have to be put in series with the key switches. The kathodes have to be connected to the Y lines and anodes to X lines.
It is highly recommended to at least place all modifier keys on a single row or column and put diodes on all of them.

5.4 Customizing the keyboard layout

KeyWarrior28 allows to load custom keyboard layouts into the controller. Tools for generating the tables and downloading them into the controller are provided for Windows.
The functions for downloading keyboard tables and setting the protection features can also be accessed directly with your own software. All functions for the configuration of KeyWarrior28 are accessed via USB interface 3, which is like a virtual device in KeyWarrior28. The interface is named "ConfigInterface".
There are several commands on this interface to read and write data. Some of the commands can be locked, most require a PIN code.

5.5 Keytable protection scheme

To prevent end user tampering with the keyboard layout KeyWarrior28 offers a couple protection options.
All commands that access the key layout data or changes settings have to provide a 64 bit PIN code. Factory setting for this PIN code is 0xFFFF.FFFF.FFFF.FFFF. If a command provides a wrong PIN code KeyWarrior28 will disable all commands except command 0. A USB reset, or unplugging is required to access the commands again.
The PIN can be changed to a custom PIN, making it basically impossible to access the commands by guessing the pin. Though losing the PIN means there is no way to even erase the KeyWarrior28 again.
It is also possible to lock the keytable. This will prevent any reading or writing access to the keytable, changing the PIN code, or writing the customer data. The only way to reset this mode is by erasing the configuration.

5.6 Reading the device information

Command 0 is always accessible, no matter what protection level has been activated.
The command is initiated by sending a 64 byte report to interface 3 with a 0x00 in the first byte (all other bytes should be zero too for future compatibility). In return KeyWarrior28 sends a 64 byte report with the following content:

Byte#	Data
0	0x00 - answer to command 0
1…3	unused, 0
4…19	Customer data
20…21	Lock status
22…23	Erase count
24…27	Serial number
28…63	unused, 0

Customer data can be programmed with command 5 and may contain whatever the customer wants to store here. For example it may be used to keep version info for the keyboard layout, a model number, or other product information.
Lock status is 0xFFFF for the unlocked status of the data, 0x0000 designates read and write protection.
Erase count shows the number of times the keytable data has been erased. This count can not be manipulated and will saturate at 0xFFFF.
Serial number is a factory programmed serial number that uniquely identifies the KeyWarrior28 chip. It can not be manipulated.

5.7 Reading the keytable

The keytable data can be read with command 1. This command may be disabled by the Lock function. The valid PIN code is required, supplying the wrong code does lock the commands.
Keytable data is read in blocks of 32 bytes each. There are 31 blocks.
The read command has the following format:

Byte#	Data
0	0x01 - Read data
1	Block number (0 to 30)
2…3	unused, write 0
4…11	PIN code
12…63	unused, write 0

It generates a report with 64 bytes with the following content:

Byte#	Data
0	0x01 - answer to Read data
1	Error code, 0 = no error
2…3	unused, 0
4…35	Keytable data block
36…63	unused, 0

Error code is zero if no error occured, 1 means the block number was out of range, 4 is returned if the keytable is locked.

5.8 Writing the keytable

Command 2 is used to write the keytable in blocks of 32 bytes each.
Writing is possible only if the keytable has been erased. It is not possible to directly overwrite the keytable data.
This command may be disabled by the lock function. The valid PIN code is required, supplying the wrong code does lock the commands.
The write command has the following format:

Byte#	Data
0	0x02 - Write data
1	Block number (0 to 30)
2…3	unused, write 0
4…11	PIN code
12…43	Keytable data block
44…63	unused, write 0

The return report supplies just an error code:

Byte#	Data
0	0x02 - answer to Write data
1	Error code, 0 = no error
2…63	unused, 0

Error code is zero if no error occured, 1 means the block number was out of range, 3 means the write did fail, 4 is returned if the keytable is locked.

5.9 Erasing the configuration data

Command 3 erases the keytable data and customer data, resets the PIN to default, removes the lock, and increments the erase count. Erasing puts 0xFF in all keytable positions.
This command is disabled if a wrong PIN code was supplied.

Byte#	Data
0	0x03 - Erase data
1…3	unused, write 0
4…11	PIN code
12…63	unused, write 0

The return report supplies just an error code:

Byte#	Data
0	0x03 - answer to Erase data
1	Error code, 0 = no error
2…63	unused, 0

Error code is zero if no error occured, 2 means the erase count failed to write, 3 means the erase did fail.

5.10 Set new PIN
The default PIN can be replaced by a custom PIN. This is possible only when the default PIN is active, so either in factory status, or after erasing.
Command 4 sets the new PIN code.

Byte#	Data
0	0x04 - Set PIN code
1…3	unused, write 0
4…11	0xFFFF.FFFF.FFFF.FFFF
12…19	new PIN code
20…63	unused, write 0

This works only if the default PIN code is active.
The return report supplies just an error code:

Byte#	Data
0	0x02 - answer to Write data
1	Error code, 0 = no error
2…63	unused, 0

Error code is zero if no error occured, 3 means the write did fail, 4 is returned if the keytable is locked.

5.11 Set customer data
Command 5 allows to write 16 bytes of customer data. This is only possible when no customer data has been written previously. To overwrite customer data it is neccessary to first erase the keytable.

Byte#	Data
0	0x05 - Write custom data
1…3	unused, write 0
4…11	PIN code
12…27	Customer data
28…63	unused, write 0

The return report supplies just an error code:

Byte#	Data
0	0x05 - answer to Set customer data
1	Error code, 0 = no error
2…63	unused, 0

Error code is zero if no error occured, 3 means the write did fail, 4 is returned if the keytable is locked.

5.12 Lock configuration
Access to the configuration data can be denied. When setting the lock condition the only commands available are the erase and the get device information commands. This prevents an end user from overwriting any configuration data or setting a new PIN code. The lock condition can only be reset by erasing the configuration data, which requires to know the PIN code.

Byte#	Data
0	0x06 - Lock configuration
1…3	unused, write 0
4…11	PIN code
12…63	unused, write 0

The return report supplies just an error code:

Byte#	Data
0	0x06 - answer to Lock configuration
1	Error code, 0 = no error
2…63	unused, 0

Error code is zero if no error occured, 3 means writing the lock condition did fail.

5.13 Binding FN function to lock LEDs
The FN1 and FN2 keys can be activated by any of the three supported lock LEDs (plus the logically supported Compose and Kana LEDs).
If this function is activated an active lock LED will result in the same behaviour as if the corresponding FN key is pressed.
Command 7 allows to read the FN-LED configuration:

Byte#	Data
0	0x07 - Read LED configuration
1…3	unused, write 0
4…11	PIN code
12…63	unused, write 0

The return report supplies an error code and the configuration byte:

Byte#	Data
0	0x07 - answer to Read LED config.
1	Error code, 0 = no error
2…3	unused, 0
4	LED configuration byte
5	reserved, should read 0xFF
6…63	unused, 0

The LED configuration can be set with Command 8:

Byte#	Data
0	0x08 - Write LED configuration
1…3	unused, write 0
4…11	PIN code
12	LED configuration byte
13	reserved, write 0xFF
14…63	unused, write 0

The return report supplies just an error code:

Byte#	Data
0	0x08 - answer to Write LED config.
1	Error code, 0 = no error
2…63	unused, 0

Error code is zero if no error occured, 3 means the write did fail, 4 is returned if the keytable is locked.

The LED configuration byte contains the number of the lock LED the FN1 and FN2 functions react to. The lower nibble contains the lock LED for FN1, the upper nibble the one for FN2:
0 - none
1 - Num
2 - Caps
3 - Scroll
4 - Compose
5 - Kana
6…E - reserved, do not use
F - none
The Compose and Kana LEDs do not have outputs on the KeyWarrior28, so they can not be connected, but they can still be used to control the FN function.
Setting the LED configuration to i.e. 0x12 will result in FN1 being active if the Caps lock LED is on and FN2 when the Num lock LED is on.

5.14 KeyTables
KeyWarrior28 uses a key table with 16 bits for each physical key to turn matrix coordinates into functions.
There are three alternative tables between which can be switched by using the FN-keys. Any of the physical keys can be assigned any of the available functions.
The functions are grouped into pages, identified by the high byte (the one on the higher address in the table) of the 16 bits for each physical key.
KeyWarrior28 supports the following pages:
0x00 - Standard keys, modifiers and FN keys
0x01 - Media and application controls
0x02 - Macros
0x03 - Mouse
0xE0…0xE7 - Modifier plus standard key combo

A more detailed description including extensive tables for all codes can be found in the "KeyWarrior II Scancode Tables" document.

5.15 Standard keys
KeyWarrior allows the use of all standard keys as defined by HID usage codes in the range of 0x04 to 0xDD. The usage codes are just entered as they are into the table, i.e. 0x0004 is the "a" key on ISO keyboards.

5.16 Modifier keys
Modifier keys are the keys, that change the meaning of another key pressed while the modifier is being held down, they are Shift, Control, Alt and Command (GUI).
The normal modifier keys are coded with their standard usage code, i.e. 0x00E2 is the left Alt key. In additon the codes 0x00E8 to 0x00EF produce a locking version of the modifier keys. So if 0x00E8 is programmed on a key, pressing this key once will result in the left Control key becoming active and staying active until the key is pressed again or another key with the normal left Control function is pressed.
To allow single finger operation a "sticky" version of the modifiers is available also. 0x00F0 to 0x00F7 do activate the modifier when the key is pressed and hold it active until any standard key has been pressed. Essentially this is a single shot locking modifier.

5.17 FN keys
To switch between the three alternative keyboard tables two FN levels are available which can be accessed in a number of ways.
0x00FF and 0x00FE are the normal FN1 and FN2 keys. While FN1 is active the second key table is used and the third table while FN2 is active. Pressing both FN keys at the same time will result in the third table being used.
Like with the modifiers there are also locking and sticky versions of the FN keys.
0x00FD is locking FN1 and 0x00FC locking FN2. They stay active until the locking key is pressed again or the respective non locking FN key is pressed.
0x00FB is sticky FN1 and 0x00FA is sticky FN2. They stay active until the next standard key is pressed.
0x00F9 is a counting FN key, every time it is pressed it changes to the next key table, after the third it wraps around to the first.
When programming FN keys remember to put the same FN key code at the same position of all three keyboard tables. Otherwise it can result in unstable behaviour, like oscillation between key tables.

5.18 Media Control and Application Keys

KeyWarrior28 supports a total of 32 media control and application keys. If they can actually be used depends on the operating system on the target platform. Not all codes are available on all systems.
The following codes are used to generate these keys (second code is the USB usage code):

0x0100	0xB0	Play
0x0101	0xB1	Pause
0x0102	0xB2	Record
0x0103	0xB3	Fast Forward
0x0104	0xB4	Rewind
0x0105	0xB5	Scan Next Track
0x0106	0xB6	Scan Previous Track
0x0107	0xB7	Stop
0x0108	0xB8	Eject
0x0109	0xB9	Random Play
0x010A	0xCC	Stop/Eject
0x010B	0xCD	Play/Pause
0x010C	0xE2	Mute
0x010D	0xE9	Volume Increment
0x010E	0xEA	Volume Decrement
0x010F	0x0184	Launch Word Processor
0x0110	0x0185	Launch Text Editor
0x0111	0x0186	Launch Spreadsheet
0x0112	0x0187	Launch Graphics Editor
0x0113	0x0188	Launch Presentation App
0x0114	0x0189	Launch Database App
0x0115	0x018A	Launch Emailer
0x0116	0x018B	Launch Newsreader
0x0117	0x018C	Launch Voicemail
0x0118	0x018D	Launch Address Book
0x0119	0x018E	Launch Calendar
0x011A	0x0192	Launch Calculator
0x011B	0x0194	Launch Local Browser
0x011C	0x0196	Launch Internet Browser
0x011D	0x01A0	Command Line
0x011E	0x01A6	Help Center
0x011F	0x021F	Find

5.19 Macros

KeyWarrior28 has an advanced macro capability essentially combining all the macro features of the KeyWarrior family variants.
A macro is programmed onto a key by 0x02xx, where "xx" is the number of the macro to be used. Each macro is 32 bytes long. The first byte selects the mode of the macro.
There are three modes for a macro: Static, typing, and cell mode. In static mode all key codes of the macro are activated and released together. Typing mode will make and break each of the keys, so repeating characters is possible. Cell mode is similar to the entry mode for characters on land line phones or cell phones with just numeric keys, every time it is pressed it generates the next key in a sequence, overwriting the last one. This is a macro mode interesting for small keyboard layouts to generate multiple characters from a single key.

5.19.1 Static macros

A static macro is defined by a 0x00 in the first byte of the macro. The following 31 bytes contain a 8 bit representation of the page 0x00 key codes. So each of these 31 codes may contain any standard key, modifier, or FN key. A 0x00 code denotes the end of the macro, any further bytes behind a 0x00 until the end of the macro are ignored.
All valid codes in a static macro are processed and send in a single report. So there is a limit to the usable codes in a static macro. No more than all modifier keys plus six standard keys may be contained in a single static macro.
Be aware that the results of having FN keys or locking/sticky modifiers in a static macro can be very complex.

5.19.2 Typing macros

A typing macro starts with 0x01 in the first byte. The following 31 bytes contain a 8 bit representation of the page 0x00 key codes. But only standard keys and non-locking/non-sticky modifiers are allowed for typing macros. A 0x00 code denotes the end of the macro, any further bytes behind a 0x00 until the end of the macro are ignored.
Any standard key in a typing macro is send and then deactivated immediately. Modifiers work a bit different. The codes 0xE0 to 0xE7 are the standard modifiers but the modifier will stay active until its break code is in the macro. Break codes for the modifiers are 0xE8 to 0xEF.
All modifiers will be released at the release of the macro key, so they do not need to be released by the end of the macro.

5.19.3 Cell macros

A cell macro is defined by a 0x02 in the first byte. The second byte holds a timeout value in 100 ms. If the timeout expires the last character generated will not be overwritten, allowing to type the same character again. A zero for the timeout will be handeled as immediate timeout.
The remaining 30 bytes can hold an 8 bit keycode each. When the macro key gets pressed the first keycode is send followed by a left arrow, so the cursor will be under the just generated character. If no key is pressed within the timeout then a right arrow will be send to move the cursor behind the character. If a different cell macro key is pressed within the timeout then also a right arrow will be send first.
Pressing the same macro key again within the timeout will produce a delete forward to be send to remove the last character and then the next keycode will be send followed by a left arrow. When the next keycode is 0x00 the macro wraps around to the first code again.

5.20 Mouse function

Page 0x03xx contains the key codes for the mouse function.
It is possible to assign left, right, up, down, and up to 8 mouse buttons to any keys. The mouse cursor movement is controlled with an acceleration curve, making it possible to do precise small movements, as well as long movements across the screen.
The codes are as follows:

0x0300	Right move
0x0301	Left move
0x0302	Down move
0x0303	Up move
0x0310	Left Button
0x0311	Right Button
0x0312	Center Button
0x0313	Button 4
0x0314	Button 5
0x0315	Button 6
0x0316	Button 7
0x0317	Button 8

5.21 Modifier plus key

Pages 0xE0xx to 0xE7xx are a combination of a modifier plus one key. The high byte contains the standard code for the modifier, 0xE0 to 0xE7. In the low byte any of the 8 bit key codes may be used.
The two keys are then send together.
This is a simple way to generate special characters from any key matrix position without having to use a complete macro.

6. Factory default key tables
The KeyWarrior28 is shipped with a standard key table. This key table may either be used as is or be erased and overwritten with a custom key table.
Following is the layout of the keys as preprogrammed.

6.1 Key table with no FN key pressed
Generic layout with all main keyboard keys (identical to the layout of KW24-8 with no FN key)

	X0	X1	X2	X3	X4	X5	X6	X7
Y0	7&	8*	9(	A	B	C	D	E
Y1	4$	5%	6^	F	G	H	I	J
Y2	1!	2@	3#	K	L	M	N	O
Y3	-_	0)	=+	P	Q	R	S	T
Y4	, <	. >	/?	U	V	W	X	Y
Y5	]}	up	|	Z	space	`~	l-alt	r-alt
Y6	left	down	right	[{	; :	' "	l-ctrl	`~
Y7	FN1	FN2	tab	del	caps	esc	l-shft	return

US keyboard layout

6.2 Key table with FN1 key pressed
Media control layout (identical to the layout of KW24-8M with no FN key)

	X0	X1	X2	X3	X4	X5	X6	X7
Y0	eject	vol +	vol -	mute	play/ pause	next track	prev track	fast fwd
Y1	rewind	stop	start brwsr.	start mailer	F1	F2	F3	F4
Y2	F5	F6	F7	F8	F9	F10	F11	F12
Y3	ctrl-X	ctrl-C	ctrl-V	ctrl-Z	ctrl-A	ctrl-O	ctrl-S	ctrl-P
Y4	cmd-X	cmd-C	cmd-V	cmd-Z	cmd-A	cmd-O	cmd-S	cmd-P
Y5	space	up	ctrl-alt-del	Ins	home	pg up	l-alt	r-alt
Y6	left	down	right	del	end	pg dn	l-ctrl	r-ctrl
Y7	FN1	FN2	tab	bksp	l-shft	esc	r-shft	return

US keyboard layout

6.3 Key table with FN2 key pressed
Special layout for gaming and other applications, including mouse function.

	X0	X1	X2	X3	X4	X5	X6	X7
Y0	Left mouse button	Mouse up	Right mouse button	esc	num	num/	num*	num-
Y1	Mouse left	Mouse down	Mouse right	§ ±	num7	num8	num9	num+
Y2	www.	a-e	f-j	- _	num4	num5	num6	Enter
Y3	k-o	tab	del	= +	num1	num2	num3	num.
Y4	Q	W	E	R	T	pause	up	num0
Y5	A	S	D	F	G	left	down	right
Y6	Z	X	C	V	B	. >	/ ?	space
Y7	FN1	FN2	l-shft	l-ctrl	l-alt	r-alt	r-ctrl	r-shft

US keyboard layout

7. DC characteristics

	Parameter	Min	Max	Units	Remarks
V_{dd}	Operating voltage	2.0	3.6	V	typ. 3.3 V
V_{cc}	Operating voltage	3.6	5.5	V	for KW28-S24 module only
I_{dd}	Operating supply current		25	mA	
I_{sb}	Suspend mode current		350	μA	internally active
I_{ol}	Sink current on port pins		25	mA	max. combined all pins 80 mA
V_{ol8}	Output low voltage		0.4	V	I = 8 mA
V_{oh8}	Output high voltage	V_{ddi}-0.4		V	I = 8 mA
V_{ol20}	Output low voltage		1.3	V	I =20 mA
V_{oh20}	Output high voltage	V_{ddi}-1.3		V	I =20 mA
R_{up}	Pull up/down resistors	25	55	kΩ	typ. 40 kΩ
V_{ith}	Input threshold voltage	0.7 x V_{ddi}		V	

7.1 AC characteristics

	Parameter	Min	Max	Units	Remarks
	Keyboard Matrix Scan Timing				
t_{scan}	Scanning interval	4		ms	
t_{scansu}	Matrix drive to read setup time	typ. 40		μs	
$t_{debounce}$	Debounce time	3x t_{scan}		ms	

7.2 Absolute maximum ratings

Storage Temperature .....-65°C to +150°C
Ambient Temperature with power applied.....-40°C to +85°C
Supply voltage on Vdd, Vdda, Vddi relative to Vss .....-0.3 V to +4 V
Supply voltage on Vcc relative to Gnd (KW28-S24) .....-0.3 V to +6.5 V
DC input voltage .....-0.3 V to +4 V
Maximum current into all ports.....80 mA
Power Dissipation.....max. 170 mW
Static discharge voltage.....>2000 V
Latch-up current .....>200 mA

8. Ordering Information

Partname	Order Code	Description	Package
KeyWarrior28	KW28-Q28	Standard part	QFN28
KeyWarrior28	KW28-DIL28	Standard part on DIL28 module	DIL28
KeyWarrior28	KW28-S24	Replacement module for KW24	SOIC24

8.1 Shipping info

QFN28 chips come in trays - TBD
DIP28 modules - TBD
SOIC24 replacement modules - TBD

8.2 USB VendorID and ProductID

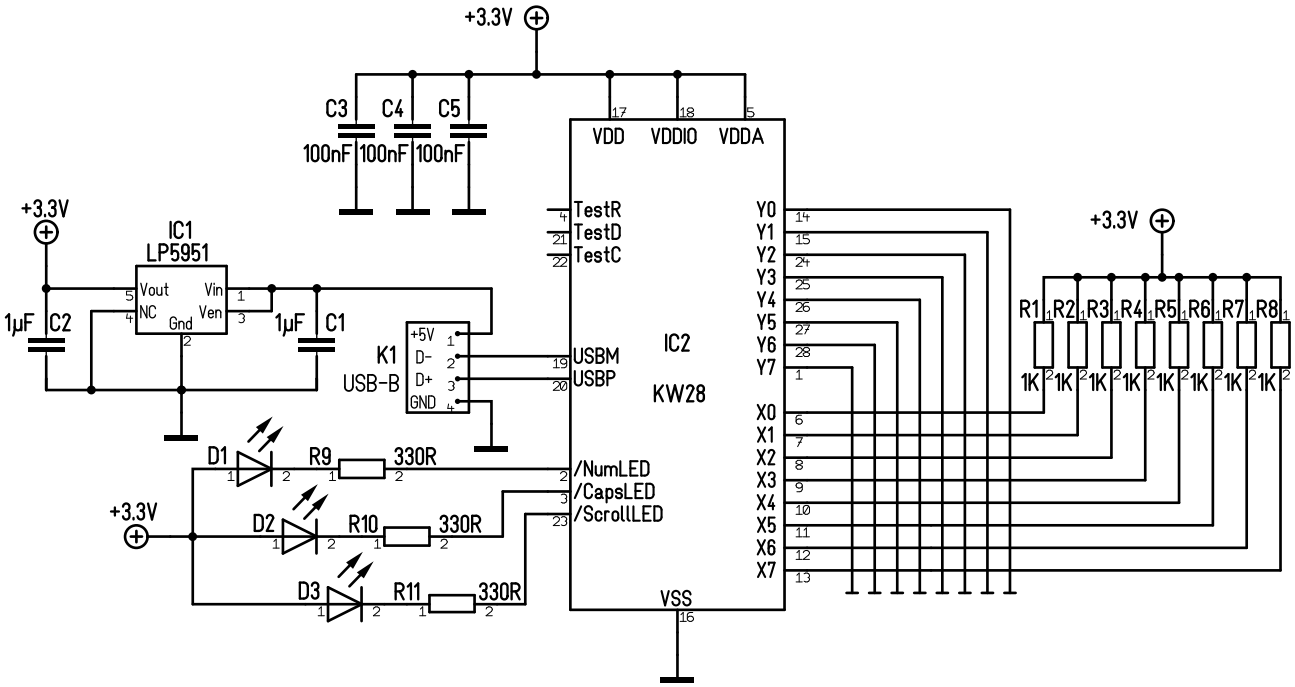
By default all KeyWarrior chips are shipped with the USB VendorID of Code Mercenaries (0x7C0 or decimal 1984).
The ProductID will be assigned by Code Mercenaries.
On request chips can be equipped with the customers VendorID and ProductID. VendorIDs can be obtained from the USB Implementers Forum <www.usb.org>
Such custom chips are subject to additional costs and minimum order volumes.
The ProductID for the standard KeyWarrior28 chips are:
KeyWarrior28 0x0180

ProductIDs are independent of the package type.

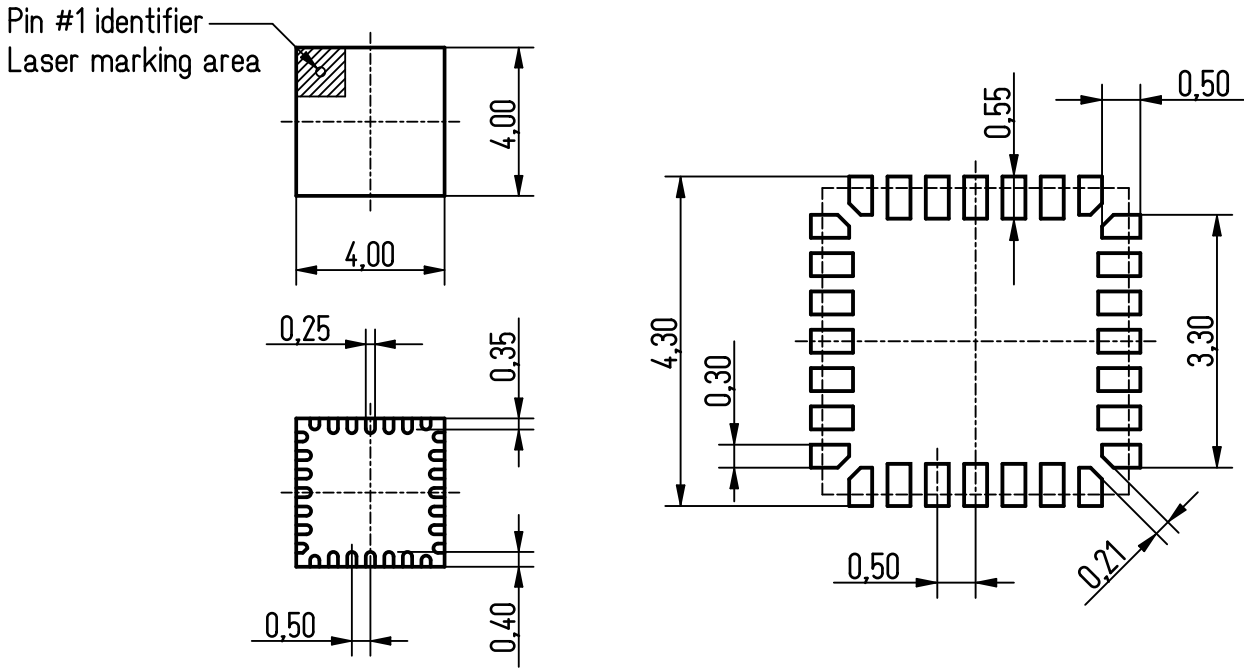
8.3 Serial numbers

The serial number of KeyWarrior28 is not a USB standard serial number. It is accessible only via the proprietary commands defined for reading the device data of KeyWarrior28.
The serial numbers are factory assigned and can neither be changed by the customer nor ordered specifically.

9. Typical Application for KeyWarrior28

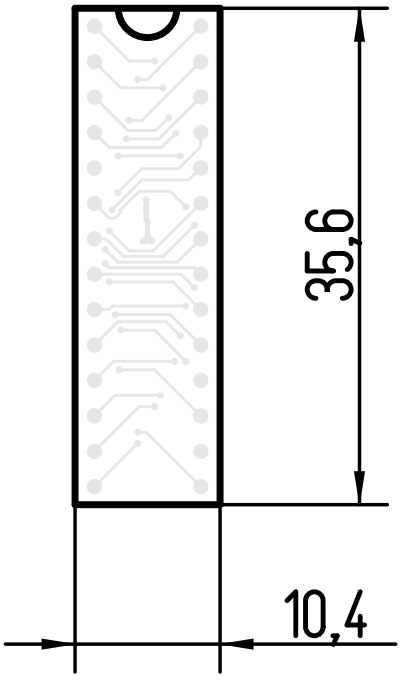


10. Package Dimensions
28 Pin QFN - UQFPN28 - 4x4 mm with 0.5 mm pitch
and recommended footprint (KW28-Q28)



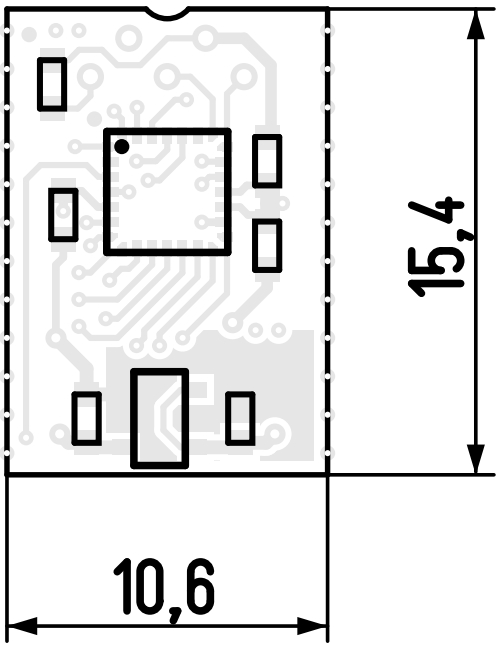
Package thickness: 0.55 mm ±0.05 mm
Outer contour tolerance: ±0.1 mm

28 Pin DIL module (KW28-DIL28)



All dimensions: mm

24 Pin SO24 Replacement Module (KW28-S24)



Height at thickest point: max. 2.2 mm

11. ESD Considerations
KeyWarrior has an internal ESD protection to withstand discharges of more than 2000V without permanent damage. However ESD may disrupt normal operation of the chip and cause it to exhibit erratic behaviour.
For the typical office environment the 2000V protection is normally sufficient. Though for industrial use additional measures may be necessary.
When adding ESD protection to the signals special care must be taken on the USB signal lines. The USB has very low tolerance for additional resistance or capacitance introduced on the USB differential signals.

11.1 EMC Considerations
KeyWarrior uses relatively low power levels and so it causes few EMC problems.
To avoid any EMC problems the following rules should followed:

- Put the 100 nF ceramic capacitors right next to the power supply pins of the chip and make sure the PCB traces between the chips power pins and the capacitor are as short as possible.
- Run the power supply lines first to the capacitor, then to the chip.
- Make the matrix lines only as long as absolutly necessary.
- Keep the two USB signal lines close to each other, route no other signal between them. USB uses differential signalling so the best signal quality with lowest RF emission is achieved by putting these lines very close to each other.

12. Revision History
The current shipping version of KeyWarrior28 is V1.0.1.7

V1.0.1.7 - Fixed a problem with USB that could lead to bidirectional USB interfaces to lock up the In direction. This problem was observed only with JW28A12L under very special timing conditions but the patch was applied to all chips with bidirectional interfaces to avoid this potential problem.

V1.0.1.6 - Fixed a problem with USB that could lead to the device not properly enumerating.

V1.0.1.1 - Cell macro behaviour improved. Any other typing keys now cause a timeout and the last macro character to not be overwritten.

V1.0.0.F - Cell macro behaviour improved so modifier keys no longer interfere.

V1.0.0.E - FN key status change alone lo longer generates a report

V1.0.0.C - Factory default keytable had an error on the FN1 level.
Cell mode macros did not always properly generate the right arrow.
Media keys could "hang".

V1.0.0.A - Initial release version

12.1 Document Revision History
V1.0.0.3 - Updated version information
V1.0.0.2 - Updated version information
V1.0.0.1 - Updated version information

13. RoHS compatibility
KeyWarrior28 conforms to the requirements that are necessary to use it in a RoHS compliant device.

Legal Stuff

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