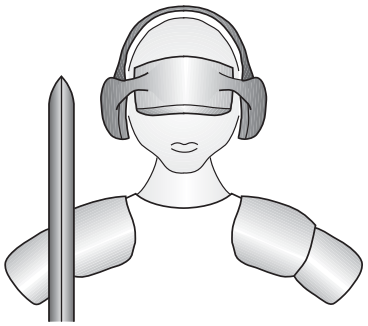
# KeyWarrior

## Universal keyboard and keyboard/ mouse combo controller chips



**Code Mercenaries**

### 1.0 Features

- USB, ADB™ and AT or PS/2 keyboard interfaces
- Auto detects active interface
- Supports up to 240 keys in 20x12 matrix
- Full USB V1.1 compliance
- Full USB HID 1.1 compliance
- ADB™ extended keyboard compatible
- Supports Power key for ADB™, USB and PS/2
- MF2 compatible with AT or PS/2 interface
- Supports diodes in the key matrix
- User defineable matrix
- In system programmable keymap (Flex, Operator, Cell, and Commander family)
- Operator family supports up to eight functions on every key
- Commander family supports 48 macros with up to 31 codes each
- Cell variant allows cell phone like behaviour with multiple characters on a key
- Assignable function shift key to switch to a second matrix table or third table
- Single chip solution with low external component count
- Direct drive for Caps lock, Num lock and Scroll lock LEDs
- Optional mouse function (KeyWarrior Combo) with either optical encoder mechanism (KeyWarrior Combo O) or VersaPoint™ (KeyWarrior Combo V)
- Up to three mouse buttons in keyboard matrix (KeyWarrior Combo only)
- Separate PS/2 and serial port for mouse function (KeyWarrior Combo only)
- Low cost ceramic resonator
- Single +5V power supply
- Low power consumption: 40mA max.
- Available in 48 pin SSOP, some variants in DIL40 module (DIP40 package has been discontinued)

### 1.1 Variants

KeyWarrior is available in a number of variants.

**KeyWarrior 8**

- 8x8 Key matrix
- Two function shift keys for three functions per key

**KeyWarrior 16**

- 16x8 Key matrix
- One function shift key for two functions per key

**KeyWarrior 20**

- 20x12 Key matrix

**KeyWarrior Combo O**

- 16x8 Key matrix
- One function shift key for two functions per key
- Mouse function with optical encoder

**KeyWarrior Combo V**

- 16x8 Key matrix
- One function shift key for two functions per key
- Mouse function with VersaPoint™ sensor

**Flex**

KeyWarrior Flex controllers do have the same functionality as the basic variants but store the keycode table in an external EEPROM.

**Operator**

KeyWarrior Operator controllers are a more sophisticated variant of the KeyWarrior Flex controllers. KeyWarrior Operator uses a larger external EEPROM to store up to 8 keycodes for every key in the matrix. This allows to generate key combinations from pressing a single key.

**Commander**

The KeyWarrior Commander chips are the most flexible controllers in the KeyWarrior family. KeyWarrior Commander use an external EEPROM to store the keycode table and allows to assign one of 48 macros to any key.
Each of the macros can be up to 31 keys long and allows any combination of keycodes to shortcut typing or generate special keys.
There is no KeyWarrior 8 Commander since KeyWarrior 16 Commander does already support 2 Function-Shift keys.

**Cell**

The KeyWarrior 8 is available in a version that supports 16 keys to operate in a manner similar to a cellular phones keypad. Pressing a key multiple times steps it through three different codes.

# KeyWarrior

## Content

**2.0 Functional Overview**

The KeyWarrior family of keyboard encoders does combine all keyboard interfaces with any market significance into a single chip. Designing keyboards based on KeyWarrior allows the manufacturer to significantly reduce inventory and production cost.

The manufacturer may choose to equip the keyboard with all interfaces and let the user decide which one to use or produce keyboards with identical electronics that just differ in the cable attached in the last production step.

KeyWarrior uses a single table to translate matrix coordinates to keycodes. The Master Translation Table is customer definable and programmed into the chip permanently before shipping or in case of the Flex, Operator, and Commander controllers it is downloadable via USB into an external EEPROM.

**2.1 Power on via USB**

If the option to power on older Macintosh via USB is required please contact us. This function is subject to patents held by Apple Computer, Inc.

## 2.2 Product Selection Matrix

| Type | Matrix | FN-Keys | Mouse | ext. EEPROM | Codes per key | DIL40 | SSOP48 | Standard Part * |
|---|---|---|---|---|---|---|---|---|
| KeyWarrior 8 | 8x8 | 2 | - | - | 1 | † | √ | - |
| KeyWarrior 8 Flex | 8x8 | 2 | - | 24C02 | 1 | † | √ | √ |
| KeyWarrior 8 Operator | 8x8 | 2 | - | 24C16 | 8 | † | √ | √ |
| KeyWarrior 8 Cell | 8x8 | 2 | - | 24C16 | 1/8 *** | † | √ | √ |
| KeyWarrior 16 | 16x8 | 1 | - | - | 1 | † | √ | - |
| KeyWarrior 16 Flex | 16x8 | 1 | - | 24C02 | 1 | † | √ | √ |
| KeyWarrior 16 Operator | 16x8 | 1 | - | 24C16 | 8 | † | √ | √ |
| KeyWarrior 16 Commander | 16x8 | 2 | - | 24C16 | 1 ** | † | √ | √ |
| KeyWarrior 20 | 20x12 | 0 | - | - | 1 | - | √ | - |
| KeyWarrior 20 Flex | 20x12 | 0 | - | 24C02 | 1 | - | √ | √ |
| KeyWarrior 20 Operator | 20x12 | 0 | - | 24C16 | 8 | - | √ | √ |
| KeyWarrior 20 Commander | 20x12 | 0 | - | 24C16 | 1 ** | - | √ | √ |
| KeyWarrior CO | 16x8 | 1 | √ | - | 1 | - | √ | - |
| KeyWarrior CO Flex | 16x8 | 1 | √ | 24C02 | 1 | - | √ | √ |
| KeyWarrior CO Operator | 16x8 | 1 | √ | 24C16 | 8 | - | √ | √ |
| KeyWarrior CO Commander | 16x8 | 2 | √ | 24C16 | 1 ** | - | √ | √ |
| KeyWarrior CV | 16x8 | 1 | √ | - | 1 | - | √ | - |
| KeyWarrior CV Flex | 16x8 | 1 | √ | 24C02 | 1 | - | √ | √ |
| KeyWarrior CV Operator | 16x8 | 1 | √ | 24C16 | 8 | - | √ | √ |
| KeyWarrior CV Commander | 16x8 | 2 | √ | 24C16 | 1 ** | - | √ | √ |

*) Standard parts are available with no setup cost or minimum order quantities. The non-standard parts may be subject to a setup charge as well as minimum order quantities.

**) Commander chips do support 48 macros with 31 codes each which can be assigned to any key.

***) KeyWarrior 8 Cell does support 48 keys in Operator mode (8 codes per key) and 16 keys in cell phone mode. Cell phone mode keys do have a single code per key, but when used while any FN key is down they step through 3 different single codes.

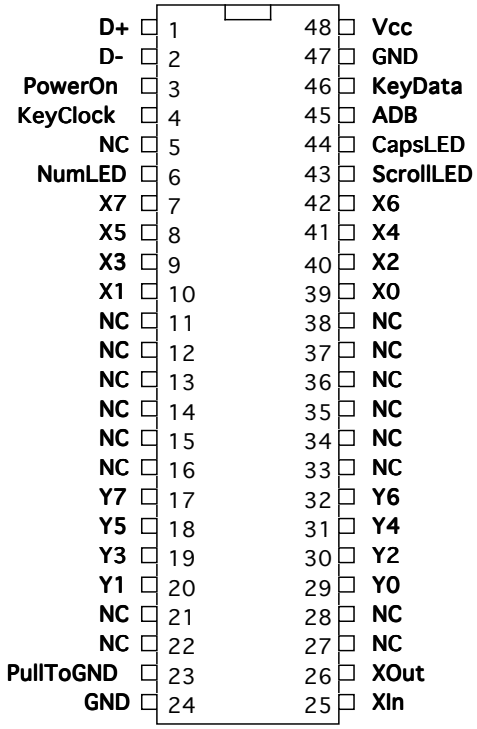
†) DIP40 package has been discontinued, a DIL40 module with the same footprint is available.

### 3.0 Pin Descriptions KeyWarrior 8 / KeyWarrior 8 Flex / Operator / Cell, SSOP 48

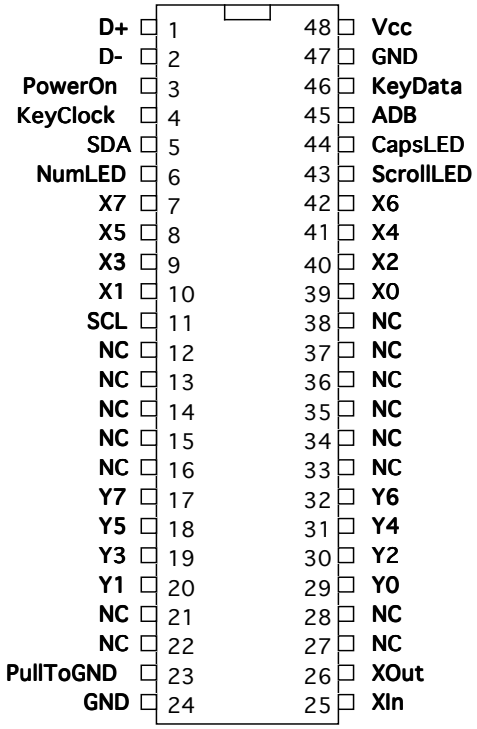
| Name | I/O | Type | Pins | Description |
|---|---|---|---|---|
| D+, D- | I/O | special | 1, 2 | USB differential data lines |
| PowerOn | I | internal Pull Up | 3 | Power Key input, detects suspend on power on |
| KeyClock | I/O | OD, internal Pull Up | 4 | PS/2 and AT interface clock line for keyboard |
| KeyData | I/O | OD, internal Pull Up | 46 | PS/2 and AT interface data line for keyboard |
| ADB | I/O | OD, internal Pull Up | 45 | ADB™ bus signal |
| CapsLED | O | OD, 16mA | 44 | Drives Caps Lock LED, active low |
| NumLED | O | OD, 16mA | 6 | Drives Num Lock LED, active low |
| ScrollLED | O | OD, 16mA | 43 | Drives Scroll Lock LED, active low |
| X[7:0] | I | input, internal Pull Ups | 7, 42, 8, 41, 9, 40, 10, 39 | Matrix row lines. Inputs to controller |
| Y[7:0] | O | OD | 17, 32, 18, 31, 19, 30, 20, 29 | Matrix column lines. Periodically driven to low by the controller to scan the matrix. |
| SCL | O | OD | 11 | SCL line for external EEPROM (Flex only) |
| SDA | I/O | OD, internal Pull Up | 5 | SDA line for external EEPROM (Flex only) |
| NC | - | - | 5, 11 | Unused pin, do not connect (KeyWarrior 8 only) |
| NC | - | - | 38, 12, 37, 13, 36, 14, 35, 15, 16, 21, 22, 27, 28, 33, 34 | Unused pin, do not connect |
| PullToGND | I | | 23 | Used during manufacturing, connect to GND |
| GND | | Power supply | 24, 47 | Ground |
| Vcc | | Power supply | 48 | Supply voltage |
| XOut | O | | 26 | On chip oscillator output |
| XIn | I | | 25 | On chip oscillator input |

**All drawings: TOP VIEW!**

**KeyWarrior 8-S**




**KeyWarrior 8 Flex-S**
**KeyWarrior 8 Operator-S**
**KeyWarrior 8 Cell-S**

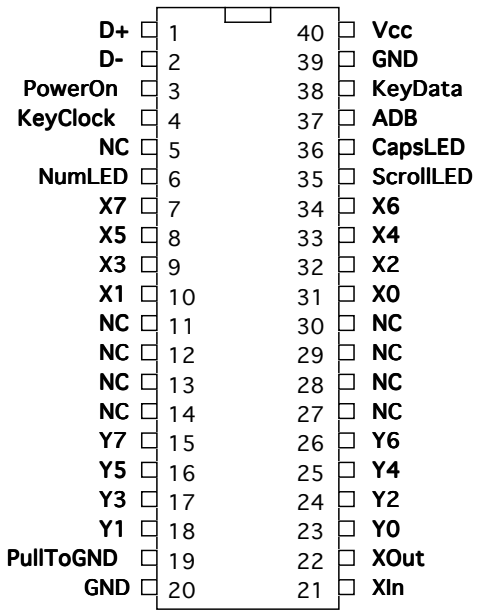


### 3.1 Pin Descriptions KeyWarrior 8 / KeyWarrior 8 Flex / Operator / Cell, DIL40 Module

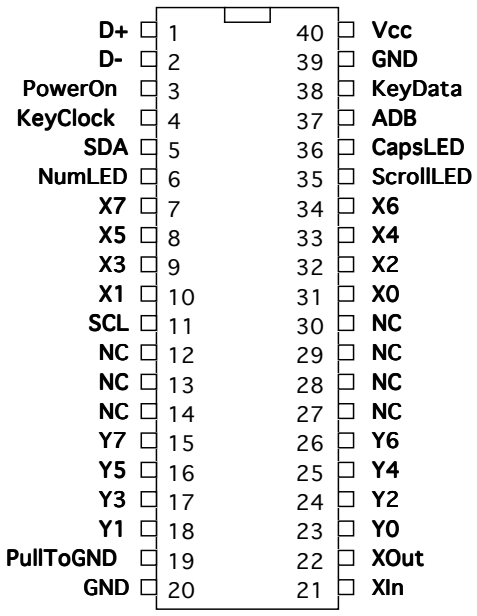
| Name | I/O | Type | Pins | Description |
|---|---|---|---|---|
| D+, D- | I/O | special | 1, 2 | USB differential data lines |
| PowerOn | I | internal Pull Up | 3 | Power Key input, detects suspend on power on |
| KeyClock | I/O | OD, internal Pull Up | 4 | PS/2 and AT interface clock line for keyboard |
| KeyData | I/O | OD, internal Pull Up | 38 | PS/2 and AT interface data line for keyboard |
| ADB | I/O | OD, internal Pull Up | 37 | ADB™ bus signal |
| CapsLED | O | OD, 16mA | 36 | Drives Caps Lock LED, active low |
| NumLED | O | OD, 16mA | 6 | Drives Num Lock LED, active low |
| ScrollLED | O | OD, 16mA | 35 | Drives Scroll Lock LED, active low |
| X[7:0] | I | input, internal Pull Ups | 7, 34, 8, 33, 9, 32, 10, 31 | Matrix row lines. Inputs to controller |
| Y[7:0] | O | OD | 15, 26, 16, 25, 17, 24, 18, 23 | Matrix column lines. Periodically driven to low by the controller to scan the matrix. |
| SCL | O | OD | 11 | SCL line for external EEPROM (Flex only) |
| SDA | I/O | OD, internal Pull Up | 5 | SDA line for external EEPROM (Flex only) |
| NC | - | - | 5, 11 | Unused pin, do not connect (KeyWarrior 8 only) |
| NC | - | - | 11, 30, 12, 29, 13, 28, 14, 27 | Unused pin, do not connect |
| PullToGND | I | | 19 | Used during manufacturing, connect to GND |
| GND | | Power supply | 20, 39 | Ground |
| Vcc | | Power supply | 40 | Supply voltage |
| XOut | O | | 22 | On chip oscillator output |
| XIn | I | | 21 | On chip oscillator input |

**All drawings: TOP VIEW!**

**KeyWarrior 8-MOD**



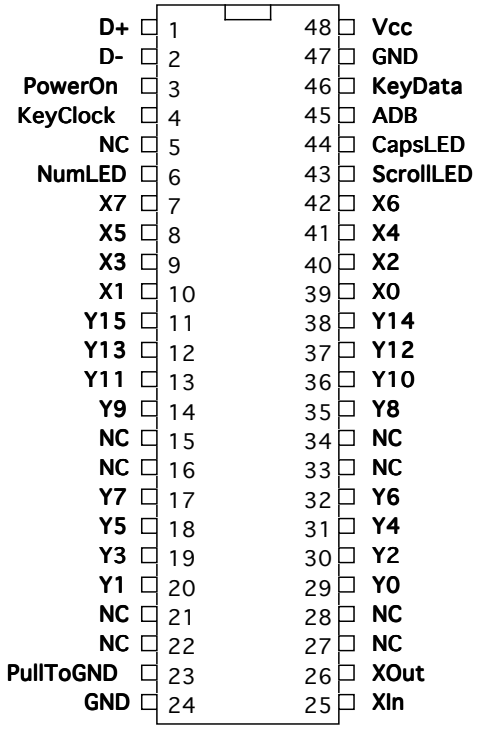

**KeyWarrior 8 Flex-MOD**
**KeyWarrior 8 Operator-MOD**
**KeyWarrior 8 Cell-MOD**



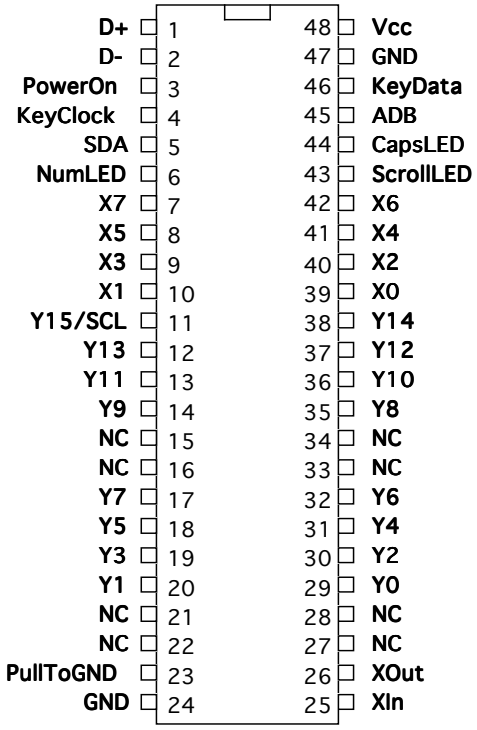
### 3.2 Pin Descriptions KeyWarrior 16 / KeyWarrior 16 Flex / Operator / Commander SSOP 48

| Name | I/O | Type | Pins | Description |
|---|---|---|---|---|
| D+, D- | I/O | special | 1, 2 | USB differential data lines |
| PowerOn | I | internal Pull Up | 3 | Power Key input, detects suspend on power on |
| KeyClock | I/O | OD, internal Pull Up | 4 | PS/2 and AT interface clock line for keyboard |
| KeyData | I/O | OD, internal Pull Up | 46 | PS/2 and AT interface data line for keyboard |
| ADB | I/O | OD, internal Pull Up | 45 | ADB™ bus signal |
| CapsLED | O | OD, 16mA | 44 | Drives Caps Lock LED, active low |
| NumLED | O | OD, 16mA | 6 | Drives Num Lock LED, active low |
| ScrollLED | O | OD, 16mA | 43 | Drives Scroll Lock LED, active low |
| X[7:0] | I | input, internal Pull Ups | 7, 42, 8, 41, 9, 40, 10, 39 | Matrix row lines. Inputs to controller |
| Y[14:0] | O | OD | 38, 12, 37, 13, 36, 14, 35, 17, 32, 18, 31, 19, 30, 20, 29 | Matrix column lines. Periodically driven to low by the controller to scan the matrix. |
| Y15 | O | OD | 11 | Matrix column line (KeyWarrior 16) |
| Y15/SCL | O | OD | 11 | Matrix column line and SCL line for external EEPROM (Flex, Operator, Commander) |
| NC | - | - | 5 | Unused pin, do not connect (KeyWarrior 16) |
| SDA | I/O | OD, internal Pull Up | 5 | SDA line for external EEPROM (Flex, Operator, Commander) |
| NC | - | - | 15, 16, 21, 22, 27, 28, 33, 34 | Unused pins, do not connect |
| PullToGND | I | | 23 | Used during manufacturing, connect to GND |
| GND | | Power supply | 24, 47 | Ground |
| Vcc | | Power supply | 48 | Supply voltage |
| XOut | O | | 26 | On chip oscillator output |
| XIn | I | | 25 | On chip oscillator input |

**KeyWarrior 16-S**




**KeyWarrior 16 FX/OP/CM-S**

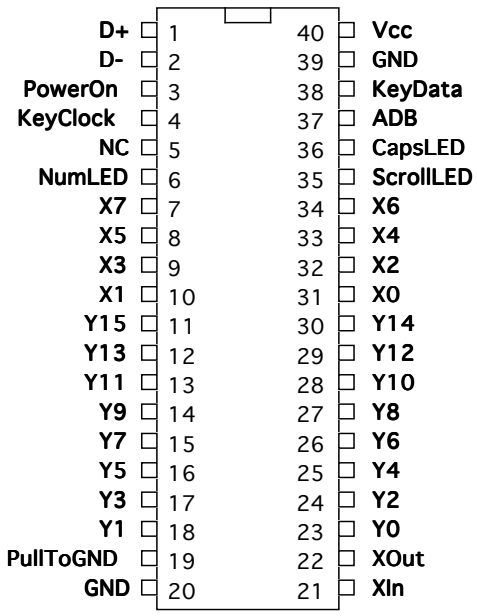


### 3.3 Pin Descriptions KeyWarrior 16 / KeyWarrior 16 Flex / Operator / Commander, DIL40 Module

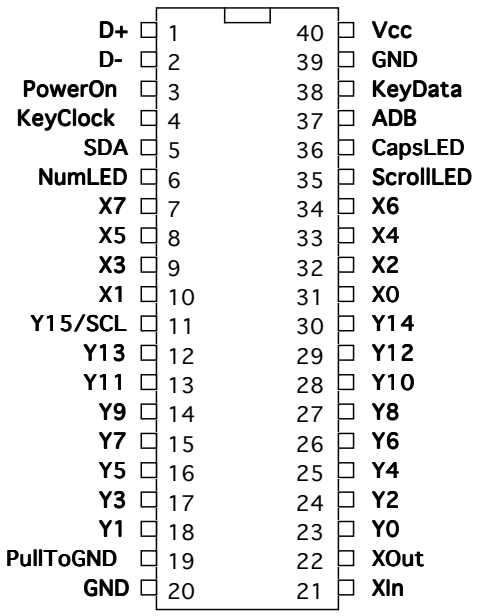
| Name | I/O | Type | Pins | Description |
|---|---|---|---|---|
| D+, D- | I/O | special | 1, 2 | USB differential data lines |
| PowerOn | I | internal Pull Up | 3 | Power Key input, detects suspend on power on |
| KeyClock | I/O | OD, internal Pull Up | 4 | PS/2 and AT interface clock line for keyboard |
| KeyData | I/O | OD, internal Pull Up | 38 | PS/2 and AT interface data line for keyboard |
| ADB | I/O | OD, internal Pull Up | 37 | ADB™ bus signal |
| CapsLED | O | OD, 16mA | 36 | Drives Caps Lock LED, active low |
| NumLED | O | OD, 16mA | 6 | Drives Num Lock LED, active low |
| ScrollLED | O | OD, 16mA | 35 | Drives Scroll Lock LED, active low |
| X[7:0] | I | input, internal Pull Ups | 7, 34, 8, 33, 9, 32, 10, 31 | Matrix row lines. Inputs to controller |
| Y[14:0] | O | OD | 30, 12, 29, 13, 28, 14, 27, 15, 26, 16, 25, 17, 24, 18, 23 | Matrix column lines. Periodically driven to low by the controller to scan the matrix. |
| Y15 | O | OD | 11 | Matrix column line (KeyWarrior 16) |
| Y15/SCL | O | OD | 11 | Matrix column line and SCL line for external EEPROM (Flex, Operator, Commander) |
| NC | - | - | 5 | Unused pin, do not connect (KeyWarrior 16) |
| SDA | I/O | OD, internal Pull Up | 5 | SDA line for external EEPROM (Flex, Operator, Comamnder) |
| PullToGND | I | | 19 | Used during manufacturing, connect to GND |
| GND | | Power supply | 20, 39 | Ground |
| Vcc | | Power supply | 40 | Supply voltage |
| XOut | O | | 22 | On chip oscillator output |
| XIn | I | | 21 | On chip oscillator input |

**All drawings: TOP VIEW!**

**KeyWarrior 16-MOD**



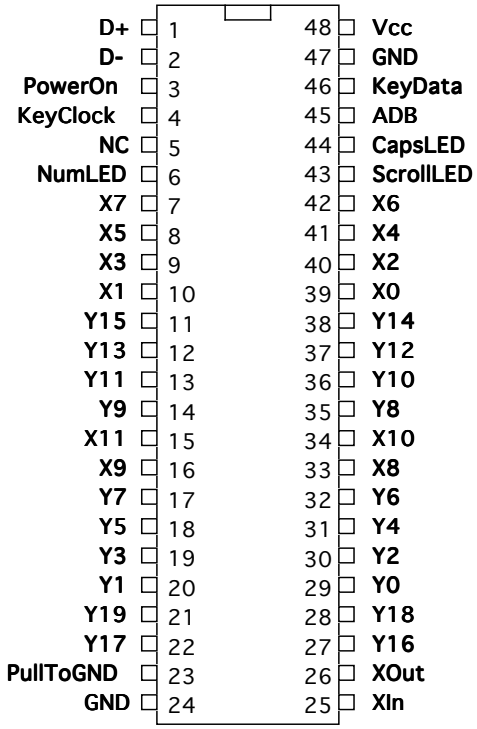

**KeyWarrior 16 Flex-MOD**
**KeyWarrior 16 Operator-MOD**
**KeyWarrior 16 Commander-MOD**



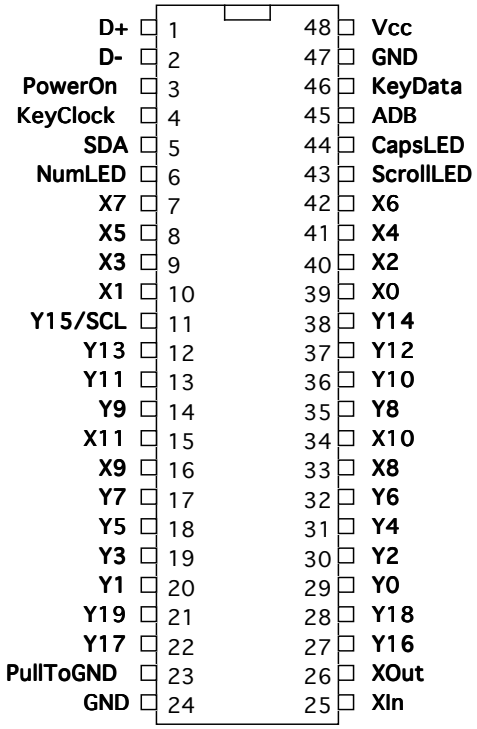
### 3.4 Pin Descriptions KeyWarrior 20 / KeyWarrior 20 Flex / Operator / Commander, SSOP 48

| Name | I/O | Type | Pins | Description |
|---|---|---|---|---|
| D+, D- | I/O | special | 1, 2 | USB differential data lines |
| PowerOn | I | internal Pull Up | 3 | Power Key input, detects suspend on power on |
| KeyClock | I/O | OD, internal Pull Up | 4 | PS/2 and AT interface clock line for keyboard |
| KeyData | I/O | OD, internal Pull Up | 46 | PS/2 and AT interface data line for keyboard |
| ADB | I/O | OD, internal Pull Up | 45 | ADB™ bus signal |
| CapsLED | O | OD, 16mA | 44 | Drives Caps Lock LED, active low |
| NumLED | O | OD, 16mA | 6 | Drives Num Lock LED, active low |
| ScrollLED | O | OD, 16mA | 43 | Drives Scroll Lock LED, active low |
| X[11:0] | I | input, internal Pull Ups | 15, 34, 16, 33, 7, 42, 8, 41, 9, 40, 10, 39 | Matrix row lines. Inputs to controller |
| Y[19:16] Y[14:0] | O | OD | 21, 28, 22, 27, 38, 12, 37, 13, 36, 14, 35, 17, 32, 18, 31, 19, 30, 20, 29 | Matrix column lines. Periodically driven to low by the controller to scan the matrix. |
| Y15 | O | OD | 11 | Matrix column line (KeyWarrior 20) |
| Y15/SCL | O | OD | 11 | Matrix column line and SCL line for external EEPROM (Flex, Operator, Commander) |
| NC | - | - | 5 | Unused pin, do not connect (KeyWarrior 20) |
| SDA | I/O | OD, internal Pull Up | 5 | SDA line for external EEPROM (Flex, Operator, Commander) |
| PullToGND | I | | 23 | Used during manufacturing, connect to GND |
| GND | | Power supply | 24, 47 | Ground |
| Vcc | | Power supply | 48 | Supply voltage |
| XOut | O | | 26 | On chip oscillator output |
| XIn | I | | 25 | On chip oscillator input |

**KeyWarrior 20-S**




**KeyWarrior 20 FX/OP/CM-S**



### 3.5 Pin Descriptions KeyWarrior Combo O / KeyWarrior Combo O Flex / Operator / Commander, SSOP 48

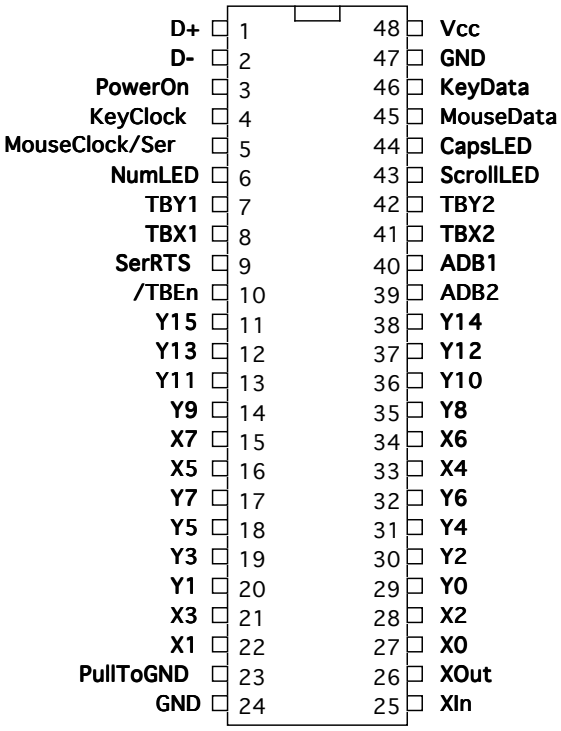
| Name | I/O | Type | Pins | Description |
|---|---|---|---|---|
| D+, D- | I/O | special | 1, 2 | USB differential data lines |
| PowerOn | I | internal Pull Up | 3 | Power Key input, detects suspend on power on |
| KeyClock | I/O | OD, internal Pull Up | 4 | PS/2 and AT interface clock line for keyboard |
| KeyData | I/O | OD, internal Pull Up | 46 | PS/2 and AT interface data line for keyboard |
| MouseClock/ Ser | I/O | OD, internal Pull Up | 5 | PS/2 interface clock signal for mouse and data signal for serial port |
| MouseData | I/O | OD, internal Pull Up | 45 | PS/2 interface data signal for mouse |
| CapsLED | O | OD, 16mA | 44 | Drives Caps Lock LED, active low |
| NumLED | O | OD, 16mA | 6 | Drives Num Lock LED, active low |
| ScrollLED | O | OD, 16mA | 43 | Drives Scroll Lock LED, active low |
| TBY1 | I | high impedance input * | 7 | Y1 signal for optical encoded mechanism |
| TBY2 | I | high impedance input * | 42 | Y2 signal for optical encoded mechanism (Y1 edges lead Y2 edges for up movement) |
| TBX1 | I | high impedance input * | 8 | X1 signal for optical encoded mechanism |
| TBX2 | I | high impedance input * | 41 | X2 signal for optical encoded mechanism (X1 edges lead X2 edges for right movement) |
| SerRTS | I | high impedance input ** | 9 | Serial port RTS, used to detect serial port and reset mouse |
| /TBEn | O | OD | 10 | Active low, used to enable LEDs in trackball mechanism. Requires external driver. (KeyWarrior Combo O) |
| /TBEn/SDA *** | I/O | OD | 10 | Active low, used to enable LEDs in trackball mechanism. Requires external driver.<br>Also SDA line for EEPROM (Flex, Operator, Commander) |
| ADB1, ADB2 | I/O | OD | 39, 40 | ADB™ Data line, tie together |
| X[7:0] | I | input, internal Pull Ups | 15, 34, 16, 33, 21, 28, 22, 27 | Matrix row lines. Inputs to controller |
| Y[14:0] | O | OD | 38, 12, 37, 13, 36, 14, 35, 17, 32, 18, 31, 19, 30, 20, 29 | Matrix column lines. Periodically driven low by the controller to scan the matrix. |
| Y15 | O | OD | 11 | Matrix column line (KeyWarrior Combo O) |
| Y15/SCL | O | OD | 11 | Matrix column line and SCL line for external EEPROM (Flex, Operator, Commander) |
| PullToGND | I | | 23 | Used during manufacturing, connect to GND |
| GND | | Power supply | 24,47 | Ground |
| Vcc | | Power supply | 48 | Supply voltage |
| XOut | O | | 26 | On chip oscillator output |
| XIn | I | | 25 | On chip oscillator input |

* External pull up resistors may be required, depending on output signal of the quadrature encoder.

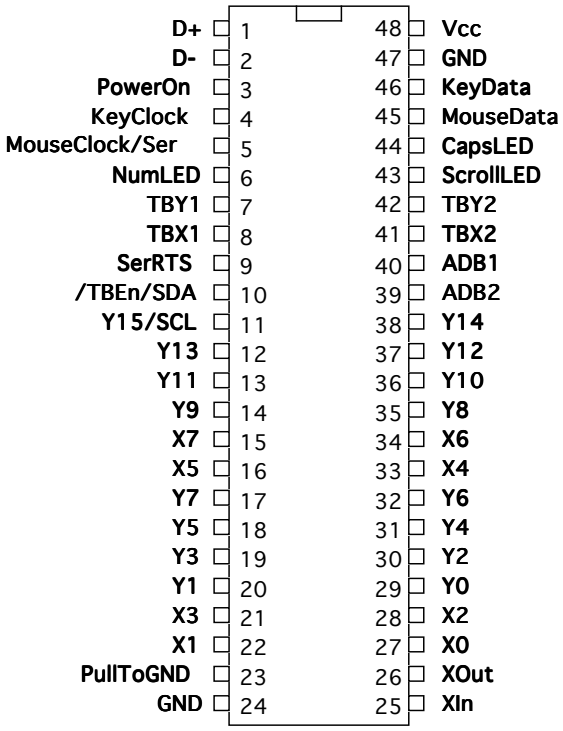
** See application circuit for external circuitry

***Due to double use intermittent disabling of trackball LEDs possible when keyboard is operated.

## KeyWarrior Combo O-S




## KeyWarrior Combo O Flex-S
## KeyWarrior Combo O Operator-S
## KeyWarrior Combo O Commander-S




**All drawings: TOP VIEW!**

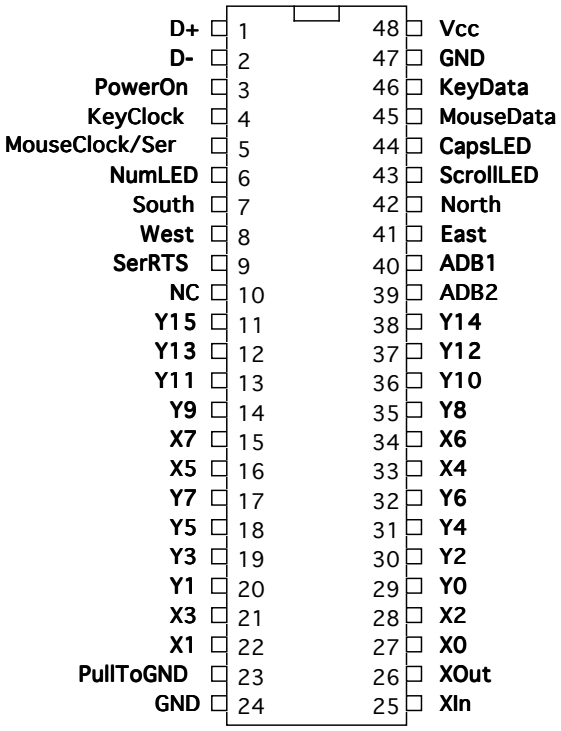
### 3.6 Pin Descriptions KeyWarrior Combo V / KeyWarrior Combo V Flex / Operator / Commander, SSOP 48

| Name | I/O | Type | Pins | Description |
|---|---|---|---|---|
| D+, D- | I/O | special | 1, 2 | USB differential data lines |
| PowerOn | I | internal Pull Up | 3 | Power Key input, detects suspend on power on |
| KeyClock | I/O | OD, internal Pull Up | 4 | PS/2 and AT interface clock line for keyboard |
| KeyData | I/O | OD, internal Pull Up | 46 | PS/2 and AT interface data line for keyboard |
| MouseClock/ Ser | I/O | OD, internal Pull Up | 5 | PS/2 interface clock signal for mouse and data signal for serial port |
| MouseData | I/O | OD, internal Pull Up | 45 | PS/2 interface data signal for mouse |
| CapsLED | O | OD, 16mA | 44 | Drives Caps Lock LED, active low |
| NumLED | O | OD, 16mA | 6 | Drives Num Lock LED, active low |
| ScrollLED | O | OD, 16mA | 43 | Drives Scroll Lock LED, active low |
| North | I/O | OD * | 42 | North input for VersaPoint™ sensor |
| South | I/O | OD * | 7 | South input for VersaPoint™ sensor |
| East | I/O | OD * | 41 | East input for VersaPoint™ sensor |
| West | I/O | OD * | 8 | West input for VersaPoint™ sensor |
| SerRTS | I | high impedance input * | 9 | Serial port RTS, used to detect serial port and reset mouse |
| NC | - | - | 10 | Unused pin, do not connect (KeyWarrior Combo V) |
| SDA | I/O | OD ** | 10 | SDA line for external EEPROM (Flex, Operator, Commander) |
| ADB1, ADB2 | I/O | OD | 39, 40 | ADB™ Data line, tie together |
| X[7:0] | I | input, internal Pull Ups | 15, 34, 16, 33, 21, 28, 22, 27 | Matrix row lines. Inputs to controller |
| Y[14:0] | O | OD | 38, 12, 37, 13, 36, 14, 35, 17, 32, 18, 31, 19, 30, 20, 29 | Matrix column lines. Periodically driven to low by the controller to scan the matrix. |
| Y15 | O | OD | 11 | Matrix column line (KeyWarrior Combo V) |
| Y15/SCL | I/O | OD ** | 11 | Matrix columns line and SCL line for external EEPROM (Flex, Operator, Commander) |
| PullToGND | I | | 23 | Used during manufacturing, connect to GND |
| GND | | Power supply | 24,47 | Ground |
| Vcc | | Power supply | 48 | Supply voltage |
| XOut | O | | 26 | On chip oscillator output |
| XIn | I | | 25 | On chip oscillator input |

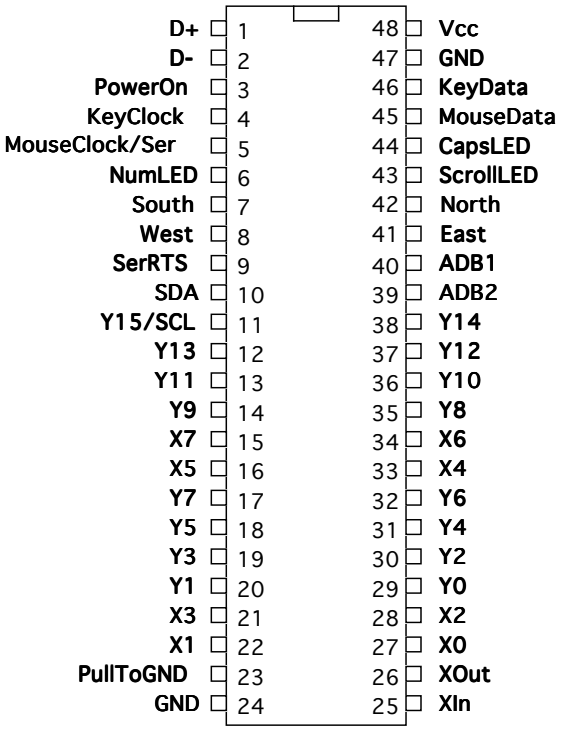
* See application circuit for external circuitry.

** Requires external pull up.

### KeyWarrior Combo V-S




### KeyWarrior Combo V Flex-S
### KeyWarrior Combo V Operator-S
### KeyWarrior Combo V Commander-S




**All drawings: TOP VIEW!**

## 4.0 Pin Descriptions

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

**PowerOn**
Input for power key, also used to determine if device should suspend on power up.
Connect a switch closing to ground here to generate the power key scancode. An internal pull up resistor is activated upon device reset.
At power up KeyWarrior checks this pin before activating the internal pull up. If this pin is tied to +5V with 100KΩ or less KeyWarrior enters a suspend mode which it leaves only when detecting USB bus activity.
When the pin is pulled to Gnd KeyWarrior goes active immediately upon reset. Do not tie this pin directly to Gnd, always use a pull down resistor of 100KΩ or more, even if no power key will be used.

**KeyClock, KeyData**
These two lines are the AT or PS/2 keyboard interface. Connect these signals to the keyboard interface of the host computer. Internal pull up resistors are activated on device reset.
If PS/2 is not used leave these pins unconnected.

**MouseClock/Ser, MouseData (KeyWarrior Combo only)**
These two lines are the PS/2 mouse interface. Connect these lines to the mouse interface of the host computer.
MouseClock doubles as the serial data output, connect this line to a RS232 driver that drives the TXD line of the serial mouse interface.
If PS/2 is not used leave these pins unconnected.

**SerRTS (KeyWarrior Combo only)**
Serial port RTS signal line input. This pin requires external circuitry as outlined in the application circuit.
Pulling this line low does halt the serial mouse data transmission and resets the mouse when it returns to high.
If the serial mouse port is not used this pin must be pulled low.

**ADB (KeyWarrior non-Combo)**
Data signal of the ADB™. Connect to the ADB™ data line of the computer. Internal pull up resistor is activated on device reset.
If ADB is not used leave this pin unconnected.

**ADB1, ADB2 (KeyWarrior Combo only)**
Data signal of the ADB™. KeyWarriror Combo uses two lines to supply suffcient current sinking capability. Tie both lines together and connect to the ADB™ data line of the computer. External weak pull up resistor is required.
If ADB is unused pull these lines high.

**CapsLED, NumLED, ScrollLED**
Open drain LED driver outputs. Each of these pins is capable of sinking 16mA max. to directly drive a LED indicating the Caps Lock, Number Lock and Scroll Lock status. Connect LEDs with appropriate resistors to +5V.

**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.

**X[8:11]**
Additional horizontal matrix lines on KeyWarrior20 variants. Internal pull up resistors.

**Y[0:15]**
Vertical matrix outputs. These open drain outputs are periodically pulled low to detect pressed keys. No internal or external pull up resistors.

**Y[16:19]**
Additional vertical matrix outputs on KeyWarrior 20 variants. Internal pull up resistors approx. 15KΩ.

**North, South, East, West (KeyWarrior Combo V only)**
An Interlink Electronics VersaPoint™ sensor may be connected here. See application circuit for external circuitry.

**TBX1, TBX2, TBY1, TBY2 (KeyWarrior Combo O only)**
Inputs for optical quadrature encoded trackball or mouse mechanism. TBX1 falling edge leads TBX2 falling edge for right movement. TBY1 falling edge leads TBY2 falling edge for up movement.
The inputs require either CMOS compatible signals or open drain signals with external pull up resistors.

**/TBEn (KeyWarrior Combo O only)**
Enable signal for the LEDs of the optical quadrature encoder. Open drain output, requires external drivers for sufficient power to drive the LEDs.

**/Pull to GND**
This pin is used during production of the KeyWarrior chips, connect to GND.

**XOut, XIn**
Connection for external oscillator. A 6MHz ceramic resonator may be connected here, no additional components are necessary. The use of a crystal is not recommended as the oscillator is optimized for ceramic resonators. An external 6MHz clock may be connected to XIn, XOut has to be left floating in this case.

**GND**
Power supply ground.

**Vcc**
Supply voltage.

**SCL (KeyWarrior 8 Flex/Operator/Cell only)**
SCL line of the IIC to connect the external EEPROM. External 10K pull up resistor is required.

**Y15/SCL (KeyWarrior 16/20 Flex/Operator/ Commander and KeyWarrior Combo O/V Flex/ Operator/Commander)**
Combination of Y15 matrix scan line and SCL line of the IIC to connect the external EEPROM. External 10K pull up resistor required.

**SDA (KeyWarrior 8/16/20 Flex/Operator/ Commander/Cell and KeyWarrior Combo V Flex/Operator/Commander)**
SDA line of the IIC to connect the external EEPROM. KeyWarrior Combo V Flex requires an external 4K7 pull up resistor on this line.

**TBEn/SDA (KeyWarrior Combo O Flex/ Operator/Commander)**
Combination of /TBEn line to enable the LEDs of the optical encoder and SDA line of the IIC to connect the external EEPROM. Requires an external 4K7 pull up resistor.
Also requires an external driver to supply sufficient power for the trackball LEDs. See application circuit of KeyWarrior Combo O Flex for a typical circuit.

### 4.1 Flex, Operator, and Commander external EEPROM

The KeyWarrior Flex, Operator, and Commander controllers need an external EEPROM which contains the Master Translation Table.
In case of the KeyWarrior Flex controllers a 24C02 EEPROM is used (i.e. Fairchild NM24C02N). The KeyWarrior Operator or Commander requires a 24C16 (i.e. Fairchild NM24C16N).
The SCL and SDA lines of the EEPROM need to be connected to the appropriate pins of the KeyWarrior controller. The A0, A1 and A2 pins of the 24C02 need to be pulled low.
A single PCB layout is capable of supporting both Flex, Operator, and Commander controllers. The 24C02 and 24C16 are pin compatible and KeyWarrior Flex, Operator, and Commander are pin compatible as well.
KeyWarrior drives the IIC at about 100kHz.
The EEPROM may be either preprogrammed before insertion into the circuit or it can be programmed via the USB.
The utility software for downloading the Master Translation Table via USB is available for MacOS and Win 98.

### 4.2 EEPROM potential problem

Though 24C02 and 24C16 chips originally were defined to have no signal on pin 7 we have found several manufacturers do use this pin for some write protect mechanism.
To avoid problems with these chips we recommend to tie pin 7 to ground, even though it will be not connected on most chips.

**5.0 Device Operation**
KeyWarrior does work with very few external components. No jumpers or circuit changes are necessary to use KeyWarrior with either of the interfaces.
KeyWarrior monitors the interface lines to detect which of the interfaces is active. Only one of the interfaces may be connected at any given time, connecting more than one interface at the same time will produce unpredictable results.
Once KeyWarrior has been powered up and has detected its active interface it does start scanning the keyboard matrix. KeyWarrior Combo does also start to decode the mouse sensor information.

**5.1 Power Up**
Every time the supply voltage is applied KeyWarrior executes an internal reset sequence. All internal pull up resistors are disabled upon power up and will be activated during the internal reset sequence.
Before enabling the internal pull ups KeyWarrior checks the status of the PowerOn pin. If this pin is high KeyWarrior will immediately enter the suspend mode which it does leave only upon detecting USB bus activity. When the pin is low KeyWarrior will become active and check the interface signals to find out which interface is in use.

**5.2 Active Interface Detection**
KeyWarrior checks the interface lines to find which interface is active. Once an active interface for the keyboard part has been detected it starts operating using this interface.
If the USB or ADB are active the mouse part of the KeyWarrior Combo chips does also go active using the same interface.
When the KeyWarrior Combo chip detects it is running on the PS/2 interface the mouse part may be using either PS/2 or serial. In this case the keyboard part may go active while the mouse part remains disabled if there is no PS/2 or serial mouse interface attached.

**5.3 Keyboard Scanning**
KeyWarrior 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 $t_{debounce}$ KeyWarrior decodes the changes and generates scancodes.
If the internal scancode buffer runs full KeyWarrior does stop scanning the matrix until it has been able to transmit scancodes to the host computer.

**5.4 Key Rollover**
KeyWarrior supports true n-key rollover. All keys in the matrix may be pressed at the same time without KeyWarrior missing any code. However due to the phantom key effect it can not be guaranteed that combinations of many keys are properly reported (see 5.4.1).
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 ordinary keys are pressed an error state is reported. So USB has a 6-key plus modifiers rollover.

**5.4.1 Phantom Keys**
Phantom keys do occur when three or more keys are pressed in a combination that leads to the matrix reading like a fourth key has been pressed.
To avoid phantom keys diodes may be added to the keys. If diodes are used they 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 place all modifier keys on a single row or column and put diodes on all of them.

**5.5. Protocol Details: USB**
KeyWarrior works as a HID compliant keyboard using boot protocol. 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 103, which include the Power key and the = sign in the keypad.

**5.6 Protocol Details: ADB™**
When running on ADB™ KeyWarrior identifies as an extended keyboard with ISO layout (Handler ID 5). It does also respond to HandlerID 3, which switches the keyboard to a mode in which it reports different scancodes for the left and right modifier keys.

**5.7 Protocol Details: PS/2**
KeyWarrior is a functional equivalent to a MF2 keyboard. It does implement code sets 1, 2 and 3.
All MF2 commands are implemented with the exception of the mode set commands $F7-$FD.
Codeset 3 is not fully implemented, it does always send make/break codes for all keys. This works for most applications.

**6.0 Mouse Function**
The KeyWarrior Combo chips do intergrate a mouse function with the keyboard encoder. Either a classical trackball or mouse mechanism with optical quadrature encoders or a Interlink Electronic VersaPoint™ force sensor may be used to control the cursor movement.
The mouse buttons are located in the keyboard matrix. Up to three mouse buttons are supported.

**6.1 Mouse on USB**
If used on the USB KeyWarrior Combo identifies as a composite device with two interfaces. The mouse function is the second interface and works as a HID compliant three button mouse using boot protocol.

**6.2 Mouse on ADB™**
When used with the ADB™ KeyWarrior works like two separate devices. The mouse part identifies as a standard mouse (HandlerID 1). It does also accept HandlerID 4.
The mouse buttons are reported according to the extended mouse protocol as outlined in the Apple Technote "HW01-ADB The Untold Story: Space Aliens Ate My Mouse".
When running with HandlerID 4 an additional byte is returned which holds the third button and additional bits for the axes.
Preprogrammed functions for the additional buttons are available on request.

**6.3 Mouse on PS/2**
The mouse function has a separate PS/2 interface. It does work as a standard three button mouse and is compatible with standard system drivers of Windows.
The mouse function defaults to the PS/2 port when the keyboard PS/2 port becomes active and no active mouse port is identified within 2 seconds after this. In this case the mouse function is enabled with the PS/2 port active, no reset identification is send. This will work for hot plugging of the PS/2 mouse port in most cases.

**6.4 Mouse on Serial Port**
The serial port does use the Logitech M+ serial protocol for three button mice. The third button is reported in a fourth byte. This is compatible with most system drivers, even those expecting MS mouse two button protocol, in this case the driver will ignore the fourth byte.
Other protocols are available on request.
The serial port requires the RTS line to be at a positive voltage for more than 25 milliseconds before it activates.

**6.5 Interface Combinations**
KeyWarrior does allow only certain combinations of mouse and keyboard interfaces to be used. The legal combinations are as follows:
USB for both
ADB for both
PS/2 for both
PS/2 for keyboard and serial for mouse
Any other combination will deliver unpredictable results.

## 7. Custom Scancode Tables

KeyWarrior uses a single table to translate the matrix coordinates to USB usage codes.
If running on ADB or PS/2 the USB usage codes are translated to the approriate scancodes by fixed tables.
The table that does the translation from matrix coordinates to USB usage codes is customer specified. This table is called the "Master Translation Table". Master Translation Tables can be factory programmed or loaded in system, depending on the KeyWarrior type.
For information on generating the Master Translation Table please refer to the document "Creating Custom KeyWarrior Scancode Tables".

### 7.1 Function Shift Keys

KeyWarrior allows the definition of function shift keys. If this key is pressed KeyWarrior uses another translation table to convert matrix coordinates to USB usage codes.
This allows a small keyboard to generate all functions of a full sized keyboard.
The function shift keys may be on any coordinate in the matrix, they are assigned by placing a special code in the corresponding table position.

### 7.2 Mouse Buttons

Like the function shift key the mouse buttons are identified by special codes in the Master Translation Table. Please refer to the document "Creating Custom KeyWarrior Scancode Tables" for details.

### 7.3 Programming a Flex, Operator, Cell, or Commander Controller

KeyWarrior Flex, Operator, Cell, and Commander controllers may be programmed via the USB from a Macintosh or Win 98 or ME PC. A utility program reads the assembly source file for a Master Translation Table and transmits it to the KeyWarrior Flex, Operator, Cell, or Commander controller.
The format of the file for Flex controllers is exactly the same as the file used to generate the data for factory programmed versions of the KeyWarrior chips. There are no factory programmed versions of KeyWarrior that offer the function of the Operator, Cell, and Commander controllers.
Alternatively the external EEPROM may be programmed in any appropriate device programmer and then inserted into the circuit.
KeyWarrior Flex, Operator, Cell, and Commander are not intended for applications which provide keyboard function programming options for the end user. The programmability is available only via the USB and it is intended for production programming only.

### 7.4 KeyWarrior Operator Key Definitions

The KeyWarrior Operator controllers allow to program up to 8 key functions onto a single key. Since USB usage codes are used in the Master Translation Table these eight key functions can translate in more than eight scan codes when running on the PS/2 interface.
Any unused key function for any individual key must be programmed as $00. A $00 in the Master Translation Table will generate no keycode.
Multiple key functions programmed onto a single key will activate in the sequence as programmed. They do stay active ("pressed") as long as the physical key is pressed.
When the physical key is pressed a sequence of make codes will be generated. Break codes can be generated only when the physical key is released.
This limits the macros to sequences in which multiple keys are pressed at the same time. It is not possible to program multiple keystrokes of the same key function onto one physical key.
If the same modifier key is programmed onto two keys and both are held down a break code for the modifier will be sent as soon as either of the keys is released.

### 7.5 KeyWarrior Commander Key Definitions

KeyWarrior Commander controllers do use a Master translation Table with a single byte per key, just like the KeyWarrior Flex.
Though a range of special codes ($B0-$DF) does allow to assign one of 48 macros to any key. Each of these macros may have up to 31 codes and can be used in one of two modes.
If the mode byte of a macro is $00 then the macro will work like those of KeyWarrior Operator. No repeated use of the same code is possible and all keycodes will be send as make codes on key down and break codes on key up. This mode is called "static mode".
A $01 in the mode byte does activate the "typing mode" wich does send a break code immediately after each make code, except for modifier keys (Ctrl, Alt, Shift, GUI). A break code for modifiers is sent either on a special break code in the macro or on release of the key.
Contrary to other KeyWarrior variants all Commander chips with 16x8 matrixes do support two FN keys allowing three function levels for every key. This is the reason why there is no KeyWarrior 8 Commander.

### 7.6 KeyWarrior 8 Cell Key Definitions

The KeyWarrior 8 Cell has two different types of keys. All keys in the rows Y0..Y5 (48 keys in total) do behave like keys on the Operator chips. Each of these keys can send up to eight codes.

There are two FN keys on the KeyWarrior 8 Cell which allows three function levels for the keys in Rows Y0..Y5.

All keys in rows Y6 and Y7 (16 keys total) do behave similar to the keypad of a cellular phone. For each of these keys four codes are programmed. The first of these codes is used when no FN key is pressed.

If any of the FN keys is pressed these 16 keys work in a cycling mode. Holding any FN key plus pressing a "Cell-Key" does send the second code for that key. Pressing the same key again without releasing the FN key does send first a backspace code and then the third code, then backspace and the fourth code, backspace and the second code and so on.

So this mode allows you to step through three different codes for each of these "Cell-Keys".

Every time the FN key is released, or a different Cell-Key is pressed no backspace will be send prior to the next code.

This allows to build a keyboard with full alpha numeric capability with very few keys.

## 8.0 DC Characteristics

| | Parameter | Min | Max | Units | Remarks |
|---|---|---|---|---|---|
| $V_{cc}$ | Operating Voltage | 4.35 | 5.25 | V | |
| $I_{cc}$ | Operating Supply Current | | 40 | mA | |
| $I_{sb}$ | Suspend mode current | | 20 | $\mu$A | Oscillator off |
| $I_{ol}$ | Sink current on LED pins | 7.2 | 16.5 | mA | Vout = 1.0V |
| | **USB Interface** | | | | |
| $V_{oh}$ | Static output high | 2.8 | 3.6 | V | 15kΩ±5% to GND |
| $V_{ol}$ | Static output low | | 0.3 | V | |
| $V_{di}$ | Differential Input sensitivity | 0.2 | | V | \|(D+)-(D-)\| |
| $V_{cm}$ | Differential Input common Mode Range | 0.8 | 2.5 | V | |
| $V_{se}$ | Single Ended Transceiver Threshold | 0.8 | 2.0 | V | |
| $C_{in}$ | Transceiver capacitance | | 20 | pF | |
| $I_{io}$ | Hi-Z State Data Line Leakage | -10 | 10 | $\mu$A | 0V < Vin < 3.3V |
| $R_{pu}$ | Bus Pull-up resistance | 7.35 | 7.65 | kΩ | 7.5kΩ±2% |
| $R_{pd}$ | Bus Pull-down resístance | 14.25 | 15.75 | kΩ | 15kΩ±5% |

## 8.1 AC Characteristics

| | Parameter | Min | Max | Units | Remarks |
|---|---|---|---|---|---|
| $t_{cyc}$ | input clock cycle time | 165.0 | 168.3 | ns | |
| $t_{ch}$ | Clock high time | 0.45tcyc | | ns | |
| $t_{cl}$ | Clock low time | 0.45tcyc | | ns | |
| | **USB Driver Characteristics** | | | | |
| $t_r$ | Transition rise time | 75 | | ns | CLoad = 50pF |
| $t_r$ | Transition rise time | | 300 | ns | CLoad = 350pF |
| $t_f$ | Transition fall time | 75 | | ns | CLoad = 50pF |
| $t_f$ | Transition fall time | | 300 | ns | CLoad = 350pF |
| $t_{rfm}$ | Rise/Fall Time matching | 80 | 120 | % | |
| $V_{crs}$ | Output signal crossover voltage | 1.3 | 2.0 | V | |
| | **USB Data Timing** | | | | |
| $t_{drate}$ | Low Speed Data Rate | 1.4777 | 1.5225 | MBit/s | |
| $t_{djr1}$ | Receiver data jitter tolerance | -75 | 75 | ns | To next transition |
| $t_{djr2}$ | Receiver data jitter tolerance | -45 | 45 | ns | For paired transitions |
| $t_{deop}$ | Differential to EOP transition skew | -40 | 100 | ns | |
| $t_{eopr1}$ | EOP width at receiver | 165 | | ns | Rejects as EOP |
| $t_{eopr2}$ | EOP width at reeiver | 675 | | ns | Accepts as EOP |
| $t_{eopt}$ | Source EOP width | 1.25 | 1.50 | $\mu$s | |
| $t_{udj1}$ | Differential driver jitter | -95 | 95 | ns | To next transition |
| $t_{udj2}$ | Differential driver jitter | -150 | 150 | ns | To paired transition |
| | **Keyboard Matrix Scan Timing** | | | | |
| $t_{scan}$ | Scanning interval | 4* | | ms | |
| $t_{scansu}$ | Matrix drive to read setup time | typ. 40* | | $\mu$s | |
| $t_{debounce}$ | Debounce time | 3x $t_{scan}$* | | ms | |

*) A version with fast scanning to better suit rubber dome keyboards is available. In this case $t_{scan}$ = 1ms, $t_{debounce}$ = 2x $t_{scan}$ and $t_{scansu}$= 10$\mu$s

### 8.2 Absolute Maximum Ratings

| | |
|---|---|
| Storage Temperature | -65°C to +150°C |
| Ambient Operating Temperature | 0°C to +70°C |
| Supply Voltage on Vcc relative to Vss | -0.5V to +7.0V |
| DC Input Voltage | -0.5V + Vcc + 0.5V |
| Max. Output Current into any Pin | 60mA |
| Power Dissipation | 300mW |
| Static Discharge Voltage | >2000V |
| Latch-up Current | >200mA |

## 9.0 Ordering Information

| Partname | Order Code | Description | Package |
|---|---|---|---|
| KeyWarrior 8 Flex | KW8FX-MOD | Keyboard for 8x8 matrix, external EEPROM | DIL40 |
| KeyWarrior 8 Flex | KW8FX-S | Keyboard for 8x8 matrix, external EEPROM | SSOP48 |
| KeyWarrior 8 Operator | KW8OP-MOD | Keyboard for 8x8 matrix, external EEPROM, macros | DIL40 |
| KeyWarrior 8 Operator | KW8OP-S | Keyboard for 8x8 matrix, external EEPROM, macros | SSOP48 |
| KeyWarrior 8 Cell | KW8CELL-MOD | Keyboard with cellphone mod, external EEPROM | DIL40 |
| KeyWarrior 8 Cell | KW8CELL-S | Keyboard with cellphone mod, external EEPROM | SSOP48 |
| KeyWarrior 16 Flex | KW16FX-MOD | Keyboard for 16x8 matrix, external EEPROM | DIL40 |
| KeyWarrior 16 Flex | KW16FX-S | Keyboard for 16x8 matrix, external EEPROM | SSOP48 |
| KeyWarrior 16 Operator | KW16OP-MOD | Keyboard for 16x8 matrix, external EEPROM, macros | DIL40 |
| KeyWarrior 16 Operator | KW16OP-S | Keyboard for 16x8 matrix, external EEPROM, macros | SSOP48 |
| KeyWarrior 16 Commander | KW16CM-MOD | Keyboard for 16x8 matrix, external EEPROM, long macros | DIL40 |
| KeyWarrior 16 Commander | KW16CM-S | Keyboard for 16x8 matrix, external EEPROM, long macros | SSOP48 |
| KeyWarrior 20 Flex | KW20FX-S | Keyboard for 20x12 matrix, external EEPROM | SSOP48 |
| KeyWarrior 20 Operator | KW20OP-S | Keyboard for 20x12 matrix, external EEPROM, macros | SSOP48 |
| KeyWarrior 20 Commander | KW20CM-S | Keyboard for 20x12 matrix, external EEPROM, long macros | SSOP48 |
| KeyWarrior Combo O Flex | KWCOFX-S | Keyboard/mouse with optical quadrature encoder, ext. EEPROM | SSOP48 |
| KeyWarrior Combo O Op | KWCOOP-S | Keyboard/mouse with optical quadrature enc., EEPROM, macros | SSOP48 |
| KeyWarrior Combo O Cmdr | KWCOCM-S | Keyboard/mouse with optical quadrature enc., EEPROM, macros | SSOP48 |
| KeyWarriorCombo V Flex | KWCVFX-S | Keyboard/mouse with VersaPoint™ sensor, external EEPROM | SSOP48 |
| KeyWarriorCombo V Op | KWCVOP-S | Keyboard/mouse with VersaPoint™ sensor, EEPROM, marcos | SSOP48 |
| KeyWarriorCombo V Cmdr | KWCVCM-S | Keyboard/mouse with VersaPoint™ sensor, EEPROM, marcos | SSOP48 |

Preprogrammed KeyWarrior chips are customized to fit the specific keyboard they should drive. For ordering KeyWarrior chips the customer needs to supply the matrix information preferably already formatted as a master translation table.
Code Mercenaries will assign a part number to any specific chip so it can be identified for future orders.
Custom chips are subject to minimum order quantities and setup charges, please contact sales for details.
KeyWarrior Flex, Operator, Cell, and Commander controllers are configured for the specific keyboard by loading the Master Translation Table into an external EEPROM. This can be done by the customer.
KeyWarrior Flex controllers are standard parts that may be purchased without any setup costs or minimum order quantities.

### 9.1 Shipping Information

SSOP48 chips come in tubes of 30 each.
To assure the safest handling we recommed that you order in multiples of full tubes.

### 9.2 USB VendorID and ProductID

By default all KeyWarrior chips are shipped with the USB VendorID of Code Mercenaries ($7C0 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>
KeyWarrior Flex and Operator chips are always shipped with a fixed ProductID and the Code Mercenaries VendorID.

Following are the ProductIDs:

| | |
|---|---|
| KeyWarrior 16 Flex | $0100 |
| KeyWarrior 8 Flex | $0101 |
| KeyWarrior 20 Flex | $0102 |
| KeyWarrior Combo V Flex | $0104 |
| KeyWarrior Combo O Flex | $0105 |
| KeyWarrior 16 Commander | $0110 |
| KeyWarrior 20 Commander | $0112 |
| KeyWarrior Combo V Commander | $0114 |
| KeyWarrior Combo O Commander | $0115 |
| KeyWarrior 8 Operator | $0119 |
| KeyWarrior 16 Operator | $0118 |
| KeyWarrior 20 Operator | $011A |
| KeyWarrior 8 Cell | $011B |
| KeyWarrior Combo V Operator | $011C |
| KeyWarrior Combo O Operator | $011D |

### 9.3 Using ADB

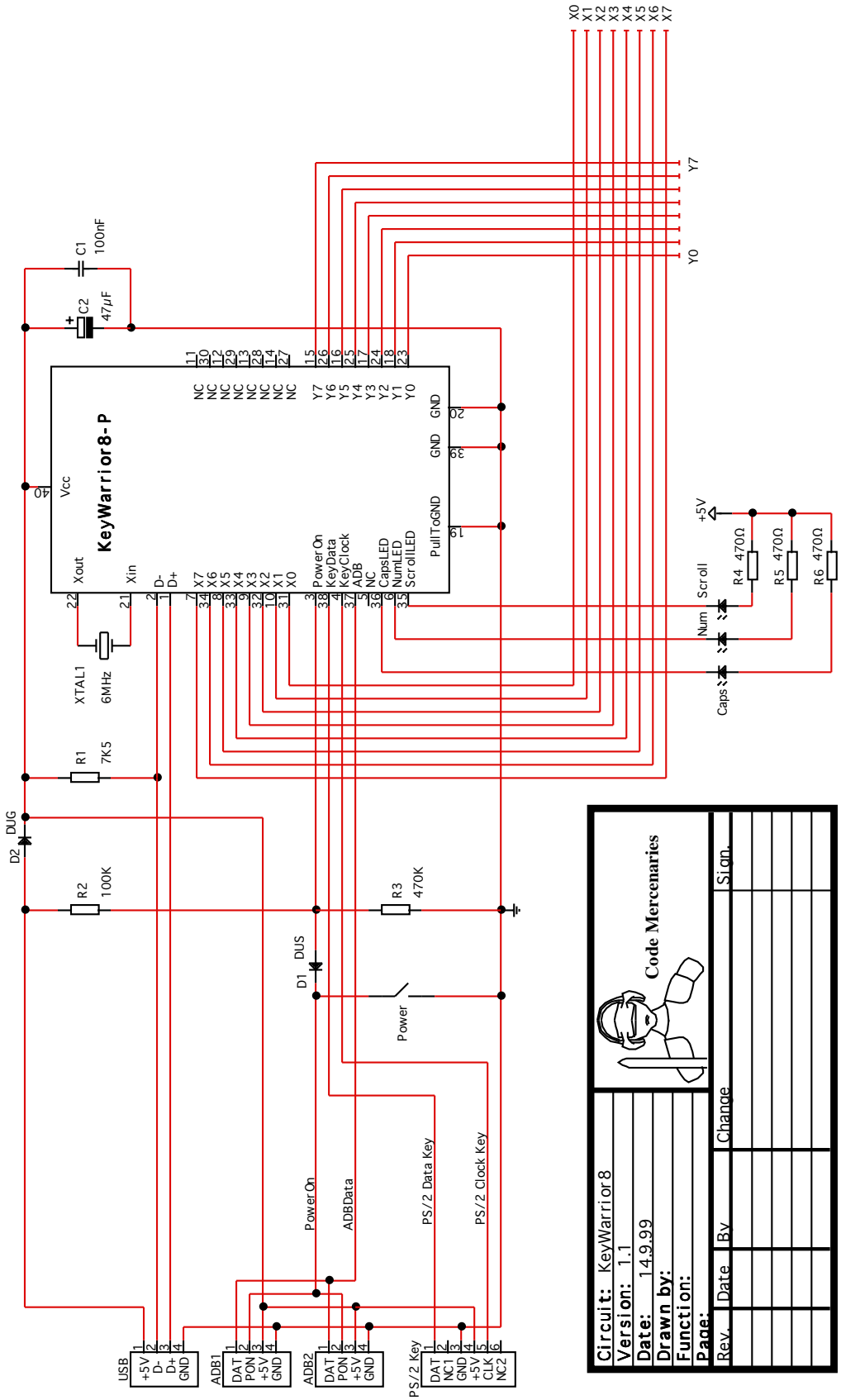
The utilisation of ADB requires a license from Apple Inc. Please contact Apple for details.

### 9.4 Currently shipping versions

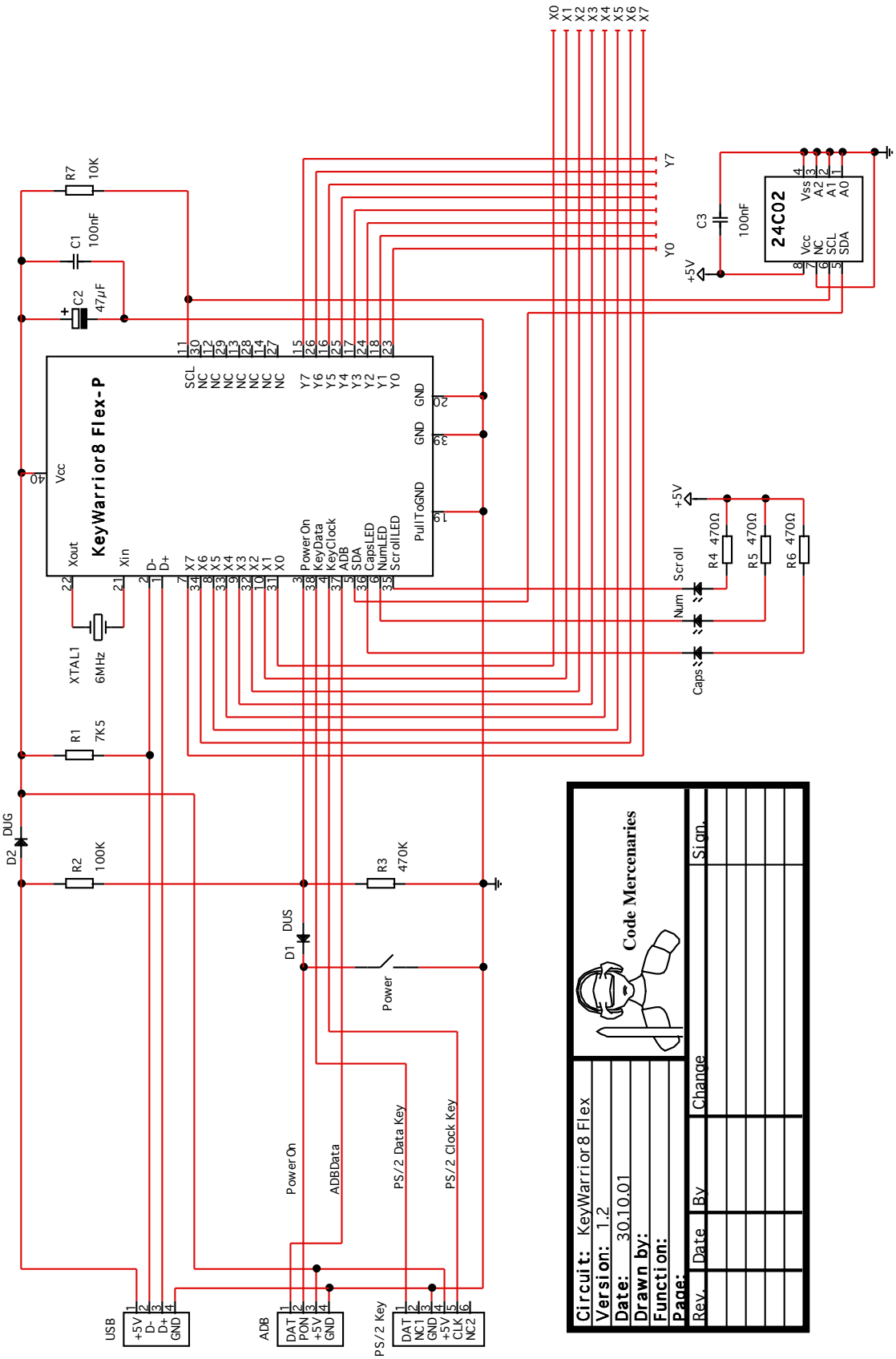
Following are the currently shipping versions for the chips:

| | |
|---|---|
| KeyWarrior 8 Flex | V1.0.9.6 |
| KeyWarrior 8 Operator | V1.0.9.6 |
| KeyWarrior 8 Cell | V1.0.9.6 |
| KeyWarrior 8 Flex LED | V1.1.0.5 |
| KeyWarrior 8 Operator LED | V1.1.0.5 |
| KeyWarrior 8 Cell LED | V1.1.0.5 |
| KeyWarrior 16 Flex | V1.0.9.6 |
| KeyWarrior 16 Operator | V1.0.9.6 |
| KeyWarrior 16 Commander | V1.0.9.6 |
| KeyWarrior 20 Flex | V1.0.9.6 |
| KeyWarrior 20 Operator | V1.0.9.6 |
| KeyWarrior 20 Commander | V1.0.9.6 |
| KeyWarrior Combo O Flex | V1.0.9.7 |
| KeyWarrior Combo O Operator | V1.0.9.7 |
| KeyWarrior Combo O CM | V1.0.9.7 |
| KeyWarrior Combo V Flex | V1.0.9.7 |
| KeyWarrior Combo V Operator | V1.0.9.7 |
| KeyWarrior Combo V CM | V1.0.9.7 |
| KeyWarrior Combo H Flex | V1.1.1.0 |
| KeyWarrior Combo H Operator | V1.1.1.0 |
| KeyWarrior Combo H CM | V1.1.1.0 |

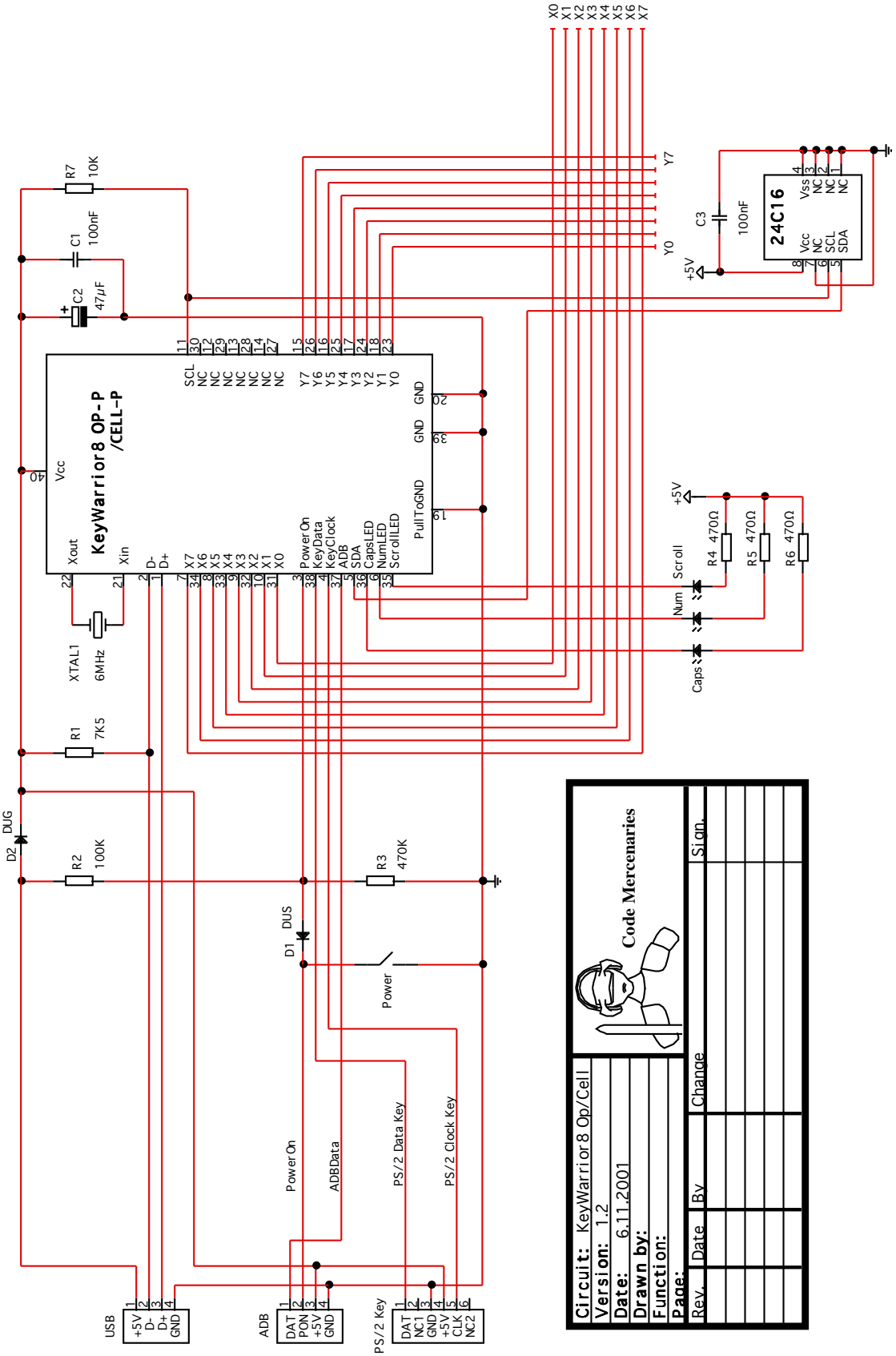
## 10.0 Typical Application for KeyWarrior 8 (DIL40 pinout)



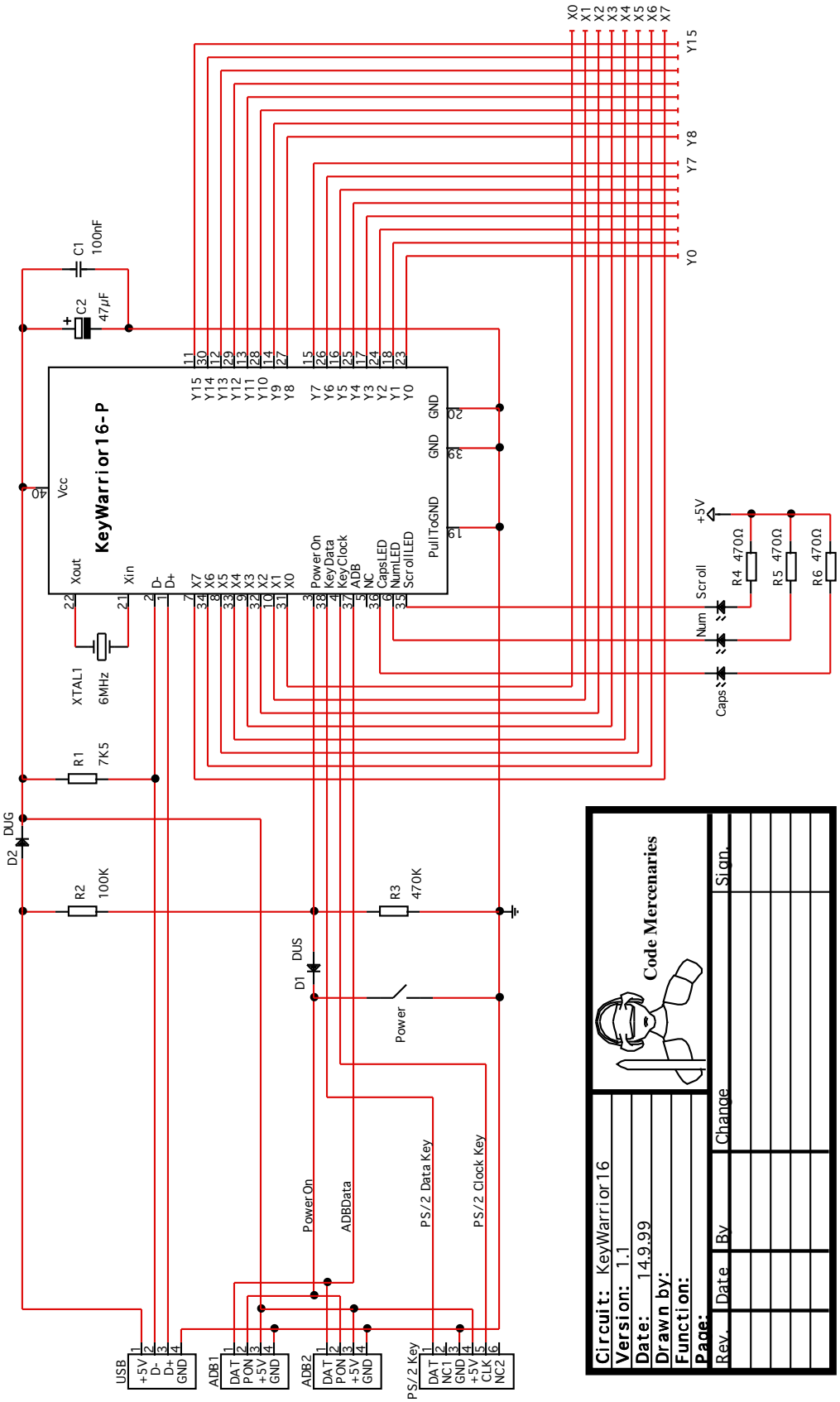
## 10.1 Typical Application for KeyWarrior 8 Flex (DIL40 pinout)



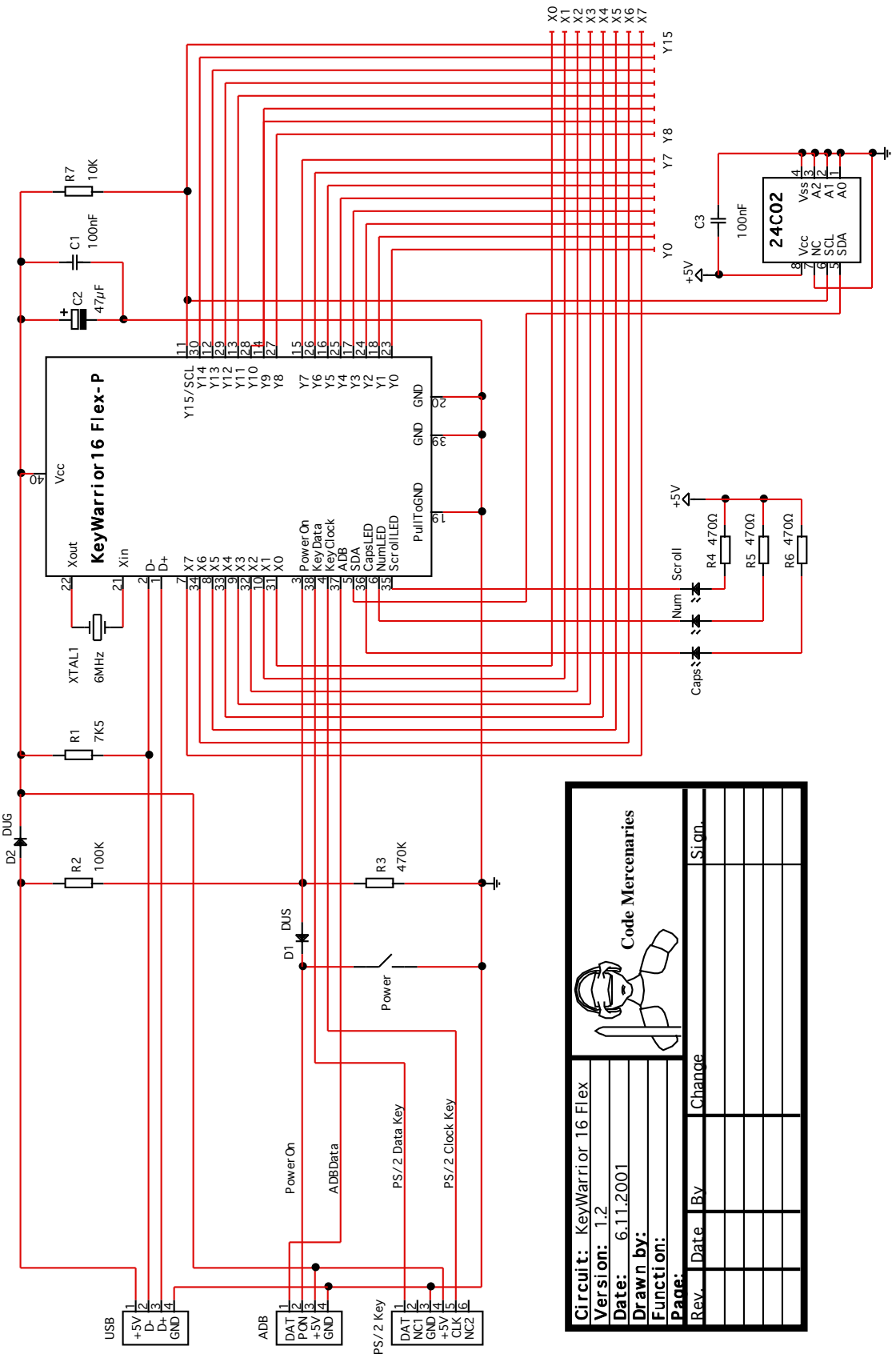
## 10.2 Typical Application for KeyWarrior 8 Operator or Cell (DIL40 pinout)



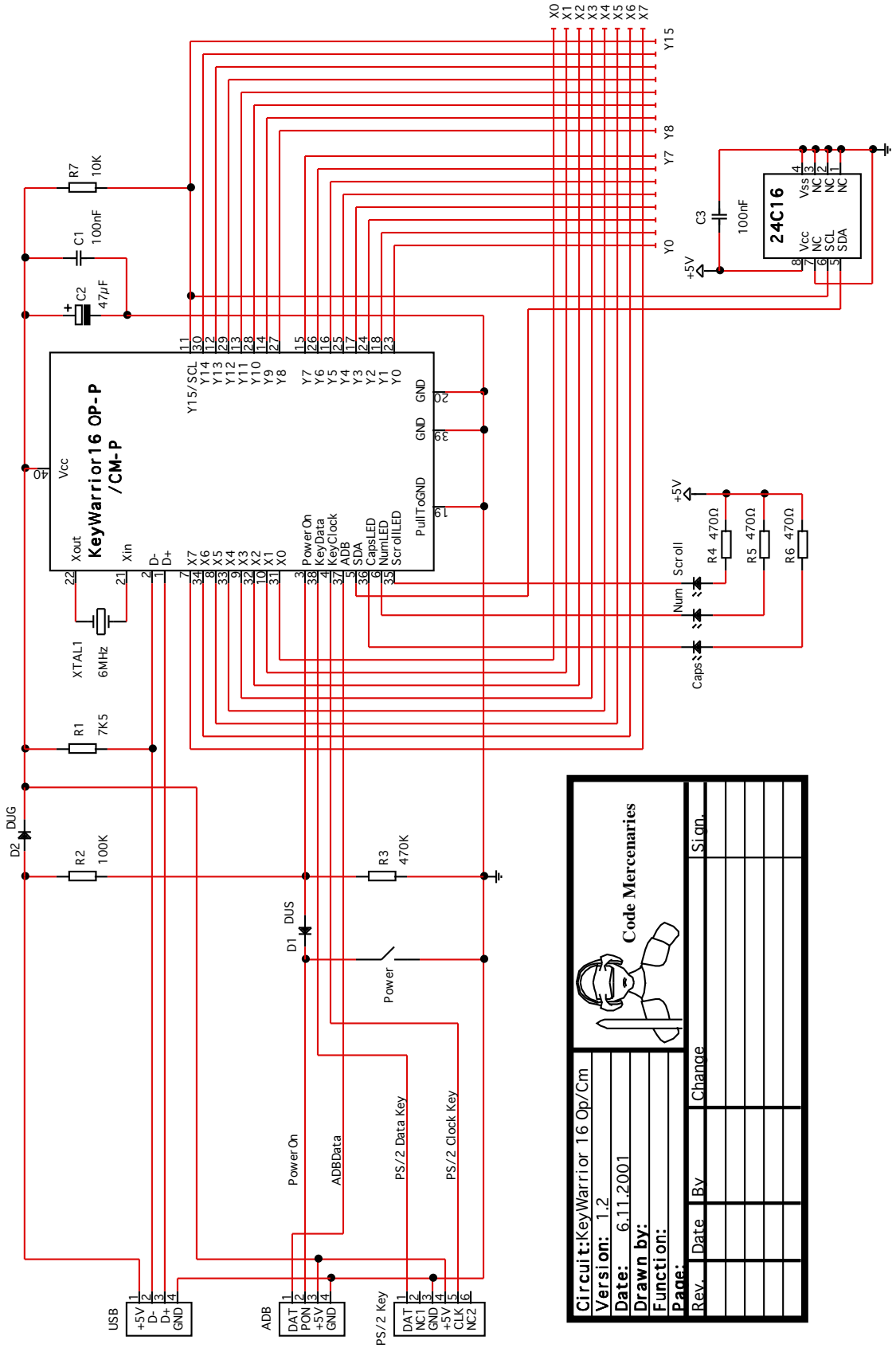
### 10.3 Typical Application for KeyWarrior 16 (DIL40 pinout)



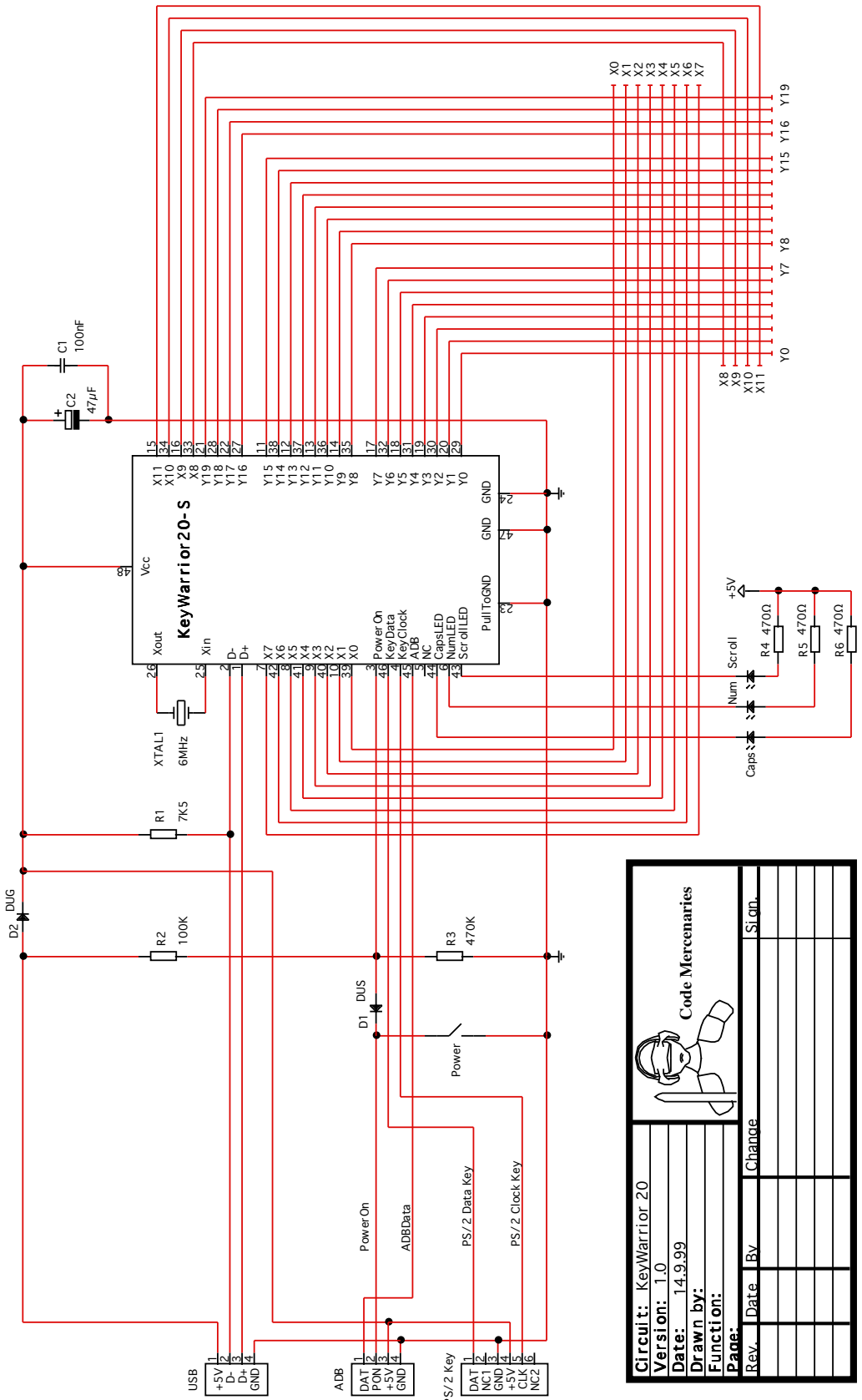
## 10.4 Typical Application for KeyWarrior 16 Flex (DIL40 pinout)



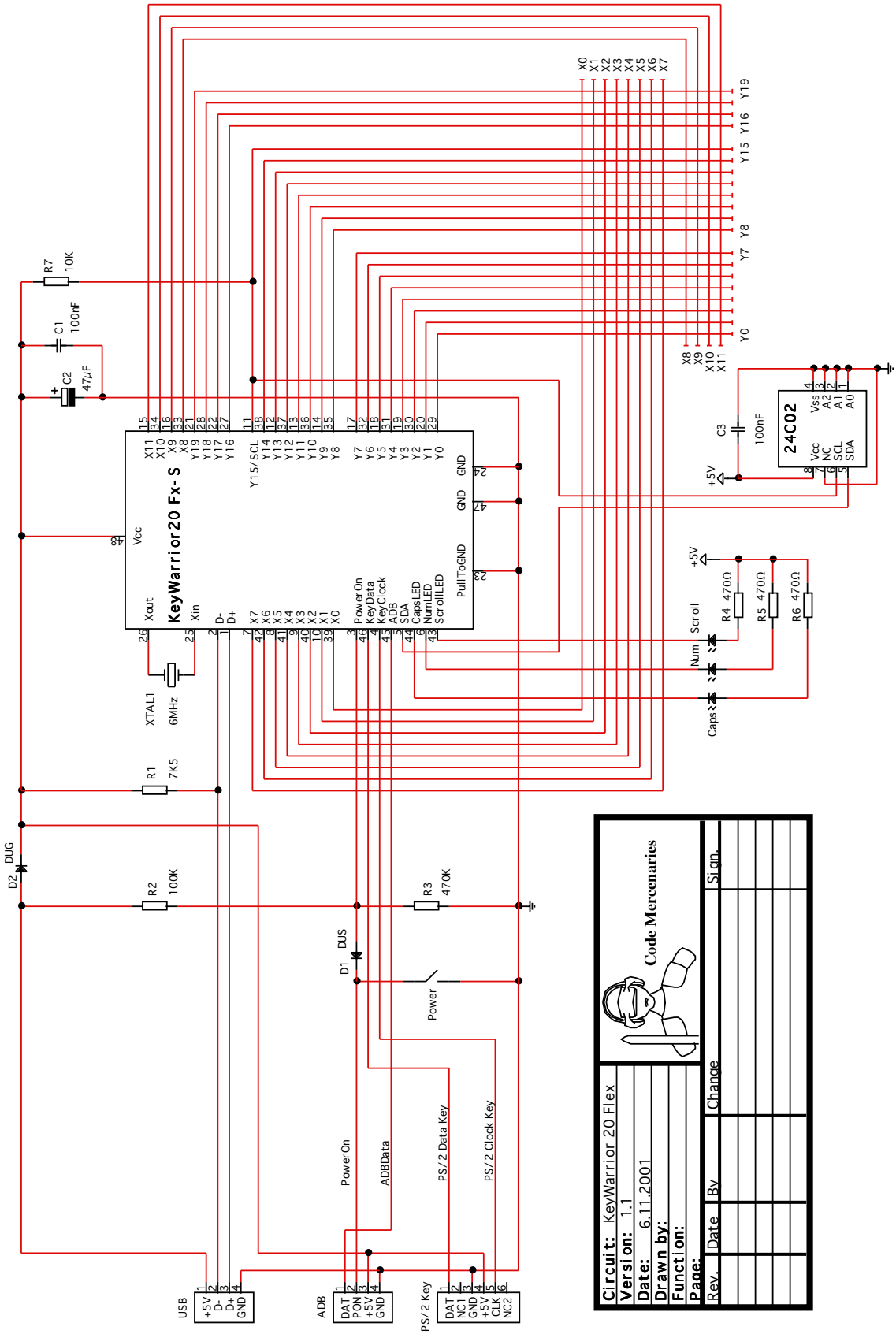
## 10.5 Typical Application for KeyWarrior 16 Operator or Commander (DIL40 pinout)



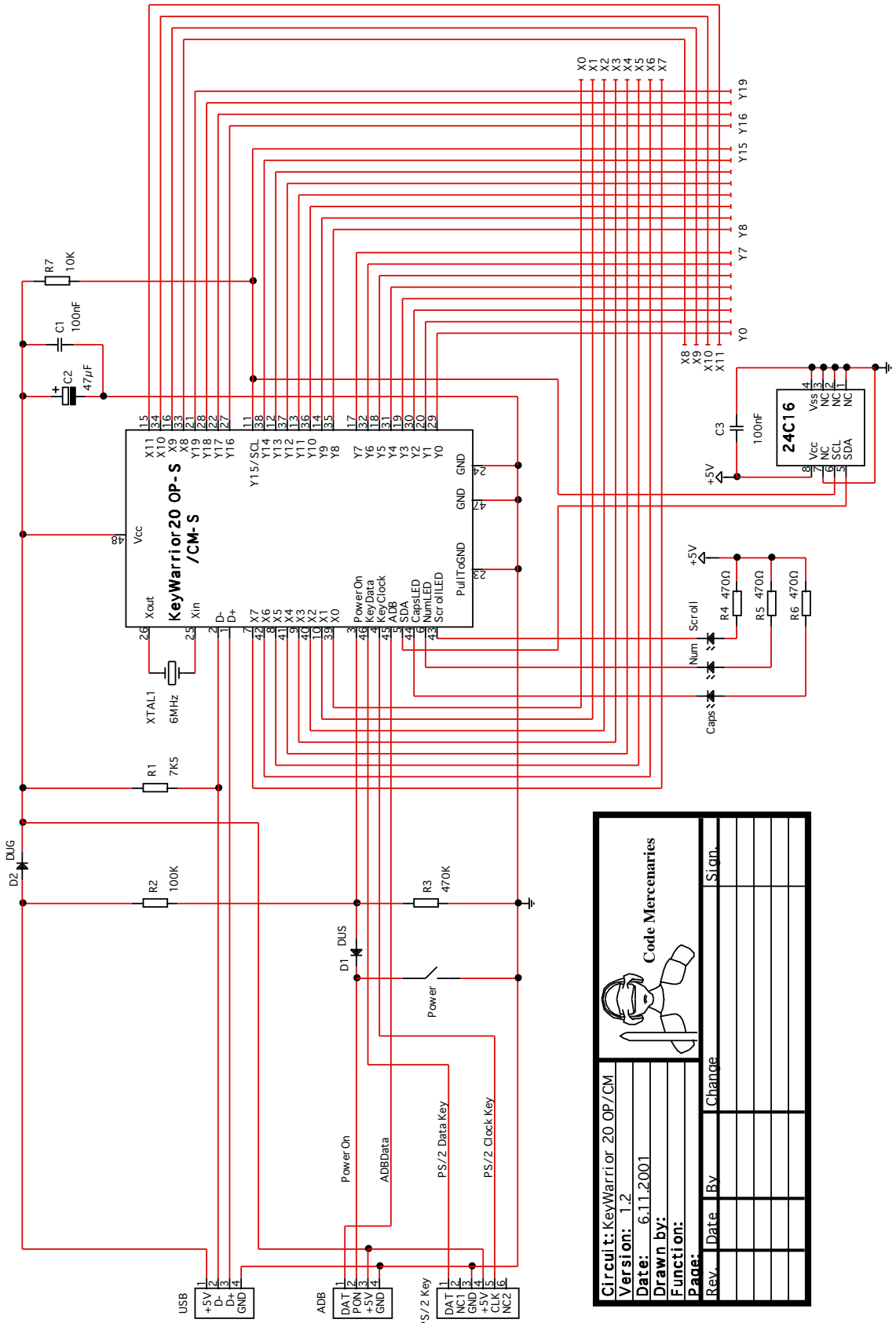
## 10.6 Typical Application for KeyWarrior 20



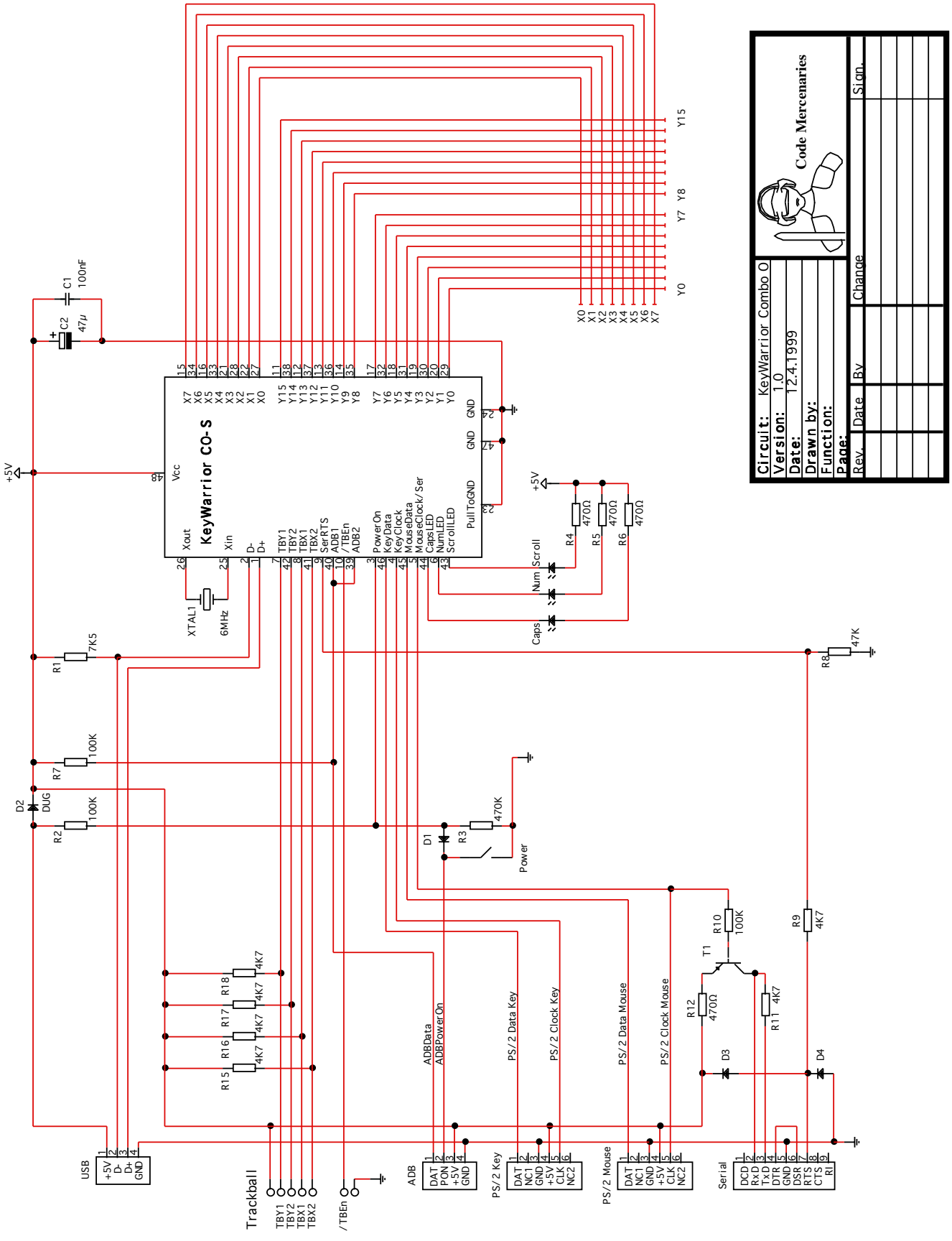
## 10.7 Typical Application for KeyWarrior 20 Flex



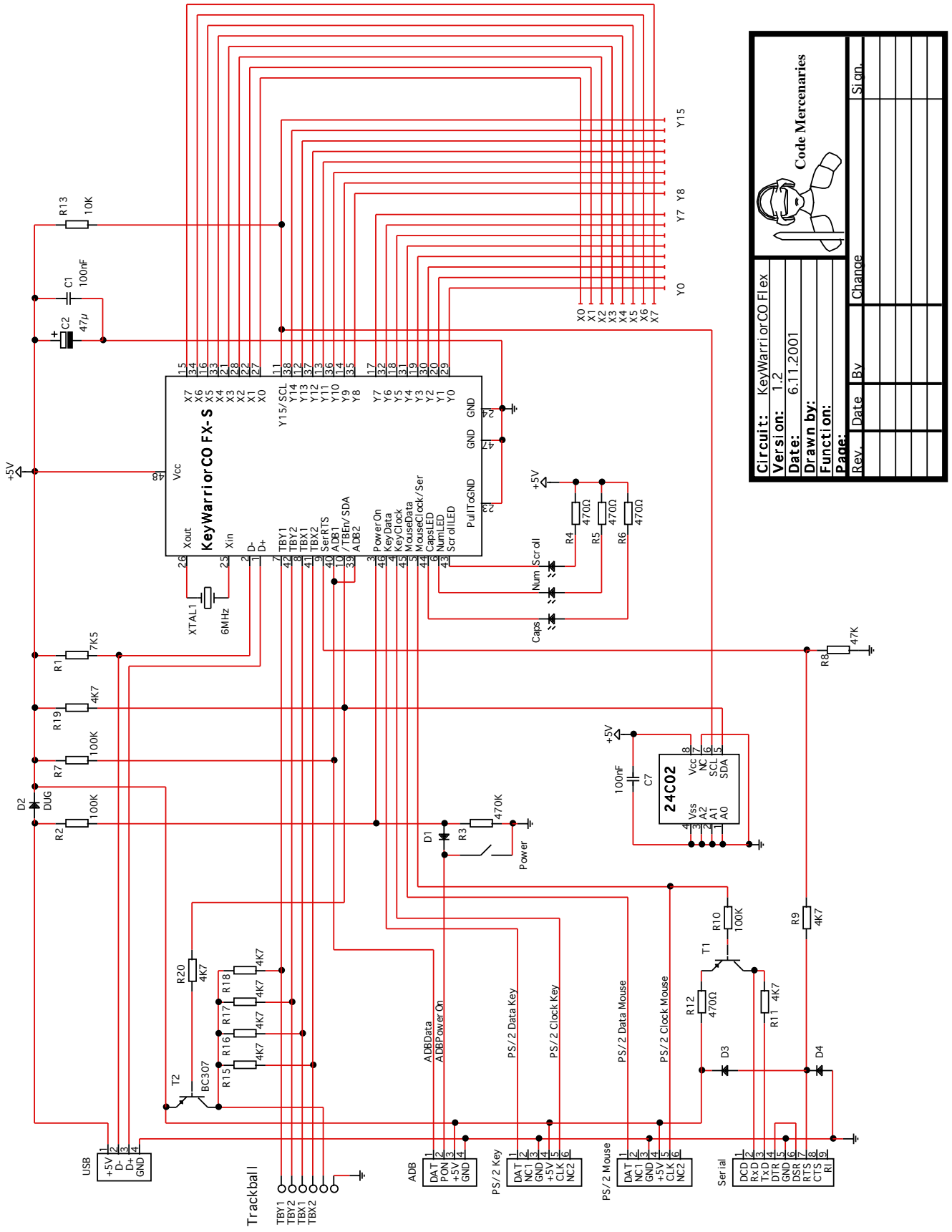
## 10.8 Typical Application for KeyWarrior 20 Operator or Commander



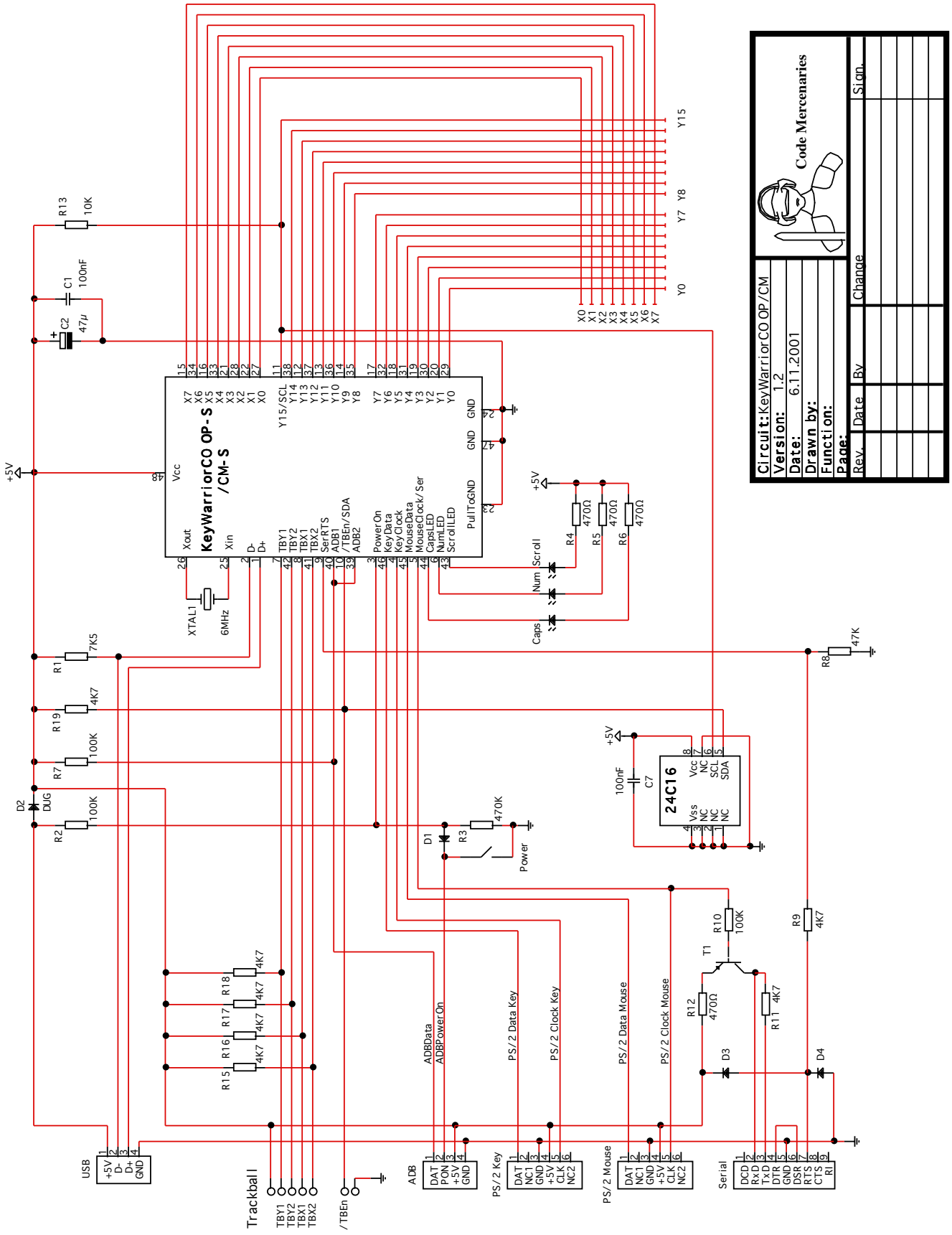
## 10.9 Typical Application for KeyWarrior Combo O



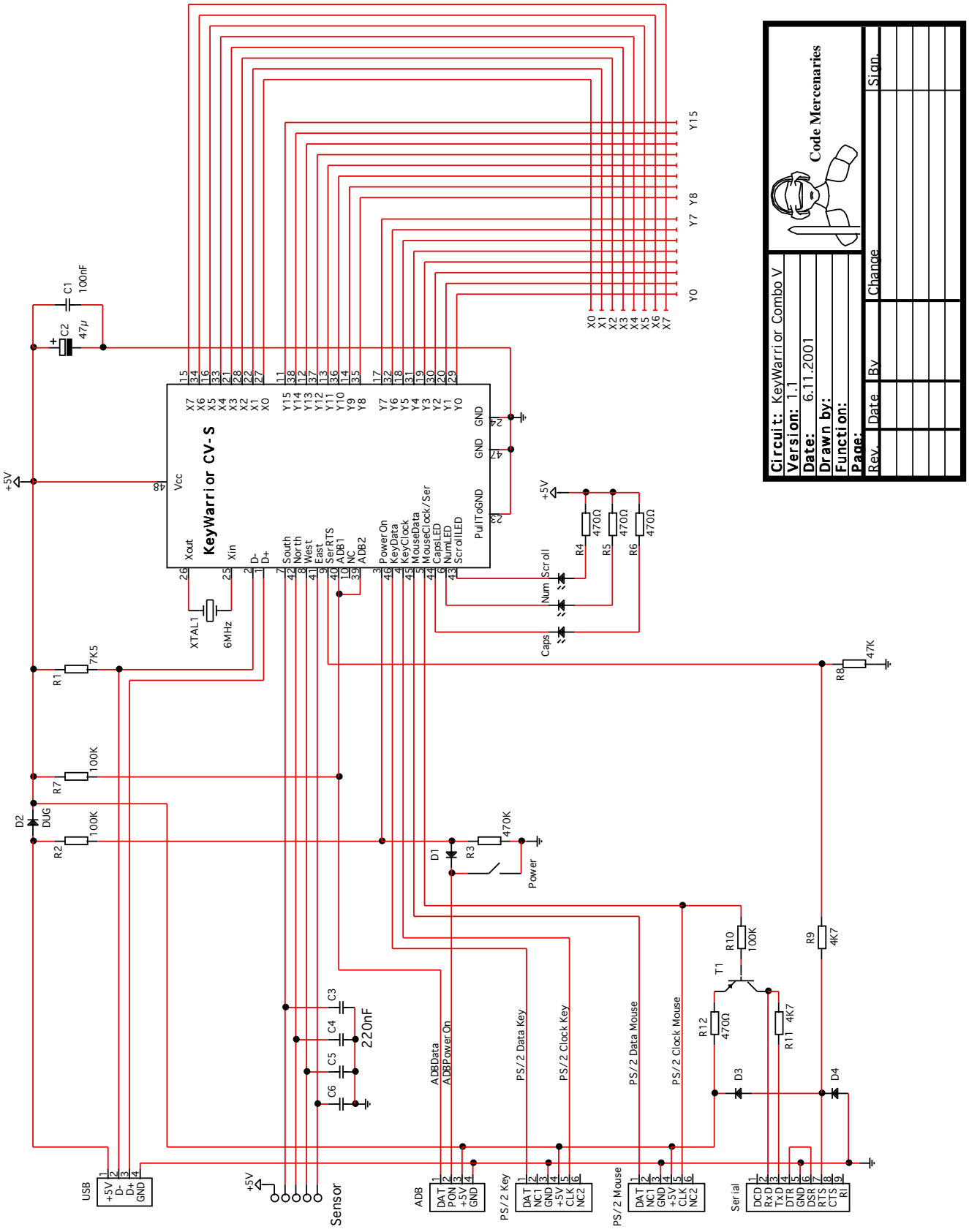
## 10.10 Typical Application for KeyWarrior Combo O Flex



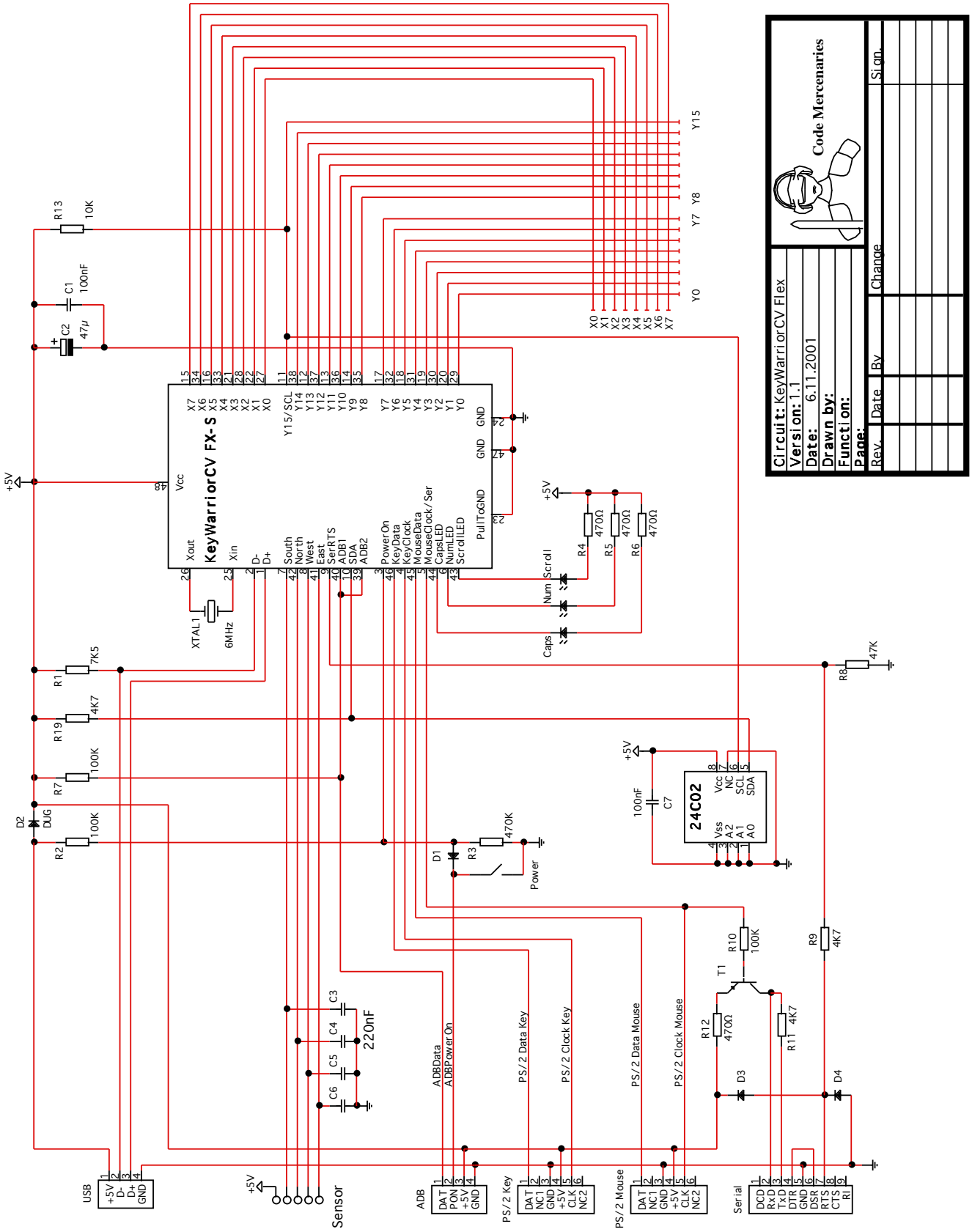
## 10.11 Typical Application for KeyWarrior Combo O Operator or Commander



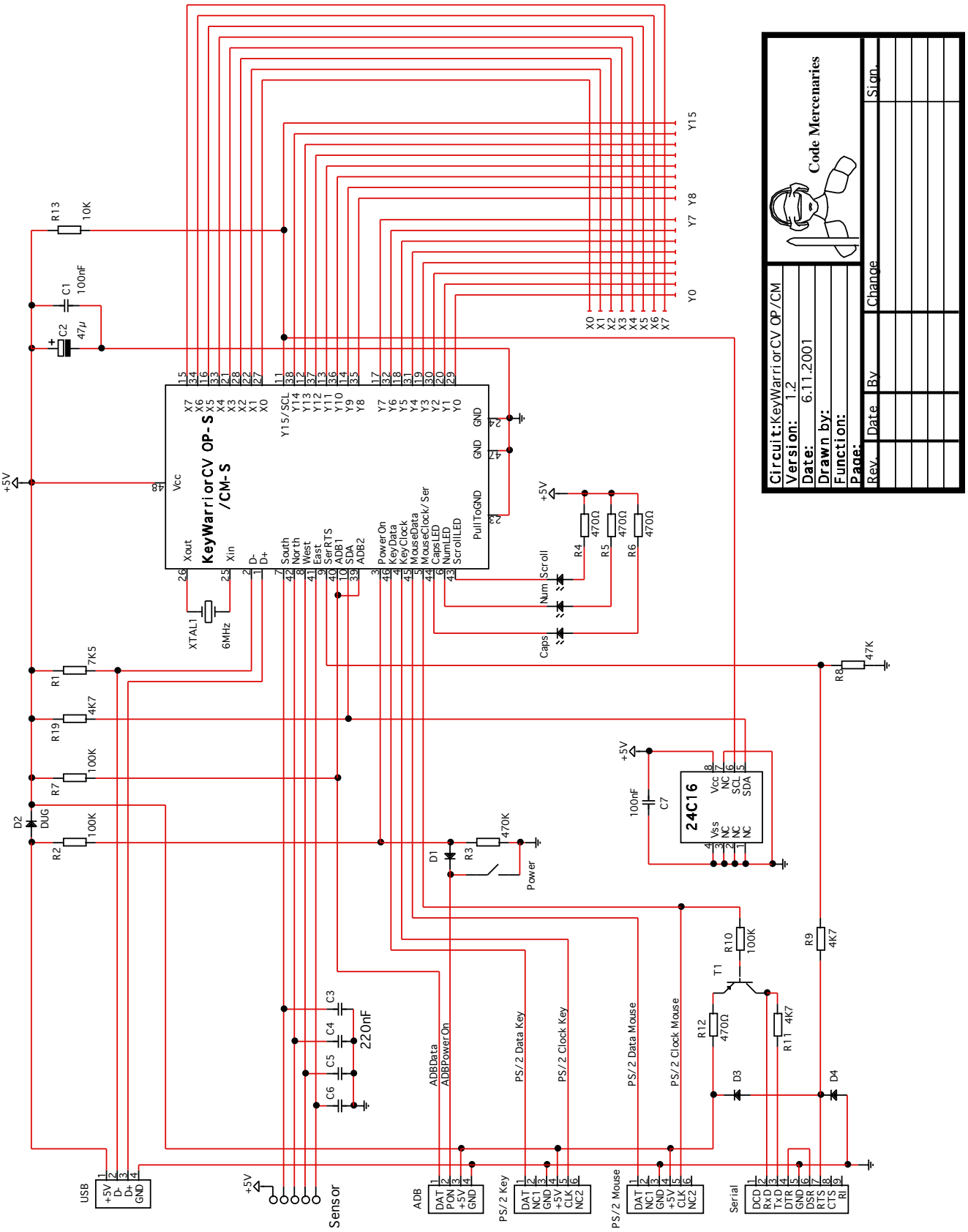
## 10.12 Typical Application for KeyWarrior Combo V



## 10.13 Typical Application for KeyWarrior Combo V Flex

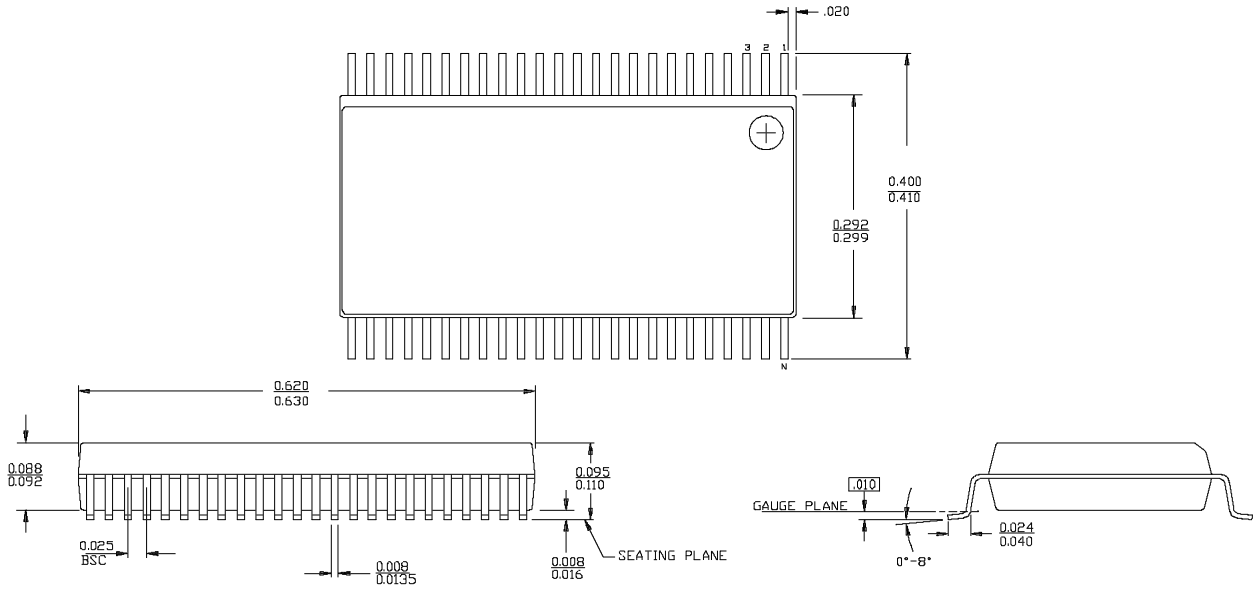


## 10.14 Typical Application for KeyWarrior Combo V Operator or Commander



## 11.0 Package Dimensions

### 48 Pin SSOP



**12.0 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.
The PS/2, serial and ADB lines are less critical. Series resistors of 27Ω and signal to ground capacitors of 27pF may be used alone or in addition to some kind of suppressor device.

**12.1 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:
- Keep the PCB traces from the resonator to the chip pins as short as possible.
- Put a 100nF ceramic capacitor right next to the power supply pins 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 absolutely necessary.

Adding a ferrite bead to the +5V power supply lines is advisable. Use separate beads for the USB and the ADB+PS/2 power supply lines, i.e. don't place the bead behind the diode in the USB power supply line.

**13.0 Revision History**
Here are the changes that have been made to KeyWarrior since V1.0.0

**1.1.1.D**
- Initial release of KeyWarrior24D.

**1.1.1.C**
- Initial release of KeyWarrior24S3.

**1.1.1.B**
- Initial release of KeyWarrior24-8M.

**1.1.1.A Custom versions only**

**1.1.1.9**
- PS/2 keyboard port now properly replys with a resend to invalid command $EC instead of ACK as before.

**1.1.1.8**
- KWWUSB pin configurations fixed.

**1.1.1.6-1.1.1.7 Custom versions only**

**1.1.1.5**
- PS/2 mouse reset and set default now trigger a recalibration for KeyWarrior Combo H

**1.1.1.4**
- Initial release of KeyWarrior24-8.

**1.1.1.3 Custom versions only**

**1.1.1.2**
- Fixed a problem with auto calibration KeyWarrior Combo H chips that could lead to an endless loop.

**1.1.1.1 Custom versions only**

**1.1.1.0 (KWCH only)**
- Release of KeyWarrior Combo H chips.

**1.1.0.6-1.1.0.C (custom versions only)**
- Added various new options for customer specific versions.

**1.1.0.5 (KW8LED only)**
- Release of KW8LED chips.

**1.1.0.0-1.1.0.4 (custom versions only)**
- Added various new options for customer specific versions.

**1.0.9.8 (custom versions only)**
- Fixed a bug in USB Control_Write that affected certain customer specific chips.

**1.0.9.7 (Combo controllers only, non-Combo remain at V1.0.9.6)**
- Moved sending mouse data to the 1msec interrupt. This increases the maximum trackable speed for trackballs. It was also necessary because some host controllers do send overlapping reset commands to keyboard and mouse which could block the mouse function.

- Added delay before starting to generate clock on PS/2 mouse for host to device transfers. Some host controllers seem not to be able to remember that they released the clock and do not transfer data properly if the clocking starts too soon.
- Added checking for continuous data low condition for PS/2 keyboard and mouse receive functions. This reduces problems with spikes on the data line.
- Optimized serial mouse code for memory use.
- Added a "wait for serial to complete" at the IIC read routine of Flex, Operator, and Commander Combo controllers. Entering the IIC routines while the serial mouse did send data could corrupt the timing of the transmitted data.

**1.0.9.6**
- Changed value for PS/2 mouse SetResolution command on KWCV to be equal to KWCO. This had caused the mouse to slow down very much when being used with Suse 7.3 Linux.
- USB had a bug causing it to resend keyboard reports at the highest possible rate. This caused problems with Sun hosts. This bug was introduced in V1.0.9.5.
- Tilde/Grave Accent key generated code $0A on ADB instead of $32. ISO keyboards need $32 off that key.
- Added redundant checking of PS/2 keboard clock idle state before starting to send data. Some host controller released the clock line briefly to then complain that we started to send data.
- Added a number of custom variants.

**1.0.9.5**
- FN-Key handling had a bug that could cause a lock down of the FN key on ADB and PS/2 if the FN key was hit briefly. This was fixed by not doing a new matrix scan before the whole sequence of matrix swapping due to the FN status change is done.
- Optimized USB stack
- Optimized PS/2 mouse timeout on reset.

**1.0.9.1-1.0.9.4** were internal versions, no general release

**1.0.9.0**
- Version numbering scheme changed. Due to frequent intermediate releases for custom variants we added another digit to our chip revisions.
- Fixed an error in the data sheet that specified the pinout of the KeyWarrior Combo V wrong. North/South and East/West had each switched positions.
- Added KeyWarrior 8 CELL variant.
- Changed USB descriptors to properly specify USB V1.1 and HID V1.1 revisions.
- Commander Variant: Added sending of additional USB reports on modifier up/down within macros. Windows does use the modifer status from last report to generate the characters. This had caused macros to behave like the modifiers are released one key later than they actually were.
- SetCodeset command on PS/2 keyboard with codeset = 0 caused controller to assume next byte received to be the second byte of a SetCodeset command.
- Changed USB keyboard HID descriptor to cover key usage codes up to $A4.
- Added several custom variants and options.

**1.0.8**
- Added Commander variant.
- Removed some redundant code from USB stack to reduce memory use. No change in behaviour.

**1.0.7**
- Set Scaling on the PS/2 mouse port does now activate a ballisitic acceleration for the mouse movement.
- Optimized USB protocol stack for code size and speed. There will be no significant changes in behaviour.
- Combo chips using PS/2 ports for keyboard and mouse do now accept overlapping commands to both ports. This could cause problems mainly with NT based hosts.
- USB requests SetIdle and GetIdle do now handle keyboard and mouse endpoints separately.
- Initial USB Idle Period for keyboard has been set to 500msec. Formerly it was zero by default causing the keyboard to send reports only on status changes.
- Removed turning on the LEDs when USB is set to unconfigured. This was a feature used during early development and has no practical value in production.
- A second USB Reset after initial configuration of the controller does now disable the keyboard scanning task until the USB device is configured again. For some reason this disturbed MacOS during the boot phase and prevented the Extension Manager from coming up when the space bar was held down during

start up.
- Added some delay between receiving a PS/2 mouse command and answering on it. This fixes problems with some badly designed host controllers.
- Fixed an interrupt related problem in the PS/2 mouse function that could under certain timing conditions cause the return of a wrong reply to a command. The correct data byte to be send was overwritten, returning a random reply. This lead to the mouse not being recognized or not properly configured on some hosts.
- Cleaned up USB suspend and wakeup code. Suspend could result in the keyboard not waking up again if a key was pressed at the moment the USB went to sleep.
- When PS/2 is activated by the startup timeout it does no longer require the host to answer on the BAT OK message to activate the PS/2 interface.

**1.0.6**
- Fixed USB command "GetReport" to properly return either keyboard or mouse report as requested. Former versions did always return the keyboard report.
- Added KeyWarrior4 variant (not a standard part but available on request).
- Fixed IIC routines in the Operator variants to send the page address as part of the command, this had caused problems with Microchip 24LC16.
- Added locking option for the FN keys and cleaned up the FN key code a bit (not part of the standard parts, this feature is available for custom chips).
- Fixed a bug in accessing code table 3 for KW8OP causing it to fall back to table 1.
- Changed speed setting for optical mice to maximum on ADB, Serial and USB.
- Fixed a bug on ADB that could crash the controller on Caps Lock down.
- Fixed TBEn handling for Combo O Operator to make sure EEPROM does not get disturbed.
- Set all combos to use CDM mouse protocol. Former versions were using a proprietary protocol.

**1.0.5**
- Changed stuffing the code into the queue to be an atomic operation, this had caused lost keys with KW8FX when used with the PS/2 port.
- Modified reset behaviour to let controller go active on PS/2 mouse identification. This was necessary to allow controller to work properly if mouse is initialized before keyboard.

**1.0.4**
- Added Operator variant.
- Fixed a bug that defaulted serial port protocol to MS.
- Fixed a bug with MF2 codeset 1 that generated wrong codes for some keys.
- Increased matrix drive to read setup time from about 10$\mu$s to 40$\mu$sec. This eliminates problems with high parasitic capacities in some key matrixes.
- Added a debounce to SerRTS which optimizes EMC.
- Added some delay before answering on PS/2 keyboard commands. This eliminates problems with some older host controllers.

**1.0.3**
- Added support for Kanji keys.
- Added a timeout to the mouse function that automatically defaults to PS/2 if no mouse port is identified within 2 secs of the keyboard becoming active. This allows hot plugging of the PS/2 mouse port and improves ESD recovery.

**1.0.2**
- Changed PS/2 mouse protocol to set bit 3 of byte 1. Windows CE did not work with this bit reset.

**1.0.1**
- Fixed a lockup on PS/2 interfaces that caused the mouse part not to respond on the next host to device request when the keyboard part received a host to device request while the mouse part was still processing a host to device request.

**14.0 Legal Stuff**



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