

**AT90USBKey**

.....  
**Hardware User Guide**





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|                               |     |
|-------------------------------|-----|
| <b>Section 1</b>              |     |
| Introduction .....            | 1-3 |
| 1.1 Overview .....            | 1-3 |
| 1.2 AT90USBKey Features ..... | 1-4 |

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|                                 |      |
|---------------------------------|------|
| <b>Section 2</b>                |      |
| Using the AT90USBKey .....      | 2-5  |
| 2.1 Overview .....              | 2-5  |
| 2.2 Power Supply .....          | 2-6  |
| 2.3 Reset.....                  | 2-8  |
| 2.4 On-board Resources.....     | 2-9  |
| 2.5 In-System Programming ..... | 2-13 |
| 2.6 Debugging.....              | 2-14 |

---

|                             |      |
|-----------------------------|------|
| <b>Section 3</b>            |      |
| Troubleshooting Guide ..... | 3-15 |

---

|                                |      |
|--------------------------------|------|
| <b>Section 4</b>               |      |
| Technical Specifications ..... | 4-16 |

---

|                        |      |
|------------------------|------|
| <b>Section 5</b>       |      |
| Technical Support..... | 5-17 |

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|                          |      |
|--------------------------|------|
| <b>Section 6</b>         |      |
| Complete Schematics..... | 6-18 |



# Section 1

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## Introduction

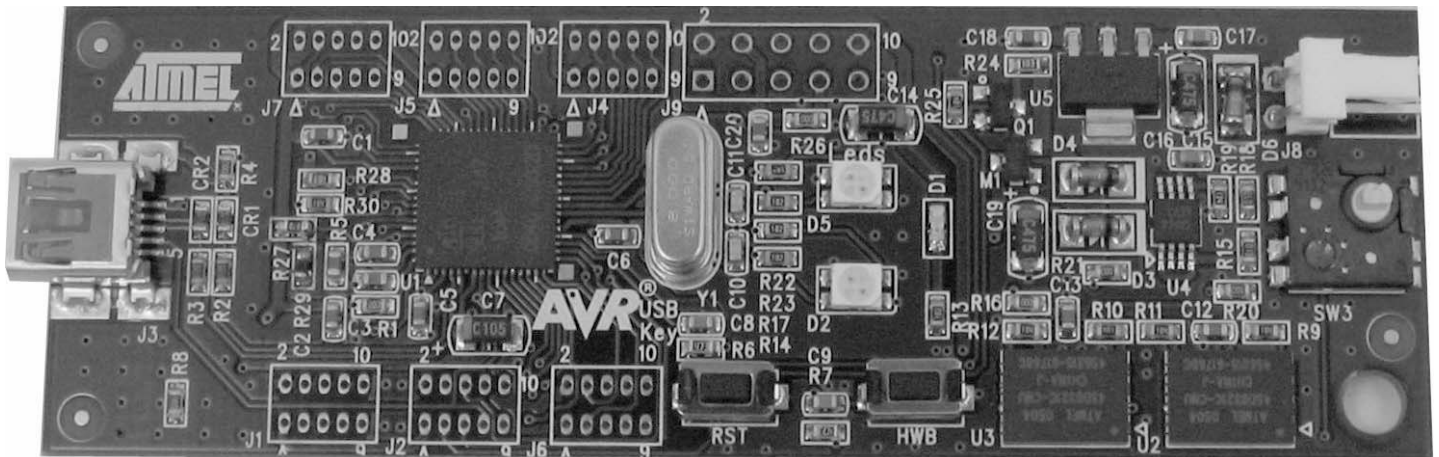
Congratulations on acquiring the AVR® AT90USBKey. This kit is designed to give designers a quick start to develop code on the AVR® and for prototyping and testing of new designs with the AT90USB microcontroller family.

### 1.1 Overview

This document describes the AT90USBKey dedicated to the AT90USB AVR microcontroller. This board is designed to allow an easy evaluation of the product using demonstration software.

To increase its demonstrative capabilities, this stand alone board has numerous on-board resources: USB, joystick, data-flash and temperature sensor.

*Figure 1-1 . AT90USBKey*



## 1.2 AT90USBKey Features

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The AT90USBKey provides the following features:

- AT90USB QFN64
- AVR Studio® software interface <sup>(1)</sup>
- USB software interface for Device Firmware Upgrade (DFU bootloader) <sup>(2)</sup>
- Power supply flagged by “VCC-ON” LED:
  - regulated 3.3V
  - from an external battery connector (for reduced host or OTG operation)
  - from the USB interface (USB device bus powered application)
- JTAG interface (connector not mounted):
  - for on-chip ISP
  - for on-chip debugging using JTAG ICE
- Serial interfaces:
  - 1 USB full/low speed device/host/OTG interface
- On-board resources:
  - 4+1-ways joystick
  - 2 Bi-Color LEDs
  - temperature sensor
  - serial dataflash memories
  - all microcontroller I/O ports access on 2x8pin headers (not mounted)
- On-board RESET button
- On-board HWB button to force bootloader section execution at reset.
- System clock:
  - 8 MHz crystal

- Notes:
1. The AVRUSBKey is supported by AVR Studio®, version 4.12 or higher. For up-to-date information on this and other AVR tool products, please consult our web site. The most recent version of AVR Studio®, AVR tools and this User Guide can be found in the AVR section of the Atmel web site, <http://www.atmel.com>.
  2. ATMEL Flip®, In System Programming Version 3 or Higher shall be used for Device Firmware Upgrade. Please consult Atmel web site to retrieve the latex version of Flip and the DFU bootloader Hex file if needed.



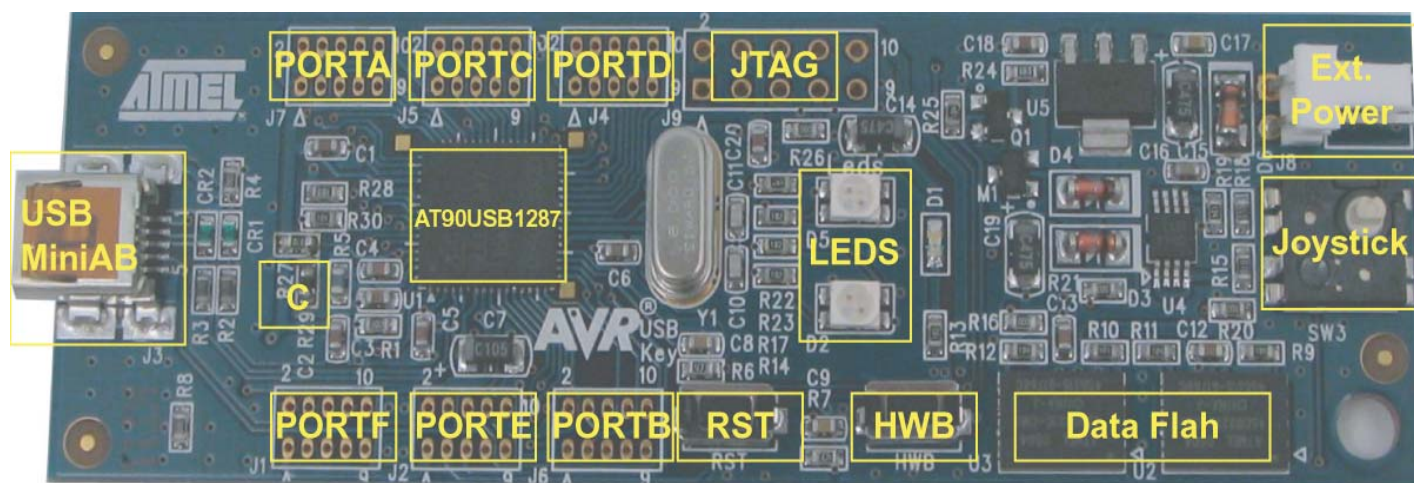
## Section 2

# Using the AT90USBKey

This chapter describes the AVRUSBKey and all its resources.

### 2.1 Overview

Figure 2-1 . AT90USBKey Overview



## 2.2 Power Supply

### 2.2.1 Power Supply Sources

The on-board power supply circuitry allows two power supply configurations:

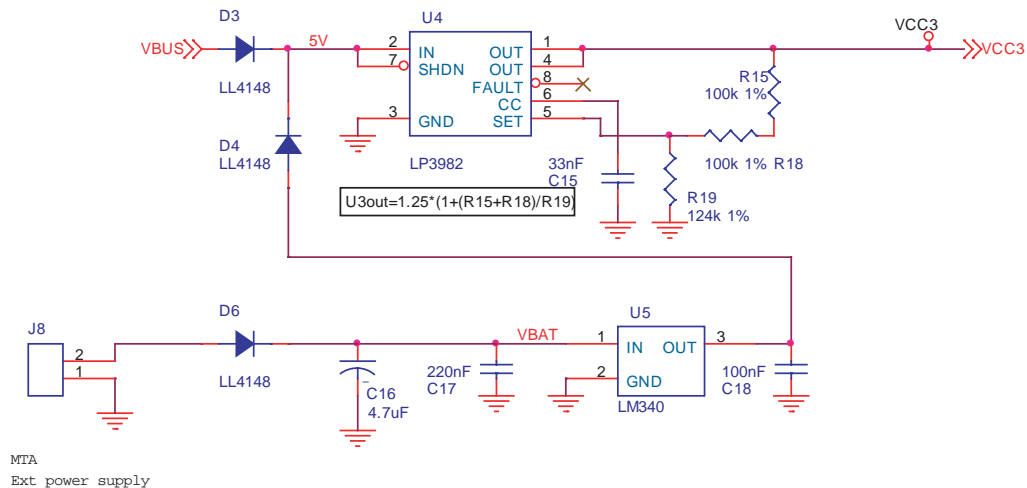
- from USB connector
- from battery connector

*USB powered* When used as a USB device bus powered application, the AVRUSBKey can be directly powered via the USB VBUS power supply line.

*Battery powered* The external battery connector should be used when the AT90USBKey is used as a USB host. This mode allows the AT90USBKey to provide a 5V power supply from its VBUS pin.

- Need of a female battery clip
- Input supply from 8 up to 15V DC (min. 100mA)

**Figure 2-2 . Power supply schematic**

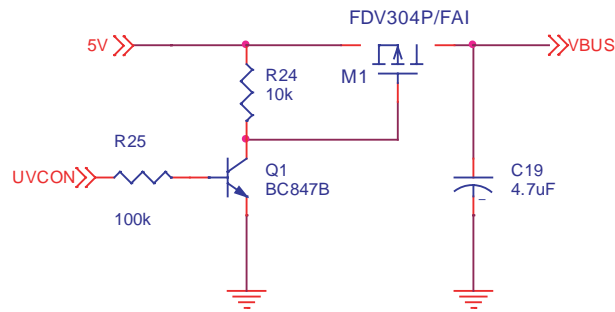


## 2.2.2 VBUS Generator

When using the AT90USB microcontroller in USB host mode, the AT90USBKey should provide a 5V power supply over the VBUS pin of its USB mini AB connector.

A couple of transistors allows the UVCON pin of the AT90USB to control the VBUS generation (See Figure 2-3). In this mode the AT90USBKey is powered by external battery power supply source.

**Figure 2-3 .** VBUS generator schematic



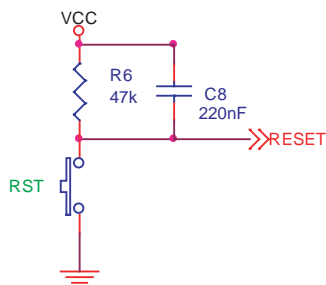
## 2.2.3 “POWER-ON“ LED

The POWER-ON LED (“D1”) is always lit when power is applied to AVRUSBKey regardless of the power supply source.

## 2.3 Reset

Although the AT90USB has its on-chip RESET circuitry (c.f. AT90USB Datasheet, section “System Control and Reset), the AVRUSBKey provides to the AT90USB a RESET signal witch can come from two different sources:

**Figure 2-4 .** Reset Implementation



### 2.3.1 Power-on RESET

The on-board RC network acts as power-on RESET.

### 2.3.2 RESET Push Button

By pressing the RESET push button on the AVRUSBKey, a warm RESET of the AT90USB is performed.

### 2.3.3 Main Clock XTAL

To use the USB interface of the AT90USB, the clock source should always be a crystal or external clock oscillator (the internal 8MHz RC oscillator can not be used to operate with the USB interface). Only the following crystal frequency allows proper USB operations: 2MHz, 4MHz, 6MHz, 8MHz, 12MHz, 16MHz. The AT90USBKey comes with a default 8MHz crystal oscillator.

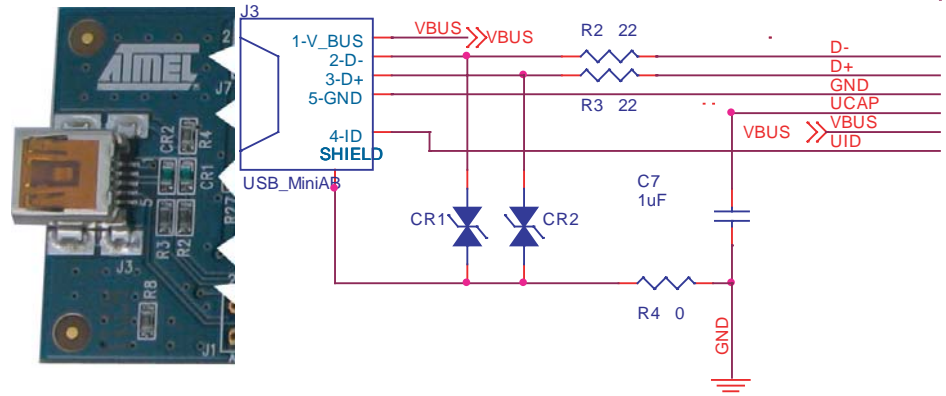


## 2.4 On-board Resources

### 2.4.1 USB

The AVRUSBKey is supplied with a standard USB mini A-B receptacle. The mini AB receptacle allows to connect both a mini A plug or a mini B plug connectors.

**Figure 2-5 .** USB mini A-B Receptacle



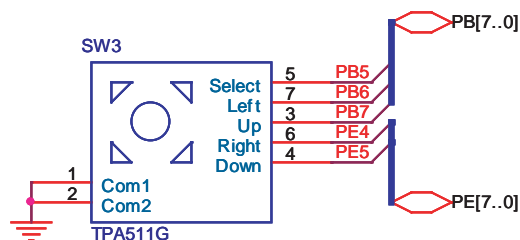
When connected to a mini B plug, the AT90USB operates as an “USB device” (the ID pin of the plug is unconnected) and when connected to a mini A plug, the AT90USB operates as a “USB host” (the ID pin of the A plug is tied to ground).

### 2.4.2 Joystick

The 4+1 ways joystick offers an easy user interface implementation for a USB application (it can emulate mouse movements, keyboard inputs...).

Pushing the push-button causes the corresponding signal to be pulled low, while releasing (not pressed) causes an H.Z state on the signal. The user must enable internal pull-ups on the microcontroller input pins, removing the need for an external pull-up resistors on the push-button.

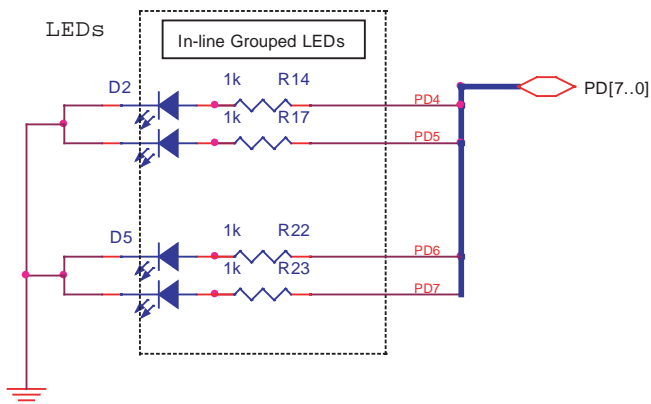
**Figure 2-6 .** Joystick Schematic



### 2.4.3 LEDs

The AT90USBKey includes 2 bi-color LEDs (green/red) implemented on one line. They are connected to the high nibble of “Port D” of AT90USB (PORTD[4..7]). To light on a LED, the corresponding port pin must drive a high level. To light off a LED, the corresponding port pin must drive a low level.

**Figure 2-7 .** LEDs Implementation schematic



**Table 2-1 .** Leds references

| LED Reference | AT90USB Connection | Color |
|---------------|--------------------|-------|
| D2            | PORTD.4            | Red   |
|               | PORTD.5            | Green |
| D5            | PORTD.6            | Green |
|               | PORTD.7            | Red   |

### 2.4.4 Temperature Sensor

The temperature sensor uses a thermistor (R29), or temperature-sensitive resistor. This thermistor has a negative temperature coefficient (NTC), meaning the resistance goes up as temperature goes down. Of all passive temperature measurement sensors, thermistors have the highest sensitivity (resistance change per degree of temperature change). Thermistors do not have a linear temperature/resistance curve.

The voltage over the NTC can be found using the A/D converter (connected to channel 0). See the AT90USB Datasheet for how to use the ADC. The thermistor value ( $R_T$ ) is calculated with the following expression:

$$R_T = (R_H \cdot V_{ADC0}) / (V_{CC} - V_{ADC0})$$

Where:

- $R_T$  = Thermistor value ( $\Omega$ ) at T temperature ( $^{\circ}$ Kelvin)
- $R_H$  = Second resistor of the bridge -100 K $\Omega$   $\pm$ 10% at 25 $^{\circ}$ C
- $V_{ADC0}$  = Voltage value on ADC-0 input (V)
- $V_{CC}$  = Board power supply

The NTC thermistor used in AT90USBKey has a resistance of 100 K $\Omega$   $\pm$ 5% at 25°C ( $T_0$ ) and a beta-value of 4250  $\pm$ 3%. By the use of the following equation, the temperature ( $T$ ) can be calculated:

$$T = \frac{\beta}{\left(\ln \frac{R_T}{R_0}\right) + \frac{\beta}{T_0}}$$

Where:  $R_T$  = Thermistor value ( $\Omega$ ) at  $T$  temperature ( $^{\circ}$ Kelvin)  
 $\beta$  = 4250  $\pm$ 3%  
 $R_0$  = 100 K $\Omega$   $\pm$ 5% at 25°C  
 $T_0$  = 298  $^{\circ}$ K (273  $^{\circ}$ K + 25 $^{\circ}$ K)

The following cross table also can be used. It is based on the above equation.

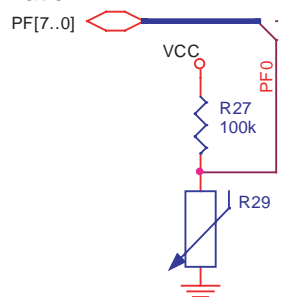
**Table 2-2 .** Thermistor Values versus Temperature

| Temp. ( $^{\circ}$ C) | $R_T$ (K $\Omega$ ) | Temp. ( $^{\circ}$ C) | $R_T$ (K $\Omega$ ) | Temp. ( $^{\circ}$ C) | $R_T$ (K $\Omega$ ) | Temp. ( $^{\circ}$ C) | $R_T$ (K $\Omega$ ) |
|-----------------------|---------------------|-----------------------|---------------------|-----------------------|---------------------|-----------------------|---------------------|
| -20                   | 1263,757            | 10                    | 212,958             | 40                    | 50,486              | 70                    | 15,396              |
| -19                   | 1182,881            | 11                    | 201,989             | 41                    | 48,350              | 71                    | 14,851              |
| -18                   | 1107,756            | 12                    | 191,657             | 42                    | 46,316              | 72                    | 14,329              |
| -17                   | 1037,934            | 13                    | 181,920             | 43                    | 44,380              | 73                    | 13,828              |
| -16                   | 973,006             | 14                    | 172,740             | 44                    | 42,537              | 74                    | 13,347              |
| -15                   | 912,596             | 15                    | 164,083             | 45                    | 40,781              | 75                    | 12,885              |
| -14                   | 856,361             | 16                    | 155,914             | 46                    | 39,107              | 76                    | 12,442              |
| -13                   | 803,984             | 17                    | 148,205             | 47                    | 37,513              | 77                    | 12,017              |
| -12                   | 755,175             | 18                    | 140,926             | 48                    | 35,992              | 78                    | 11,608              |
| -11                   | 709,669             | 19                    | 134,051             | 49                    | 34,542              | 79                    | 11,215              |
| -10                   | 667,221             | 20                    | 127,555             | 50                    | 33,159              | 80                    | 10,838              |
| -9                    | 627,604             | 21                    | 121,414             | 51                    | 31,840              | 81                    | 10,476              |
| -8                    | 590,613             | 22                    | 115,608             | 52                    | 30,580              | 82                    | 10,128              |
| -7                    | 556,056             | 23                    | 110,116             | 53                    | 29,378              | 83                    | 9,793               |
| -6                    | 523,757             | 24                    | 104,919             | 54                    | 28,229              | 84                    | 9,471               |
| -5                    | 493,555             | 25                    | 100,000             | 55                    | 27,133              | 85                    | 9,161               |
| -4                    | 465,300             | 26                    | 95,342              | 56                    | 26,085              | 86                    | 8,863               |
| -3                    | 438,854             | 27                    | 90,930              | 57                    | 25,084              | 87                    | 8,576               |
| -2                    | 414,089             | 28                    | 86,750              | 58                    | 24,126              | 88                    | 8,300               |
| -1                    | 390,890             | 29                    | 82,787              | 59                    | 23,211              | 89                    | 8,035               |
| 0                     | 369,145             | 30                    | 79,030              | 60                    | 22,336              | 90                    | 7,779               |
| 1                     | 348,757             | 31                    | 75,466              | 61                    | 21,498              | 91                    | 7,533               |
| 2                     | 329,630             | 32                    | 72,085              | 62                    | 20,697              | 92                    | 7,296               |
| 3                     | 311,680             | 33                    | 68,876              | 63                    | 19,930              | 93                    | 7,067               |
| 4                     | 294,826             | 34                    | 65,830              | 64                    | 19,196              | 94                    | 6,847               |



| Temp. (°C) | R <sub>T</sub> (KΩ) | Temp. (°C) | R <sub>T</sub> (KΩ) | Temp. (°C) | R <sub>T</sub> (KΩ) | Temp. (°C) | R <sub>T</sub> (KΩ) |
|------------|---------------------|------------|---------------------|------------|---------------------|------------|---------------------|
| 5          | 278,995             | 35         | 62,937              | 65         | 18,493              | 95         | 6,635               |
| 6          | 264,119             | 36         | 60,188              | 66         | 17,820              | 96         | 6,430               |
| 7          | 250,134             | 37         | 57,576              | 67         | 17,174              | 97         | 6,233               |
| 8          | 236,981             | 38         | 55,093              | 68         | 16,556              | 98         | 6,043               |
| 9          | 224,606             | 39         | 52,732              | 69         | 15,964              | 99         | 5,860               |

Figure 2-8 . Thermistor Schematic

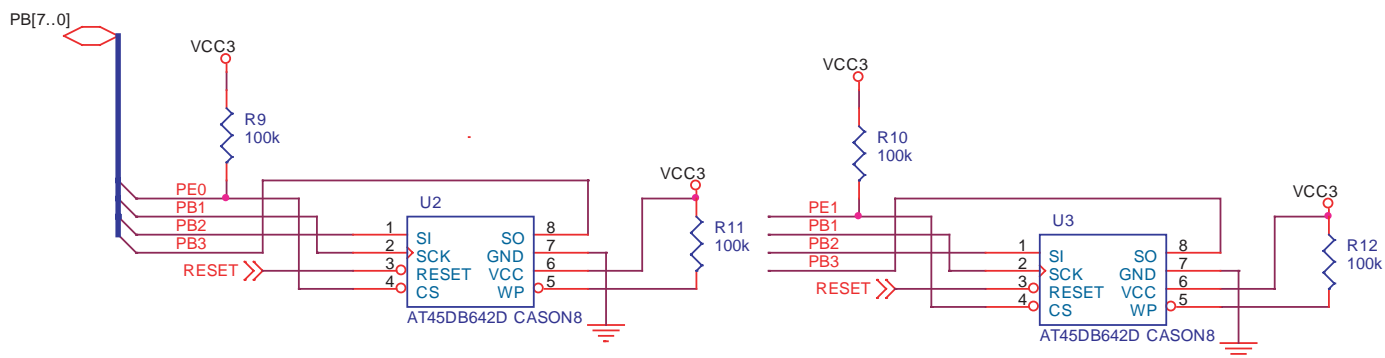


### 2.4.5 Data Flash memory

For mass-storage class demonstration purpose, the AT90USBKey provides two on-chip serial Flash memories (AT45DB642D) connected to the AT90USB Serial Port Interface (SPI).

The data-flash chip select signals are connected to PortE bit 0 and bit 1 of the AT90USB (See Figure 2-9).

Figure 2-9 . On-board data flash schematic



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## 2.5 In-System Programming

### 2.5.1 Programming with USB bootloader: DFU (Device Firmware Upgrade)

AT90USB part comes with a default factory pre-programmed USB bootloader located in the on-chip boot section of the AT90USB. This is the easiest and fastest way to reprogram the device directly over the USB interface. The “Flip” PC side application, is available from the Atmel website, offers a flexible and user friendly interface to reprogram the application over the USB bus.

The HWB pin of the AT90USB allows to force the bootloader section execution after reset. (Refer to AT90USB datasheet section “boot loader support”). To force bootloader execution, operate as follow:

- Press both “RST” and “HWB” push buttons
- First release the “RST” push button
- Release the “HWB” push button

For more information about the USB bootloader and “Flip” application, please refer to the “USB bootloader datasheet document” and “Flip’s user manual”.

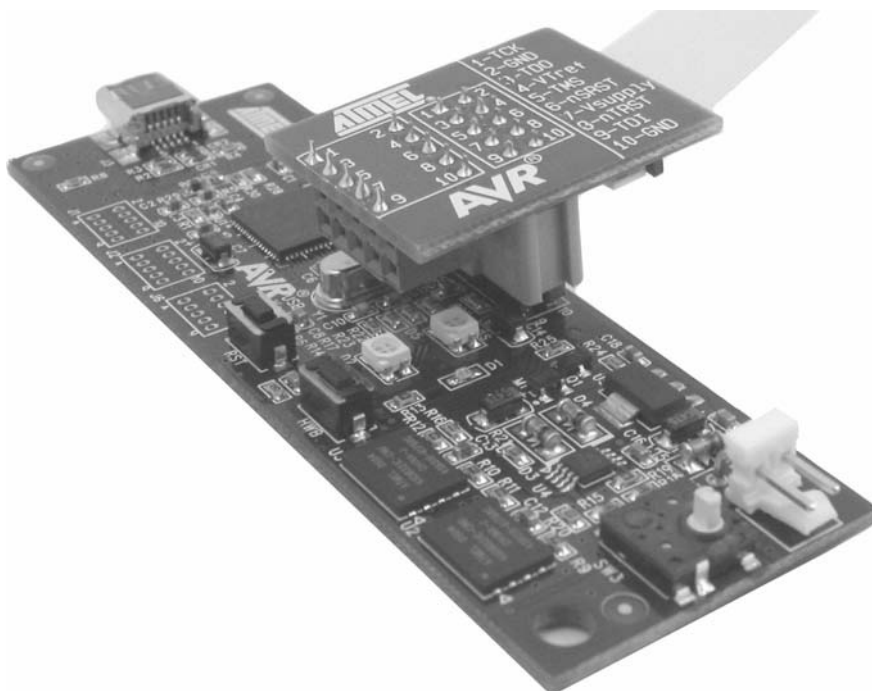
Note: The HWB pin is active only if the HWBE fuse is set (default factory configuration).

### 2.5.2 Programming with AVR JTAGICEmkII

The AT90USB can be programmed using specific JTAG link. To use the AVR JTAGICEmkII with an AT90USBKey an optional HE10 connector should be soldered to J9 footprint. Then the JTAG probe can be connected to the AT90USBKey as shown in Figure 2-10.

Note: When the JTAGEN Fuse is unprogrammed, the four TAP pins are normal port pins, and the TAP controller is in reset. When programmed, the input TAP signals are internally pulled high and the JTAG is enabled for Boundary-scan and programming. The AT90USB device is shipped with this fuse programmed.

**Figure 2-10 .** Connecting AVR JTAG ICE to AVRUSBKey



The Flash, EEPROM and all Fuse and Lock Bit options ISP-programmable can be programmed individually or with the sequential automatic programming option.

Note: See AVR Studio® on-line Help for information.

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## 2.6 Debugging

### 2.6.1 Debugging with AVR JTAG ICE mkII

The AT90USBKey can be used for debugging with JTAG ICE MK II.

Connect the JTAG ICE mkII as shown in Figure 2-10, for debugging, please refer to AVR Studio® Help information.

When using JTAG ICE MK II for debugging, and as AT90USB parts are factory configured with the higher security level set, a chip erase operation will be performed on the part before debugging. Thus the on-chip flash bootloader will be erased. It can be restored after the debug session using the bootloader hex file available from ATMEL website.



## Section 3

# Troubleshooting Guide

**Figure 3-1 .** Troubleshooting Guide

| Problem                                      | Reason   | Solution  |
|--|--|---|
| The Green "VCC-ON" LED is not on             | No power supply                                    | Verify the power supply source (check battery charge or USB connection).  |
| AVRUSBKey does not work                      |  |   |
| The AT90USB cannot be programmed             | The AVR JTAG ICE probe is not connected            | Connect the JTAG ICE 10-PIN header to the correct AVRUSBKey JTAG header (page 13)   |
|  | The memory lock bits are programmed                | Erase the memory before programming with JTAG ICE.  |
|  | The fuse bits are wrongly programmed               | Check the fuse bits with JTAG ICE   |
|  | Can not connect to USB bootloader                  | Force bootloader execution with HWB under reset.<br>USB bootloader erased after a JTAG debugging session: reprogram the USB bootloader with JTAG. |
| AVR Studio does not detect the AVR JTAG ICE. | Serial/USB cable is not connected, or power is off | Connect serial cable to RS232 (STK500 - AVR ISP) and check power connections  |
|  |  | Connect serial cable to USB (JATG ICE MKII, AVR ISPMkIII) and check power connections   |
|  | PC COM port is in use                              | Disable other programs that are using PC COM port.  |
|  |  | Change PC COM port  |
| AVR Studio does not detect COM port.         | AVR Studio does not detect COM port.               | Disable COM port auto-detection in AVR Studio file menu. Force COM port to correct COM port   |



## Section 4

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# Technical Specifications

### ■ System Unit

- Physical Dimensions ..... L=90 x W=30 x H=8 mm
- Weight ..... 12 g

### ■ Operating Conditions

- Internal Voltage Supply ..... 3.3V
- External Voltage Supply ..... 8V -15V

### ■ Connections

- USB Connector ..... Mini AB receptacle
- USB Communications ..... Full speed/low speed
- JTAG Connector ..... Footprint for HE10 connector
- All ports connectors ..... J1, J2, J4, J5, J6, J7
- Battery connector ..... MTA right angle





## Section 5

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# Technical Support

For Technical support, please contact [avr@atmel.com](mailto:avr@atmel.com). When requesting technical support, please include the following information:

- Which target AVR device is used (complete part number)
- Target voltage and speed
- Clock source and fuse setting of the AVR
- Programming method (ISP, JTAG or specific Boot-Loader)
- Hardware revisions of the AVR tools, found on the PCB
- Version number of AVR Studio. This can be found in the AVR Studio help menu.
- PC operating system and version/build
- PC processor type and speed
- A detailed description of the problem



## Section 6

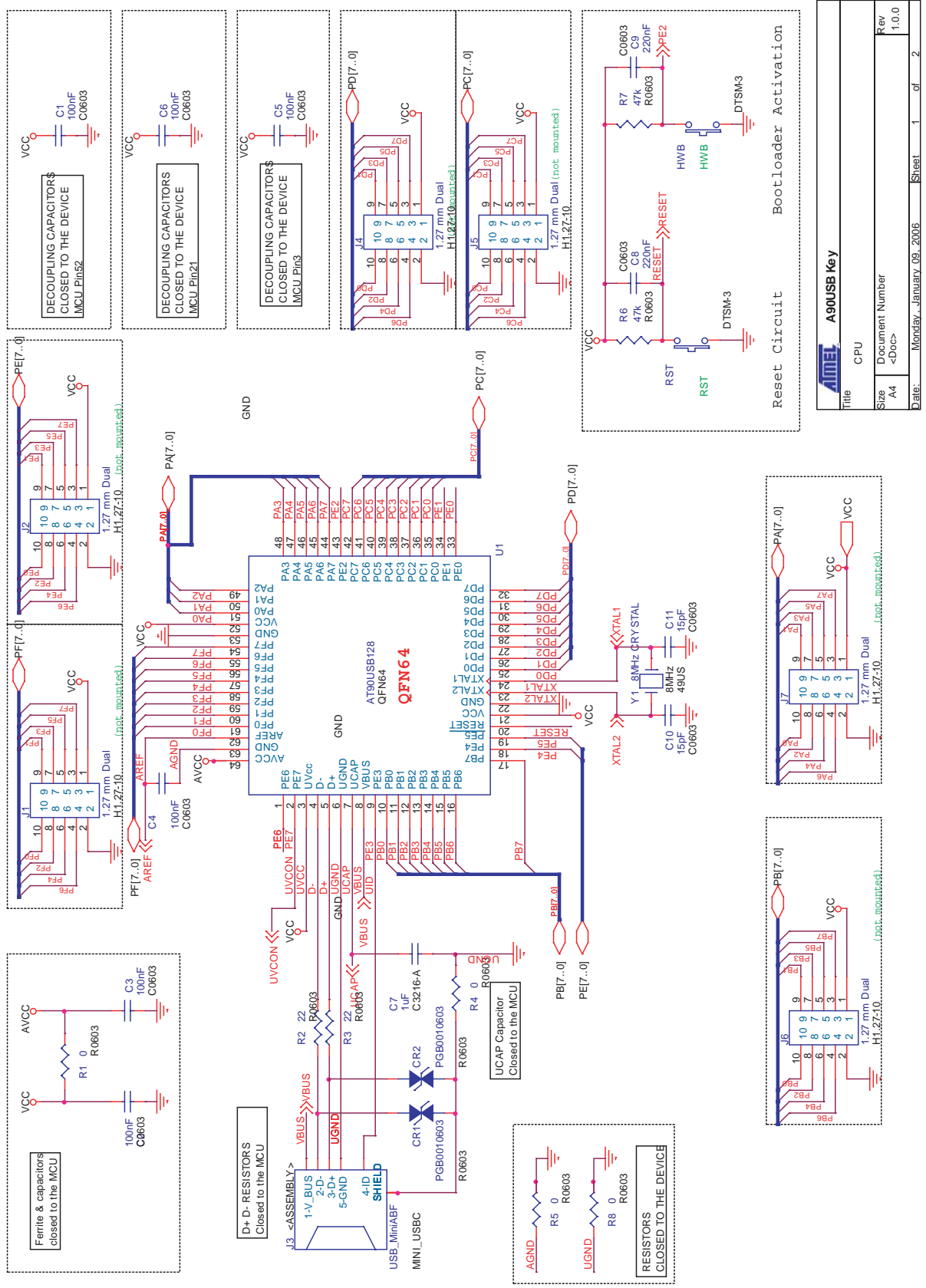
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# Complete Schematics

On the next pages, the following documents of AT90USBKey are shown:

- Complete schematics,
- Bill of materials.

Figure 6-1 . Schematics, 1 of 2



|                 |                          |       |        |
|-----------------|--------------------------|-------|--------|
| Title           |                          | CPU   |        |
| Size            |                          | A4    |        |
| Document Number |                          | <Doc> |        |
| Date:           | Monday, January 09, 2006 | Sheet | 1 of 2 |
| Rev             |                          | 1.0.0 |        |



Figure 6-2 . Schematics, 2 of 2

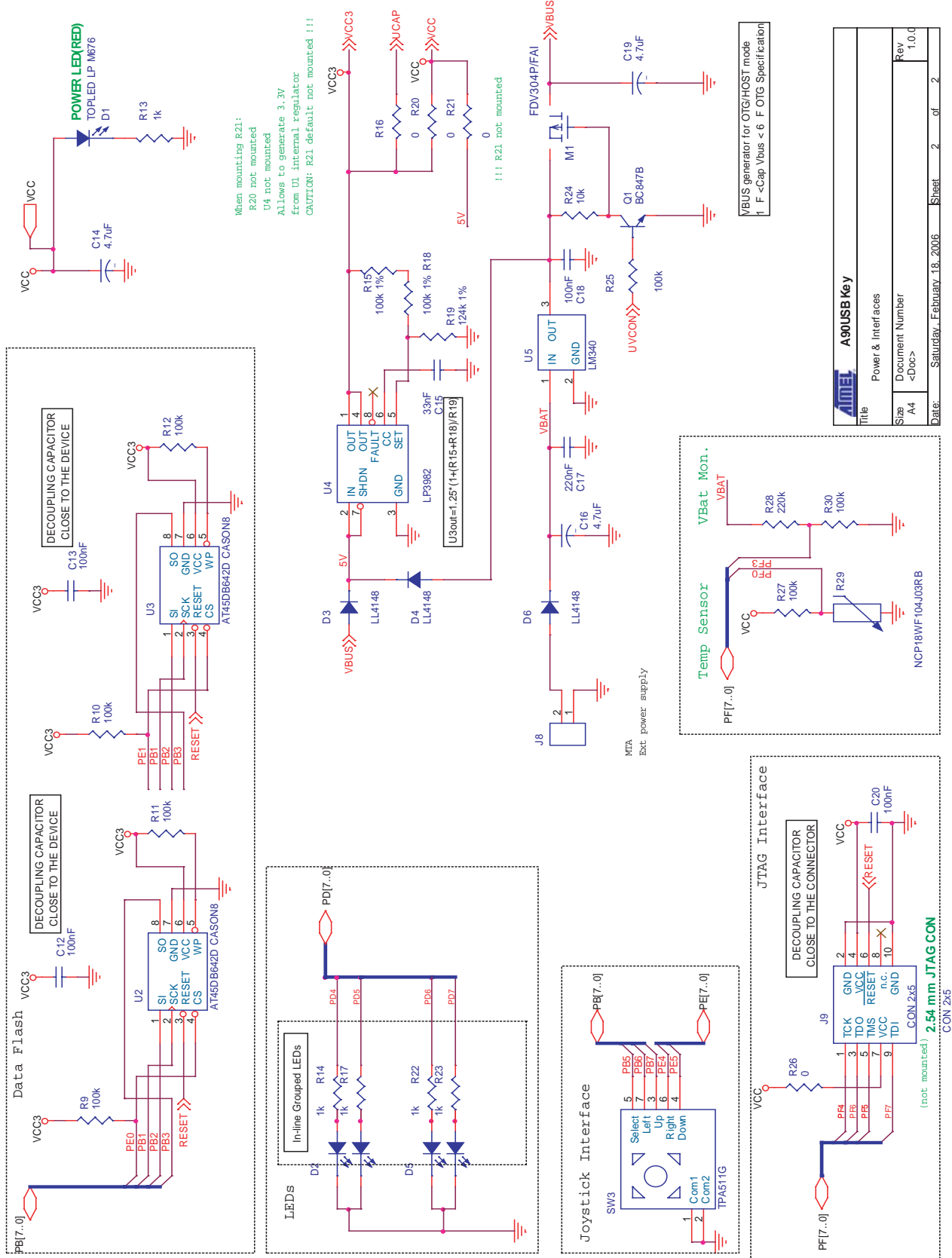


Table 6-1 . Bill of material

| Item | Q.ty | Reference                               | Part                                       | Tech. Characteristics | Package       |
|------|------|---|--|-----------------------|---------------|
| 1    | 2    | CR1,CR2                                 | ESD protection (PGB0010603)                |                       |               |
| 2    | 10   | C1,C2,C3,C4,C5,C6,C12,<br>C13, C18, C20 | 100nF                                      | 50V-10% Ceramic       | CASE 0603     |
| 3    | 1    | C7                                      | 1uF  | 10Vmin ±10%           | EIA/IECQ 3216 |
| 4    | 3    | C8,C9, C17                              | 220nF                                      | 50V-10% Ceramic       | CASE 0603     |
| 5    | 2    | C10, C11                                | 15pF                                       | 50V-5% Ceramic        | CASE 0603     |
| 6    | 3    | C14, C16, C19                           | 4.7uF                                      | 10Vmin ±10%           | EIA/IECQ 3216 |
| 7    | 1    | C15                                     | 33nF                                       | 50V-5% Ceramic        | CASE 0603     |
| 8    | 2    | D2,D5                                   | LED BI-COLOUR/ LSGT670                     | I=10 mA               | PLCC-4        |
| 9    | 1    | D1                                      | TOPLED/ LPM676-K2M1                        | I=10 mA               | PLCC-2        |
| 10   | 2    | D3,D4                                   | DII LL4148-7                               | i=200mA max           | LL-34         |
| 11   | 1    | J3                                      | USB mini AB receptacle Surface mount       |                       |               |
| 12   | 0    | J9                                      | CON 2x5 (2.54mm)                           | <b>(Not Mounted)</b>  |               |
| 13   | 0    | J1,J2,J4,J5,J6,J7                       | 1.27 mm Dual header                        | <b>(Not Mounted)</b>  |               |
| 14   | 1    | J8                                      | Connector MTA 2 cts right angle            |                       |               |
| 15   | 1    | M1                                      | FDV304P/FAI                                |                       | SOT23         |
| 16   | 1    | Q1                                      | BC847B                                     | IC peak=200mA         | SOT23         |
| 17   | 2    | R2,R3                                   | 22   | 1/16W-5% SMD          | CASE 0603     |
| 18   | 1    | R5                                      | 68k  | 1/16W-5% SMD          | CASE 0603     |
| 19   | 2    | R6,R7                                   | 47k  | 1/16W-5% SMD          | CASE 0603     |
| 20   | 7    | R1,R4,R5,R8,R16,R20, R26                | 0  |                       | CASE 0603     |
| 21   | 0    | R21                                     | 0  | <b>(Not Mounted)</b>  | CASE 0603     |
| 22   | 1    | R28                                     | 220k                                       | 1/16W-5% SMD          | CASE 0603     |
| 23   | 7    | R9,R10,R11,R12,R25,R27,R3<br>0          | 100k                                       | 1/16W-5% SMD          | CASE 0603     |
| 24   | 5    | R13,R14,R17,R22,R23                     | 1k   | 1/16W-5% SMD          | CASE 0603     |
| 25   | 2    | R24,R28                                 | 10k  | 1/16W-5% SMD          | CASE 0603     |
| 26   | 1    | R29                                     | NCP18WF104J03RB                            | 100K - β=4250         | CASE 0603     |
| 27   | 2    | R15,R18                                 | 100k 1%                                    | 1/16W-1% SMD          | CASE 0603     |
| 28   | 1    | R19                                     | 120k 1%                                    | 1/16W-1% SMD          | CASE 0603     |
| 29   | 2    | SW1,SW2                                 | PUSH-BUTTON / DTSM31N                      | 6x3.5mm - 1.6N        | See DS        |
| 30   | 1    | SW3                                     | TPA511G 4 ways joystick + center CMS mount |                       |               |
| 31   | 1    | U1                                      | AT90USB1287                                |                       | QFN64         |
| 32   | 2    | U2,U3                                   | AT45DB642D                                 |                       | CASON8        |
| 33   | 1    | U4                                      | LP3982IMM-ADJ                              | Vin Max 6V, 300mA     | MSOP8         |
| 34   | 1    | U6                                      | LM340MP5.0                                 |                       |               |
| 35   | 1    | Y1                                      | 8MHz CRYSTAL                               | H=4mm                 | HC49/4H       |



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### Biometrics/Imaging/Hi-Rel MPU/ High Speed Converters/RF Datacom

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