

# The CW Machine Hardware



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## Introduction

The ***CW Machine Hardware*** is a multi-purpose device designed to run one of several firmware programs. At the heart of the CW Machine Hardware is the AVR Butterfly board with an ATMEL ATmega169 processor and 512kb of non-volatile flash memory.

The CW Machine Hardware has the capability to load firmware into the processor through its serial port. Therefore, new versions of existing firmware or complete new applications implemented in firmware may be loaded into the device.

A typical example is our ***CW Machine*** firmware, which comes loaded and ready-to-run with the CW Machine Hardware. It turns the CW Machine hardware/firmware combination into, arguably, the most advanced memory keyer on the market. It has a matching PC program, the ***CW Machine Manager***, which simplifies and extends the firmware functions in connection with PCs running Microsoft Windows. Another application is our ***CW Trainer*** firmware and its companion Windows program, the ***CW Trainer Manager***.

This document describes the hardware platform only, in essence a small specialized computer. It requires additional firmware to perform any meaningful function, and those application functions are described in separate documents which come with each firmware application.

## Connecting the Hardware

The CW Machine Hardware has several connectors at the back and a DIN connector for a PS/2 keypad / keyboard on the left side. The connectors on the back, from left to right as shown in the photo are:



- A power connector with a 2.5mm center pin for (+) and 5.5mm outer diameter. You should use a power supply that can deliver at least 150mA at 9-15V DC. Don't exceed a supply voltage of 18V DC ! On the left side of the device, not shown in the photo, is a drawer that holds a 9V battery. It can power the keyer for an extended period if no external power supply is available.
- A yellow RCA connector for the sound output. It is connected to port B pin 5 of the ATmega 169 via a 2N7000 FET buffer. The output level is sufficient to drive headphones or a small speaker. **Refer to the hardware section if you connect this to an audio amplifier and need to reduce the output level.**
- A female DB9 connector to attach the keyer to a serial port on your PC. This connection is required to load firmware and application data into the keyer, and, depending on the firmware you are running, to exchange information with a PC program. If your PC does not have a serial port, a USB-RS232 adapter can be used to attach the keyer to a USB port. A suitable adapter is offered as an option for the CW Machine.
- A red RCA connector for the keyer output. This output uses positive keying with a maximum rating of +60V DC at 0.2A. It is connected to port F pin 2 of the ATmega 169 via a 2N7000 FET buffer.
- A 1/8" stereo connector that is typically used to hook up a dual lever paddle. The two leads connect, through 2N7000 FET buffers, to port B pin 6 and pin 7 of the ATmega 169. These two pins are also used by the joystick on the AVR Butterfly board. The "hot wire" of a **straight key** can be connected to the ring or the tip.
- On the left side of the keyer, not shown in the photo, is a mini-DIN connector to attach a PS/2 numeric keypad or keyboard. It is attached to the USI that is mapped to port E of the ATmega 169.

## Power Considerations

The CW Machine device does not have a dedicated power switch because it normally is continually on and powered by an external power supply. Since all application contents are kept in non-volatile memory, nothing will be lost when the device is without power. In addition it has a 9V battery that can power the device in full operation for extended periods if external power fails or is not available. If you are using a new alkaline battery, the typical life time can be expected to be around 30 hours or more, depending on the application and your operational pattern.

When the device is not in use it is best to remove the battery. In normal operation the CW Machine draws less than 20mA. The lowest current drain is achieved when you push the Reset button and the LCD screen goes blank; in this state the current drain, although not zero, is below 10mA, which a 9V alkaline battery can provide for more than 60 hours.

When you first connect a power supply or a battery, the LCD display will be blank. **You start the firmware application by moving the joystick up.**

## Serial Communication

If your PC does not have a serial port, you can use a high-quality **USB-serial adapter**. It should be mapped to **COM1 ... COM8**. Many inexpensive adapters have proven problematic, and the only types that have worked consistently at full speed without problems are the adapter that we offer as an option with the CW Machine and adapters made by Keyspan, e.g. the **Keyspan USA-19HS**.

The serial connector on the CW Machine Hardware is used for two purposes:

- It lets you load firmware into the keyer. This is typically done using the boot loader that comes with the AVR Butterfly board and the AVRprog program for Windows. (similar programs are available for other PC operating systems) **AVRprog will only work with ports up to COM4.**
- It lets the firmware exchange data with programs running on a PC. A typical example is the log file created by our **CW Machine** firmware, which can be uploaded to a PC or restored from a copy kept on a PC.

All firmware programs will support communication with a terminal program on a PC, although more convenient Windows programs may be available to complement the functions of a particular firmware. A typical example is our **CW Machine Manager** program, which simplifies and extends the operation of the

**CW Machine** firmware if you are running a Windows PC; if you are using it you don't have to concern yourself with the communication settings.

If you are using a terminal program, however, it has to understand XON/XOFF flow control, and it has to support one of the communication speeds that you can select in the firmware. The speed is normally set to 38,400 baud.

You have to set the communication parameters in your terminal program as follows:

- 8 data bits, no parity, 1 stop bit
- XON/XOFF flow control
- Uncheck (disable) these options in the ASCII Sending section:
  - *Send line ends with line feeds*
  - *Echo characters locally*
- Set the line delay and the character delay both to 0 milliseconds
- Make sure to set the ASCII Receiving parameters to:
  - *Enable Append line feeds to incoming line ends (check the box)*
  - *Disable Force incoming 7-bit ASCII (uncheck the box)*
  - *Enable Wrap lines that exceed terminal width (check the box)*

## Installing the USB-Serial Adapter

The USB-serial adapter that is offered as an option with the CW Machine requires device drivers. They are in a directory named **FTDI USB-RS232** on the installation CD that comes with the CW Machine. When you plug the adapter into a USB port for the first time, Windows will detect the new device and will try to find appropriate device drivers. (The exact procedure depends on the Windows version). If you include the FTDI USB-RS232 directory on the CD in the search path, the drivers will be installed, and the adapter will be ready for use after a few minutes.

To allow firmware updates, the adapter should be mapped to a port in the range of **COM1 ... COM4**. You can change the mapping in the Windows **Device Manager** ( Start -> Run: devmgmt.msc ), where you will find the adapter under **Ports (COM & LPT)** as a **USB Serial Port**. If you double-click on that line, you get a panel with the device properties, which has a **Port Settings** tab with an **Advanced** button. Clicking on that button, finally, gives you a screen where you can change the COM port that is assigned to the adapter.

The Keyspan adapters, which also work well with the CW Machine, come with an installation disk and a utility program which simplifies the installation and configuration.

## Loading the Firmware

The CW Machine Hardware usually comes with the CW Machine firmware already installed. But you can update it, or load some other firmware designed for the CW Machine Hardware, at any time through the serial connection. **The port has to be COM1 ... COM4. The AVRprog program that is used to update the firmware will not work with ports above COM4, although the firmware applications will support COM1 ... COM8.**

If you are using a Windows PC, we will always provide a program that complements a particular firmware application and, among other functions, has the ability to update the firmware. If your firmware is, e.g., the default **CW Machine** firmware, you are encouraged to use the **CW Machine Manager** program if you are running a Windows PC.

If you have a non-Windows PC, there are versions of the **AVRProg** program, a program provided by ATMEL that performs the actual firmware update, for other platforms. You have to get a version of AVRProg for your platform from AVR/ATMEL or various sources that can be found on the Internet.

The update process is similar in either case:

- reset the CW Machine Hardware by pushing the small Reset button on the front panel
- push (... like in pushing a button) and hold the joystick button down, then start the AVRProg program by clicking on the "Update Keyer" button in the CW Machine Manager program or starting it manually if you are not running a Windows machine. If you start it without holding the joystick button you will get a message that no supported board was found. AVRProg and the firmware in the keyer will go through an identification process, and if the serial connection works you will see a pop-up window after a few seconds. At this time you can release the joystick, which has to be kept pushed until the communication is established.
- In the pop-up you have to use the function to load the **Flash** memory (**don't** use the option to load the EEPROM memory). Browse for the hex file that contains the keyer firmware and upload it. (The hex file for the CW Machine firmware is called **keylargo.hex**, but other firmware applications will use different names for the hex file) There is a blue bar that indicates the progress of the load process – when it is finished it is important that you **click the Exit button** (don't just close the window), then close the window.

**After the new firmware is loaded you restart the device with the newly loaded firmware by moving the joystick up.** You should see the scrolling version message which identifies the firmware, and any movement of the joystick should then start the firmware operation.

## The Hardware

The following pages show all hardware aspects of the CW Machine Hardware. The pictures of the printed circuit board are shown at actual size as positive and negative images so that you can reproduce the board with any photographic process. If you want to create this board yourself, you should use the dimensions of the ground plane on the bottom layer as a guidepost: it is exactly 3.1" x 2.2". The centers of the four mounting holes are spaced 2.4" horizontally and 1.75" vertically.

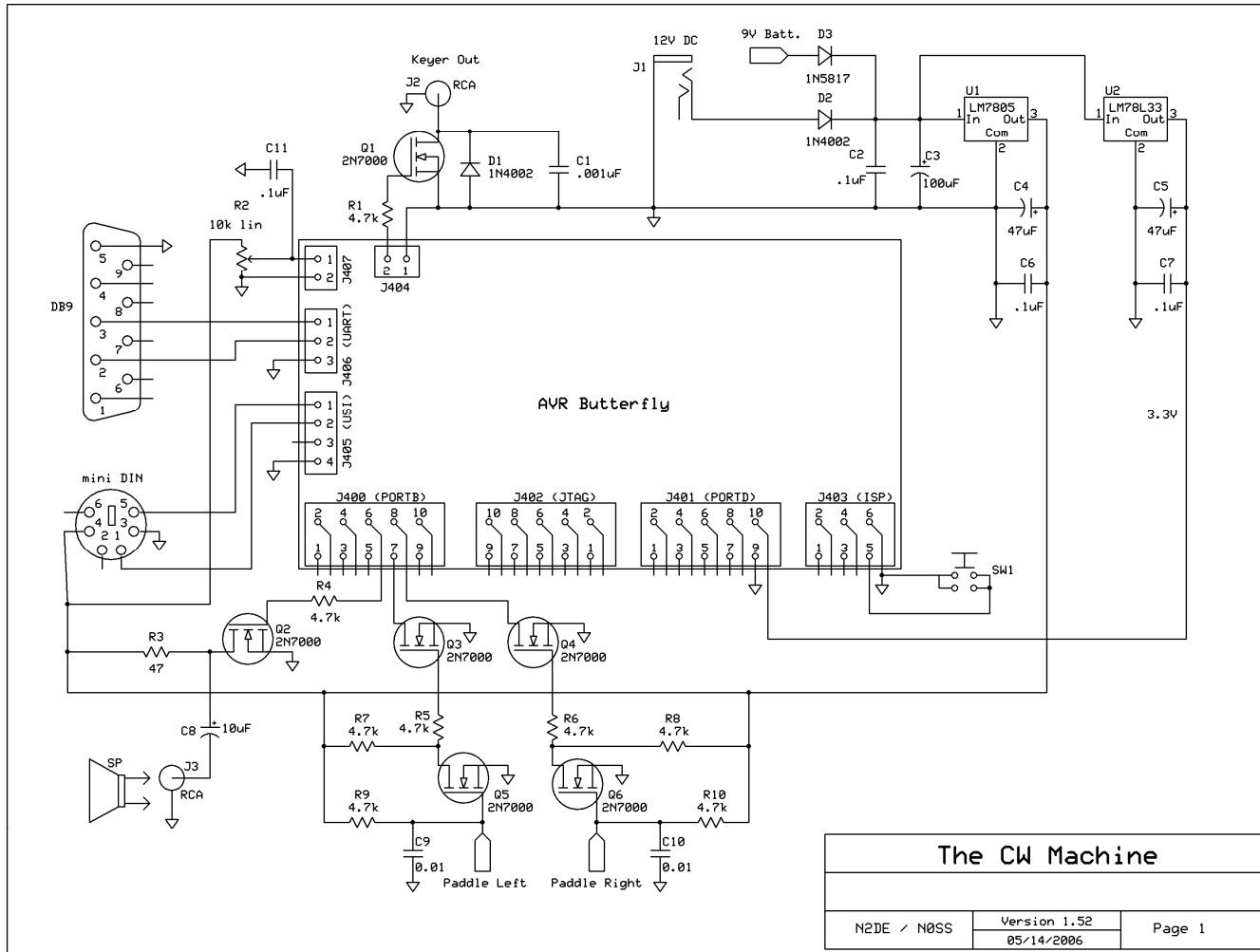
The printed circuit board has a strip of 20 pins on one side to connect all of the cabinet mounted connectors. You can install a right-angle pin strip and use a receptacle with 20 wires leading to external components, or you can solder the wires directly for a more economical solution. The right-angle pin strip and the mating receptacle are not included in the bill of materials.

Few of the component values are really critical: the 4.7k resistors, e.g., could be replaced by resistors half or twice that value, the filter capacitors could be 10uF instead of 47uF, the 1N4002 diodes could be 1N4001 types. Care should be exercised with capacitor C1 because a large value would impact the keying waveform, and resistor R3 should not be made smaller, so that the output rating of Q2 is not exceeded. The DC input voltage can be anything between 9V and 13.5V, and it could even be AC if the filter capacitors are made large enough.

**The sound output of the device is sufficient to drive a small speaker or headphones; however, if you are patching the output into the audio chain of your receiver, the output volume may be overdriving your audio amplifier. In this case you should put a small (0.01uf – 0.1uf) ceramic capacitor into the lead that connects to the RCA jack. You may have to experiment a bit to find a suitable value.**

Since DigiKey is the US distributor for the AVR Butterfly evaluation board that is at the heart of the CW Machine, you may as well order all the other components that you don't find in your grab box from them. The bill of materials shows the DigiKey part numbers for your convenience.

# Schematic

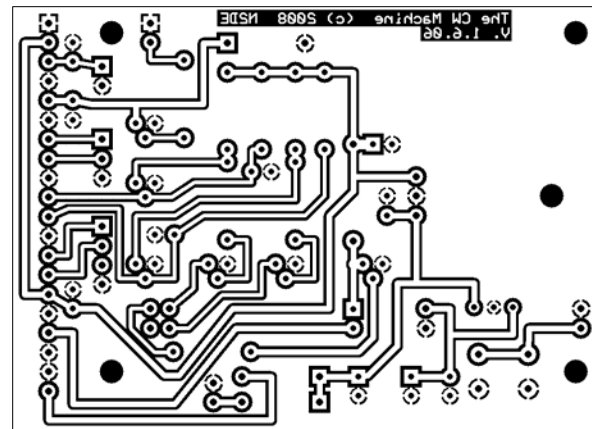
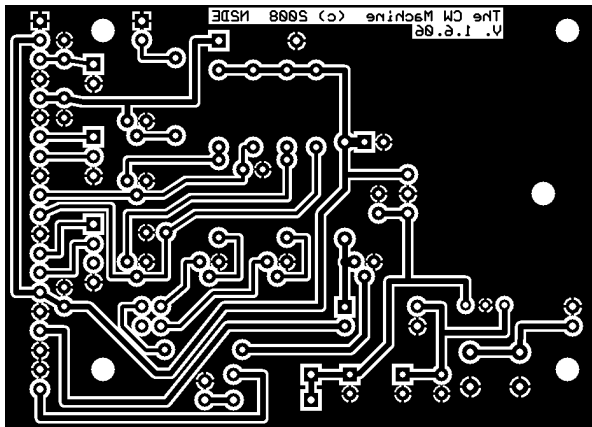


## Bill of Materials

Qty	Schematic Id	Value / Type	Description	DigiKey Part #
1			AVR Butterfly Evaluation Board	ATAVRBFLY-ND
1	C1	0.001uF	100V ceramic capacitor	478-2456-ND
4	C2, C6, C7,C11	0.1uF	50V ceramic capacitor	478-3192-ND
1	C3	100uF	35V electrolytic capacitor	493-1081-ND
2	C4, C5	47uF	35V electrolytic capacitor	493-1080-ND
1	C8	10uF	35V electrolytic capacitor	493-1077-ND
3	C9 - C10	0.01uF	100V ceramic capacitor	478-3178-ND
2	D1, D2	1N4002	Diode	1N4002/54GICT-ND
1	D3	1N5817	Schottky Diode	1N5817-E3/54GICT-ND
1	DB9		9-pin female D-sub connector	609-1525-ND
1	D-sub socket kit		screws, washers, nuts	609-1420-ND
1	J1		DC jack	CP-6-ND
1	J2		RCA phono jack, red	CP-1413-ND
1	J3		RCA phono jack, yellow	CP-1415-ND
1	mini DIN		6-pin mini DIN female	CP-2960-ND
1	Paddle Left/Right		3.5mm stereo jack	CP-43502PM-ND
6	Q1-Q6	2N7000	FET	2N7000FS-ND
8	R1, R4-R10	4.7k	0.25W resistor	4.7KQBK-ND
1	R2	10k linear	potentiometer	CT2205-ND
1	R3	47 Ohm	1W resistor	P47W-1BK-ND
1	SW1	SPDT	miniature push button switch	EG2506-ND
1	U1	LM7805	regulator, 5.0V, TO-220	LM7805CT-ND
1	U2	LM78L33	regulator, 3.3V, TO-92	497-4258-1-ND
1			40-pin breakaway pin header	A26513-40-ND
4			2-pin receptable	A26451-ND
1			4-pin receptable	A26452-ND
1			3-pin receptable	A26415-ND
1			4-pin receptable	A26416-ND
1	Speed Knob		.5" aluminum matte	226-4084-ND

## ***Printed Circuit Board Bottom Layer***

The printed circuit board is designed as a single-layer board. It is shown here at actual size as seen from the component side (x-ray through the board). If your printer has a fine enough resolution you can use one of these pictures as a template for any photographic process that uses a positive or a negative image. The dimensions of the ground plane are 3.1"x2.2". When you print these images from Adobe Acrobat make sure that page scaling is off (Zoom: 100%), otherwise the size will not be correct.



## Printed Circuit Board Component Placement

