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 a time. 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 a serial port. Therefore, new versions of the 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 firmware to perform any meaningful function, and those application functions are described in separate documents which come with each firmware application.

The CW Machine device is shipped with a numeric keypad, which is required to control many functions of the CW Machine keyer and the CW Trainer firmware.

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 9-25V DC. Don't exceed a supply voltage of 25V DC ! The CW Machine comes with a matching plug, and you will have to solder a cable with a connector to it to attach the CW Machine to your power supply. You have to observe the polarity, making sure that the center conductor is (+); the circuit is protected against reverse polarity and no damage will occur if you reverse the polarity by mistake. **The CW Machine can also be powered from a 5V supply through a pin on the serial port, as described further down**.

- A 1/8" stereo connector for the sound output. The CW Machine has configuration switches, described further down, to let you use a mono plug and to choose between high and low impedance output. In the low impedance mode, the output on this port is sufficient to drive headphones or a small speaker directly.

- A female DB9 connector to attach the CW Machine 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 device to a USB port. A suitable adapter is offered as an option for the CW Machine.

  Pin 6 on this connector, the lower right pin in the above photo, can be used to power the CW Machine from a 5V source**. It has to be 5V within narrow margins, or damage can result to the circuitry.** All computers provide 5V internally, and you can wire this pin to your computers power bus. The USB-serial adapter that we offer as an option is wired to supply 5V from the USB bus to this pin. **Refer to the description of the C/E configuration switch if you want to use this pin to power the CW Machine.**

- A red RCA connector for the keyer output. This output can key **positive or negative** voltages up to 400V at 140mA – suitable for solid state transmitters and tube transmitters with grid-block keying. No configuration change is required to key either type of transmitter.

- A 1/8" stereo connector that is typically used to hook up a **single or dual lever** paddle with separate contacts for the dash and dot sides. There is no agreed upon standard which of the two "hot" wires is used for dashes or dots – the CW Machine firmware, however, lets you electronically reverse the orientation and you won't have to unsolder anything if you connect this the "wrong" way. The "hot wire" of a **straight key** can be connected to either 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. The CW Machine comes with a numeric keypad to control many firmware functions, but you can also plug in a full-size PS/2 keyboard. **This has to be a keyboard with a "native" PS/2 plug – a USB keyboard with a PS/2 adapter will not work.**

The Configuration Switches

When you open the device by removing the 4 screws at the bottom and pulling off the silver bottom part of the enclosure, you will see a row of three DIP switches mounted at the bottom of the printed circuit board.
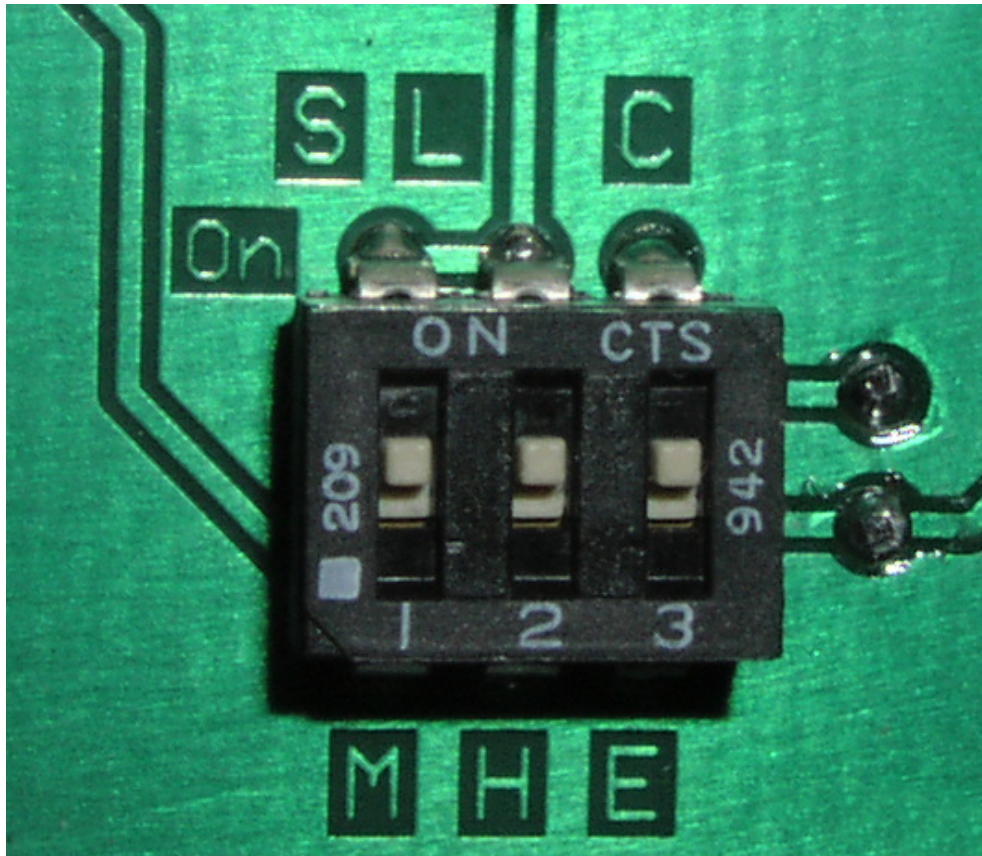
When the CW Machine is shipped, all three switches are in the ON position. The switch positions have single letter labels on the printed circuit board, describing their function. You can move the switches with a small screw driver or pen.

The left two switches configure the tone output port. Switch 1 has the positions S and M, standing for **S**tereo and **M**ono, and it determines the kind of plug that you insert into the stereo jack for the tone output. If you were to insert a mono plug without sliding the switch into the M position, the sound output would be shorted to ground. This does not cause any damage, but you would obviously not get any sound. So, if you are using a 1/8" mono plug, slide this switch to the M position, otherwise leave it on S.

Switch 2 has the positions L and H, standing for **L**ow and **H**igh impedance. If you are using a low impedance device, like headphones or a small speaker, leave this switch in the L position. If you are feeding the output into an amplifier with a high-impedance input, the output level may be too high – slide the switch into the H position for a high-impedance match and reduced output volume.

Switch 3, with the positions C and E, standing for **C**omputer and **E**xternal, is used in connection with a serial cable which may be wired to provide 5V DC via pin 6 of the DB9 connector (as our USB-serial adapter does.)   If your serial cable is not wired to provide 5V on pin 6 then the setting of this switch is irrelevant. If you have a cable that supplies 5V to this pin, however, but you want to use an external power supply anyway, then you have to slide this switch to the E position. **The CW Machine can be damaged if it receives power from both sources at the same time.** One reason why you may want to use the external supply, although you have our USB-serial adapter with that special wiring, is that there may already be other devices that are powered by the USB bus in your computer, and the additional current drain of the CW Machine would exceed the rating of the USB bus. USB hubs can usually provide 500mA of current, maybe less on small notebook/netbook computers, and the CW Machine can draw around 110mA in some situations, although less than 20mA is a typical average value during normal operation.

Power Considerations

The CW Machine device does not have a dedicated power switch because normally it is continually on and powered by an external power supply or by the computer through the serial connector. Since all application contents are kept in non-volatile memory, nothing will be lost when the device is without power.

If you open up the device, you will see a holder for a CR2450 lithium knob cell on the right side. The knob cell slides into the holder with the (+) side down.
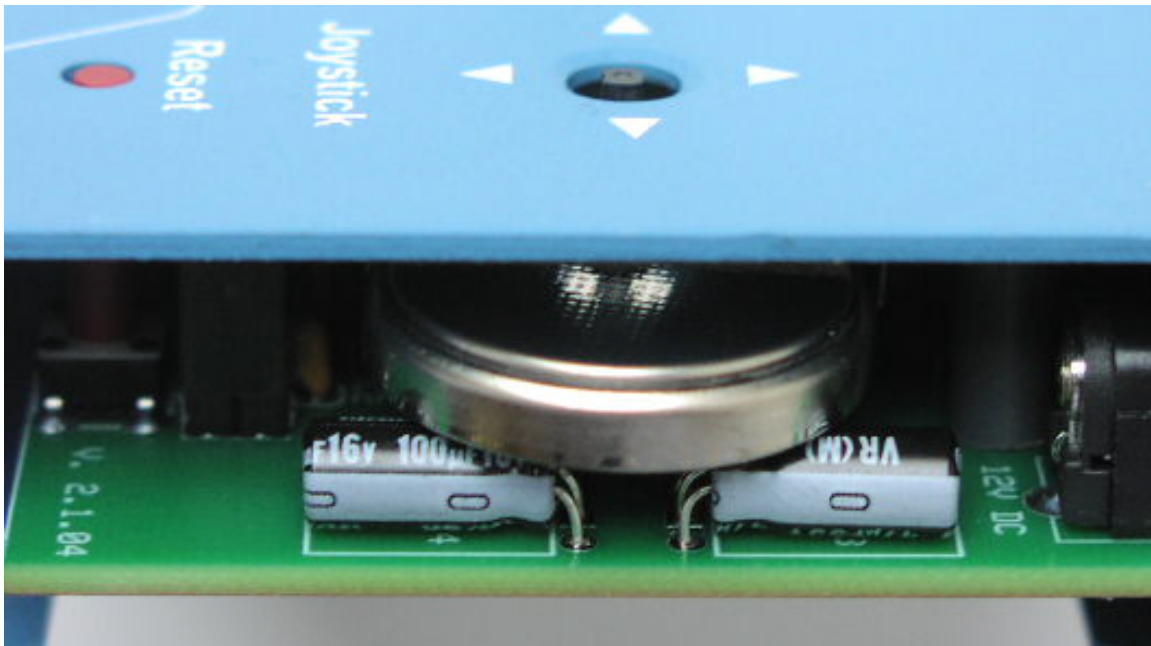
This knob cell can be used to keep the clock running for about a week in case of a power outage. You can also invoke all menu functions and even communicate via the serial port with only that knob cell. All other keyer functions, however, will not work when the device is powered only by this knob cell.

You should not install a knob cell unless you really want to keep the clock for the logger running during a power outage (e.g. during a field day), and you should remove the battery when it is no longer needed. The memory in the device is non-volatile and does not require a battery or external power. A "half dead" battery, however, can cause serious problems in the firmware.

When you first connect a power supply or insert the battery, the LCD display will be blank. You start the firmware application by touching the left side of your paddle (or 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 … COM16**. 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 connection on the CW Machine Hardware is used for two purposes:

- It lets you load firmware into the keyer. This is typically done using 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 our 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, which is the maximum speed for the CW Machine.

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. You can also pre-install the drivers and make absolutely sure that Windows finds and uses the correct drivers by running the **USBAdapterSetup.exe** program that is included on the CD.

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 following screen shot shows the typical screens that you would use to change the COM port mapping for a USB-serial adapter.
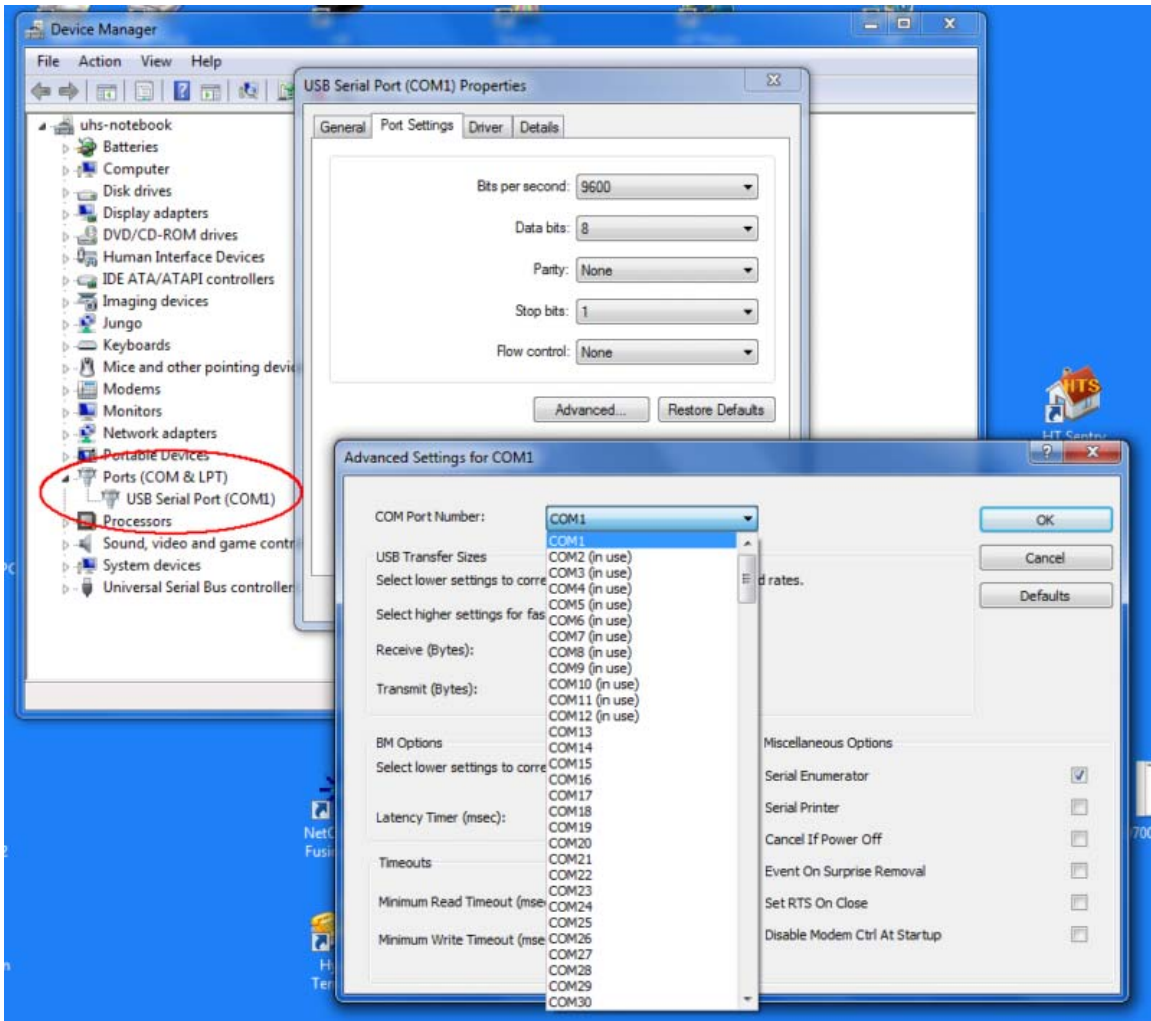
The Keyspan adapters, which also work well with the CW Machine, come with an installation disk and a special utility program which obviates the need to go through the Windows Device Manager.

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 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 our Windows applications will support COM1 … COM16.**

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.

I 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
- press (like in pressing a button) and the joystick button and **KEEP PRESSING IT**, 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 pressing 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 pressed 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*, the file for the CW Trainer is *KeyTrain.hex*) 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 touching the left side of your paddle (or by moving the joystick up). You should see the scrolling version message which identifies the firmware, and any paddle contact or movement of the joystick should then start the firmware operation.

The Hardware

The following pages show important hardware aspects of the CW Machine device. **The CW Machine is not intended for disassembly, and you would have to unsolder the speed potentiometer from the printed circuit board before you could gain access to the components.** The bill of materials shows the DigiKey part numbers.

Schematic
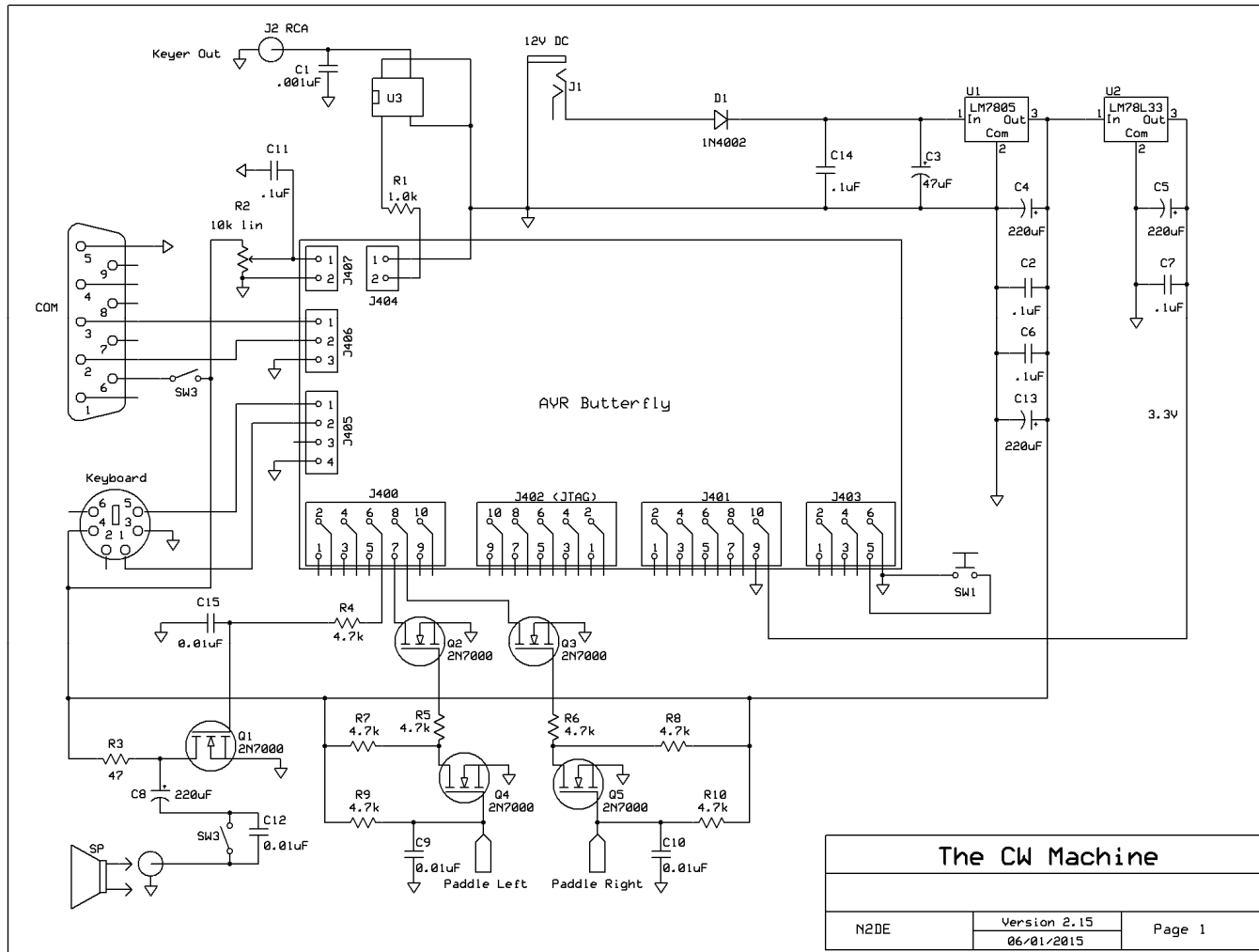
Bill of Materials

Qty	Schematic Id	Value / Type	Description	DigiKey Part #
1			AVR Butterfly evaluation board	ATAVRBFLY-ND
1	SW1		miniature push button switch	EG2506-ND
1	SW3		DIP switch 3 position	CT2093LPST-ND
1			RCA phono jack, red	CP-1419-ND
1			DB9 connector	182-09FE-ND
1	Keyboard		DIN connector	CP-2260-ND
2			3.5mm stereo jacks	CP1-3553NG-ND
1	R2		10k linear pot 6mm shaft	P3C3103-ND
1			knob 6mm shaft .625"	226-3092-ND
1			power jack, 5.5/2.5mm	CP-102B-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	U1	LM7805	regulator, 5.0V, TO-220	LM7805CT-ND
1	U2	LM78L33	regulator, 3.3V, TO-92	LP2950CZ-3.3-ND
1	U3		opto-electronic relay 400V/140mA	CLA275-ND
1	C1	1000pF	ceramic capacitor 1kV	490-4258-ND
4	C2,C6,C7,C11,C14	0.1uf	ceramic capacitor 50V	478-3192-ND
3	C9,C10,C12	0.01uF	ceramic capacitor 100V	478-3178-ND
1	C3	47uF	electrolytic capacitor 35V	493-1080-ND
3	C4, C5, C8, C13	220uF	electrolytic capacitor 16V	493-1040-ND
1	D1	1N4002	diode	1N4002FSCT-ND

5	Q1-Q5	2N7000	FET	2N7000FS-ND
1	R1	1k	resistor	1.0KQBK-ND
1	R3	47 Ohm	resistor 1W	P47W-1BK-ND
7	R4-R10	4.7k	resistor	4.7KQBK-ND

Component Placement