

# HYDRA BARE BONES ECONOMY KIT

## *ASSEMBLY INSTRUCTIONS*

Congratulations on your purchase of a Hydra Bare Bones kit. These instructions are intended as a guide only. The Hydra Bare Bones Kit is a minimalist approach to a firing system sequencer built around the incredibly user-friendly and versatile Arduino hardware/software package. We encourage our DIY customers to take advantage of this versatility and exercise some creativity.

**CAUTION!** *Fireworks can be extremely dangerous. Although firing systems can reduce the risk of personal injury, nothing can remove that risk entirely. When using firing systems, certain procedure must be followed to ensure safety. Ultimately, the safety of yourself, the audience and surrounding property is up to YOU. Modifying existing hardware or software can be extremely dangerous. By purchasing this kit, you accept full responsibility for any damages or injuries related to the use or misuse of the product.*

Included in this document is a “pin-out” list that describes which Arduino pins control which aspects of the circuit board. As you become more confident with electronics, you may wish to wipe the original programming and write your own, more sophisticated program using the Hydra Bare Bones board as a “shield” or break-out board.

### **STEP 1:** Completing the circuit board

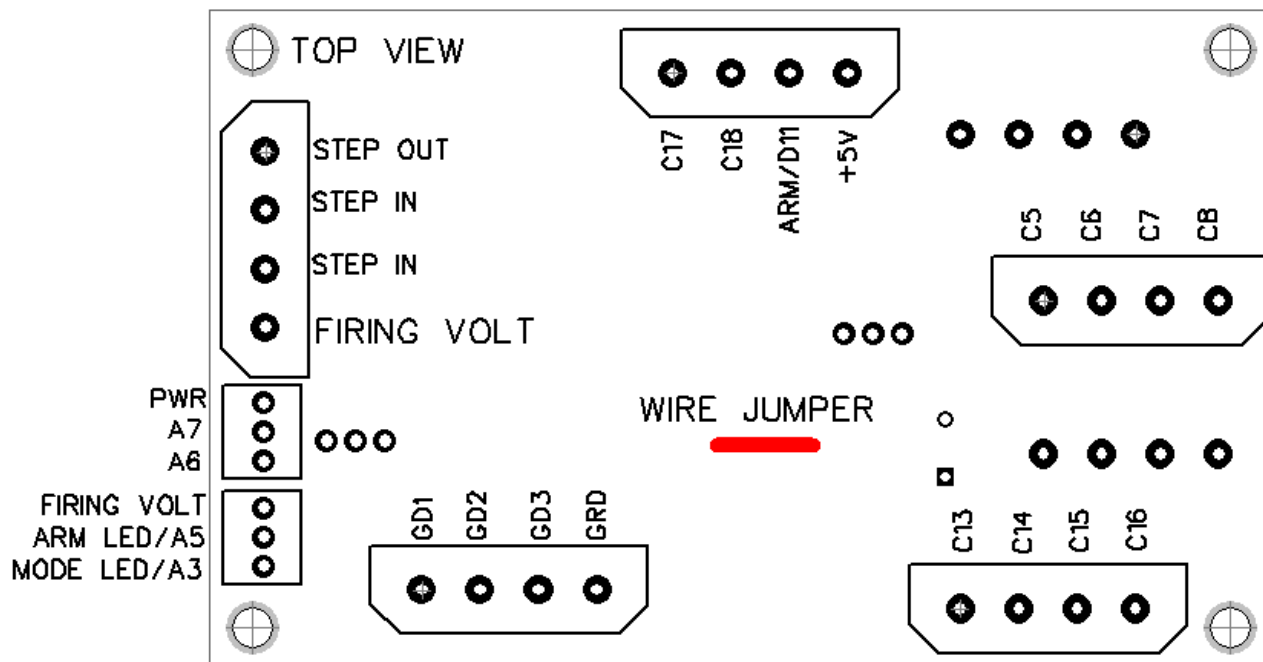
The Economy package requires that various through-hole components be soldered onto the board before it can be used. You will receive (7) 4-position terminal blocks with 0.20” spacing and (4) 3-position terminal blocks with 0.10” spacing. Solder the screw terminals in place first. Orion Pyrotechnics suggests staggering the screw terminals top and bottom with each set of terminals facing opposite direction to make wiring easier. An example layout is shown in Fig. 1 and Fig. 2.

**NOTE:** The terminal block containing D0, D1 and RST is partially obstructed by the capacitor and by header strips on the reverse side. The terminal block will only sit flush on the board when the terminals are facing towards the capacitor. However, this block is included as a courtesy and is not necessary for operation. Reference Fig. 2; read more on page 4.

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# ORION PYROTECHNICS: HYDRA BARE BONES



**FIG. 1**

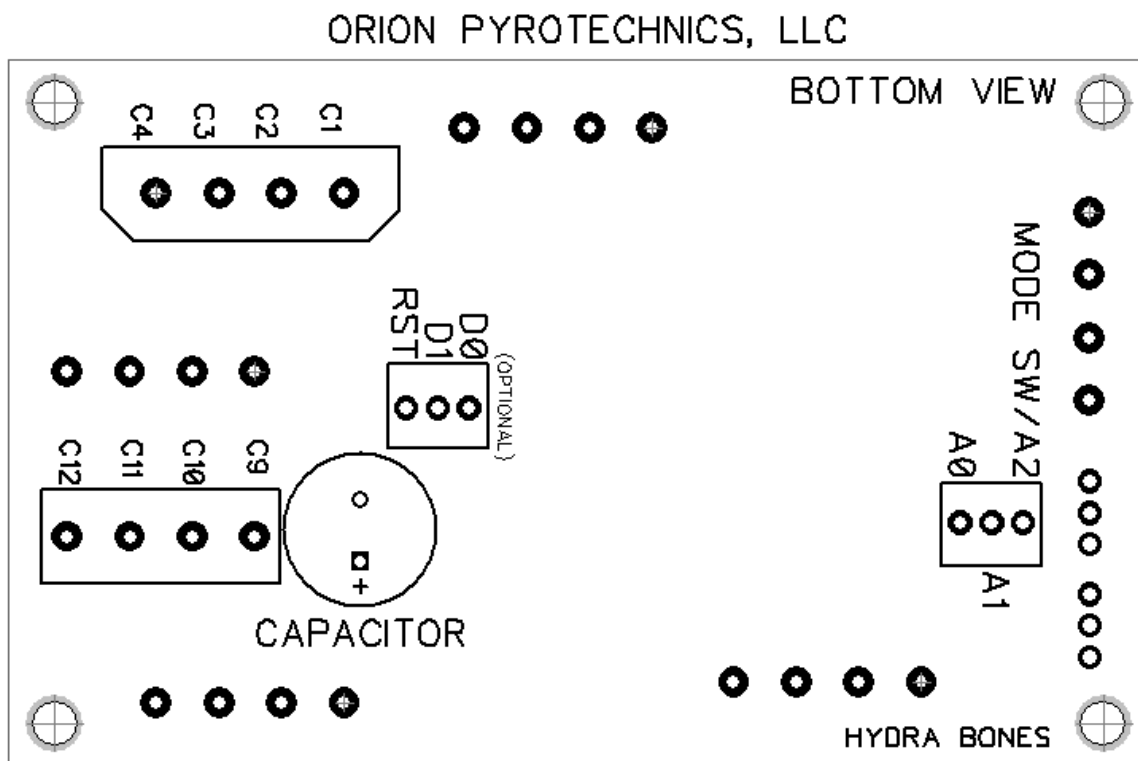
**SUGGESTED LAYOUT SHOWING OPTIONAL WIRE JUMPER**

## Soldering Tips:

- *The keys to a good solder joint: Cleanliness, Temperature, Time, Coverage!*
- *Keep your soldering iron tip clean by frequently wiping on a soft rag*
- *Keep your soldering iron tip tinned; after wiping it clean reapply a small amount of solder to the tip*
- *Keep the joint clean and free from oils and other contaminants*
- *Use a quality flux core solder for through-hole components*
- *Heat the joint and apply solder to the joint, not to the iron; if the solder does not melt into the joint, it's not hot enough!*
- *Allow the iron to contact the joint long enough to heat the whole joint but don't wait too long or you may damage components with the heat*
- *Finally, use an appropriate amount of solder; joints should be neat and shiny*

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**FIG. 2**

*SUGGESTED LAYOUT SHOWING OPTIONAL SCREW TERMINALS*



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## STEP 1: Completing the circuit board (CONTINUED)

After the screw terminals are in place, the last component that must be soldered is the large capacitor. Orion Pyrotechnics recommends that the leads of the capacitor be bent 90° and the capacitor be installed on its side. Make sure that the polarity of the capacitor is correct when you install it.

If a terminal block for pins D0, D1 and RST is installed, it will be obstructed by the capacitor. Installing the capacitor vertically will partially obstruct the terminal block. If the 4-position terminal block adjacent to the capacitor is installed on the top side, then the capacitor may be installed horizontally so as not to obstruct the 3-position terminal block. The 3-position terminal block is included as a courtesy and is not used for Hydra Sequencer operation.

The capacitor only need be installed if the unit will be powered via 9V batteries. The large internal resistance of 9V batteries means that, during a large current load like firing an igniter, the voltage on the batteries can drop to about 5V. This is insufficient to keep the circuit board running. The capacitor acts as a “reserve” to provide voltage to the microcontroller during these brown-out periods. Powering the board with a separate 9V battery or using SLA batteries with low internal resistance will make the capacitor unnecessary. (See the section on power requirements).

## STEP 2: Decide how to power the board

The Hydra Bare Bones board can be powered by a variety of options up to 32 volts. For firing voltages greater than 32V, contact us for special instructions. A few popular options are detailed below:

**(2) 9V Batteries in series (RECOMMENDED):** This provides 18 volts for both firing cues and powering the circuit board. A jumper should be installed across the terminals FIRING VOLTAGE and PWR on the 3-position speaker terminals. Alternatively, you can solder a permanent jumper between two pads located under the Arduino board (which unplugs from the rest of the circuit board). The approximate location of this jumper is marked in Fig. 1. The positive lead of the 18V battery gang should be connected to the FIRING VOLTAGE terminal of the 4-position screw terminals and should go through a switch. The negative or ground lead of the 18V battery gang should be connected to the GRD terminal on the 4-position screw terminals. This arrangement requires the large capacitor on the back side of the board!

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**(3) 9V Batteries:** This arrangement places two batteries in series and one in parallel in the same fashion as COBRA™ modules. You will have one negative lead, common to all three batteries and two positive leads. The positive lead coming from the two batteries in series is at 18V and should be connected to the FIRING VOLTAGE terminal on the 4-position screw terminal through a switch. The second positive lead is at 9V and should be connected to the PWR terminal of the 3-position screw terminal, also through a switch. The capacitor is not necessary in this case.

**SLA Battery Box up to 32V:** SLA stands for Sealed Lead Acid battery and is an expensive, reliable and rechargeable battery commonly found in electric golf carts, uninterruptable power supplies, security systems and even in your car! A single 12V battery is sufficient for most firing tasks but for long runs of scab wire or firing large numbers of igniters, you may need greater voltage. With the jumper installed between the FIRING VOLTAGE and PWR terminals (as detailed above), you may use up to 32V. The capacitor is not strictly required for operation but it is recommended. You can purchase SLA batteries on the internet or you can get nicely packaged battery boxes from a variety of manufacturers including TRMPyro, LLC (TRMPyro.com). For voltages greater than 32V, contact us! In this arrangement, the firing voltage is again connected to the FIRING VOLTAGE terminal on the 4-position screw terminals and should be switched.

#### **VOLTAGES GREATER THAN 32V:**

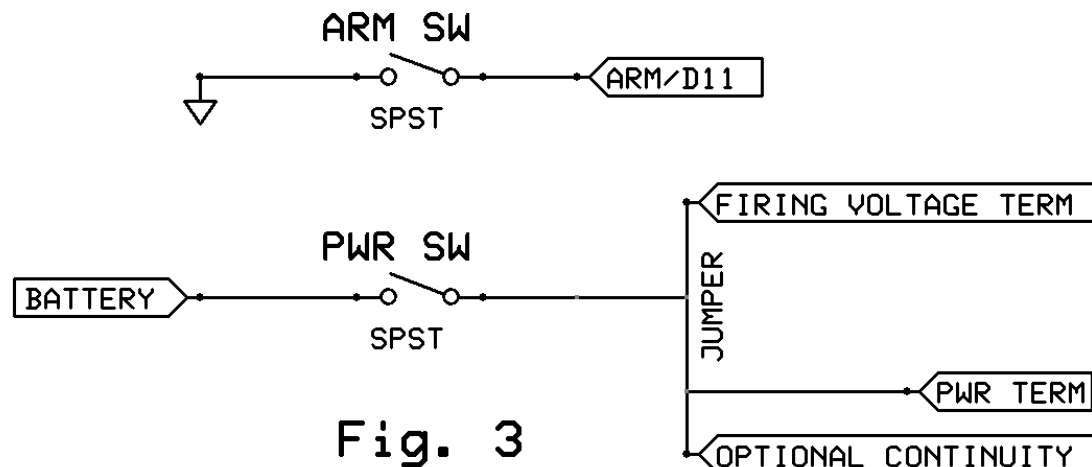
*To power the sequencer with voltages greater than 32 V, you will need to power the circuit board and the firing circuit separately. One option is to use one or two 9V batteries to power the circuit board via the PWR terminal and an external SLA battery array to power the FIRING VOLTAGE terminal. If you wish to include continuity testing LEDs, you will have to choose the resistors carefully so as to limit the current to a safe level without burning up the resistors. See below.*

**SWITCHES:** All arrangements require the use of three switches: a POWER switch, an ARM switch and a MODE switch.

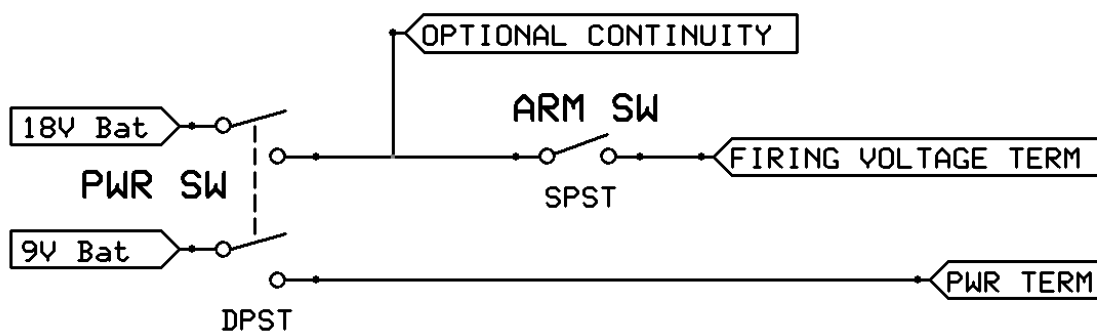
If you are using a jumper between FIRING VOLTAGE and PWR, then the power switch interrupts both firing voltage and circuit board power. The ARM switch must then be connected to the D11/ARM terminal on the 4-position screw terminals. The other terminal of the switch is connected to ground. When this switch is closed (connecting D11 to ground) the system is *disarmed*. Opening the switch causes the system to *arm*. Both of these switches can be SPST variety. See Fig 3.

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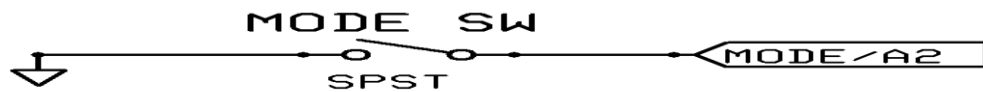




If you are using two independent voltage sources for the firing voltage and circuit board power, then the main power switch should be a DPST switch that shuts off both voltage sources. The arm switch is in series with this switch and shuts off the firing voltage. Nothing should be connected to the D11/ARM pin. See Fig 4.



Additionally, the MODE/A2 terminal should be connected to the MODE switch to enable the sequencer mode. When this pin is connected to ground through a switch, the unit will be put into sequencer mode. When this pin is unconnected, the unit will remain in stepper mode. See Fig 5.



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### STEP 3: Get creative (wiring up speaker terminals)

Find a box or other method of mounting your circuit board and run wires from the 4-position screw terminals to your speaker terminals, pyro-clips or other means of connection. Terminal C1 corresponds to cue 1 and so-forth. The wires coming from the C1-18 screw terminals should be connected to the red (+) speaker terminals/pyro-clips. Cues 1-6, 7-12 and 13-18 share common grounds. Therefore, the black speaker terminals/pyro-clips for cues 1-6 should all be connected together and wired to the GRD 1 screw terminal. Similarly, the black speaker terminals/pyro-clips for cues 7-12 should be connected together and wired to the GRD 2 screw terminal and so-forth.

### STEP 4: Continuity Testing (optional)

You may wish to include the ability to test the continuity of the igniters connected to the sequencer. This can be accomplished through the use of LEDs or Light Emitting Diodes and a resistor to limit the current to 20 mA or less. When selecting the resistor size, you will need two equations:

$$R = \frac{V}{I}$$

$$P = I^2 R$$

The first one is Ohm's law; it tells us that the voltage, (measured in Volts), divided by the current (measured in Amps) is equal to the resistance. In practice, a typical LED has a voltage drop of about 1.2 V. Knowing this and knowing that our maximum current shouldn't exceed 20 mA, we can use the following equation to find the value of the resistor. The value used for V is equal to the firing voltage.

$$\frac{V - 1.2}{0.020} = R$$

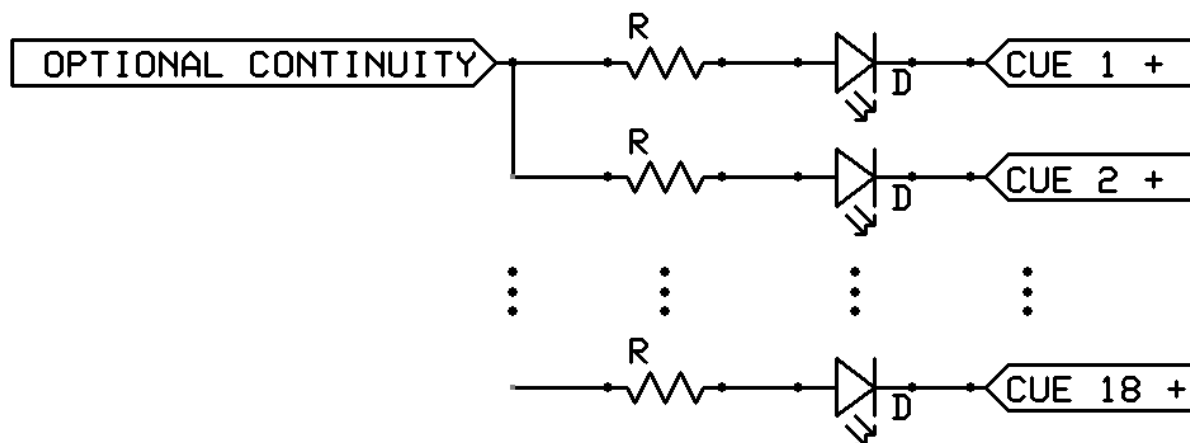
When you purchase resistors, they will be specified by both the resistance and the power they can safely dissipate. Therefore, you must make sure that you buy resistors with a sufficiently high power rating. The power dissipated is given by the second equation. Using the maximum current of 20 mA and substituting in our expression for the resistance, we arrive at the following equation:

$$P = (0.02)(V - 1.2)$$

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For each of the cues, you should wire the LED and resistor in series as per Fig. 6. Note that continuity is only checked when the system is disarmed. This conserves battery power during a show.



**Fig. 6**

## STEP 5: Downloading the Arduino IDE

To program sequences, you will need to use the Arduino IDE and the provided USB cable. The first step is to download the Arduino IDE on your computer. Go to

<http://arduino.cc/en/Main/Software>

and click the link to download the software for your operating system. Once the software has been installed, you will need to make sure that the appropriate drivers are installed. If you are using a Windows machine, this should happen automatically when you plug in the circuit board. If it does not or if you are using a different operating system, go the following link and follow the detailed instructions on driver installation:

<http://arduino.cc/en/Guide/HomePage>

Once you have the drive installed open the Arduino program (if you are unsure how to do this, look for Arduino.exe in the installation folder and double click this icon). Once the program is running, you will need to select the serial port that you will use to communicate with the Arduino circuit board. First, disconnect the circuit board and go *Tools > Serial Port* and note which options are available. Now, reconnect the circuit board via the USB cable and again go to *Tools > Serial Port*. This time you will click on the new option.

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## STEP 6: Programming and use

At this point, everything is configured properly. Now go to *Tools > Serial Monitor* or press CTRL + SHIFT + M to bring up the serial monitor window. The circuit board will print out a message:

```
*****
**          HYDRA STEPPER by Orion Pyrotechnics, LLC          **
**          COPYRIGHT (c) 2013 Orion Pyrotechnics, LLC          **
*****
```

```
IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY
CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT,
TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE
SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
```

```
On time currently set to: 100 mS
Press 's' to enable sequencer mode
or press 'd' to change ON TIME
```

You can click on the text bar above the serial monitor and type 'd' to change the minimum amount of time cues are kept on. You can also type 's' to go into sequencer mode and program a sequence of times. See the following instructions on how to enter time sequences:



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## CUSTOM SEQUENCES:

- Custom sequences may be entered via computer as 18 numbers, corresponding to time steps in milliseconds, separated by commas and bracketed by parenthesis. The user need not input all 18 values.
- Acceptable values range from 1 to 2147483647. Additionally, -1 is an acceptable input. However, for safety reasons, time steps should be kept relatively short.
  - Orion Pyrotechnics recommends no time steps greater than 5 seconds or 5000 mS. **The inherent danger of simple sequencers is that, once started, there is no way to deactivate them remotely.** In the event that you need to pause or abort your show, a sequencer with large time steps becomes a major hazard.
- Any time steps not entered will be set to the default value -1. A value of -1 means that the following cue will not be turned on until another input pulse is received; it effectively puts the cue into “stepper mode”.
- The time step between cues 6 and 7 and the time step between cues 12 and 13 must be equal to the minimum on time.
- Every additional input pulse received after all cues have been fired will generate an output pulse
- **Examples:**

(500,500,500,250,250,**250**,100,100,100,50,50,**250**,1,1,1,1,1,1) =

TIME	CUE	TIME	CUE
Input pulse received	1	0.1s after cue 9	10
0.5s after cue 1	2	0.05s after cue 10	11
0.5s after cue 2	3	0.05s after cue 11	12
0.5s after cue 3	4	0.25s after cue 12	13
0.25s after cue 4	5	0.001s after cue 13	14
0.25s after cue 5	6	0.001s after cue 14	15
0.25s after cue 6	7	0.001s after cue 15	16
0.1s after cue 7	8	0.001s after cue 16	17
0.1s after cue 8	9	0.001s after cue 17	18
		0.001s after cue 18	OUT

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(500,500,500,-1,250,**250**,100,100,-1,50,50,-**1**,1,1,1,1,1,-1) =

TIME	CUE	TIME	CUE
Input pulse received	1	Input pulse received	10
0.5s after cue 1	2	0.05s after cue 10	11
0.5s after cue 2	3	0.05s after cue 11	12
0.5s after cue 3	4	Input pulse received	13
Input pulse received	5	0.001s after cue 13	14
0.25s after cue 5	6	0.001s after cue 14	15
0.25s after cue 6	7	0.001s after cue 15	16
0.1s after cue 7	8	0.001s after cue 16	17
0.1s after cue 8	9	0.001s after cue 17	18
		Input pulse received	OUT

(500,500,500,-1,250,**250**,100,100,-1,50,50,**250**) =

TIME	CUE	TIME	CUE
Input pulse received	1	Input pulse received	10
0.5s after cue 1	2	0.05s after cue 10	11
0.5s after cue 2	3	0.05s after cue 11	12
0.5s after cue 3	4	0.25s after cue 12	13
Input pulse received	5	Input pulse received	14
0.25s after cue 5	6	Input pulse received	15
0.25s after cue 6	7	Input pulse received	16
0.1s after cue 7	8	Input pulse received	17
0.1s after cue 8	9	Input pulse received	18
		Input pulse received	OUT

**The bolded values are the time steps between banks. Note that these must either be -1 or greater than one-half the value of the dwell.**



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