



## Tadao Raider Ion Board Instructions

### Features

- Based on the Musashi 7 software
- Compatible with PSP, NPPL and Millennium marker rules
- New model microcontroller runs at 8 Mhz
- Includes 12 fire modes: uncapped semi-auto, capped semi-auto, PSP auto-response, PSP mild ramping, PSP max ramping, PSP z-burst, NXL full-automatic, auto-response, mild ramping, max ramping, z-burst, and full-automatic
- Asynchronously monitors the trigger switch using an interrupt based scan at 2 million times per second
- Gangster setting allows 3 different options for every fire mode, giving 36 different "breakout" style modes
- Adjustable ABS programming prevents first shot drop-off
- AMB (anti-mechanical bounce) and CPF (cycle percentage filter) algorithms help to eliminate mechanical bounce and switch bounce
- Power efficient software and hardware lengthens battery life
- Programming mode allows changes to debounce, total dwell, pulse dwell, loader delay, AMB, ABS dwell, fire mode, fire mode max rate of fire, eye mode, CPF, ramp start, gangster mode, burst dwell, and dwell percentage
- All settings are stored in non-volatile memory so they are not lost when battery is disconnected
- One-touch startup enables the marker to fire instantly
- Automatic 15-minute idle power down saves batteries
- Two eye modes: delayed and forced with force shot
- Low battery indicator hardware and software shows battery level each time the marker is turned on
- Additional connectors allow external placement of the power switch and status LED

### Installation

Installation of the Raider Ion board must be carefully done to ensure the electronics are not damaged.

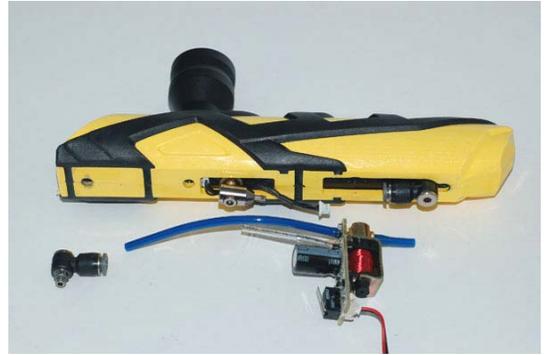
Stock board removal:

1. Remove the grip panels from both sides of the frame.
2. Remove the battery, disconnecting it from the wiring harness.
3. Remove the three grip frame screws (two from the underside pointing up, one just in front of the breech pointing down).
4. Gently lift the Ion body away from the frame until the stock board is half visible.



5. Remove the front pneumatic fitting with a 1/8" Allen wrench. Make sure to remove the pneumatic fitting from the hose afterwards and set it aside.

6. Continue to lift the Ion body away from the frame with the stock board.
7. Unplug the eye harness from the stock board.
8. Unplug the remaining two hoses from the Ion body pneumatic fittings.
9. The stock board should now be completely detached from the Ion body.



Reassembly with the Tadao Raider Ion board:

1. Plug the two short hoses into the pneumatic fittings on the Ion body.
2. Connect the eye harness to the Tadao Raider Ion board.
3. Plug the longest hose into the pneumatic fitting you set aside earlier.
4. Gently align the Tadao Raider Ion board with the slot in the grip frame, threading the battery harness down inside.
5. Slide the board halfway into the frame.
6. Screw the forward pneumatic fitting back into the front of the grip frame. Make sure to push the long hose down into its retaining slot.
7. Slide the board and solenoid the rest of the way into the grip frame, making sure no wires or hoses get pinched.
8. Replace the three frame screws.
9. Plug in a fresh alkaline 9 volt battery.
10. Replace the grip panels.

### LED Indicator

The white status LED that shines from behind the power button membrane shows which mode of operation the marker is currently in:

Solid	Ball in breech, ready to fire
Slow Blinking	No ball in breech
Fast Blinking	Eye malfunction, max rate of fire reduced to 10 bps. Clean eyes or make sure the gun is fired with paint and air
Slow Double Blink	Eyes disabled, rate of fire limited to 20 balls per second in mode 1; otherwise capped at max rate of fire setting for fire modes 2 – 12

### Power Operation

Pressing and releasing the power button turns the marker on. The battery indicator will show the current power level of your battery with a flickering red, orange, or green LED (located inside the grips on the surface of the board). To turn off, press and hold the power button until the LED turns off, then release. Every time the marker is turned on, the eyes are enabled. The marker can be turned off regardless of the state of the eyes. See "Battery Indicator" section for additional details.

### Eye Operation and Logic

The eyes are enabled when the marker is first turned on. The eyes can be toggled by pressing and releasing the power button quickly. The LED will change to a slow double blink to indicate that the eye system is off.

If used, the eye system cycles the marker as fast as possible. During each shot the eyes watch for the bolt to return, ending the current firing cycle and starting another as quickly as the pneumatics allow. If the eye system is continually blocked (e.g. putting your finger in front of the eyes) and is unable to see the bolt return after every shot, the max rate of fire will be reduced to about 10 balls per second to prevent further chopping, and the LED will blink rapidly to indicate a malfunction. The only way to show the true speed of the Ion board is to fire the marker with paint and air. When the eyes are off, the rate of fire is limited to 20 balls per second unless in fire mode 2-12, in which case the rate of fire is selected by the user.

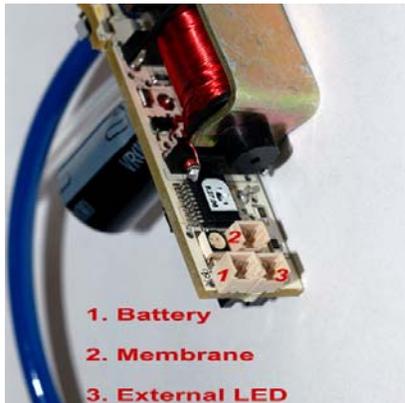
To determine if the eyes are working correctly, insert an object into the breech. Check to see if the LED changes from slow blinking white to solid white and then back to slow blinking white once the object is removed.

## Battery Indicator

Battery indicator software and hardware are standard on the Ion board. When the marker is turned on, the LED located on the surface of the board beneath the grip panels will briefly flicker red, orange, or green to indicate the status of your battery. Due to variations in voltage, current, and quality, different types of batteries may last longer than others, regardless of what the battery indicator shows. Tadao Technologies recommends the use of high quality alkaline or lithium batteries. The use of rechargeable or “heavy duty” batteries may result in poor performance.

## Accessory Sockets

The Tadao Raider Ion board includes accessory sockets to allow the user to mount an external LED and membrane pad. This makes it easier to turn the marker on and off, and allows the user to personalize his Ion.



As shown in the above diagram, there is a specific socket for a membrane pad harness and external LED harness. Both harnesses can be purchased separately, if needed, and allow for easy installation of the desired accessories.

## Programming

The tournament lock must be disabled in order to change settings on the board. The push button switch beneath the grip panels toggles the tournament lock. While the marker is turned off, push and hold the lock button. The programming LED will flash red or green to indicate the status of the lock. Red means the lock is on, while green means the lock is off. While the lock and the marker are off, pull and hold the trigger, then push the power button. The marker will boot into programming mode, showing a rainbow sequence before stopping at solid green.

Pulling and releasing the trigger quickly will toggle between the different programming modes:

Green	Debounce
Purple	Total dwell
Yellow	Loader delay
Blue	AMB (anti-mechanical bounce)
Red	ABS dwell
White	Fire mode
Teal	Fire mode max rate of fire
Flickering Green	Eye mode
Flickering Purple	CPF (cycle percentage filter)
Flickering Yellow	Ramp start
Flickering Blue	Gangster mode
Flickering Red	Pulse dwell
Flickering White	Dwell percentage

When the LED is lit for the desired setting, press and hold the trigger until the LED goes out. When you release the trigger, the LED will blink to show the current setting. For example, if the current setting for debounce is 5, the LED will blink green 5 times. Once the LED stops blinking, you have 2 seconds to begin entering the new setting. To enter the new setting, pull the trigger the desired number of times. For example, to set the debounce to 2, you must pull the trigger 2 times. Every time you pull the trigger the LED will light. After all settings have been changed, turn the marker off, using the power button.

### Programming Example

If you want to set the dwell to 15, you should:

1. Make sure the marker is powered off and the tournament lock is disabled.
2. Pull the trigger and push the power button to turn on the marker.
3. The programming LED shows a rainbow sequence then stops on solid green. This is the debounce mode.
4. Quickly pull and release the trigger 1 time to switch to the dwell mode. The programming LED will show purple.

5. Pull and HOLD the trigger until the programming LED turns off.
6. Release the trigger. The programming LED will blink out the current setting.
7. When the programming LED stops blinking, enter the new setting by pulling the trigger 15 times.
8. Wait until the programming LED turns back on, indicating programming has been completed.
9. Turn the marker off.

### Program Reset

To reset all settings to factory defaults, hold down the lock button for 10 seconds while in programming mode. The programming LED will rapidly cycle through every setting color to indicate that the process has completed.

## Settings

**Debounce** – The Ion board features an interrupt based debounce algorithm that effectively “scans” the trigger over 2 million times per second. It runs this completely independent of code execution on the microcontroller so your trigger pulls are always registered. The debounce setting is in increments of 1/2 milliseconds. Users should be aware that low debounce settings may cause the marker to read switch bounce as additional pulls, falsely generating shots or near full-automatic fire. The setting ranges from 1 to 50 and is defaulted at 10 (5 ms).

**Total dwell** – The total amount of time the solenoid is energized each time the marker is fired. The default is 28 ms. The range is 10 to 40 ms. Too low of a dwell may lead to inconsistency or drop-off. Too high of a dwell can cause bad air efficiency or power use. **If using a QEV, the recommended dwell setting is 14-16 ms.**

**Loader delay** – Adds a slight delay after the eye has seen a ball and the bolt is cycled, causing the gun to fire. If not using force fed loaders, it may be necessary to increase this setting to prevent chopping. A setting of 1 means no loader delay, which is the fastest. The default is 2 and may be set from 1 to 25.

**AMB (Anti-mechanical bounce)** – Allows the user to adjust the anti-mechanical bounce feature. Mechanical bounce occurs due to the kick generated during each shot and can cause the marker to “run away” on the first few shots. AMB helps stop markers from going full-auto when the trigger is pulled very slowly. The default is 2 and may be set from 1 to 5 (1 being off). AMB is only used in fire modes 1 and 2 (semi-automatic unlimited and adjustable).

**ABS dwell** – Amount of dwell time added for an ABS (anti-bolt stick) shot. The range is from 1 to 9 additional milliseconds of dwell. The default is 1, which is off. ABS programming helps to eliminate first shot drop-off. First shot drop-off occurs when the lube and o-rings settle or “stick” inside the marker after it has been sitting. The next shot fired will be lower in velocity because the bolt has to break free. ABS will slightly increase the dwell to compensate if the marker is left sitting for 15 seconds.

**Fire mode** – Included are 12 different fire modes (default is 1):

1. Semi-automatic, unlimited rate of fire
2. Semi-automatic, adjustable rate of fire
3. PSP auto-response
4. PSP mild ramping, adjustable ramp start
5. PSP max ramping, adjustable ramp start
6. PSP z-burst
7. NXL full-automatic
8. Auto-response
9. Mild ramping
10. Max ramping
11. Z-burst
12. Full-automatic

Setting 1 is normal semi-automatic with an unlimited rate of fire while the eyes are enabled. When the eyes are turned off, the max rate of fire is set to 20 balls per second.

Setting 2 is semi-automatic with an adjustable rate of fire. It limits the maximum balls per second that can be fired. The cap is set by the max rate of fire setting.

Setting 3 is the PSP auto-response fire mode that works as follows:

- The first 3 shots of a string are semi-automatic
- After the 4<sup>th</sup> shot the marker will fire on the pull and release in auto-response mode
- If the user stops firing for more than 1 second, the 3-shot semi-automatic count starts over

Setting 4 is the PSP mild ramping fire mode that works as follows:

- The first 3 shots of a string are semi-automatic
- After the 4<sup>th</sup> shot the marker will ramp based on the speed of the trigger pulls as long as the user pulls the trigger faster than the ramp start setting
- If the user stops firing for more than 1 second, the 3-shot semi-automatic count starts over

Setting 5 is the PSP max ramping fire mode that works as follows:

- The first 3 shots of a string are semi-automatic
- After the 4<sup>th</sup> shot the marker will ramp up to the loader's maximum speed or the maximum rate of fire as long as the user pulls the trigger faster than the ramp start setting
- If the user stops firing for more than 1 second, the 3-shot semi-automatic count starts over

Setting 6 is the PSP z-burst fire mode that works as follows:

- The first 3 shots of a string are semi-automatic
- After the 4<sup>th</sup> shot the marker will burst fire from 2-3 shots per pull, depending on how quickly the trigger is pulled and released
- If the user stops firing for more than 1 second, the 3-shot semi-automatic count starts over

Setting 7 is the NXL full-automatic fire mode. It functions similarly to the PSP fire modes except, after the 3<sup>rd</sup> semi-automatic shot, the user may pull and hold the trigger for the marker to fire in full-automatic.

Setting 8 is the normal auto-response fire mode. The marker will fire on each pull and release of the trigger, generating two shots per full pull cycle.

Setting 9 is the normal mild ramping fire mode. The marker will fire in semi-automatic unless the user pulls the trigger faster than the ramp start setting. Once the ramp start setting has been achieved, the marker will mildly ramp, generating additional shots depending on how fast the user pulls the trigger.

Setting 10 is the normal max ramping fire mode. The marker will fire in semi-automatic unless the user pulls the trigger faster than the ramp start setting. Once the ramp start setting has been achieved, the marker will ramp up to the maximum feed rate of the loader or the maximum rate of fire setting, whichever is lower.

Setting 11 is the normal z-burst fire mode. The marker will burst fire 2 times or more for every pull and release of the trigger, depending on how fast the user pulls the trigger.

Setting 12 is the normal full-automatic fire mode. As long as the trigger is depressed the marker will fire in full-automatic.

**Fire mode max rate of fire** – The max rate of fire setting applies to the 2<sup>nd</sup> -12<sup>th</sup> fire modes. The max rate of fire is adjustable from 14 to 20 balls per second in 1/4 balls per second increments, and has an unlimited setting for maxing out the loader system. The default is 5, which is roughly 15 balls per second. Oscillator inconsistencies from chip to chip make it impossible to time perfectly, so the only true way to check rate of fire is to use a Pact Timer or ballistic chronograph. The red radar chronographs commonly found at fields are NOT reliable.

Setting	BPS	Setting	BPS	Setting	BPS
1	14.0	9	16.0	17	18.0
2	14.25	10	16.25	18	18.25
3	14.5	11	16.5	19	18.5
4	14.75	12	16.75	20	18.75
5	15.0	13	17.0	21	19.0
6	15.25	14	17.25	22	19.25
7	15.5	15	17.5	23	19.5
8	15.75	16	17.75	24	19.75
				25	20.0
				26	Unlimited eyes on 20 bps eyes off

**Eye Mode** – Two eye modes are available:

1. Delayed – If the eye system does not detect a ball in the breech for 1/2 second, the marker automatically fires. This is useful for sound activated loaders because it ensures that a shot is fired, even without paint, so the loader will continue to feed.
2. Forced with force shot – The marker only fires if paint is seen in the breech or the user pulls and holds the trigger for 1/2 second, thereby initiating a force shot. This is the default eye mode.

**CPF (Cycle percentage filter)** – The cycle percentage filter allows adjustment of the point within the current firing cycle that a new buffered shot is allowed. Almost all electronic paintball markers allow a single shot to be buffered in the event the user is fast enough to release the trigger and pull again during the current firing cycle. The CPF setting is adjustable from 1 to 10. Setting 1 turns the CPF off, allowing buffered shots at any point in the firing cycle. Setting 2 through 10 sets the percentage of the firing cycle that must pass before shots may be buffered:

1. CPF turned off
2. 10% of the firing cycle must pass before a buffered shot is allowed
3. 20%
4. 30%
5. 40%
6. 50%
7. 60%
8. 70%
9. 80%
10. 90%

A higher CPF setting results in less unintentional bounce. For instance, it is possible that if your debounce setting is border line, you can fire the marker a few times, then hold it loosely and allow it to brush against your finger, going full-automatic. Since most switch bounce from either a low debounce setting or mechanical bounce occurs almost immediately after the trigger is released, CPF can be very effective in eliminating falsely generated trigger activity.

**Ramp start** – This setting is only used for the four ramping fire modes (PSP mild and max ramping, and normal mild and max ramping). It sets the minimum pulls per second that must be maintained for the software to add shots or ramp up to the maximum rate of fire setting. The default is 5 and is adjustable from 4 to 14 pulls per second. PSP requires a minimum setting of 5, while the Millennium requires a minimum setting of 8.

**Gangster mode** – The Ion board includes a special mode that can be applied three different ways to each of the 12 fire modes, giving 36 “breakout” style combinations. Gangster mode gives the user full-automatic with an unlimited rate of fire for a single pull, for use at the start of the game. The setting is defaulted at 4, which turns gangster mode off. A setting of 1-3 dictates at which pull that gangster mode will become active. If set to 1, the first shot after you turn on the marker will be full-automatic with an unlimited rate of fire for as long as you hold down the trigger. As soon as you release the trigger, the marker will stop shooting and default back to your selected fire mode. If set to 3, the gangster mode will be active on the third shot after the marker is turned on. Regardless of the fire mode selected, the shots before the gangster mode will be semi-automatic. Gangster mode can only be used once for each time the marker is turned on.

**Note: The gangster mode is illegal for use in all tournament series. Tadao Technologies LLC takes no responsibility for the user's choice in using the gangster mode.**

**Pulse dwell** – The Ion solenoid requires an initial burst of high energy to open the valve, followed by a longer but less powerful pulse to keep the valve open. The pulse dwell setting selects the initial amount of time that the solenoid is pulsed at full power. The default is 5 ms, and is adjustable from 2-9. When the marker is fired, the solenoid is fully powered for the **pulse dwell** time, followed by a reduced duty cycle for the remaining **total dwell** time (minus the **pulse dwell** time). If set to the defaults, the solenoid will receive 100% power for 5 ms, followed by 23 ms at reduced power (since the default total dwell time is 28 ms).

**Dwell percentage** – As explained in the Pulse dwell setting description, the Ion solenoid requires an initial full power burst of energy, followed by a longer but lower power pulse to stay open during the dwell time. The dwell percentage setting allows the user to adjust the duty cycle on the solenoid during the second half of the dwell time. The settings (1-5) are: 66%, 71%, 75%, 77%, and 80%. The default setting is 3, which is 75%. Too low of a setting may not allow the marker to cycle reliably, if at all, while too high of a setting increases power consumption. Variations in the manufacturing of each Ion solenoid determine the potential performance. An exceptional solenoid may be able to run at lower dwell times and lower dwell percentages to achieve the same or greater performance.

## Additional Features

**Force Shot** – In the event the eyes are enabled, the breech is empty, and the user wants to fire a clearing shot, a force shot can be initiated by pulling and holding the trigger for 1/2 second. This is useful with force fed loaders that sometimes push a ball slightly into the detents where the eyes are unable to see it. After force firing, the next ball will load and operation will continue as normal.

**A tip for setting the debounce, AMB, and CPF** – This only applies to semi-automatic fire modes (modes 1 and 2) since AMB is disabled in the PSP fire modes or NXL mode.

Debounce, AMB, CPF setup steps, while using paint and air:

1. Turn AMB and CPF off (set both to 1).
2. Starting at debounce 1-3, raise the debounce setting a notch at a time until excessive trigger bounce goes away. The goal is to have one pull, one shot, regardless of rate of fire. Do NOT slow pull test for bounce during this phase. Instead, pull the trigger rapidly or walk it, listening for double or triple fires.
3. When it appears that it is only one shot, one pull for solid trigger pulls, try the slow pull test. Holding the marker steady, slowly pull the trigger and see if multiple shots can be generated from the single pull.
4. Increase the CPF setting a notch at a time until the slow pull bounce starts to disappear. An additional test is to fire a few rounds quickly, then hold the trigger right on the activation point to see if the marker will run away.
5. If you reach setting 10 with CPF and the marker can still be slow pulled to fire full-automatic, your debounce setting is probably too low. Go back to step 2.
6. AMB should not be set above 3, if possible, since it is not as transparent to the user as CPF. Even a CPF setting of 10 will not be noticed by the user.

### Example Setting Profiles

1. Tournament legal semi-automatic (NPPL)
  - a. Fire mode 1 or 2 (semi-auto unlimited or capped)
  - b. Debounce 5-20
  - c. AMB 2
  - d. CPF 2-5
  - e. Loader delay 1-4 for Halo, 4-10 for gravity feed
2. PSP X-Ball, CFOA
  - a. Fire mode 3, 4, 5, or 6
  - b. Max rate of fire set to 3-5, depending on Pact Timer readings
  - c. Debounce 5-20
  - d. Ramp start 5 or higher if using PSP mild/max ramping
  - e. Loader delay 1-4 for Halo, 4-10 for gravity feed
3. Millennium
  - a. Fire mode 4 or 5 (PSP mild or max ramping)
  - b. Max rate of fire set to 3-5, depending on Pact Timer readings
  - c. Debounce 5-20
  - d. Ramp start 8 or higher
  - e. Loader delay 1-4 for Halo, 4-10 for gravity feed
4. NXL
  - a. Fire mode 7 (NXL full-automatic).
  - b. Max rate of fire set to 3-5, depending on Pact Timer readings
  - c. Debounce 5-20
  - d. Loader delay 1-4 for Halo, 4-10 for gravity feed
5. Ludicrous Speed (absolute fastest/bounciest)
  - a. Any fire mode
  - b. Max rate of fire set to 26 (unlimited)
  - c. Debounce 1
  - d. AMB 1 if using semi-automatic
  - e. CPF 1
  - f. Ramp start 4 if using any ramping modes
  - g. Loader delay

### Warranty

Limited lifetime warranty against manufacturing defects for the original owner. Warranty claims must be accompanied by dated receipt of purchase. Problems caused by shipping damage, user modifications, misuse, or neglect are not covered.

### Additional Information

[www.tadaotechnologies.com](http://www.tadaotechnologies.com)