



Musashi 5 AKA Board Instructions

Features

- Combination board – works in both the Viking and Excalibur, with Humphrey or MAC solenoids
- Based on the Musashi 5 software
- Includes 5 fire modes: uncapped semi-auto, adjustable semi-auto, PSP ramping, PSP burst, and NXL full-automatic
- Continuously monitors the trigger switch through the entire firing cycle
- Adjustable ABS programming prevents first shot drop-off
- AMB (anti-mechanical bounce) and CPF (cycle percentage filter) algorithms help to eliminate mechanical and switch bounce
- Power efficient software lengthens battery life
- Programming mode allows changes to debounce, dwell, loader delay, Viking bolt delay, cycle percentage filter, ramp start, board mode, Excalibur solenoid delay, Excalibur watch delay, Excalibur bolt close delay, and Excalibur eyes off rate of fire
- 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
- Three eye modes: delayed, forced with force shot, and test with LED rate of fire indicator
- Low battery indicator software

Installation

Installation of the M5 AKA board is relatively easy, but care must be taken so as not to pinch or damage the wiring.

1. Remove the front and rear grip frame screws with a 1/8" Allen (hex) wrench.
2. Gently pull the grip frame away from the body, being careful not to jerk any wires.
3. Unscrew the two nylon mounting screws that hold the stock board in place and gently lift the board out of the grip frame.
4. Remove one plug at a time from the stock board and transfer it to the matching socket on the M5 AKA board. Every socket is labeled on the M5 AKA board, but it is easier if you transfer each plug over, one at a time. One edge socket (labeled "sol 2") is unused if installing in a Viking.
5. Carefully place the M5 AKA board into the grip frame, making sure that all the wires are tucked out of the way and do not get pinched.
6. Secure the M5 AKA board using the two nylon screws.
7. Test to make sure everything works by turning the marker on.
8. Carefully put the grip frame back onto the main body of the Viking or Excalibur. As you do this, make sure none of the eye or solenoid wires are pinched between the body halves. The wires must be contained within the body cavity where they will not be damaged.
9. Secure the grip frame to the marker body, using the front and rear frame screws.

LED Indicator

The multi-color LED that shines out the data port shows which mode of operation the marker is currently in:

Rapid Blinking Red	At startup this indicates an exhausted battery
Rapid Blinking Yellow	At startup this indicates a low battery
Rapid Blinking Green	At startup this indicates a good battery
Solid Blue	Ball in breech, ready to fire
Slow Blinking Blue	Breech empty (marker will still fire if in Excalibur mode)
Slow Blinking Yellow	Eye malfunction; clean eyes or make sure the gun is being fired with paint and air
Slow Blinking Red	Eyes disabled
	If using a Viking, the rate of fire is limited to 20 balls per second in fire mode 1; otherwise capped at fire mode max rate of fire for fire modes 2 – 5
	If using an Excalibur, the rate of fire is limited to the Excalibur eyes off rate of fire setting.

Power Operation

Sliding the power switch to the "on" position turns the marker on. The battery indicator will show the current power level of your battery with a flickering red, yellow, or green LED. It will then show a solid or blinking blue LED, depending on the presence of an object in the breech. Every time the marker is turned on, the eyes are enabled.

Eye Operation & Logic

The eyes are enabled when the marker is first turned on. The eyes can be toggled on and off by holding down the trigger for 3 seconds.

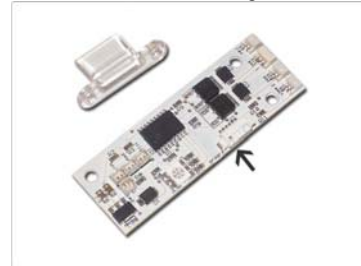
If used, the eye system cycles the marker as fast as possible. During each shot the eyes watch for the bolt to return, ending the current firing cycle and starting another as quickly as the pneumatics allow. If the eye system is continually blocked (e.g. putting your finger in front of the eyes) and is unable to see the bolt return after every shot, the max rate of fire will be reduced to about 12 balls per second to prevent further chopping, and the LED will slowly blink yellow to indicate an eye malfunction. The only way to show the true speed of the M5 AKA board is to fire the marker with paint and air.

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

Programming

The tournament lock must be disabled in order to change settings on the board. By default the tournament lock is disabled. To toggle the tournament lock:

1. Turn the marker off.
2. Ground the left two pins of the programming connector together with a conductive object (see arrow in picture below).
3. Turn the marker on.
4. The LED will continuously flash red or green to indicate the status of the tournament lock (red is lock ON, green is lock OFF).



To change settings you must enter programming mode. While the marker and the tournament lock are off, pull and hold the trigger and turn the marker on. This will initiate the programming mode, showing a rainbow sequence, and then stop on solid green. Pulling and releasing the trigger quickly will toggle between the different programming modes:

Green	Debounce
Purple	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	Viking bolt delay
Flickering Yellow	CPF (cycle percentage filter)
Flickering Blue	Ramp start
Flickering Red	Board mode
Flickering White	Excalibur solenoid delay
Flickering Teal	Excalibur watch delay
Alt Green/Blue	Excalibur bolt close delay
Alt Red/Blue	Excalibur eyes off rate of fire

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 20, you should:

1. Make sure the marker is powered off and the tournament lock is disabled.
2. Pull the trigger and turn on the marker.
3. The LED goes through a rainbow sequence then shows green. This is the debounce mode.
4. Quickly pull and release the trigger 1 time to switch to the dwell mode. The LED will show purple.
5. Pull and HOLD the trigger until the LED turns off.
6. Release the trigger. The LED will blink out the current setting.
7. When the LED stops blinking, enter the new setting by pulling the trigger 20 times.
8. Wait until the LED turns back on, indicating programming has been completed.
9. Turn the marker off.

Program Reset

A program reset can be used to default all settings by holding down the trigger for 10 seconds while in programming mode. The LED will cycle through all the colors to indicate the reset has completed. Beware this will also default the board mode to Viking if you happen to be using an Excalibur.

Settings

Debounce – The M5 AKA 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 ½ 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).

Dwell – The amount of time the solenoid is energized each time the marker is fired. The default is 10 ms. The range is 1 to 30 ms. Too low of a dwell may lead to inconsistency or drop off, or may not even fire the marker. Too high of a dwell can cause bad air efficiency. Recommended values:

Marker	Humphrey Solenoid	MAC Solenoid
Viking	10 ms	17 ms
Excalibur	6 ms	10 ms

Loader Delay – Adds a slight delay after the eye has seen a ball and the bolt is closed. 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 – 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,” firing even after the trigger has been released. 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 capped).

ABS dwell – Amount of dwell time added for an ABS (anti-bolt stick) shot. The range is from 1 to 10 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 five different fire modes (default is 1):

1. Semi-automatic, unlimited rate of fire
2. Semi-automatic, adjustable rate of fire
3. PSP ramping, adjustable rate of fire
4. PSP burst, adjustable rate of fire
5. NXL full-automatic, adjustable rate of fire

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 a capped rate of fire. It limits the maximum balls per second that can be fired. The cap is set by the Max ROF setting.

Setting 3 is the first PSP fire mode that works as follows:

- The first 3 shots of a string are semi-automatic.
- After the 4th shot the marker will add shots as long as the user fires faster than the ramp start setting. For example, if the ramp start setting

is 5, the user must pull 5 times per second or faster for the software to add additional shots.

- If the trigger is released, the marker will stop firing immediately.
- If the trigger is not pulled again within 1 second of release, the 3-shot semi-automatic count starts over.

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

- The first 3 shots of a string are semi-automatic.
- After the 4th shot the marker will fire 2 or more shots per pull as long as the user continually pulls and releases the trigger.
- If the trigger is released, the marker will stop firing immediately.
- If the trigger is not pulled again within 1 second of release, the 3-shot semi-automatic count starts over.

In normal operation, continually pulling the trigger faster than 5 to 6 pulls per second will effectively give the user full-automatic at the max rate of fire. If the user stops shooting then resumes within 1 second, the marker will return to the max rate of fire. If the user stops shooting for more than 1 second, the next 3 shots will be semi-automatic. On the 4th shot it will resume a faster fire rate.

PSP ramping and PSP burst differ in that PSP ramping requires the user to maintain the ramp start rate of fire for software assistance, whereas the PSP burst mode will fire at least 2 shots per pull, regardless of rate of fire. Some players prefer multiple shots every time they pull the trigger after the initial 3 semi-automatic shots, while others like to shoot 1 ball at a time until they achieve a certain rate of fire.

Setting 5 is the NXL full-automatic fire mode. It functions similarly to the PSP fire modes except, after the 3rd semi-automatic shot, the user may pull and hold the trigger for the marker to fire in full-automatic.

Fire mode max rate of fire – The max rate of fire setting applies to the 2nd – 12th fire modes. The max rate of fire is adjustable from 10 to 25 balls per second, and has an unlimited setting for maxing out the loader system. The default is 7, which is roughly 13 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
1	10.0	12	15.5
2	10.5	13	16.0
3	11.0	14	17.0
4	11.5	15	18.0
5	12.0	16	19.0
6	12.5	17	20.0
7 (default)	13.0	18	21.0
8	13.5	19	22.0
9	14.0	20	23.0
10	14.5	21	24.0
11	15.0	22	Unlimited eyes on, 25.0 bps eyes off

Eye mode – Three eye modes are available:

1. Delayed – The marker fires ½ second after every trigger pull regardless of a ball being in the breech. This is useful for sound activated loaders because it makes sure 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 ½ second, thus initiating a force shot. This is the default eye mode.
3. Test – This mode is specifically for seeing how fast the user can fire the marker. The eyes work in such a way as to prevent firing if they are blocked. This mode is only for dry firing. The LED is used to show the fastest achieved rate of fire:

Red	Less than 10 bps
Yellow	Between 10 and 15 bps
Green	Between 15 and 20 bps
Blue	Between 20 and 25 bps
Purple	Between 25 and 30 bps
Teal	Between 30 and 35 bps
White	35 bps or greater

As long as the user continues to fire, the fastest achieved rate of fire will continue to be displayed on the LED. If the user stops firing for 1 second, the LED will cycle back through the rate of fire colors. The rate of fire is determined by the user's average of 3 shots in a row. For example, you must fire 3 times in a row at 20+ bps to attain the blue level.

Viking bolt delay – If using a Viking this setting determines how long the eyes are ignored after the dwell time ends. Some delay is necessary to allow the bolt to move far enough forward so the eye system does not mistake a small gap between a paintball and the bolt face for a bolt return. The default is 10 ms and may be set from 1 to 25 ms. Higher settings will reduce the maximum capable rate of fire, while lower settings may lead to skipped or blank shots, because the bolt does not have enough time to block the eyes on its forward stroke.

Cycle percentage filter (CPF) – The cycle percentage filter allows adjustment of the point within the current firing cycle where 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 and defaulted at 2. 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 – The ramp start setting is only used for the PSP ramping fire mode (mode 3). 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 12 pulls per second.

Board mode – This setting allows the user to toggle between the Viking and Excalibur board modes. If using a Viking, this should be set to 1. If using an Excalibur, this should be set to 2. If the board mode is set incorrectly, the marker may malfunction or not work at all.

Excalibur Operation Settings

Before changing any Excalibur settings, it is necessary to know how the marker operates:

1. User pulls trigger. Ram solenoid is energized for the dwell time, releasing a burst of air.
2. Excalibur solenoid delay runs, giving the air enough time to expand and push the ball down the barrel.
3. Bolt solenoid is energized, causing the bolt to open.
4. If the eye system is enabled, the bolt stays open for the Excalibur watch delay unless a ball falls in, in which case the bolt closes automatically.
5. If not using the eye system, the bolt stays open for a set amount of time based on the Excalibur eyes off rate of fire setting.
6. The bolt closes and the next shot cannot start until the Excalibur bolt close delay ends. If the bolt close delay is set too low, it may be possible to fire the marker again before the bolt has closed completely, creating blowback, inconsistency, or drop-off.

Excalibur solenoid delay – The Excalibur uses two solenoids, one to control the valve and one to control the bolt. This setting times the delay between the valve opening and the bolt going back. The range is 1-25 in ½ ms increments. The default is 10 (5 ms). Too short of a delay will cause blowback up the feed neck.

Excalibur watch delay – If the eye system is enabled, this setting allows adjustment of how long the bolt will remain open after each shot, waiting for the next ball to fall into the breech. The range is 4-10, in increments of 20 ms. The default is 8 (160 ms).

Excalibur bolt close delay – This setting affects both eyes on and eyes off modes and sets the delay allowed for the bolt to close. If the bolt close delay is too short, the next shot may be initiated before the bolt has completely closed. This can cause inconsistent velocity, multiple paintballs loaded into the barrel, and other erratic operations. The range is from 1-35 ms. The default is 25. If your Excalibur seems to misfire while rapid firing, the bolt close delay may be too short.

Excalibur eyes off rate of fire – This setting allows independent adjustment of the eyes off rate of fire for the Excalibur. The range is from 5 to 20 balls per

second. The default is 10. If playing in the PSP, CFOA, or Millennium, this setting must be at 15 or lower to comply with the 15 bps cap.

Additional Features

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 air (no paint):

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, then 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-automatic unlimited or capped)
 - b. Debounce 5-20
 - c. AMB 2
 - d. CPF 2-5
 - e. Loader delay set to match your loader (1-4 for Halo, 4-10 for gravity feed)
2. PSP X-Ball, CFOA, Millennium
 - a. Fire mode 3 or 4 (Millennium requires mode 3)
 - b. Max rate of fire set to 3-5 (14.5 to 15.0 bps), depending on Pact Timer readings. To be safe use setting 3 (14.5 balls per second).
 - c. Excalibur eyes off rate of fire set to 14-15 balls per second or lower
 - d. Debounce 5-20
 - e. Ramp start 5 or higher if using PSP ramping
 - f. Ramp start 8 or higher if playing Millennium
 - g. Loader delay set to match your loader (1-4 for Halo, 4-10 for gravity feed)
3. NXL
 - a. Fire mode 5 (NXL full-automatic)
 - b. Max rate of fire set to 3-5, depending on Pact Timer readings. To be safe, use setting 3 (14.5 balls per second).
 - c. Excalibur eyes off rate of fire set to 14-15 balls per second or lower
 - d. Debounce 5-20
 - e. Loader delay set to match your loader (1-4 for Halo, 4-10 for gravity feed)
4. 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 PSP ramping
 - g. Loader delay 1

Additional Information
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