Mach3 Motion Devices and Probing Support

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This paper looks at the impact of Mach3 motion control devices on probing operations.

Probing is a real time sequence of operations and requires the support of the motion control device for Mach3.

In the early days of Mach3, the only motion device was the Mach parallel port driver. Mach implemented the actual probing (G31) sequences inside the parallel port driver and the results of the G31 probe movement are communicated from the driver into Mach.

Later, the "plug-in" interface into Mach was developed and this enabled additional motion controls devices to support Mach3.

The implicit behavior of the parallel port driver became the de-facto "gold standard" specification for the information provided to mach for each probing (G31) operation.

However, some Mach3 motion control devices either do not implement the G31 actions and/or did not report the G31 results correctly from the plug-in to Mach. When a plug-in (and thus the associated motion device) exhibit this type of problem, probing operations do not work correctly.

Calypso Ventures, Inc offers the MachStdMill (MSM) enhancement package for Mach3 and one popular feature of the package is the extensive probing support. The MachStdMill package uses G31 to implement all of the MSM probing features. Thus we find ourselves in a unique position to know when a motion control device does not correctly implement the Mach's G31 actions (as customers tend to want to blame the MSM software; when in fact the core problem is a deficiency in the motion control device).

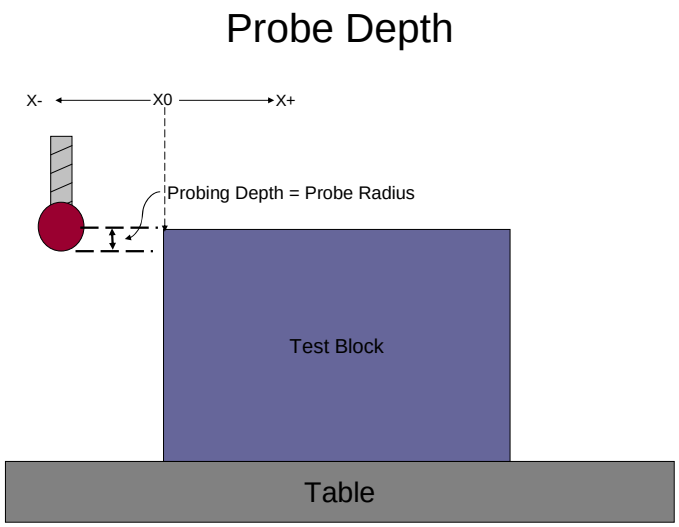
To help customers trouble shoot this type of problem, we have written this paper which includes simple steps that can be used to test G31 operation with any mach motion control devices. All of the procedures here use only the G31 gcode command and can be executed with only Mach3 (i.e. MSM is neither required nor used, and does not even need to be installed, therefore any failures are not likely to be attributable to MSM…).

Test set up

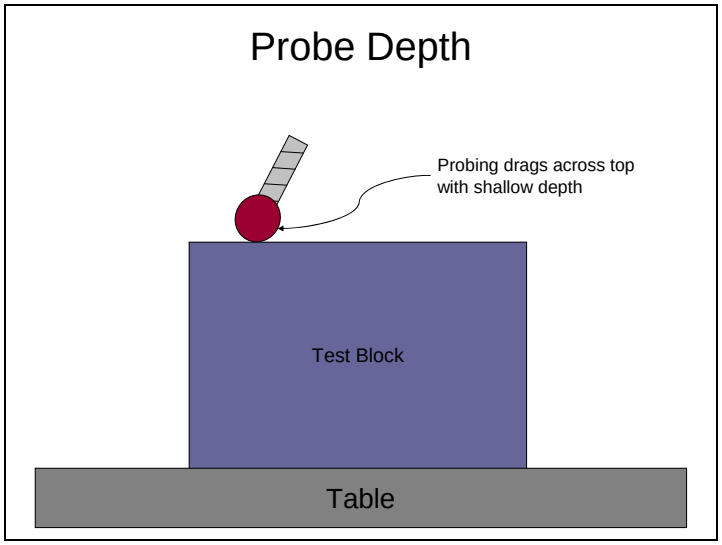
For these tests, we will assume a 3 axis vertical mill and you will need to set up a fixed block on the table. Any handy rectangular block will do. We will be doing the tests with the X axis. See the following figure.

Move the probe to so that the center of the tip is over the edge of the block along X, and set X0 to this location. Just get close by eye and set X0, we are not interested in high precision here, just that X0 is reasonably close to the edge of the block along the X axis.

Now move the probe in the X- direction and lower the Z height of the probe so that the bottom of the probe tip is about 1 probe radius below the top of the test block. Set Z0 to this level as shown:



The intention is that we want the probe to trigger when encountering the block, but if something goes wring and the probe does not trigger we want the probe to just drag across the top of the test block without breaking the probe.



We now know that X0 is about the edge of the block and Z0 is the depth that will let us test X direction G31 motions with out breaking our probe.

The following tests use imperial units (metric users can convert the values).

Test 1: Hardware interface test

Verify that the probe is hooked up and working at the electrical level.
Check the Probe LED on the screen – it should be off when the probe is not touching anything.
Deflect the probe tip by hand – the probe LED on the screen should light when the probe is deflected from the rest position. It should go back out, when the probe shaft is released.

If this does not happen, stop and figure out why the probe is not working. Until this basic functionality is verified, do not attempt any of the subsequent tests.

Test 2: G31 G90
The first test verifies the operation of G31 in G90 mode.

Using the MDI input, execute the following commands:

F25 G01	we will use a feed rate of 25 IPM
G90	
Z.5	to get above the block by a safe margin
X-1	to get to the left of the block edge

Ok we are in G90 mode, with a feed rate of 25IPM, let's see if we can find the block face…

Z0	lower to probe depth
G31 X1	this will move in X+ until either we trigger the probe (at about X0) or we get to X1 (1 inch past the block face).

Did the probe stop at the block face?
If not, something is wrong.
What did it do? Go to X1? If we stopped at X1, then the probe never triggered – that shouldn't have happened if Test 1 was good.

Test 3: G31 G91 G90
OK, assuming we are stopped on the block face from a successful test 1, let back off the block

X-1	get back to same start point as for test 2
G91 G31 X2	test G31 in G91 mode. The stopping point for no trigger will again be X1 (X-1 + 2 = X1)

Did the probe stop at X0 as expected?
If not, where did it stop?
Some controls implement probing correctly in G90 but mess up in G91 mode.

Test 4: G31 to current location
Ok, let get back to our test start point

G90	back to abs coordinate mode
X-1	back to 1 inch off the block

G31 X-1	this should cause no movement and the probe should not trigger

Are we still at X-1 ?
Some controls mess up handling this degenerate case and fail.

Test 5: G31 G91 to current location
Ok, let get back to our test start point

G90	back to abs coordinate mode
X-1	back to 1 inch off the block
G91	
G31 X0	this should cause no movement and the probe should not trigger

Are we still at X-1 ?
Some controls mess up handling this degenerate case and fail.

Additional tests:
OK if all the tests above pass, then the control may implement Mach's probing OK.
If you want you can re do these tests for the Y axis.

You can also run similar tests for Z… but first position the probe to the X- side of the vertical face of the block, and adjust the probe targets to be smaller than 1 inch (E.g. perhaps only a probe radius below the Upper Z level as most probes can take that much compression in Z without breaking any thing).

Usually I test X and if X works, then Y and Z usually do also.

If you really want to test a motion control device and you have rotary axes, you can also do similar tests for A, B & C.

If all the simple G31 tests pass, you can the move on to try the MSM probing operations. Read section 8 of the MSM user manual first – and pay particular attention to section 8.11 re getting started with probing.

If the simple G31 test gave problems, mach and your motion control device are not working correctly. You will need to figure out why (the most likely problem is the motion control board) before trying the more complex MSM probing operations. MSM uses G31 internally to do all it's probing – so if mach and G31 are not working, there is no hope that MSM probing will work.

Comments about some controls and mach3 plug-ins:
As of the date of this paper, here are what CVI knows or has been told by users about some Mach motion control devices:

Company: Artsoft USA

Device: **Mach3's Parallel port driver**

Status: No known probing problems.
This is the "gold Standard" for Mach; This defines the behavior expected from other motion control devices.

Company: Warp9 Tech Design Inc.

Device: **Smooth Stepper (Ethernet or USB)**

Status: no known problems with current firmware
(early firmware had bugs that have been fixed).

Company: Ajax CNC

Devices: **Ajax controls for mach3**

Status: Probing in mach does not work. Ajax has been contacted and informed of the technical issue involved. They have acknowledged that they did not follow the mach conventions and they have said they did so intentionally, and that they have no intention of fixing this in their mach plug-in.

Conclusion: Ajax controls will never work correctly with mach for probing operations.

Company: Galil

Devices: Those models supported by the **Mach3 with Galil Plug-in** available from Artsoft.

Status: Depends on the revision of the plug-in being used.
G31 G91 mode – this mode did not work in the galil plug-in but has been fixed in recent revisions.
G31 current position causes a failure in the galil plug-in. (maybe fixed recently, check with the plug-in authors).

The most recent versions of the Galil plug-in do not seem to be posted on the Machsupport site. If you are interested in Galil controls, contact CVI and we'll put you ion contact with the Galil plug-in author

Company: Various Chinese venders

Devices: **USB Breakout Board (leafboy77)**

Status: MSM users have reported many problems with these boards when attempting to do probing. The same mach/MSM combinations that work correctly on PP and Smooth Stepper boards, fails with these boards.

Company: CS-Labs

Devices: **CSMIO/IP-6 Ethernet motion controllers**

Other devices from CS-Labs: Other devices have not been tested first hand. Since they all appear to use a common plug-in, we would expect the other motion control product to have the same bugs.

Status: These controller **almost** works correctly. Unfortunately the two bugs exhibited by these controllers are show stoppers for MSM.

Known Bug #1: A bug in the CSMIO plug-in breaks mach's scritp preprocessing handling of #expand. The result is that no script that uses #expand can run on this controller. The bug was not present in plug-in 1.350 but is present in all later plug-ins at as of Aprl-5-2013). Since essentially all MSM scripts use the mach #expand feature, essentially all MSM scripts are broken by this control.

Known Bug #2: The controller will not execute gcode correctly during an M6 sequence; the controller throws a "ePID fault" and goes into estop. This does not happen for M6 executed from MDI. For MSM this means that the controller fault when attempting to for a probe sequence to measure a tool during a tool change (M6).

Conclusion: If you can stick to plug-in 1.350 (Bug #!) and you don't need MSM's ATLO features (Bug #2), it has been verified that all other MSM probing operations work fine on this control.

Both technical problem have been reported in detail (including test cases for the bugs) to CS-Labs. To date they have not fixed the problems and they have indicated to CVI and an MSM customer that they are not very interested in fixing the bugs.