PROBE-IT!

by: Crafty CNC

A Probing, Reverse Engineering, and CMM Wizard for Mach 3

Contents

1. Introduction

Thanks for your interest in Probe-It!, a wizard add-on for the popular Mach3 CNC control software. I began writing Probe-It! to be able to provide functionality in Mach3 I didn't see provided by any other options, even after much searching in forums and on the web...

Probe-It! provides some of the same general functionality as found in other existing probing macros and wizards such as:
- General/simple measurements
- Locating positions of corners, edges, and centers of bores
- Setting origins on pieces to be machined easily (edge finder functionality)

Probe-It! also provides some features useful for measuring and reverse engineering, such as:
- Ability to 'calibrate' the probe tip (calibration accounts for errors in probe tip deflection, and backlash within reason)
- Ability to probe in any sort of vector in the X-Y plane, with result corrected by calibration data
- Automatic 2.5D perimeter tracing (not a bed of nails approach in 3D space, which doesn't provide an accurate 'outline' of 2D parts)
- Ability to record data direct to a DXF or CSV file for later analysis or usage in a CAD program
- Logic added to probing routines to detect a 'hit' or a 'miss'
- Ability to probe parts/features not square to the table (part rotation)
- Auto Z up/down as part of basic x-y probing routines

The goal of Probe-It is to provide a useful tool with functionality I couldn't find anywhere else. Probe-It! doesn't include other probing features already existing or available, for example the 3D 'bed of nails' approach which is in a Wizard shipped with Mach3, is not found in Probe-It!.

1.1.   Installation and Requirements

1.1.1. Requirements

1.1.1.1.   Mach3

You must be using a **later** version of Mach3 by Artsoft. I recommend and have done all testing using rev 3.43.66. The minimum required version is rev 3.43.19, due to macro calls only available after that release.

1.1.1.2.   Equipment

You must have a probe hooked up and configured in Mach3 to use ProbeIt. Your probe need not be very fancy, it just needs to trigger the 'digitize' input within Mach3.

It should also be noted that probing using Mach3 with a motion controller may have different results than using Mach3 and the parallel port driver. This is because the probe events happen within the motion controllers control and firmware, and how they behave and report back to Mach3 is not 100% consistent as I have found.

The following devices have been noted to work:
- The parallel port driver driven by Mach3– 100% compatible, no known issues.
- The SmoothStepper – Should be 100% compatible after version 1.1.1 of ProbeIt. Note: It has been noted that users with a USB SmoothStepper could see their machine automatically home if a condition occurred when a G31 event was commanded while the probe was pre-triggered against a part. This is an issue internal to the SS. ProbeIt has been updated to look for this condition, pop-up a warning, and abort the move without causing a homing event.
- The CSLabs CSMIO – Should be 100% compatible after version 1.0.2 of ProbeIt. Note: It was noted that the CSMIO did not report data back to Mach3 after a G31 probe event 'miss' the same way that the SS and parallel port driver do. ProbeIt was modified to work around the issue by getting position data from the X/Y/Z position DROs instead of the internal probing variables when the probe misses.

Please note that use of any other motion control device is untested and may or may not work correctly! Test at your own risk.

1.1.2. Installing

Probe-It! is provided as a .ZIP archive. The extracted *ProbeIt* folder (and all its contents) should be dropped into the ->Mach3->Addons directory. Restart Mach3 (if it was open), and go to the 'wizards' menu and select 'pick wizard'. You will find ProbeIt listed for use:
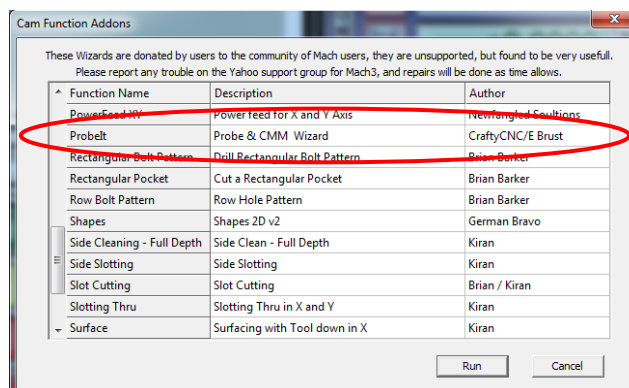
1.1.3. Demo Limitations & License File

Probe-It! initially installs in a *DemoMode* to allow you to try its functionality and use it for limited amounts of data collection. Limitations in Demo Mode are as follows:

- Probe Calibration can be used for 8 probe events and then it will turn off
- CSV and DXF recording will be limited to 8 probe events in the BasicXY probing and then will turn off
- CSV and DXF recording on the Perimeter Probing routine will be limited to 50 points maximum and the routine will stop and save your data.
- Other than the limit of data collection, the full functionality is available for you to use/test! The routines are not crippled in any way beyond number of points recorded.

By closing and reopening Probe-It! wizard, the demo mode will reset and you can use it again for the same limited time. Or you can use the basic functionality as much as you like in DemoMode, the wizard will not quit working or time out. If this works for your needs, you don't need to purchase a license to keep using the wizard.

If you plan to use ProbeIt for significant reverse engineering or a business use, purchase of a license file will remove all limitations, and you will be able to record as many points to a CSV or DXF file as you wish.

1.1.4. License File

If you purchase a License file, simply place the file you receive via email or download into the ProbeIt directory, reopen Mach3, and open the Probe-It! wizard. The intro page should now show a status of 'Licensed', and all restrictions are removed.

1.2.   Warning, Legal disclaimers and all that good stuff....

I have attempted to make Probe-It! as fool proof as I can with regards to the probing routines. However Probe-It ties in to operate your CNC machine via Mach3 and its settings. The setup of Mach3 (and of the probe input signal into Mach3) is the responsibility of you, the user to setup. You the user assume full responsibility for checking and testing all signals, the setup of your CNC machine/XML file, and also for familiarizing yourself with the probing routines and usage of Probe-It!. I recommend probing at items that are not clamped to the table as you learn and test, so if something goes wrong, you are less likely to destroy your probe.

Probe-It! is a tool, it takes instructions from you the user (via DRO inputs and button clicks) and then provides commands to Mach3 via macros to move/probe, and then collects and saves the data to file. If the user positions the probe incorrectly, or issues a G0 command that plows the probe through the part, that is on the user and Probe-It! will

not prevent this. If you issue a mistaken command, remember to use the EStop, feedhold, or even hitting 'ESC' key will usually cancel an in process probing event.

A final reminder, machining is dangerous. Even though Probe-It! is just a 'probing' utility and won't be used during a machining process, it is important the user operates the machine in a safe manner and with as much care as if machining! Never place your hands in the working envelope of the machine while probing. Always turn off or disconnect the spindle motor power source when a touch probe is mounted. Do not probe at excessive federates. And always use common sense and be safe. By using Probe-It!, you agree to accept all liability for damage or harm that could be caused during use of this software, both to you and your equipment. If you disagree, please do not use this software.

2. Menu Pages

As of version 1.1.3, there are dedicated 'menu' pages to select which probing screen you want to use.

You may either use the main 'probing menu' button on the bottom,
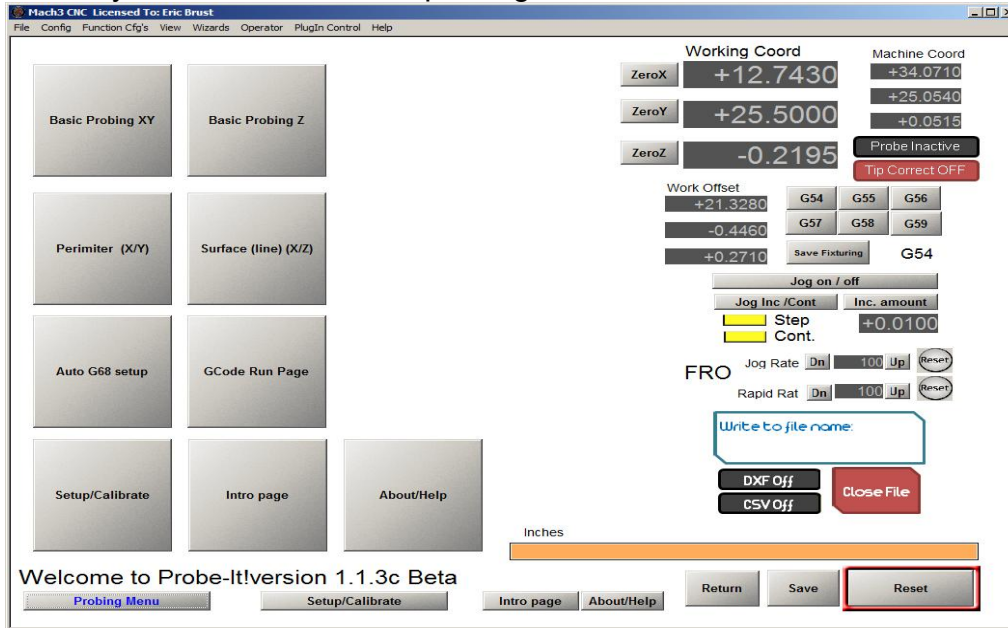
or hitting the TAB key will bring up a fly-out menu on the right side of the screen.

3. General info about Probing routines and saving data

Some general hints about using the wizard before you get to far in.

3.1. Aborting a probe event

If you need/want to abort a probing event, hitting the 'ESC' key will stop the running routine and stop movement. You should also be able to use feedhold or eSTOP, but 'ESC' works well without loss of position and homing, and aborts the running macro.

3.2. Feed rate control

Almost all moves made are G31 moves with feeds controlled by user inputs. There are some clearance moves (the jogs around corners, moves back to center of bore, etc) that are made as G01 rapid moves. If you have a fast machine and you would rather not see fast moves during probing, use the 'Rapid Rate FRO' control to slow the rapid move rate of your machine.
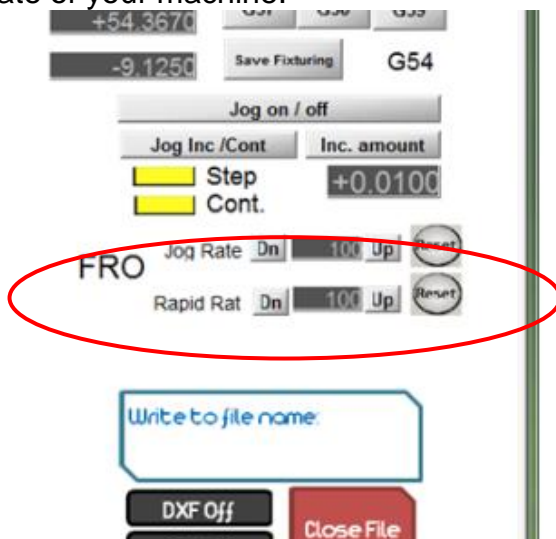
3.3. Positioning for a probe event

Positioning before probing is done manually by jogging. Locating the probe tip isn't very critical, just make sure that the tip is closer to the part than the 'max probe distance' value entered.

3.4. File Recording

When you open a file to record to, you can start and stop recording as needed. You can jump to the perimeter page, record some perimeter feature (hit 'ESC' to stop), jump over to the basic XY page and record a bore or edge feature, set a new z location, go back to the perimeter page and record another perimeter all to the same file. When all done, then hit 'CLOSE FILE' button to save it all.

4. Intro Page

The intro page contains no functional buttons or probe routines, and is meant to be a reminder to check your probe before proceeding with any probing on the following pages. It is the default page that appears when starting the wizard.

4.1.   Probe Test LED

The large LED in the center of the page will turn on when your probe is properly connected and setup, and you manually trigger the probe with your hand. Please verify the functionality and setup every-time you use the Wizard. There is an error in your setup if the LED does not turn on, or if it defaults to 'Probe Active' and turns off when you manually activate the probe.

4.2.   License status

The LED and a label in the lower left of the Intro Page will show the status of the Wizard.

If 'Demo Mode' is displayed, All features and functions of the Wizard are fully functional, with the following exceptions:
1) You will be limited to 8 probe points with the tip correction turned on.
2) You will be limited to 8 probe points recording to either DXF or CSV output files on the 'Basic Probing XY' page.
3) You will be limited to 25 probe points recording to either DXF or CSV output files on the 'Perimeter Probing' page.

When you have reached the maximum number of allowed points, you will still be able to probe, but recording to CSV and DXF are disable and tip correction is disabled until the wizard is closed and restarted.

If you have purchased a license file (thank you for your purchase and support!), copy it to your ProbeIt folder. You should now have 'Licensed' shown, and all limitations will be lifted.

5. Setup Page
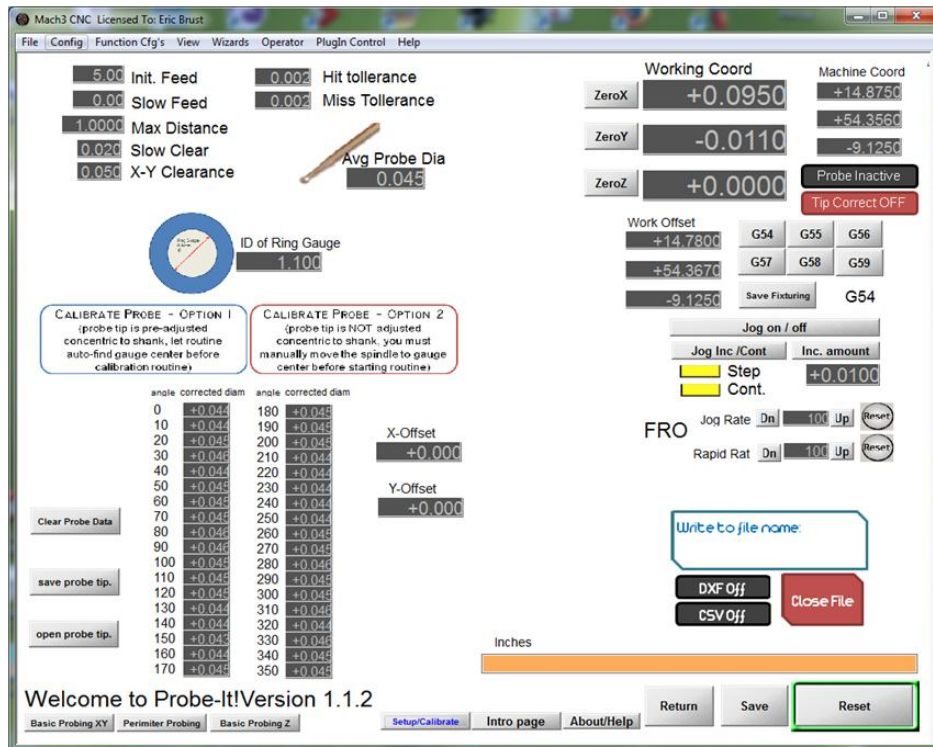
The Setup Page is primarily for the purpose of performing probe tip calibration and generating a table of 'corrected tip diameters' at various probing angles. The corrected values account for correcting the following errors while probing:

1) Probe tip trigger travel and deflection
2) Backlash and mechanical errors
3) Leadscrew inaccuracy (within the range where the calibration was performed)
4) Offset between the spindle and the probe tip for runout (if calibrated using Option 2)

NOTE: It should be noted that because the probe's contribution may not be identical in all directions, you should make an attempt to reinstall your touch probe in the same orientation every time (For example, install the probe so the lead always exits in the same direction.).

There are a few other settings that are found on this page as well.

5.1.   Probe Calibration Buttons and LED

5.1.1. Calibrate Probe

Calibration of the probe should be done

- initially at first setup,

- every time you install a new tip or spring in your probe,
- if you crash your probe
- if you make some other significant change to your Mach3 setup (such as backlash settings).

This is accomplished by using a master 'ring' gauge of known inner diameter. Enter the actual inner diameter of the gauge to be probed and enter the actual measured probe tip diameter in the "Avg Probe Dia" DRO.

NOTE: Calibration can improve accuracy, or accommodate a non-adjustable probe so that probe routines to find centers/edges/etc locate the spindle centerline to the feature instead of the probe tip. You are not required to run the calibration routine to do any of the probing routines, but you must have a value entered in to the 'Avg Probe Dia' DRO to be used as a default.

5.1.1.1. Calibrate Probe-Option 1

This routine REQUIRES the probe to have been mechanically adjusted so that the ball of the stylus is concentric with the shank/spindle it is inserted into. This routine will not correct for a probe that has runout/offset in the tip to the shank.

Move the probe tip to approximate center of the bore and hit "Calibrate Probe Option 1" button. The routine will first probe to find the approx center of the bore, and then probe around the ID at 10 degree increments to build up a table of 'tip corrections'. Tip corrections are made under the assumption that 1) the bore is exactly the diameter entered in the 'ring gauge' DRO, and the bore is perfectly round.

If the table started out empty, the routine will automatically run twice to further reduce the error as it will find the center using the prior correction table for the second run. After the routine runs, the table will contain 36 corrected tip diameter values, and the 'Avg Probe Dia' value will be adjusted from the originally entered value to be the mean value of the 36 corrected values.

Note: The X and Y offset are not used and should both be '0.000' after calibrating with this method

5.1.1.2.   Calibrate Probe-Option 2

This routine REQIRES the user to manually locate the center of the ring gauge to the spindle. Methods that could be used include using a dial test indicator, a co-axial indicator, or touching sides with a pin of known diameter and working out were the center is. Benefits of this method are that the correction table will account for minor runout/offset in the probe tip.

After locating the center of the ring gauge with the spindle and installing the probe, hit "Calibrate Probe Option 2" button. The routine will probe around the ID at 10 degree increments to build up a table of 'tip corrections' as well as an X and Y offset. Tip corrections/offsets are made under the assumption that 1) the bore is exactly the diameter entered in the 'ring gauge' DRO, and the bore is perfectly round.

After the routine runs, the table will contain 36 corrected tip diameter values, and the 'Avg Probe Dia' value will be adjusted from the originally entered value to be the mean value of the 36 corrected values.

5.1.2. Clear Probe Data
Pressing the 'Clear Probe Data' sets the calibration table to all zeros. This is useful for if you have just made a change and will be recalibrating from scratch.

5.1.3. Save Probe Tip
Following calibration, pressing this button will prompt for a file name to save the tip data into. This is useful if you have a couple of different tips or touch probes you alternate between, and allows you to reload the saved calibration data.

5.1.4. Open Probe Tip

Pressing this button will prompt for a file name of saved tip data to open. You will have to manually type in the filename you had previously saved (there is no file browsing , sorry). After hitting enter on the filename dialog, the saved values will be populated into the 36 calibration DROs as well as the 'Avg Probe Dia" DRO.

5.1.1. Probe Correction LED

Probe inactive
Tip Correct OFF → Tip Correct ON
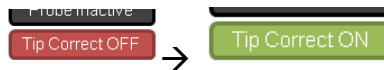
Pressing this LED will enable or disable tip correction based on the correction table. It is recommended to leave it on once you have run tip calibration and the table is populated with proper correct values. The LED should not be on if the tip table is out of date or incorrect (i.e., you just swapped a tip but did not recalibrate). If the Probe correction is turned off, the 'AVG Probe Diameter' DRO value is used for all probe events.

When you initiate calibrating the tip, if the Tip Correction is on, it will turn off until the calibration routine runs and completes.

5.2.   Settings DROs

5.00	Init. Feed	0.002	Hit tollerance
0.00	Slow Feed	0.002	Miss Tollerance
1.0000	Max Distance		
0.020	Slow Clear		Avg Probe Dia
0.050	X-Y Clearance		0.045
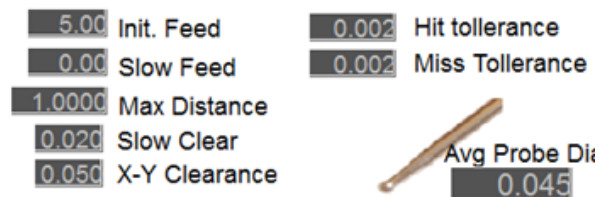
5.2.1. Init. Feed

This is the initial feed rate in native units (in/minute if working in inches, mm/min if working in mm) that the probe travels at during probe operation. This setting appears on all other pages, but is found here for convenience of setting during the calibration procedure. Recommended value: Start slow and increase within your comfort and accuracy level.

5.2.2. Slow Feed

This is the secondary feed rate in native units (in/minute if working in inches, mm/min if working in mm) that the probe travels at during a slow probe operation. The probe travels at initial feed, then backs off and re-probes at this slower feed value. Leaving 'slow feed' set to 0 results in no secondary slow probe event. Recommended value: 1-5 in/minute (25-125 mm/min)

5.2.3. Slow Clear

This is the distance, in native units (in or mm) that the probe will back away from the surface before probing at the slow feed rate. If slow feedrate is 0, slow clear is ignored.

5.2.4. Max Distance

The *max distance* parameter is the distance in native units (inch or mm) that the probe will travel towards the surface. This value is used along with the *hit tolerance* value to determine if the surface was hit or missed.

5.2.5. X-Y Clearance

The *X-Y clearance* *value is the distance in native units that the probe will back away from the touched surface before moving in a clearance move (such as moving around the corner or along the edge of a side.).*

5.2.6. Hit Tolerance

The *hit tolerance* value is used in the probing routines to determine if the probe made contact with an object or if it missed, specifically on probing moves where the expected result is to hit an object. If the probe travels the full 'max probe distance' minus the *hit tolerance* value, it assumes that an object was 'missed' on a probing move, which is an error. Recommended value: .001-.005" (.02-.12mm)

5.2.7. Miss Tolerance

The *miss tolerance* value is used in the probing routines to determine if the probe made contact with an object or if it missed, specifically on probing moves where the expected result is to miss an object (i.e., a clearance move). If the probe travels less than the full 'max probe distance' minus the *miss tolerance* value, it assumes that an object was 'hit' on a clearance move, which is an error. .001-.005" (.02-.12mm)

Note: Hit tolerance and Miss tolerance have similar roles, but were left as separate inputs. In most cases, entering the same value in both inputs will work fine.

6. Perimeter Probing Page
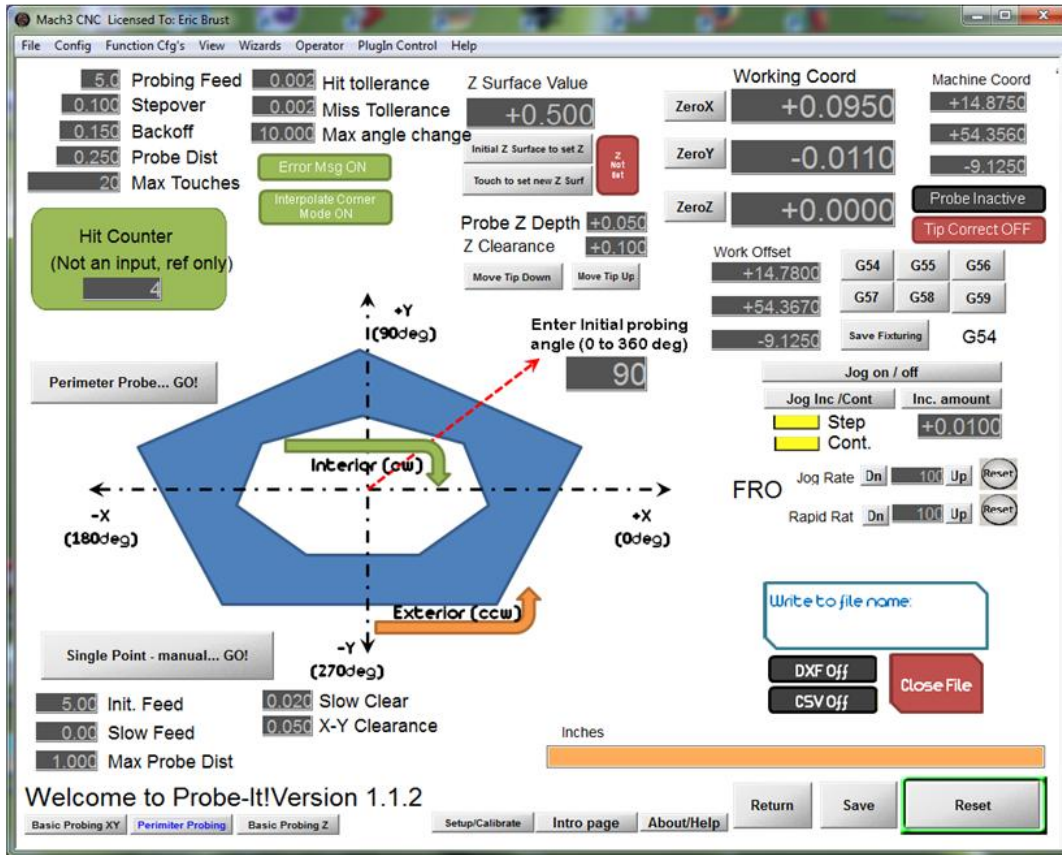
The Perimeter Probing Page runs a probing routine that automatically follows the exterior shape of an object and records the touched points, connected by lines, direct to a DXF file, or provides tabular X,Y,Z data in a CSV file. The perimeter probing routine attempts to always probe perpendicularly to the surface of the object, and continually adjusts probing angles to attempt to do so. By probing 'square' to the surface and using the lookup table of probe tip corrections from the setup page, the perimeter can be accurately reproduced.

The routine will work on both external an internal perimeters. It should be noted the routine always works in the same general 'direction', so when probing external shapes, it will travel around the part in a counter clockwise fashion. When working on an interior pocket, it will travel around the part in a clockwise fashion. The diagram on the page is meant to be a reminder of this.

6.1. Buttons

6.1.1. Perimeter Probe -> GO!

This button starts the routine. To perform perimeter probing, enter required values in the settings DROs and set option LEDs, move the probe tip to approximate starting

location near the perimeter of the object (at proper depth), and press the button. The routine will continue traveling around the perimeter of the item until max number of hits is reached, or the edge is lost in error.

The routine may be interrupted at anytime as necessary by pressing 'ESC' button.

You may reposition the probe tip and restart as necessary while recording to the same CSV or DXF file. The file will wind up with a 'break' in the curves recorded, which may be joined in a CAD program as part of post processing cleanup.

6.1.1. Single Point - Manual

This button performs a single probe event in a vector direction dependent on the 'initial probing angle' DRO. This is handy for collecting a few points around an object into a DXF or CSV file. It is also handy if you are probing a complex object that gives the perimeter routine difficulty in certain areas, you can go back after the fact and manually record a few points into your file before closing/saving it.


6.2.   Settings DROs

6.2.1. Initial Probing Angle

The **initial probing angle** value is the angle in degrees to define the initial probing vector direction, as related to the current tip position and the machines +X axis. This value allows you to start (or restart) the probing routine on any side of the object as necessary, or manually record a single point in that direction.

Imagine the vector of probe movement to be defined by a polar coordinate system, with the origin at the current probe position, and 0 degrees pointing towards +X, and positive 90 degrees pointing towards +Y.

Some examples to define the usage:
1. To probe in +X direction (if your probe is located on the 'left' side of object outer perimeter looking down at table), enter a value of 0.

2. To probe in +Y direction (if your probe is located on the 'bottom' side of object outer perimeter looking down at table), enter a value of 90

3. To probe in –X and -Y direction towards a face that is at approx 45 degrees (if your probe is located on the 'top right' side of object outer perimeter looking down at table), enter a value of 225.

4. To probe in +X and +Y direction towards a face that is at approx 45 degrees (if your probe is located on the 'bottom left' side of object inner perimeter looking down at table), enter a value of 45.

Probe starting position

Enter 0

Enter 225

Enter 45

Object

Enter 90
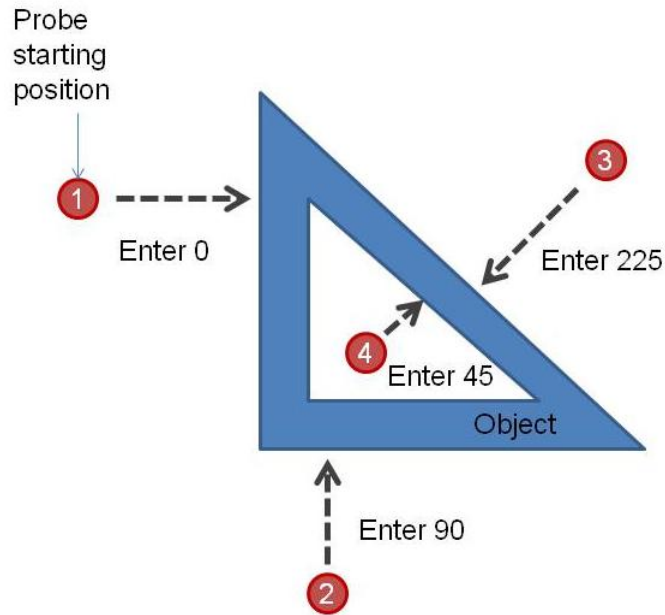
6.2.2. Probing Feed

This is the feedrate that the probing operations will be performed at. The perimeter routine only probes at a single federate, one touch per hit (i.e., no backoff and slow re-touch). You may adjust this value in the process of perimeter probing, without interrupting or pausing the process. This allows you to set a fast federate for non-complicated areas that don't require absolute precision. An you may also slow down the probing federate when approaching complicated corners and features, or if the desire is to improve the accuracy of recorded points (less overtravel in recorded values).

The value can be updated at any time while the perimeter probing routine is running.

Perimeter Probing Routine

Y

X

Probe Dist
(max amount of travel
– needs to be greater
than backoff and actual
distance from part)

Probe starting position

Stepover
(resolution or distance between points around perimeter)

Backoff
(how far to retract away from surface to move to next point)

Hit tollerance:
Used to compare Probe Dist value to actual distance moved in probe event to determine if a hit was made

Miss tollerance:
Used to compare Probe Dist value to actual distance moved in probe event to determine if a miss occured

Recommended starting values:
Stepover: .050"
Backoff: .070"
Probe Dist: .150"
Hit Tollerance: .002"
Miss Tollerance: .002"

6.2.3. Stepover

The **stepover** parameter is the distance in native units (inch or mm) that the probe points are separated by around the perimeter. Actual probe points will not be exactly at the stepover distance unless probing along a straight line. The Stepover translates into the number of points required to be sampled around the perimeter. A smaller stepover results in more samples and a finer resolution of surface measurement. This value cannot be adjusted without pausing the routine and restarting the measurement.

The value can NOT be updated at any time while the perimeter probing routine is running. If you want to update the stepover, you must stop the routine, and restart it with the new value entered.

6.2.4. Backoff

The **backoff** parameter is the distance in native units (inch or mm) that the probe backs away or clears from the surface to prepare for the next hit.

The value can NOT be updated at any time while the perimeter probing routine is running. If you want to update the backoff, you must stop the routine, and restart it with the new value entered.

6.2.5. Probe Distance

The **probe distance** parameter is the distance in native units (inch or mm) that the probe will travel from the backoff point towards the surface. This value is used along with the **hit tolerance** value to determine if the surface was hit or missed. The probe distance value should always be set to a value greater than the backoff value. As a suggestion, make the **probe distance** greater than **backoff** by an amount of 1-3 probe tip diameters as a suggested value.

The value can NOT be updated at any time while the perimeter probing routine is running. If you want to update the probe distance, you must stop the routine, and restart it with the new value entered.

6.2.6. Max Touches

The **max touches** parameter is the number of touches the perimeter probing routine will collect before it stops. This allows you to enter a large number of touches and walk away, as the routine will just continue around the perimeter till number of hits is reached. You can estimate the number to use for max touches by dividing approximate perimeter length of the object to be measured by the **stepover** value and adding ~20%. If you didn't enter a large enough number to make it around the part, you may just restart probing and recording to the same file where it left off as long as you don't close the file. Just update the initial probe direction for where you need to restart.

In **DEMO MODE**, the max touches parameter is automatically capped to 50 points. After that limit is reached, the routine will stop and save your file, and you will have to restart the wizard to run the routine again.

The value can NOT be updated at any time while the perimeter probing routine is running. If you want to update the stepover, you must stop the routine, and restart it with the new value entered.

6.2.7. Hit Tolerance

The **hit tolerance** value is used in the probing routines to determine if the probe made contact with an object or if it missed, specifically on probing moves where the expected result is to hit an object. If the probe travels the full 'max probe distance' minus the **hit tolerance** value, it assumes that an object was 'missed' on a probing move, which is an error. Recommended value: .001-.005" (.02-.12mm).

This DRO is repeated on this page for convenience of adjusting it without going to setup page.

The value can NOT be updated at any time while the perimeter probing routine is running. If you want to update the hit tollerance, you must stop the routine, and restart it with the new value entered.

6.2.8. Miss Tolerance

The ***miss tolerance*** value is used in the probing routines to determine if the probe made contact with an object or if it missed, specifically on probing moves where the expected result is to miss an object (i.e., a clearance move). If the probe travels less than the full 'max probe distance' minus the ***miss tolerance*** value, it assumes that an object was 'hit' on a clearance move, which is an error. .001-.005" (.02-.12mm).

This DRO is repeated on this page for convenience of adjusting it without going to setup page.

The value can NOT be updated at any time while the perimeter probing routine is running. If you want to update the miss tolerance, you must stop the routine, and restart it with the new value entered.
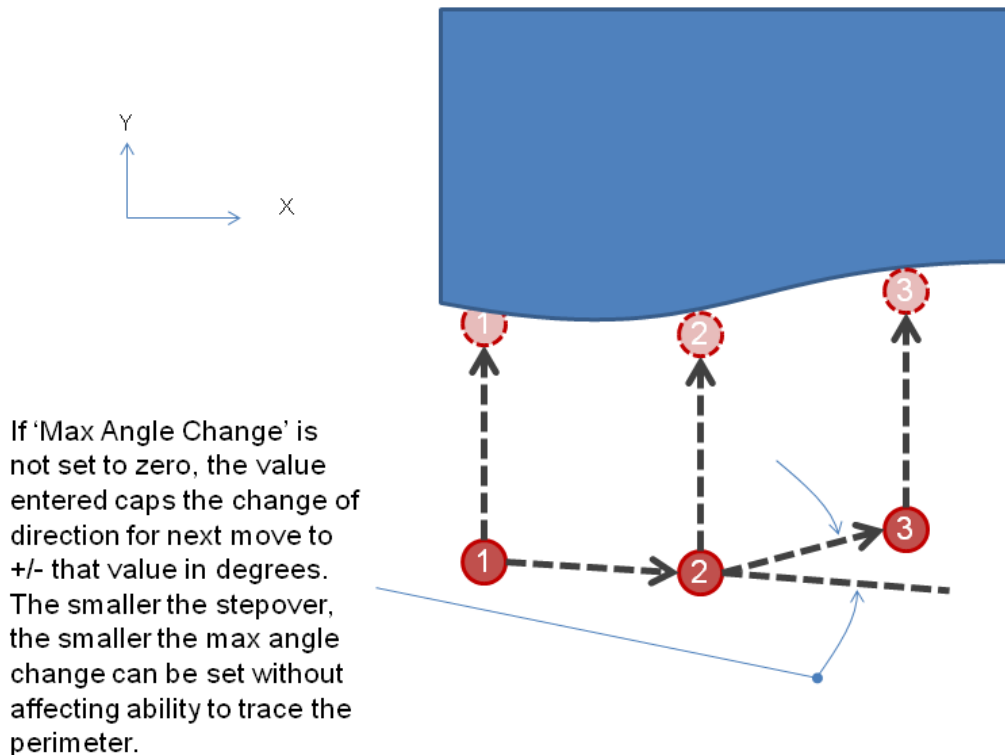
6.2.1. Max Angle Change

The ***max angle change*** value is new to version 1.1.2 and later. It is added to allow you to constrain how rapidly the perimeter routine may change directions. Setting this value to 0 disables this control. Setting a value of 10 makes it so that the routine cannot change direction by more than 10 degrees (either plus or minus).

The value can be updated at any time while the perimeter probing routine is running.

This may be useful if you set the stepover to a very small value. A small stepover can cause large changes in calculated angles to occur due to small errors or deviations in the surface, which leads to errors in recorded data.

Max Angle Change

If 'Max Angle Change' is not set to zero, the value entered caps the change of direction for next move to +/- that value in degrees. The smaller the stepover, the smaller the max angle change can be set without affecting ability to trace the perimeter.

6.3. Settings LEDs

6.3.1. Error Message ON/OFF

This button is used to toggle if error messages will be displayed or not. Error messages ON results in a pop-up message box that interrupts the probing process to notify user if

a) Probe missed target when it would be expected to have touched. Clicking OK causes the routine to change assumed direction and look for the part again as if rounding an exterior corner.
b) Probe hit something on a 'clearance' move. Clicking OK causes the routine to change assumed direction and work around the perimeter as if rounding an interior corner.
c) Probe routine has lost track of the surface. Routine will try to locate within a couple more moves, and then stop.

These messages may be useful to keep on while learning how the routine works, and this also provides a pause for the user to assess the probing routine. On an error, the routine pauses until the message box is clicked 'OK'. If turned off, the routine will just continue probing along without pause or notification.

This can be turned on or off in the middle of a running perimeter routine.

6.3.1. Interpolate Corner ON/OFF

This button is used to toggle if corners will have intersection points estimated and plotted into the DXF or CSV data. If left off, the DXF/CSV will only contain actual touch points, which may leave exterior and interior corners under defined. Turning this on will result in the insertion of an estimated corner point on abrupt corner changes (such as when the probing misses and changes direction around a corner) using the assumption that the corner is square (90 degrees). While not entirely correct in all instances, this will provide better representation in the DXF file that may be corrected with a CAD software in post processing the data.

This can be turned on or off in the middle of a running perimeter routine.

7. Surface (line) X/Z Probing Page

New in Version 1.1.3 is a preliminary (BETA) version of a routine which probes along a surface in the X/Z plane. Function, buttons, and inputs are all pretty much identical to the X/Y perimeter probing routines. Review section 6 above for inputs.

Some differences of note:
A primary difference in this routine is that there is a travel direction input, which is used to define if the routine travels in the +x (enter +1) or the –x (enter -1). Initial probing direction angle should also be entered in the range of 180 to 360 degrees. If you consider a coordinate system in the X/Z plane, 0 degrees represents + x, and 90 degrees represents +Z. The goal is to constrain probing in the 3rd and 4th quadrants of the X/Z coordinate system.

Note that DXF data recorded is in the X/Z plane. When you open a file in your CAD program, you will have to switch to a 'front' or 'back' view to see the profile, as a 'top' view will be looking at the data on edge.

8. Basic Probing XY Page
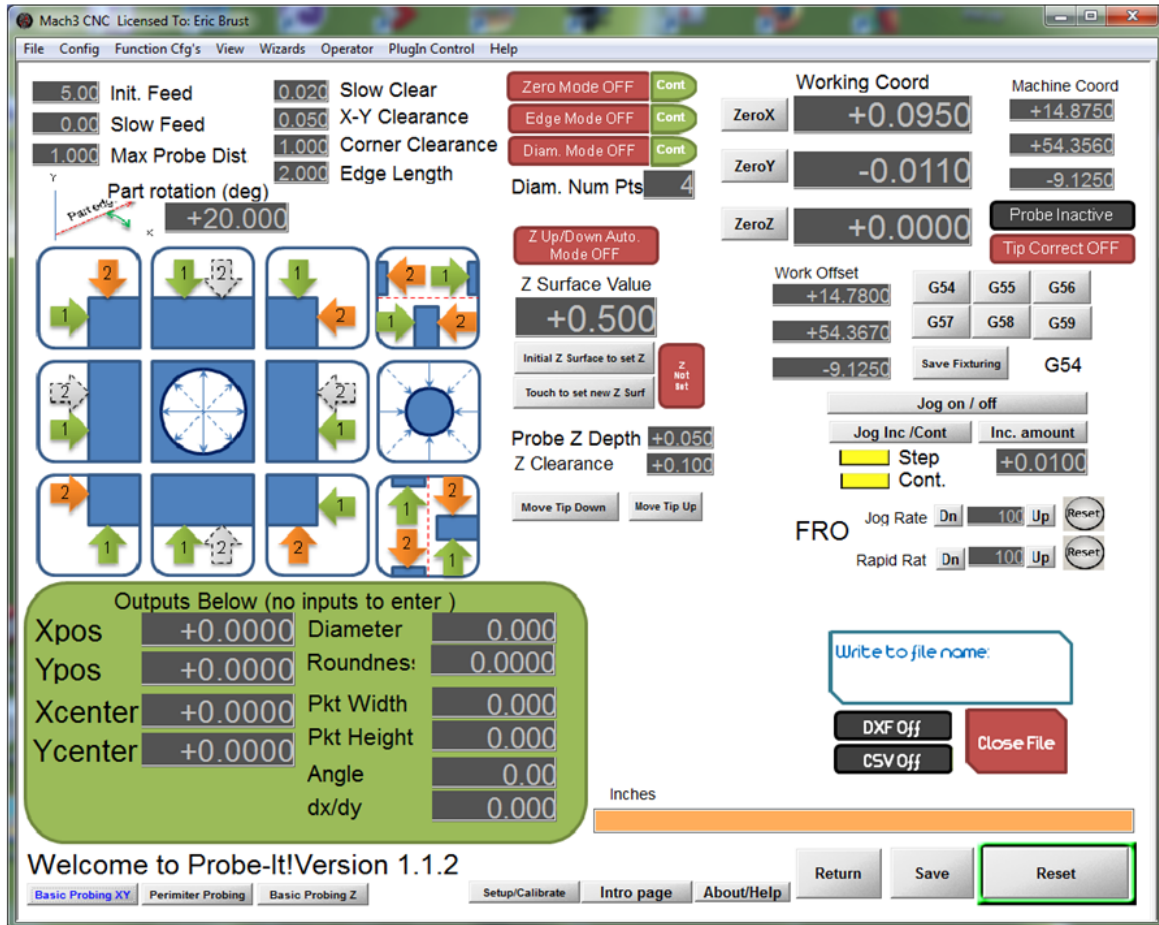
The Basic Probing XY page can serve a few purposes depending on your task at hand. For general probing and setup work, it can be used to locate edges, corners, bore or post centers, mid points of slots, etc. , and set the coordinates appropriately.

It will also report measurements such as point location (edge/corner), diameter/roundness (bore/post), pocket width/height, and angle (edge).

If you are reverse engineering or measuring a part, this page is a compliment to the perimeter probing routine. With the DXF/CSV recording enabled, the probing routines will record the data into either a CSV or DXF file. In fact, you can jump between the perimeter probing and standard XY probing and record all geometry in a single file.

8.1.   Probe Routine Buttons
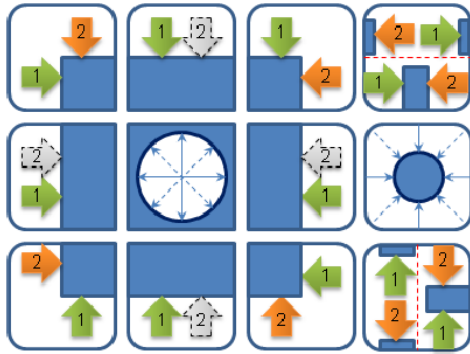
8.1.1. Probe Side / Edge

Pressing this button will probe at a side, or edge if the edge mode is enabled. Edge mode returns the slope of the side. Probing the side returns the X/Y point contacted. If zero mode is on and edge mode is off, the X or the Y axis will be zeroed depending on if probing horizontally or vertically.

This probe event is modified by part rotation value. This probe event can be run with auto up/down turned on.
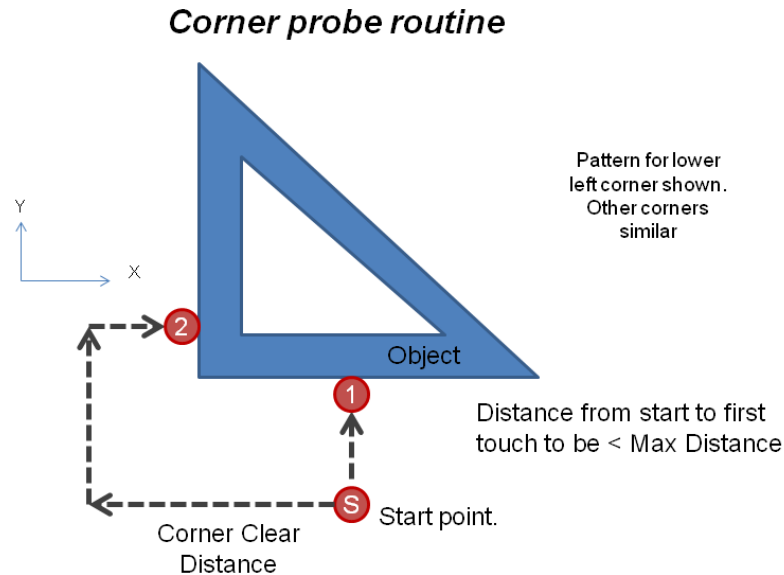

Side/Edge probe routine
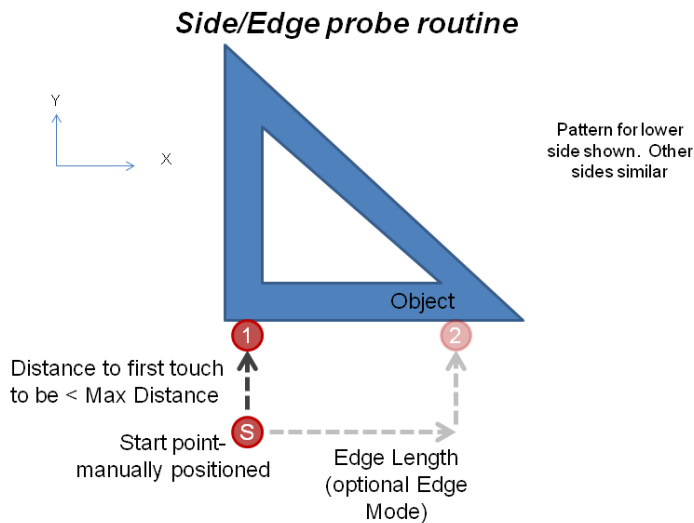
8.1.2. Corner
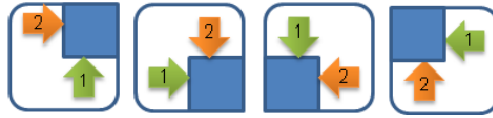
Pressing this button will probe at a corner. The returned point is the intersection of the two sides, or the exact corner. You may set the corner as x0, y0 if zero mode is on.

This probe event is modified by part rotation value. This probe event can be run with auto up/down turned on.

8.1.3. Probe Bore

The probe bore button probes the ID of a bore or a rectangular pocket. The probe tip should be located near the approximate center of the bore in the XY plane.

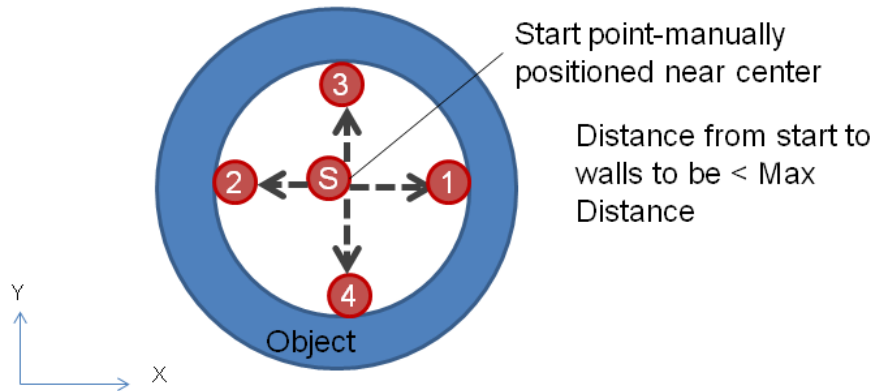If the Diam. Mode LED is off, the routine will perform a basic routine locate the center of a bore or rectangular pocket, probing in +/- X and +/-Y only. If DXF recording is on, it will prompt user to confirm if it is a round bore or rectangular pocket being probed so that the appropriate geometry is recorded to file. Depending on the response, either a circle or a rectangle will be plotted into the DXF.

If the Diam Mode LED is on, the routine will perform a basic routine to first locate the center of a round bore, and will then sample the ID for as many points is entered in the 'Diam Num Pts' DRO. This will return a measured diameter and roundness as a result, and draw a circle into the DXF file.

Warning: Do not probe a rectangular pocket with Diam Mode LED on, the routine may run probe into walls.

This probe event is modified by part rotation value if diameter mode is off. This probe event can be run with auto up/down turned on.

Pocket probe routine

Start point-manually positioned near center

Distance from start to walls to be < Max Distance

3
2 S 1
4

Object

Y
X

Note: pocket may be circular or rectangular, but if pocket is rectangular, 'Diameter Mode' must not be enabled

Pocket probe routine – Diameter Mode
(continuation of pocket routine if selected as option)

Probe tip automatically moves to exact center following initial 'pocket probe' routine

Equally spaced radial probe moves are made up to 'N' point samples as entered by user. N must be an even integer value.

4 3
2
S 1
N

Object

Y
X
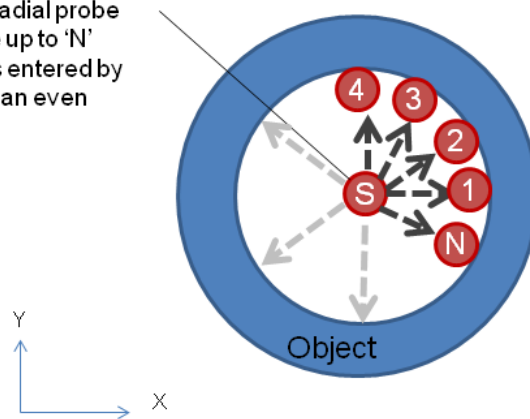
8.1.4. Probe Boss

The probe boss button probes the OD of a post. The probe tip should be located to the approximate center of the post in the XY plane, above the post a small amount.

If the Diam. Mode LED is off, the routine will perform a basic routine to locate the center of a boss or rectangular post, probing in +/- X and +/-Y only. If DXF or CSV recording is on, it will prompt user to confirm if it is a round or rectangular post being probed so that the appropriate geometry is recorded to file. Depending on the response, either a circle or a rectangle will be plotted into the DXF.

If the Diam Mode LED is on, the routine will perform a basic routine to locate the center of a round bore, and will then sample the OD for as many points is entered in the 'Diam Num Pts' DRO. This will return a measured diameter and roundness as a result, and draw a circle into the DXF file.

Warning: Do not probe a rectangular post with Diam Mode LED on, the routine may run probe into walls.

This probe event is modified by part rotation value. This probe event can be run with auto up/down turned on.
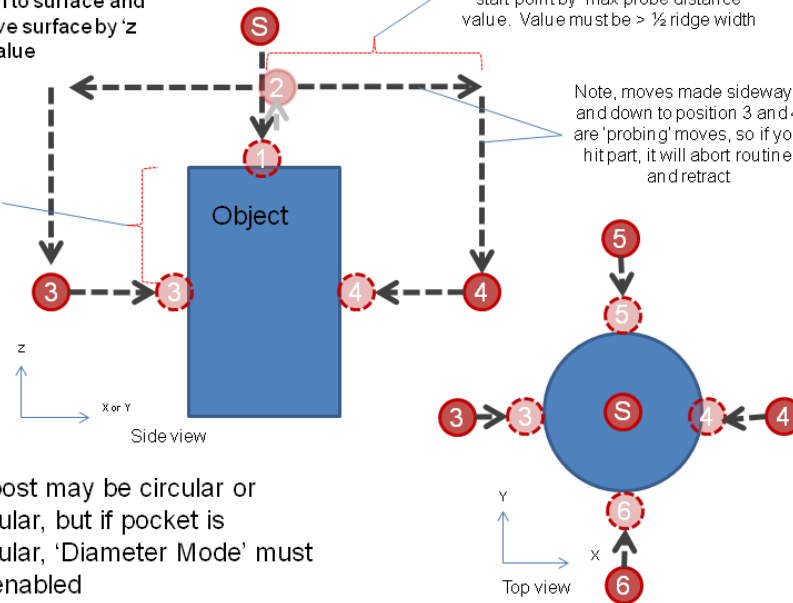
Post Routines

Start point-manually positioned to approx center above object

Probes down to surface and retracts above surface by 'z clearance' value

Tip moves to towards sides (either X or Y depending on button pressed) from start point by 'max probe distance' value. Value must be > ½ ridge width

Note, moves made sideways and down to position 3 and 4 are 'probing' moves, so if you hit part, it will abort routine and retract

Tip moves to 'Z depth' below top of part to probe sides

Object

Side view

Top view

Note: post may be circular or rectangular, but if pocket is rectangular, 'Diameter Mode' must not be enabled

Post probe routine – Diameter Mode
(continuation of pocket routine if selected as option)

Probe tip automatically moves to exact center following initial 'post probe' routine

Equally spaced radial probe moves are made up to 'N' point samples as entered by user. N must be an even integer value.
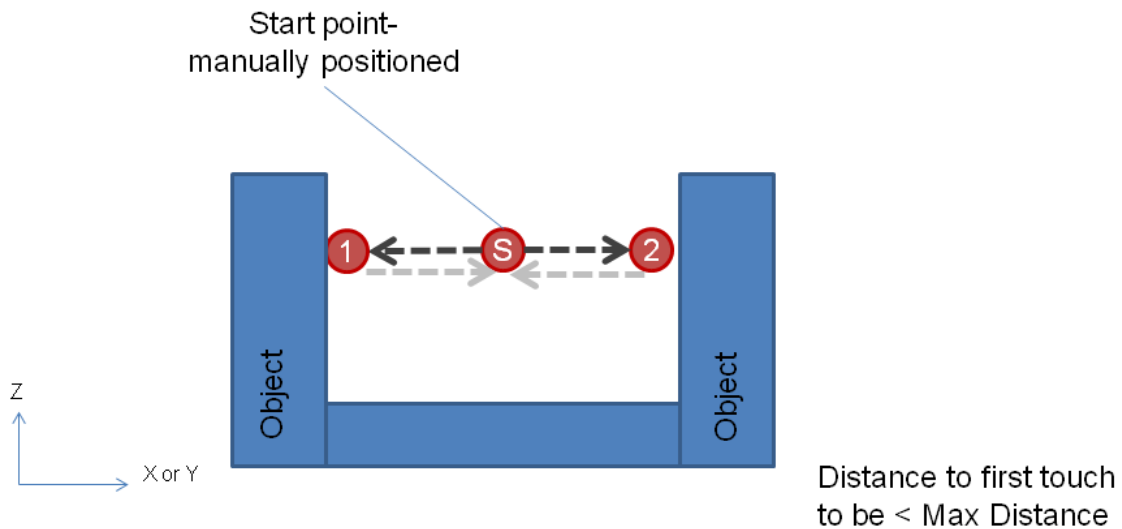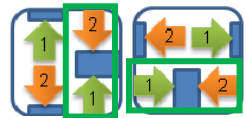
Object
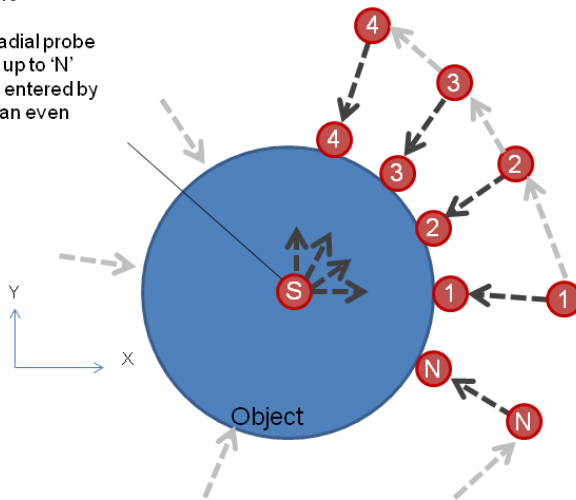
8.1.5. Probe Slot (inner)

To probe the inner edges of a slot, start with the probe approximately centered within the slot. The probe will proceed to make moves to probe both sides. Following completion, the probe will return to the exact center of the slot. Width or Height and center position will be returned. This probe event is modified by part rotation value. This probe event can be run with auto up/down turned on.

Slot probe routine

8.1.6. Probe Ridge (outer)

To probe the outer edges of a ridge or tab, start with the probe approximately centered above the tab/ridge. The probe will initially travel down to find the top of the tab/ridge, and will then proceed to make moves to probe both sides. Following completion, the probe will return to the exact center of the tab/ridge above the top surface. Width or Height and center position will be returned. This probe event is modified by part rotation value. This probe event cannot be run with auto up/down turned on, and if it is on when this probe event is initiated, it will turn it off.
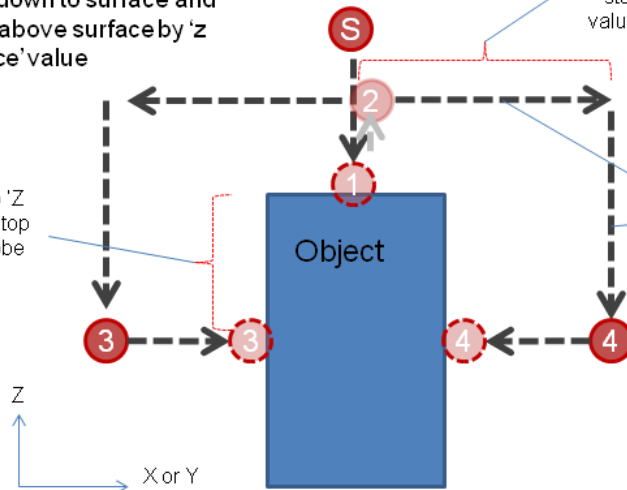
Ridge Routines

Start point-manually positioned to approx center above object

Probes down to surface and retracts above surface by 'z clearance' value

Tip moves to towards sides (either X or Y depending on button pressed) from start point by 'max probe distance' value. Value must be > ½ ridge width

Tip moves to 'Z depth' below top of part to probe sides

Note, moves made sideways and down to position 3 and 4 are 'probing' moves, so if you hit part, it will abort routine and retract

Object

Z

X or Y

8.2. Settings DROs

5.00 Init. Feed	0.020 Slow Clear
0.00 Slow Feed	0.100 X-Y Clearance
0.500 Max Probe Dist	1.000 Corner Clearance
	0.250 Edge Length

Part rotation (deg)   +0.000

8.2.1. Initial Feed

This is the initial feed rate in native units (in/minute if working in inches, mm/min if working in mm) that the probe travels at during probe operation. This setting appears on all other pages, but is found here for convenience of setting during the calibration procedure. Recommended value: Start slow and increase within your comfort and accuracy level.

8.2.2. Slow Feed

This is the secondary feed rate in native units (in/minute if working in inches, mm/min if working in mm) that the probe travels at during a slow probe operation. The probe travels at initial feed, then backs off and re-probes at this slower feed value. Leaving 'slow feed' set to 0 results in no secondary slow probe event. Recommended value: 1-5 in/minute (25-125 mm/min)

8.2.1. Max Probe Distance

The **max distance** parameter is the distance in native units (inch or mm) that the probe will travel towards the surface. This value is used along with the **hit tolerance** value to determine if the surface was hit or missed.

8.2.2. Slow Clear

The **slow clear** value is used to determine how far to back off of the touched surface after an initial feed rate probe before running the slow federate probe event. Enter value in native units (inch or mm).

8.2.3. X-Y Clearance

The **X-Y clearance** value is used to determine how far to back off of the touched surface following the completion of a probe event. Enter value in native units (inch or mm).

8.2.4. Corner Clearance

The **corner clearance** value is used to determine how far to move to get around a corner. Enter value in native units (inch or mm). You will need to position your probe closer to the corner than the value entered in **corner clearance** to assure it makes it around the corner without hitting.

8.2.1. Edge Length

The **edge length** value is used to determine how far to move along an edge to take the second point. Enter value in native units (inch or mm). You will need to enter a smaller value in **edge length** than the overall edge length being measured to assure it does not miss the second touch.

8.2.1. Part Rotation

The **part rotation** value is used to modify the orientation of all probing events (except edge and diameter modes) in a rotated manner. Use this if your part is not square to the table and/or you have rectangular pockets or corners to be found and measured that are not 'square' to the table. Rotation value to be entered in angular degrees of rotation, positive value for rotation ccw. Assume the +X axis is 0 degrees, and the angle of part's 'bottom edge' is relative to the X axis. Part rotation modifies DXF recorded features to be oriented in the rotated state.

Part rotation
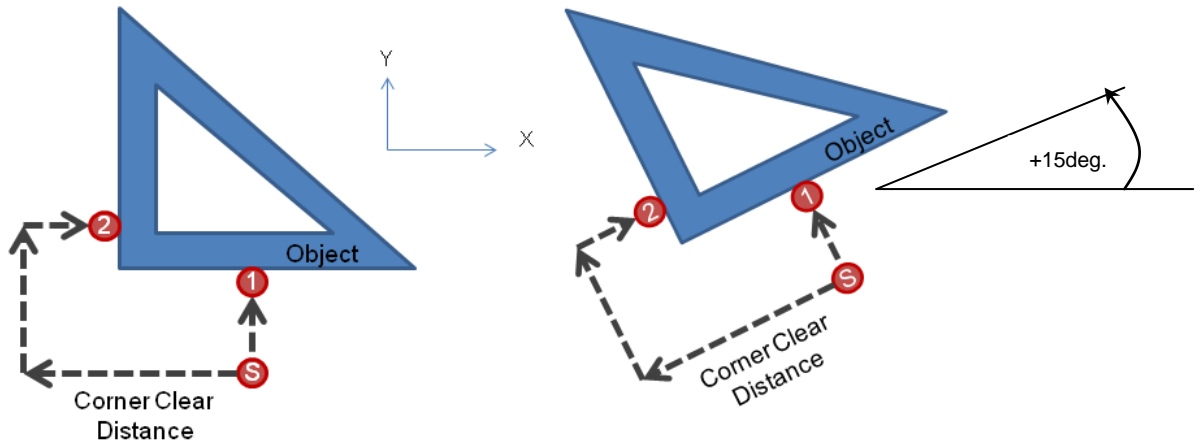
Bottom-Left Corner routine
with 0 part rotation

Bottom-Left Corner routine
with +15 degree part rotation

8.3.   Settings LEDs

8.3.1. Zero Mode ON/OFF

This button is used to toggle if the probe point (edge, corner, center, etc) is used to set the X/Y DROs to Zero for work setup. The 'Cont. / 1X' toggle button is used to determine if it sticks as a continuous mode, or turns the mode off after completion. Turning zero mode on while DXF or CSV recording is on will turn them off. They will need to be turned back on after you complete resetting the coordinate by zeroing.

8.3.2. Edge Mode ON/OFF

This button is used to toggle if the sides will be treated as a single point (edge mode off) or as two points to measure an angle (edge mode on). The 'Cont. / 1X' toggle button is used to determine if it sticks as a continuous mode, or turns the mode off after completion.


8.3.3. Diameter Mode ON/OFF

This button is used to toggle if the bore or post will be treated as a simple center find routine (diam mode off) or as multiple points to measure an accurate diameter (diam mode on). The 'Cont. / 1X' toggle button is used to determine if it sticks as a continuous mode, or turns the mode off after completion.
Warning: Do not probe a rectangular post or pocket with Diam Mode LED on, the routine may run probe into walls.


8.3.1. Z Up/Down Auto Mode ON/OFF

This button is used to toggle if the routines are setup to automatically plunge the probe tip to a set depth, perform the operation, and then retract the probe tip to a safe clearance height automatically. See section 4.4 below. This mode is handy for if you have numerous features such as bores, to locate in a plate. This allows you to jog to the appropriate starting point, hit one probe button, and after completion, jog to the next point without having to jog Z axis up and down manually.

8.4.   Auto Up/Down Features
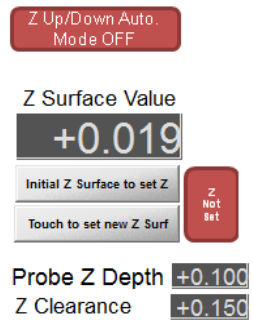
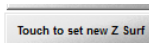### 8.4.1. Initial Z Surface to set Z Button
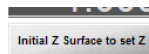
This button is used to set the Z axis DRO to a value representing a desired surface of your object being probed (top surface, etc) . The value is set by what is entered into the 'Z Surface Value' DRO. Move the probe manually over surface to be set before using button.

The button works in conjunction with an LED indicating if a surface is set:

- If the LED indicating a Z surface is set and already on (surface has been set prior), the LED will turn off requiring another touch of the surface to set it.

- If the LED indicating a surface is not on (surface not set), the routine will probe to down to a touch, set the Z axis DRO to the value set in the 'Z Surface Value', and then retract to the clearance defined in the 'Z Clearance' DRO.

8.4.2. Touch to set new Z Surf Button

This button is used to change the 'Z Surface Value' DRO to a new value representing by probing a desired surface of your object being probed (flange, alternate level, etc) . Move the probe manually over surface to be set before using button.

This button requires that an initial surface was set using the 'Initial Z Surface to set Z' button has been used prior and the surface set LED is on, or else the routine will not run.

8.4.3. Surface Set LED
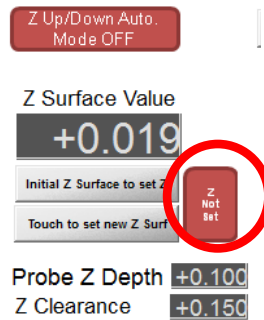
This LED is used as a 'safety' and must be turned on by first probing an initial surface using the 'Initial Z Surface to set Z' button before the auto up/down routines will function. This is used to ensure that the surface and probing depths are 'known' so safety checks can be used to prevent crashing the probe.

8.4.4. Z Surface Value DRO
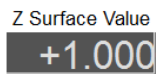
This DRO contains the value that represents the top surface of the item being probed. Initially, you will enter a value to define the surface, and press the 'Initial Z Surface to set Z' button. This will probe down to touch the surface, and transfer the value you entered in the Z Surface DRO to the Z Axis DRO.

The 'Touch to set new Z Surf' button is used to set a new level on the part being probed by actually measuring off. Pressing this button will probe down to touch a new surface, and transfer the value from the Z Axis DRO into the Z Surface DRO.

The Z Surface Value represents the 'Z coordinate' that will be recorded into your CSV or DXF file. It is separate from the Z axis DRO, since your probe tip needs to be below the actual edge that you would like to define in your recording.

8.4.5. Probe Z Depth DRO
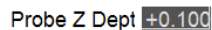
Enter the depth (in native units) that you want the probe to go below the set surface for probing. Do not set any deeper than the length of your overall probe tip, or you will crash the probe body into the part. It is recommended to set Probe Z Depth to approximately the same value as the probe diameter as a starting point.

As an example, if you set the top surface of your part to Z=1.000 inches, entering a value of .100 into Probe Z Depth will cause the probe to auto move to Z=.900 to take a measurement. However your recording will save Z coordinates at Z=1.000.

8.4.1. Z Clearance DRO
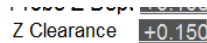
Enter the clearance (in native units) that you want the probe to go above the set surface following probing (so you may then manually jog around without hitting object).

As an example, if you set the top surface of your part to Z=1.000 inches, entering a value of .150 into Z Clearance will cause the probe to auto move to Z=1.150 after the probe event completes.

8.5.   Probing with GCode (grid probing, etc)

If you have a need to probe several items to setup a number of coordinate system offsets on a routine basis, it may be beneficial to create a 'gcode' file that calls upon the probe routines. This method was first requested by, and then subsequently co-developed with the help of a good guy, John Grimsomo (of Grimsomo knives).

The basic requirements to perform this are:
1) Create an MCode script file that calls the desired probe function, making it accessible from GCode. The result of calling the routine from GCode is the same is if you pressed the corresponding button in the wizard
2) Have the settings 'pre-set' in the wizard to accomplish the desired probing routine. The wizard doesn't need to be active, it just needs to have all the proper DROs populated with the desired settings, and LED toggles set properly for things such as 'zero mode'. It is HIGHLY recommended that you have a good handle on having manually executed the desired probe operation and verified it performed as desired before trying to fully automate the process.
3) Create a Gcode file that performs desired actions such as
   a. Moving to location
   b. Invoking desired coordinate offset to be active
   c. Calling probe command

8.5.1. Making probe routines available from GCode (create M-code script)

To be able to call a probe routine from GCode, you first need to make it available via an MCode script (macro) As an example, suppose you want to perform an OD 'post' probe, and you want to assign it as MCode M1010:

- Create a text file called M1010.m1s
- Place only the text following text in the file as shown:

```
setuserDRO(1937,0)
runscript("addons\probeit\post")
```

- Place the file in the 'macros' folder for your particular Mach3 profile

Once the above is complete, using *M1010* in GCode will invoke the probe routine, just as if you were in the wizard and pressed the button.

8.5.1.1. Available routines you can call:

- Post - OD probes a boss/post. Suggest to NOT have diameter mode enabled.

  ```
  setuserDRO(1937,0)
  runscript("addons\probeit\post")
  ```

- Pocket - ID probes a pocket. Suggest to NOT have diameter mode enabled.

  ```
  setuserDRO(1937,0)
  runscript("addons\probeit\pocket")
  ```

- Side - Probes a side (single point) or an edge (two points) depending on if 'edge mode' is enabled. *Requires you to set DRO 1937 with an angle to define direction. Suggest to have Auto Z up/down enabled, unless you handle z moves in your gcode seperately.

  ```
  setuserDRO(1937,0)
  runscript("addons\probeit\side")
  ```

- Corner – Probes a corner. *Requires you to set DRO 1937 with an angle to define direction. Suggest to have Auto Z up/down enabled, unless you handle z moves in your gcode seperately.

  ```
  setuserDRO(1937,0)
  runscript("addons\probeit\corner")
  ```

- Slot-inner – Probes inside a slot. *Requires you to set DRO 1937 with an angle to define direction. Suggest to have Auto Z up/down enabled, unless you handle z moves in your gcode seperately.

  ```
  setuserDRO(1937,0)
  runscript("addons\probeit\slot-inner")
  ```

- Slot-outer - Probes outside a slot/ridge. *Requires you to set DRO 1937 with an angle to define direction. Suggest to have Auto Z up/down enabled, unless you handle z moves in your gcode seperately.

  ```
  setuserDRO(1937,0)
  runscript("addons\probeit\slot-inner")
  ```

**Note: DRO1937 is used to set the direction of probing for the routines, the value is defined in degrees, with 0 being along x axis, 90 along y axis:

```
 setuserDRO(1937,0) -> Probe in + X direction
setuserDRO(1937,90) -> Probe in +Y direction
setuserDRO(1937,180) -> Probe in - X direction
setuserDRO(1937,270) -> Probe in -Y direction
```
Values are not limited to 0,90,180,and 270, but the user should use caution when setting up arbitrary angles.

8.5.2. Pre-setting the probing settings

Preparing settings should be done beforehand, while in the wizard. Every DRO that controls the probing behavior needs to be pre-entered, and should be tested manually to do a single probing event. Please review all settings such as feed rates, probe distances, clearances, zdepth and zclearance, etc from above sections.

8.5.3. GCode methods to grid probe

The method to perform the probing is entirely up to the user, and there is no single right or wrong way. Here are a couple of ways to perform the task:

8.5.3.1. Pre-setting the approximate centers of fixture locations by coordinate offsets.

The method John Grimsmo used is a fairly safe method, and was done by the following.
1) Set each fixture location as approximate x0/y0 manually by eye:
   a. Move probe over first location (roughly centered by eye)
   b. Invoke desired coordinate offset (G59Pxx, where xx is desired offset)
   c. Zero x and y axis
   d. Move to next location and repeat a thru c (with exception of calling a new fixture offset)
2) Run Gcode file that calls each fixture offset in order, command a move to x0, y0, then command a probe event via Mcode assigned. An example GCode file (which assumes the probe command is M1001) is as follows:

G59P30 (call fixture offset)
G0 x0 y0 (move to 'center' of location)
M1001 (custom macro which calls probe macro)
G0 Z2 (go to z clearance plane)
G59P31 (call next offset and repeat steps)
G0 x0 y0
M1001
G0 Z2
G59P32
G0 x0 y0
M1001
G0 Z2
G59P33
G0 x0 y0
M1001
G0 Z2
M30

Note: Use caution to ensure all your offsets have Z at nearly the same level. It may be beneficial to locate fixture locations in a comon G54 offset with absolute coordinates as well

8.5.3.2. Using Subroutine Loops with incremental moves

This method is based around having a fixture with equally spaced locations. This GCode routine will toggle between using incremental moves between locations, then use repetitive subroutines to call the offset and probe routine. This is more of a parametric method, and can be customized for your needs.

1) Change the 'inputs' portion of the GCode file to match number of rows, number of columns, spacing in X and Y, etc. Also indicate the numbering that will correspond to the first offset.
2) Place the probe over approximate first location.
3) Run Gcode file. An example GCode file (which assumes the probe command is M1001) is as follows:

```
(Grid Probing program)

G20 G40 (standard setup lines)

#201=3  (number of columns)
#202=1  (number of rows)
#203=1.0          (nominal Y spacing value, positive to move up or negative to move down)
#204=1.0          (nominal X spacing value, positive to move right or negative to move left)
#205=30(first coordinate system, i.e., 30 for G59P30, 40 for G59P40, etc)
#206=.1 (safe height/zretract value)

G54
G0 Z#206 (go to z clear value)

G00 X0 Y0   (set position of first hole as positioned from zero point of fixture, the way this is set now, move probe over first probe location and zero x and y)

M98 P1000 L#202 (repeat rows #202 times)
M30




O1000
(this sub routine moves Y axis for number of rows)
M98 P1001 L#201 (repeat columns #201 times)
G91 (set to move incremental)
G00 Y#203 (do move of #203 inch)
G90 g00 X.5 (set to absolute and go back to start of line)
M99

O1001
(this sub routine moves X axis)
```

M98 P1002 (Probe routine)
G91 (set to incremental)
G00 X#204 (do move of #204 inch)
G90 (back to absolute)
M99

(probing subroutine)
O1002
G59P#205 (set the coordinate system to current value)
M1001 (call the probe routine M file)
#205 = [#205+1] (increment up the coordinate system offset value, for next location)
G54 (get back to G54 offset for moving to next fixture point)
g0 z#206 (move up to clearance plane)
M99

----

9. Auto G68 Rotation Page

The G68 command in Mach3 rotates the working coordinate system relative to the machine coordinates and axis definitions. Using this page, you can probe the edge of a part and set the Mach3 coordinate system rotation so that X and Y axes are

parallel/perpendicular with your part. This is handy if your part is not setup square to the table.

9.1.   Buttons
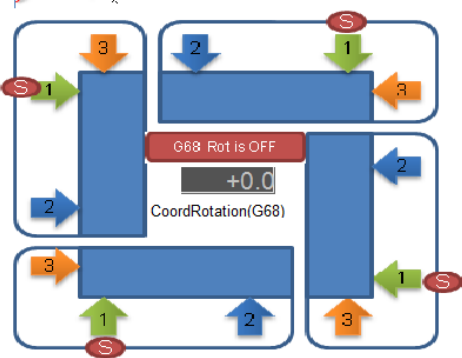
There are 4 buttons, which are for probing at 4 corners of a part. The edge that will be aligned to the rotated X or Y axis is the edge that gets 'hit 1' and 'hit 2' as defined by the buttons. The routine expects that the corner between 'hit 1' and 'hit 3' is square. This is not absolutely required, but if you try to set the corner as 0,0, there will be a small amount of positional error if the corner is not square.

After positioning the probe tip at the approximate location as indicated by the '(S)' in the buttons, hit a button and the routine will probe in the following sequence:
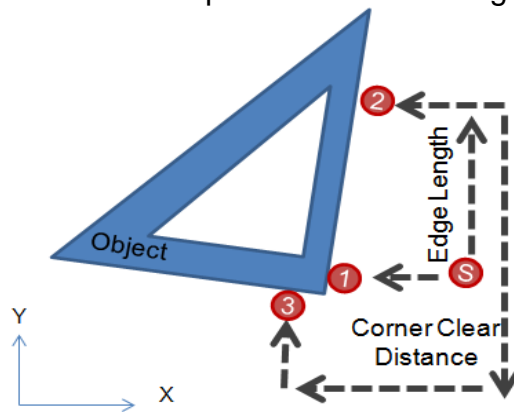
Bottom-Right Corner routine
(no part rotation turned on)

When the routine completes the axis will be rotated and you will notice a few things:
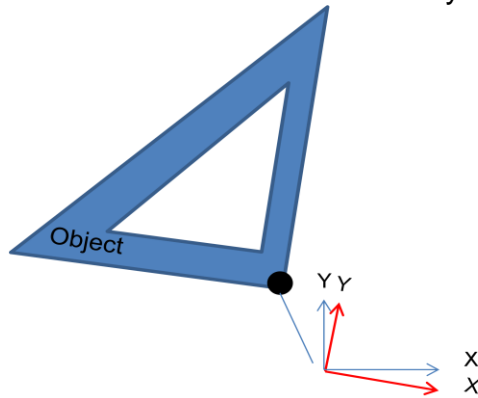
After routine: Coordinates rotated
about corner point to match part edge.
Corner may be set as 0,0 or left at
original coordinates (toggle 'zero'
option).

1) The coordinate systems are rotated such that X and Y are aligned with the edge
   you probed (reference red axis in above picture).

2) The X and Y DROs in Mach3 will now be RED, indicating that G68 is in effect (there is a rotation)
3) The LED in the middle of the buttons will be Lit, indicating G68 is in effect
4) The DRO in the middle of the buttons will have a number in it. This number is the rotation angle in DEGREES.

From now on, any movement command is relative to the new rotated coordinate system, until G68 mode is canceled. G68 can be canceled by pressing the LED button or entering '0' in the angle DRO, both located in the middle of the 4 buttons. You will know the rotation is canceled when the X and Y axis DROs return to white numbers.

10. Basic Z Surface Page
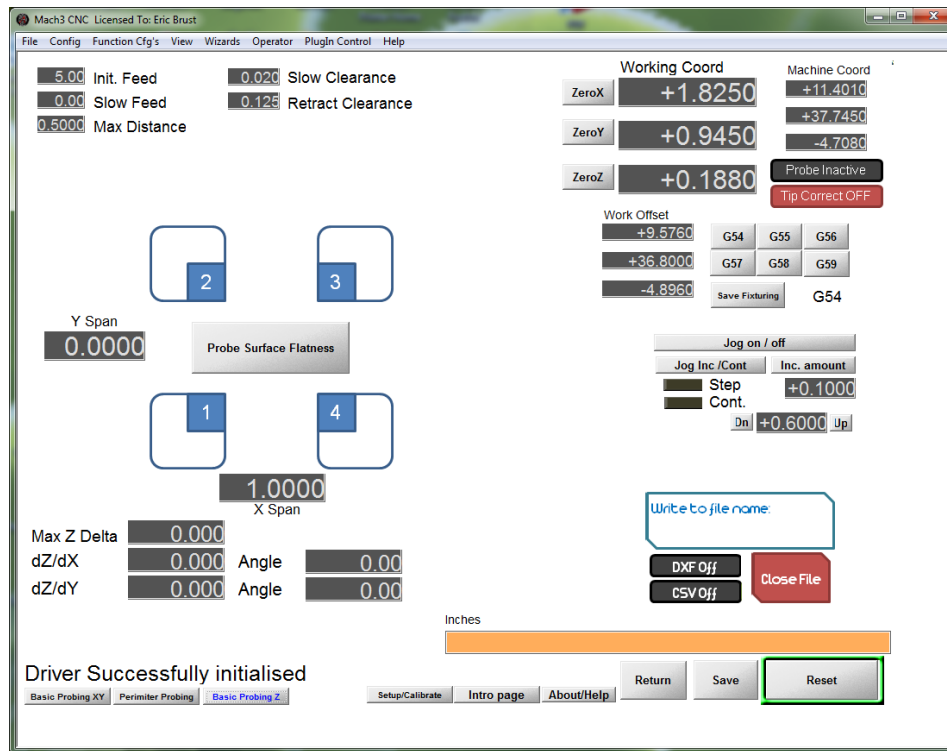
The Basic Z Surface page is only meant to provide a very basic check of how flat the surface of your object is relative to the X-Y plane of the machine. You can probe in the X only, Y only, or an X-Y square pattern to determine if your part is 'level' and or of a constant thickness. It is useful to determine if your part is bowed or tipped in your fixturing for operations that require a very flat and level surface, such as engraving.

10.1. Probe Z Surface Button

Pressing this button will run the Z Surface probe routine. Position the probe in the lower left corner of the area you want to probe, a small distance above the surface. You must enter a distance in either X span, Y span, or both X & Y span DROs. The routine will probe the first point in the spot where the probe was manually positioned, and then will move in a delta X or Y location based on the span DROs.

10.2. Settings DROs

10.2.1. X Span

This value is the distance in native units (in or mm) between probe events in the X axis. If Y Span is left as 0, the routine will only record 2 points and provide a dz/dx along the X axis.

If Y is not 0, the routine will probe in both X and Y directions.

10.2.2. Y Span

This value is the distance in native units (in or mm) between probe events in the Y axis. If X Span is left as 0, the routine will only record 2 points and provide a dz/dy along the Y axis.

If X is not 0, the routine will probe in both X and Y directions.

11. Data Recording and Saving

Probe-It! will record probing data to either a CSV (comma separated value) format that can be imported by Excel, or into a DXF format. You can also record both formats simultaneously if you wish. **Files are stored in the 'output' folder of the 'ProbeIt' directory (i.e., C:\Mach3\addons\ProbeIt\output\ ).**

The files recorded are unit independent and unit-less. If you record to a CSV, values of positions and sizes are just reported as numbers in your native units. Same goes for the DXF format. Geometry is recorded into the files in based on numbers recorded in your native format. If you probe a bore that is one inch (25.4 mm), depending on if you have Mach3 set in metric or SI units, you will either record a circle with a diameter of 1.000 or 25.4. You can then convert the file by scaling if you use direct in a CAM or CAD file.

11.1.   Format selection

You activate recording to a file by selecting and turning on the CSV button, the DXF button, or both at the same time.

You will be prompted to enter a file name for your recording. If you select both CSV and DXF, you will record the file name to both formats.

Once the LED for either DXF or CSV is on and a file name is entered, you don't need to do anything but probe the part, all data is recorded as you go until you close the file.

11.2.   Data Save / Close File
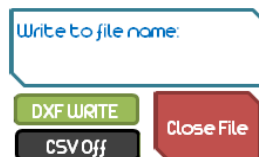
As long as you have set a file name to record to, you will keep recording and appending data to that file. This allows you to jump from page to page within the wizard and continue recoding to a single file. You can be on the XY page, probe a bore and record

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it to a file, then switch to the Perimeter probing page, and record the exterior perimeter. In addition, if you have an issue in the middle of probing, you can always hit 'escape' to stop, reposition, and restart a probing event and it will keep recording to the file. Note that you may get some extra data you'll have to manually delete from your DXF later, but you won't have to paste together several DXF files to reverse engineer a part!

After you have completed all probing of a part, press the *'Close file'* button. **Note that once you close a file, you cannot add to it. If you re-enter the same name into the 'write to file name' box, you will over-write any existing file.**

11.1.   Working with CSV data

The CSV file format is a tabular format that can be opened and imported into Excel. The best usage for this may be basic CMM measurement of features on a part, such as recording diameters and locations of a series of holes for inspection purposes.

The format looks like the following, and provides a description of the probe event along with the numerical data

Example bore measurement:

Measuren	Xpos1	Ypos1	Zpos	Xpos2	Ypos2	XCenter	YCenter	Pocket W	PocketHe	Angle	Edge Delt	Diameter	Roundnes
Round Bore			-1.49618			0.000153	-1.57E-05	1.7008	1.70065			1.699819	0.000927

Example perimeter data

Measurement	Xpos1	Ypos1	Zpos	Xpos2	Ypos2	XCenter	YCenter	Pocket W	PocketHe	Angle	Edge Delt	Diameter	Roundness
Perimeter Point	10.62676	-1.09057	0.387803										
Perimeter Point	10.55183	-1.01756	0.387803										
Perimeter Point	10.56654	-0.98764	0.387803										
Perimeter Point	10.59601	-0.94302	0.387803										
Perimeter Point	10.59156	-0.92435	0.387803										
Perimeter Point	10.53148	-0.86334	0.387803										
Perimeter Point	10.4884	-0.82976	0.387803										
Perimeter Point	10.44664	-0.85935	0.387803										
Perimeter Point	10.36606	-0.8481	0.387803										
Perimiter Segment	10.36316	-0.84595	0.387803	10.35795	-0.83705								
Perimiter Segment	10.35795	-0.83705	0.387803	10.34988	-0.82581								
Perimiter Segment	10.34988	-0.82581	0.387803	10.34574	-0.81905								
Perimiter Segment	10.34574	-0.81905	0.387803	10.33865	-0.80971								

Note that segments are defined as short lines with a start point (Xpos1, Ypos1) and an end point (Xpos2, Ypos2).

11.2. Working with DXF data

The DXF file format is standard and should be able to be opened by any program that can read/import a DXF. Recorded geometry will be drawn as points, lines, circles, etc in the file.

Perimeter probing primarily creates a series of line segments that represent the perimeter of the part. A start and end point of a line segment are actual locations probed and recorded along the perimeter of the part (as adjusted for probe tip, etc.). Ie, the lines run along the true perimeter of the part, the lines do not represent the center points of the probe ball where it hit. Occasionally during the perimeter probing routine, if a 'corner' is found or missed during a direction change, the routine will guess and interpolate a corner point. These points are highlighted as small yellow circles. The center of the circle is the guessed location. You may need to do some cleanup work on these locations.

The DXF geometry can be used to construct better CAD geometry, or be joined into polylines and smoothed, or imported directly into a CAM program to be used to create cutting paths. Measurements can be made by snapping circles and dimensions to endpoints and curve fitting also.

Below is an example of a perimeter recording of an ER collet wrench. The red perimeter is made up of many small short segments, but the 'diameter' can be easily measured by constructing a circle using 3-point definition, and snapping to the segments as an example. You can also note the locations of the yellow circles indicating 'guesses'. These often happen when the geometry has an abrupt direction change. Zooming in and doing some manual cleanup of the geometry may be required.
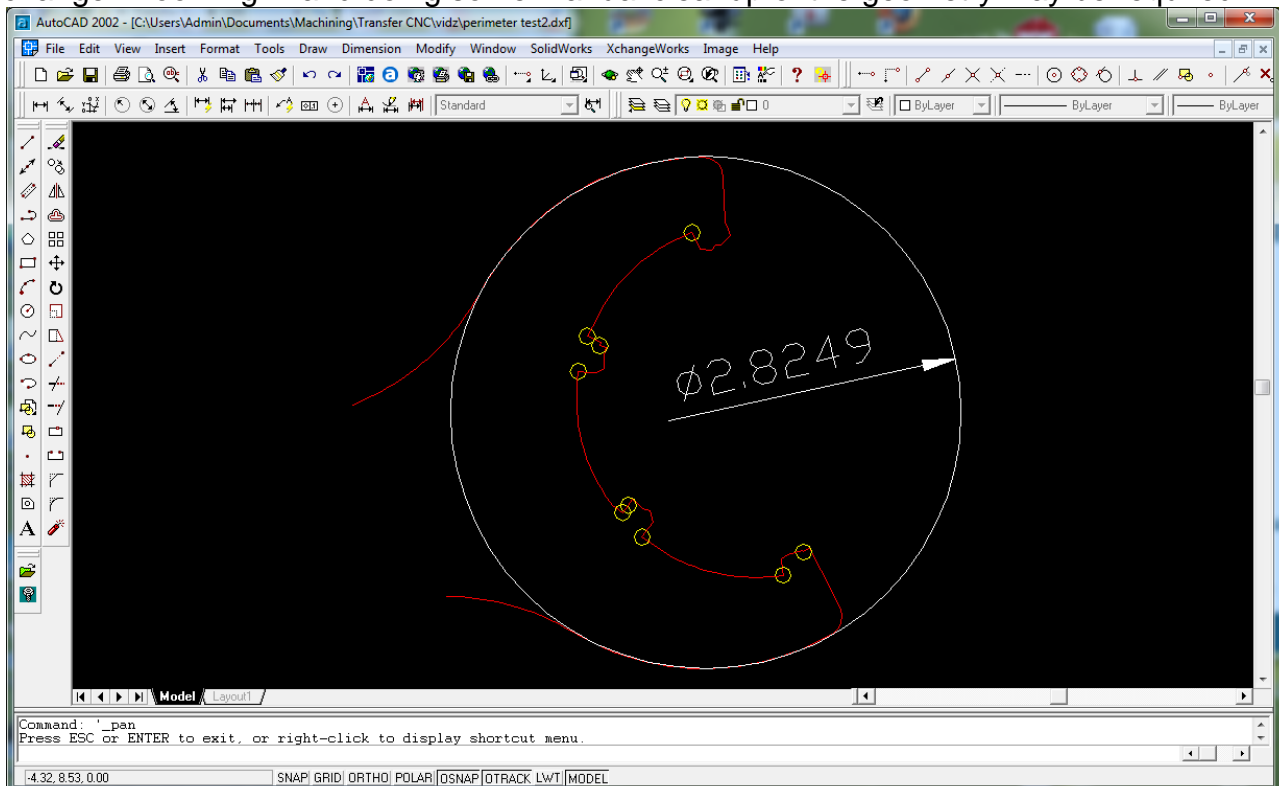
By zooming in on the geometry, you can see how it is made up of short segments. Segments in ACad show the two endpoints and a center point. The center-point is not recorded from Probe-It, but rather is how ACad shows the segments:
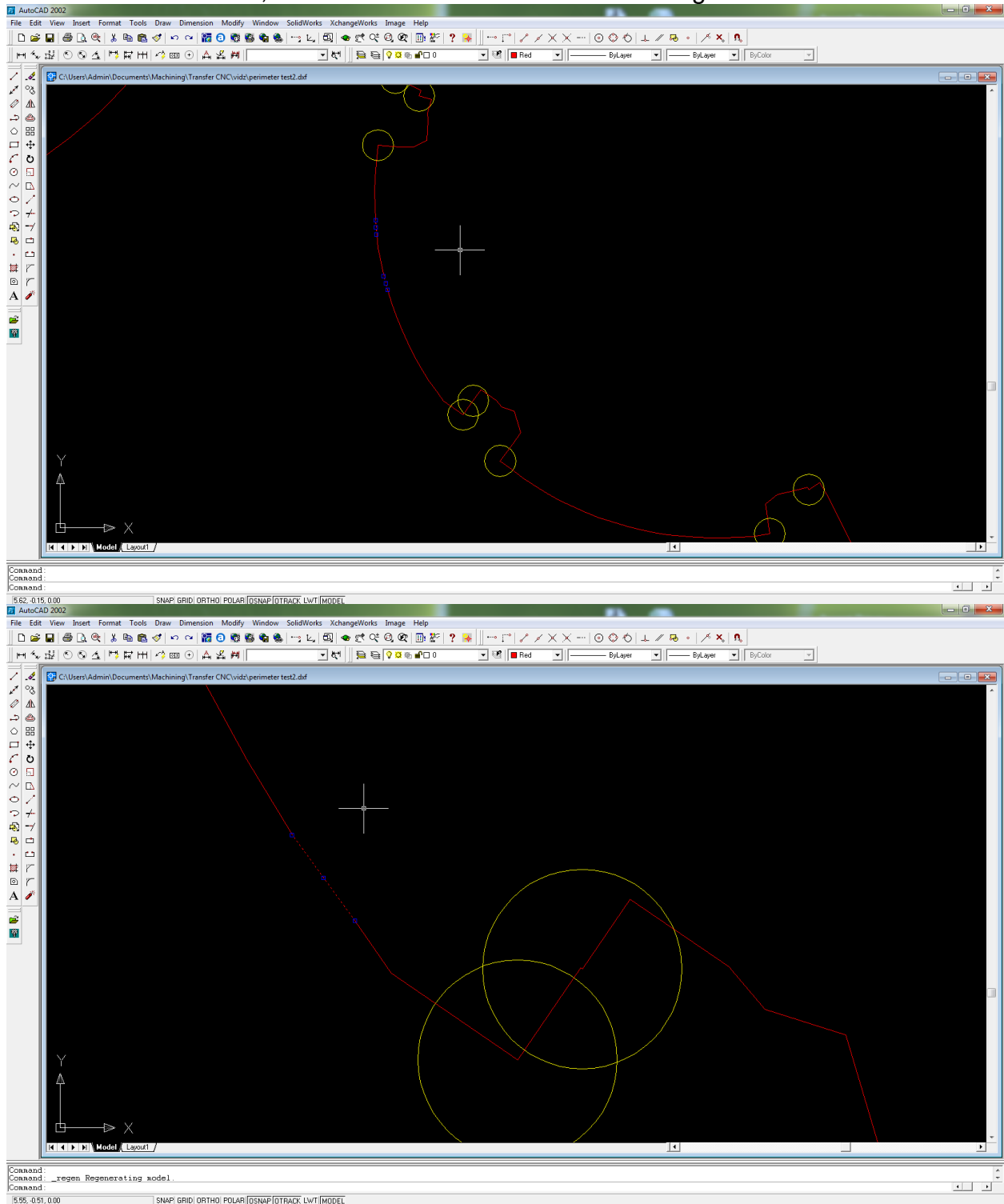
12. Appendix 1 – Troubleshooting / FAQ

How do I stop an in process probe event?
- Pressing 'ESC' key will hault any running probe macro, including the basic X-Y routines, and the perimeter routine.

I stopped in the middle of recording a perimeter profile but I wasn't done with the part, now what?
- Assuming you have the licensed version and can record unlimited points, you may stop and restart the perimeter routine as much as you need and keep recording to the same DXF or CSV file. This allows you to
1. Mix basic X-Y routines with the perimeter routines on a single part file
2. Change your probing settings such as stepover and backoff to achieve more precision in some locations, and move faster in less critical areas.
3. Recover from an error due to the routine loosing the part, or getting hung up on a difficult area.

Your recorded data will have a broken line at the location where the routine was restarted. This is easily fixed in CAD afterwards, as there are points at the line ends that you can join.

Can I adjust perimeter probing feedrate while routine is in process?
- Yes, you can. You can change the feedrate value at any time, and the max angle change parameter. These are the only values that you can change in the middle of the running routine. If you want to change the stepover, backoff, etc, you must halt the routine (press ESC key), adjust parameters, then restart the routine. It would be to risky to adjust the other parameters on the fly, as those parameters are used in determining probe positions on the fly.

Some of the clearance moves are too fast!
- Most of the moves are made as G31 moves at your input feedrate, however a few moves are done as G0 rapid moves. If you find some of the moves to be too fast, use the 'RAPID FRO' button to slow the rapid feeds down.