BL Touch guided install on Duet Hardware

How to install a Latest Generation BL Touch Sensor onto the Duet Ecosystem of hardware.

This guide is meant to break down the mystery and try to condense everything in to one place for an easy to follow guide for each duet board.

Note: For this guide it is assumed you have a Duet-2 board installed on your printer, which is operational, it is also assumed you are on RRF-3 Firmware. And that you can connect to your printer via a web browser.

This guide will cover Physical installation, How to wire the probe up correctly to the board and how to configure the software and finally how to commission & adjust the sensor so as to place the nozzle the desired height above the print surface.

MOUNTING

The first thing to do is to physically mount the sensor on your printer, there are a multitude of suitable mounts to suit your printer available on Thingiverse, it should be noted that the sensor should be mounted so that the base of the sensor (not the pin) is 8mm above the tip of the nozzle, the sensor should also be at least 15mm away from the high temp hot- end components. See the picture below for a visual of what the ideal should be.
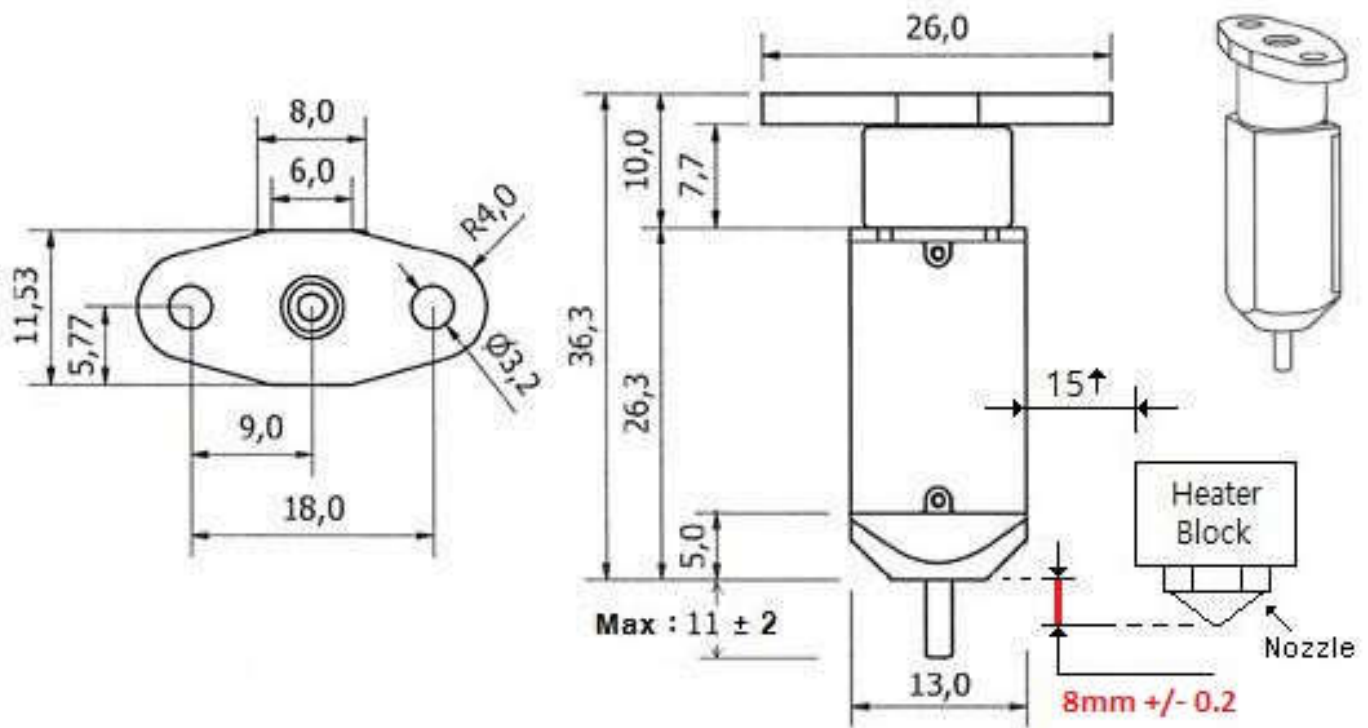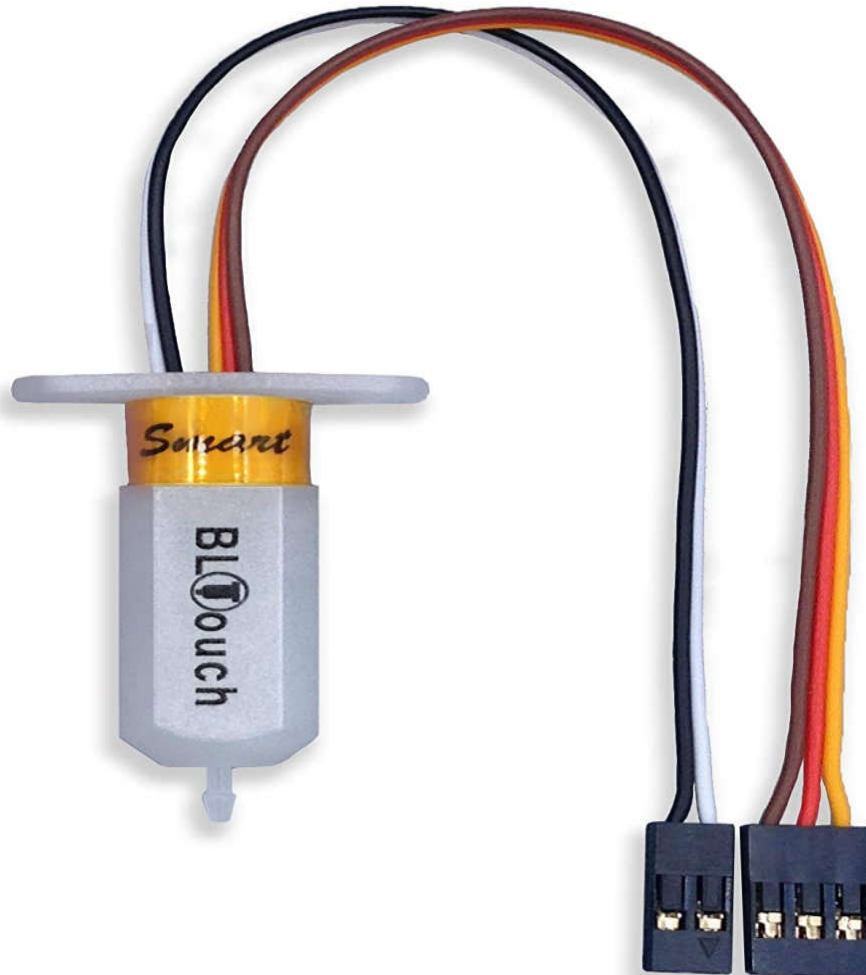
WIRING

The Next consideration is related to the wiring the sensor to the duet board and this will depend on which Duet board you have, there a number of possible combinations.

The BL Touch uses the following wiring colour scheme:

White = Signal Out
Black = Ground
Orange = Servo Control
Red = VCC
Brown = Ground

Duet-2 Wi-Fi/Ethernet boards. WITHOUT a Duex-2/5

The Duet-2 has a dedicated "probe" connector you attach the wires as shown in the table & picture below.

BL Touch (Wires)		Duet-2
White		Z Probe IN signal to Z probe connector, FIRST PIN (FROM THE LEFT)
Black		Z Probe GROUND to Z probe connector, SECOND PIN (FROM THE LEFT)
Orange		Servo control pin to Expansion Header Pin #8 (heater 3) FOURTH BOTTOM PIN (FROM THE RIGHT)
Brown		Servo control ground to Expansion Header Pin #2, FIRST BOTTOM PIN (FROM THE RIGHT)
Red		+5v Expansion Header Pin #1 FIRST TOP PIN (FROM THE RIGHT)
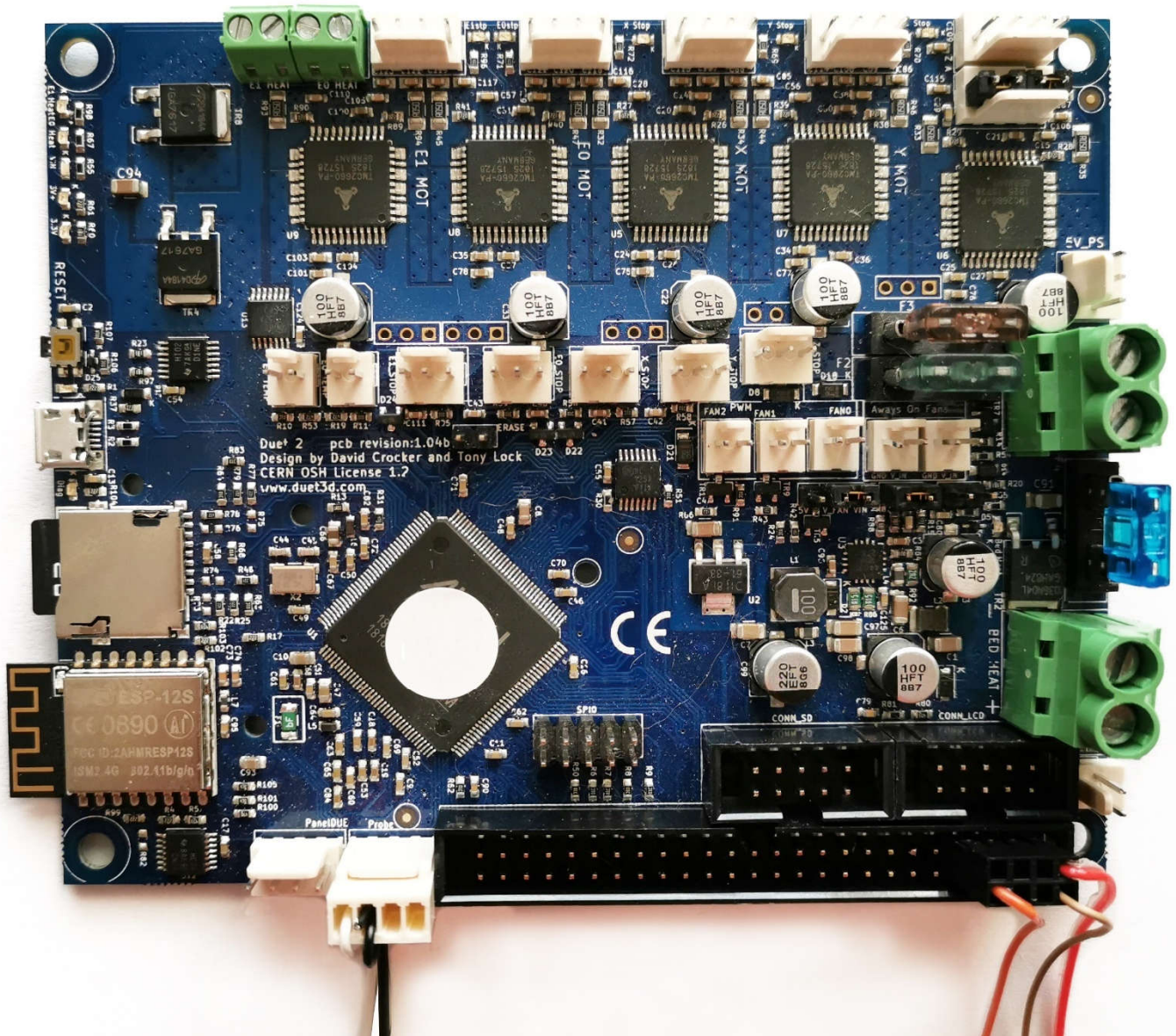
To re-cap.

You should check that the probe has been correctly and securely installed on to the printer and that all wiring is secure and cannot be damaged by any printer movement.

You should double check that your wiring matches the pictures and that the correct wires are connected to the correct pins BEFORE you power up the printer, it is better to check your work a second time than it is to damage expensive electronics.

Software Configuration

Once the Sensor is correctly wired up you can move on to the software configuration aspect of the install, this is carried out by editing the Duet-2's config.g file by adding G-Code Commands and creating a few other files. For a full list of the G-Code files used by the Duet Ecosystem you can go to the Dozuki Here

You need to edit the config.g file, which is easily done from within the D.W.C. interface or you can use any preferred text editor to edit/create files from within a computer.

In the Duet-2's config.g file you need to add the following G-Code commands M558, M950 & G31

This First command M558 with parameter options tells the Duet what type of probe you have installed and to tell the duet which pins the probe is connected to along with other data.

The M558 Command is normally placed after the end-stop section of the config.g file where you will create a "Z-Probe" section.

For the BL-Touch you need the M558 command to have additional parameter options.

The full text for all the commands are as follows (The whole commands with their additional parameters will be broken down to allow you to understand what they all mean).

M558 P9 C"^zprobe.in" H5 F100 T2000

On to the break down and meaning, it looks Daunting but it's not really.

M558 = this parameter tells the Duet which g-code command is being specified.

P9 = this parameter tells the Duet the type of probe being employed to allow for the pin to be deployed & retracted (in this case the BL-Touch uses P9).

C"^zprobe.in" = this parameter tells the Duet which is the input pin and any optional modulation pin. This parameter is mandatory, it should be noted that when using the pin labelled "zprobe.in" the character "^" must be used to enable the on-board pull up resistor which is required for this install.

H5 = this parameter tell the Duet what the Dive height expressed in (mm) should be. When using mesh bed compensation or running G30 commands with specified XY coordinates (for example from the bed.g file), the firmware moves the Z probe to this height above where it expects the bed to be before commencing a probing move. The maximum depth of the probing from this position is twice the dive height. If you input a very large dive height this will allow for a very uneven bed or poor calibration. And conversely a small dive height will make probing faster, because the Z probe has less distance to travel before reaching the bed.

F100 = this parameter tells the Duet the "feed" rate at which it should carry out the probing move, this is expressed in (mm/min).

T2000 = this parameter tells the Duet the speed at which it should travel (in the X & Y planes) between any probe points.

Next you must next create a G.P.I.O./Servo pin, this is to control the deployment & retraction of the probe pin. To do this you use the M950 G-Code command with additional parameters.

M950 S0 C"exp.heater3"

And the Meaning:

M950 = this command tells the Duet that you wish to create a G.P.I.O./Servo pin which is mapped to a specific pin.

S0 = this parameter tells the Duet the servo pin index is set to "0".

C"exp.heater3" = this parameter tells the Duet which physical pin to connect the output to.

In essence when you (or the Duet) tells the probe to deploy or retract it sends a signal to the BL touch via this pin to do as requested, remembering that we connected the Orange wire to pin #8 on the duet expansion board which is "heater-3".

The next step is to set the probe status using a G31 command with the correct parameters.

G31 X20 Y-10 Z3.3 P25

And the Meaning (With a Diagram). **This is an example only**, **your offset values will be different, and you will have to measure your offset's yourself**

G31 = this command tells the Duet the status of the probe.

X20 = this parameter tells the Duet the location of the probe pin in relation to the nozzle on the X axis and in this case "X20" means that the probe is located 20mm to the RIGHT of the nozzle.

Y-10 = this parameter tells the Duet the location of the probe pin in relation to the nozzle on the Y axis and in this case "-10" means that the probe is located 10mm away from the nozzle.

Z3.3 = this tells the Duet the height at which the probe triggers (you will adjust this properly later).

P25 = this tells the Duet the trigger sensitivity value.

See the picture on the next page for a visual on the probe offset in relation to the nozzle (when looking up at the print head from below)

Y -30mm

X -20mm
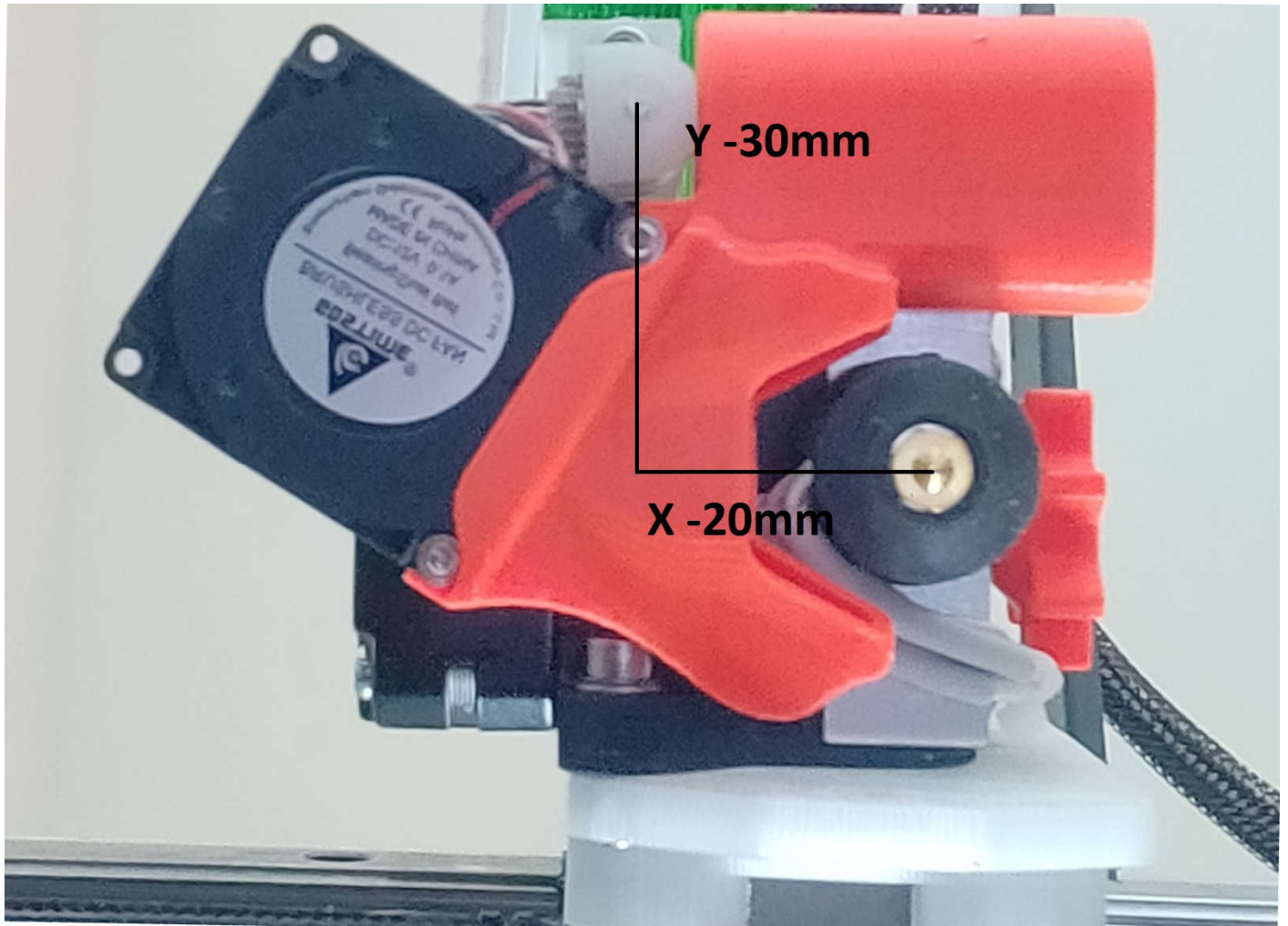
You should now have a probe that is physically installed, correctly wired and you should also have 90% of the required G-Code commands to allow the probe to operate the probe successfully and you have created all the required commands in config.g file.

See below for what the section entitled "Z-Probe" should look like in its entirety in the config.g file.

; Z-Probe

```
M950 S0 C"exp.heater3"              ; Create the servo pin and its location
M558 P9 C"^zprobe.in" H5 F100 T2000 ; Set the probe parameters
G31 X20 Y-10 Z3.3 P25               ; set the probe's offset, status & trigger height
```

Once you have those commands (with the correct parameters) input into the config.g file you can save and exit (this might ask you if you wish to reboot) choose yes and allow the firmware to restart.

The Final step (before commissioning/testing) is to create two new .g files which you will place inside the /SYS folder. These two new .g files are to allow you (and the Duet) to deploy the probe to allow the probe to find the trigger point during the probing move and to retract the probe after it has been triggered.

The First .g file should be called "deployprobe.g" the second .g file should be called "retractprobe.g" (DO NOT USE any capitalization)

Once you have created these two new files you can open them and input the required G-Code commands with the correct parameters. So firstly open up the "deployprobe.g" file and input the following:

M280 P0 S10 ; Deploy the BL-Touch Pin

And the Meaning

M280 = this command tells the Duet to set the servo (The BL-Touch Pin) to a specific state.

P0 = this parameter tells the Duet the servo pin index is set to "0".

S10 = this parameter tells the Duet which state to set the servo (The BL-Touch Pin) to, in this case the low number "10" tells the probe to deploy (drop) the pin.

Once you have those commands (with the correct parameters) input into the "deployprobe.g" file you can save and exit. You can now open the .g file called "retractprobe.g" file and input the following command with the correct parameters.

M280 P0 S90 ; Retract the BL-Touch Pin

And the Meaning

M280 = this command tells the Duet to set the servo (The BL-Touch Pin) to a specific state.

P0 = this parameter tells the Duet the servo pin index is set to "0".

S90 = this parameter tells the Duet which state to set the servo (The BL-Touch Pin) to, in this case the higher number "90" tells the probe to retract (lift) the pin. You can now save and exit.

To re-cap. Before you carry out the Commissioning & Testing Phase

You should carry out one final sanity/wiring check so as to ensure that the probe has been correctly and securely physically installed on to the printer and that all wiring is secure and cannot be damaged by any printer movement.

You should also double check that your wiring all matches the pictures and that the correct wires are connected to the correct pins BEFORE you begin the Commissioning & Testing Phase.

Commissioning & Testing

To commission, test & adjust the BL-Touch so it is operating and adjusted correctly you first need to home X & Y.

It is considered good practise with a Z probe to home the Z Axis with the nozzle located at the CENTRE of the Bed, so you should have the correct commands and parameters in your home X & Y that send the nozzle to the centre of the bed after X & Y has completed their homing moves.

You should start with the nozzle a safe distance from the print surface (at the very least 100mm away).

When you power up the printer the BL-Touch should perform a "Self-Test" and cycle by deploying and retracting the pin and the LED should be RED.

Home the X & Y axis and then from within the D.W.C interface in the "console" section send the following command and see what happens:

M280 P0 S10 (the full meaning of this command was provided earlier)

This should deploy the probe pin and the Red LED should turn OFF, and the "probe" section in the D.W.C. Interface should display a value of "0" (or N/A).

If this is successful very gently attempt to touch the bottom of the probe pin to try to get the "0" value in the D.W.C Interface to change to a positive value (anything up to 1000) NOTE: due to the sensitivity of the sensor this might not happen even when the sensor is operating correctly.

You can then again send the following command from within the D.W.C interface in the "console" section and see what happens:

M280 P0 S90 (the full meaning of this command was provided earlier)

This should retract the probe pin and the Red LED should turn ON, and the "probe" section in the D.W.C. Interface should again display a value of "0" (or N/A).

If required you can also create a "macro" entitled "Re-Set Probe" this will allow you to re-set the probe is you accidently touch or pull the pin while it is carrying out an action and then you find the probe does not respond.

To do this go to the Marco's section in the DWC and click on the "new file" button and then input the file name as listed above, press OK and then the DWC will open a window where you can input g code in this window insert the following Code:

M280 P0 S160

Most of the Code has already been explained before the only change in this instance is the parameter "S160" which tell the BL-Touch to re-set itself.

Final Adjustment

If all is well you can proceed to the final phase of ascertaining the correct Z axis trigger height, this is arrived at by carrying out a simple test procedure and by editing the Z parameter in the G31 command in the "Z-Probe" section of the config.g file.

It is advisable to carry out this final adjustment with the hot-end and heated bed at their normal operating temperatures, in relation to the temperatures of the materials you print with most.

After the printer has reached the required temperatures home both X & Y, and then place the head/nozzle to the centre of the bed via the D.W.C then from the D.W.C. console send the following command to tell the Duet to allow the Z axis to move even though it has not been homed yet.

M564 H0

And the Meaning.

M564 = this command tells the Duet what to do with regards limiting (or not) limiting an axis even if it has not been homed

H0 = this parameter tells the Duet to allow movement of axes that have not been homed

Now you need to slowly "jog" the Z axis using the "Machine Movement" section in the D.W.C until the nozzle is almost touching the print surface.

So bring the nozzle closer to the bed until you have your desired clearance between the print surface and the nozzle, in this instance you can use the sheet of paper method where you "jog" the nozzle until it "just" grips a normal sheet of A4 print paper. Once this has been achieved you need to send the following command from within the D.W.C interface in the "console" section:

G92 Z0

And the Meaning

G92 = this command tells the Duet to set the position of an axis

Z0 = this parameter tells the Duet to set the position of the Z axis to "0"

This sets the printer to the desired "zero" datum point (with the required clearance from using the paper). With this done you need to move the nozzle AWAY from the Print surface by using the "Machine Movement" section in the D.W.C to "jog" the nozzle for example 5mm, once done you then send the following command to the Duet from within the D.W.C interface in the "console" section:

G30 S-1

And the meaning

G30 = this tells the Duet to carry out a single probe move at the current XY position.

S-1 = this tells the Duet when the probe is triggered, and tells the Duet to not adjust the Z coordinate, but to report the height at which the probe was triggered.

After the **G30 S-1** Command has completed the D.W.C. Will report the trigger height. If the display of the trigger height disappears from the screen too soon, you can check in the "console" for what the trigger height was reported as.

For Example the D.W.C will report the following:

Stopped at height 0.117 mm

This is the FINAL magic number you require to use in the Z parameter of the G31 command in the "Z-Probe" section your config.g file. Open up the config.g file and navigate to the G31 command and change it to read as follows, the original Z parameter was Z3.3 you need to CHANGE it to Z0.117

NOTE YOUR ACTUAL READINGS MIGHT BE DIFFERENT

BEFORE: **G31 X20 Y-10 Z3.3 P25**

AFTER: **G31 X20 Y-10 Z0.117 P25**

Note**:** You should carry out the final adjustment test three or four times to check for repeatability

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You should have now SUCCESSFULLY installed your BL-TOUCH

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If you find that the "squish" of your first layer is not quite right when the print starts and you used the "baby stepping" feature to correct the issue and you wish to make the "baby stepping" adjustment permanent, you can adjust the Z parameter in the G31 command to reflect (and permanently adjust) the height change, the required change can seem counter intuitive.

For example if you found that you were required the lift the nozzle an extra 0.15mm AWAY from the bed to obtain the perfect first layer height and that the current Z parameter in the G31 command was: Z0.117 you need to SUBTRACT 0.15mm from 0.117 to lift the nozzle AWAY from the bed this would result in a new reading of Z -0.033. And if you found you were required to LOWER the nozzle CLOSER to the bed by 0.15mm to get the perfect "squish" of the first layer then the Z0.117 would change to Z0.267