PCL 600

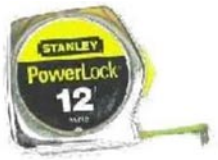
Cutting calibration

Contents

1. Introduction

This procedure applies to the plasma unit Fine focus 800

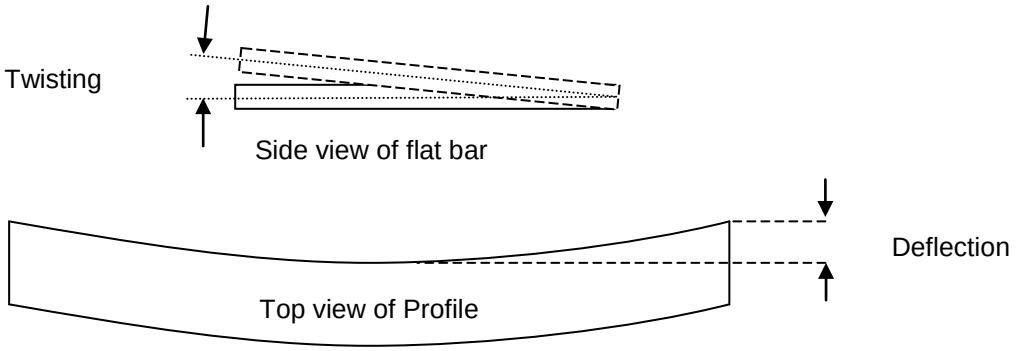
1.1. Tools needed

		
Caliper	Allen Key	Measuring tape

1.2. Select the calibration material

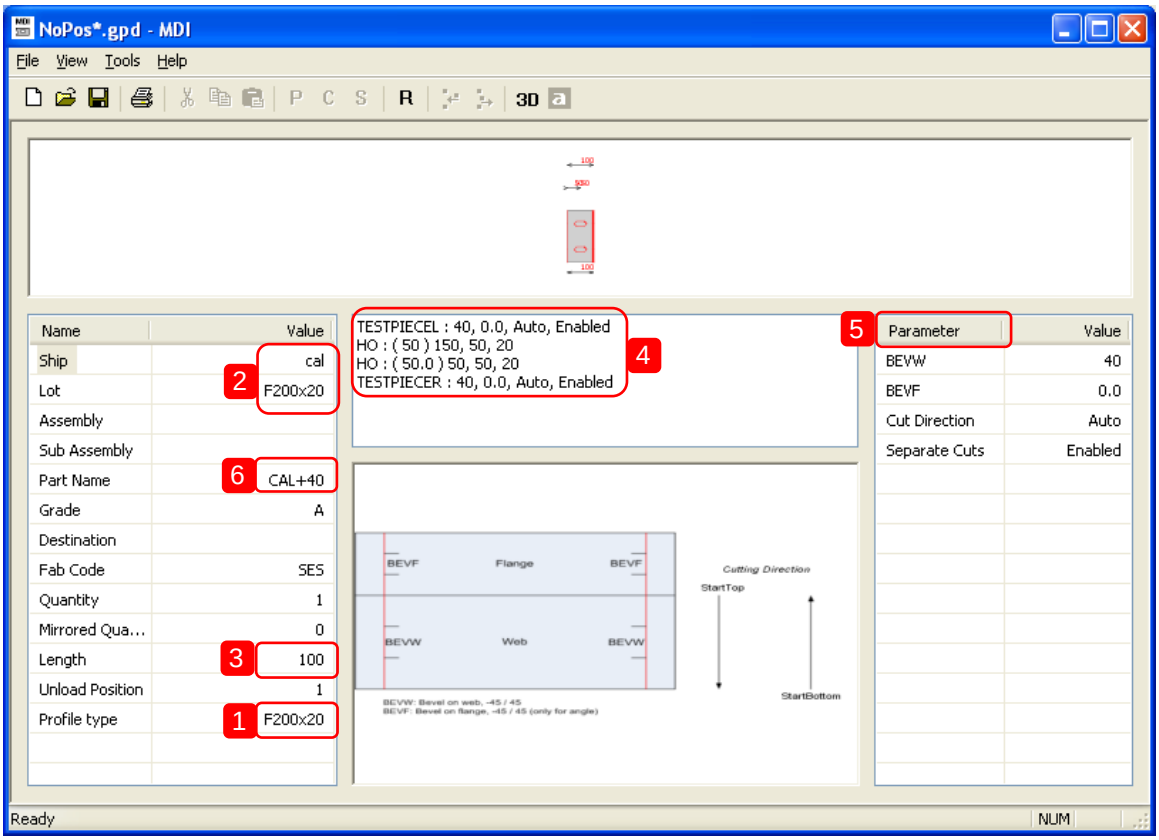
To calibrate the PCL600 you must use FLAT material with the following characteristics:

- Web size = 200 to 300mm
- Thickness = 20 to 25mm
- Max deflection = 0.5mm / m
- Max overall deflection = 3mm
- Max twisting = 0.1 degrees



1.3. Programming of calibration pieces

Three calibration pieces have to be programmed. Start the design program (MDI). In the figure below you see the design program. The red marked fields have to be set.

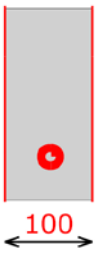


1) Select the profile type according the material you have selected for calibration.

2) Set the following settings:
   Ship = cal
   Lot = F200x20 (the same as the profile type name)

3) Set the length to 100mm
4) Change the left and right end cut macro to “TESTPIECE”

   Remove any TEXT macros and add a *TESTHOLES macro

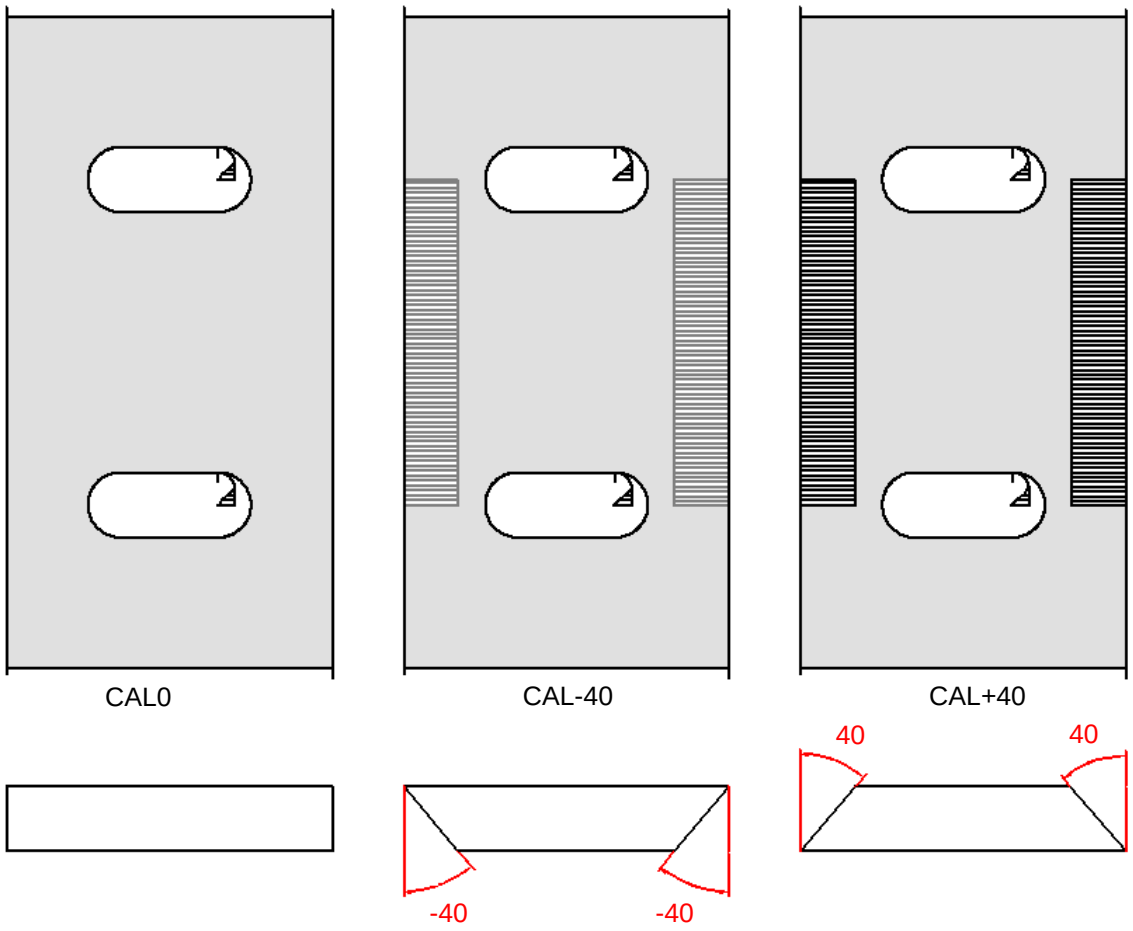
		
TESTHOLES macro	Macro HO	Macro D

*If you don’t have a TESTHOLE macro you have to program one HO or D macro.
HO parameters: (VL = 50, A = 50, B = 20) D parameters: (VL=50, D=20)

5) Create the following data files

	TESTPIECE setting (left and right end cut)	
Part Name	**BEVW**	**BEVF**
CAL0	0.0	0.0
CAL+40	40	0.0
CAL-40	-40	0.0

The three calibration pieces will look like:



*Note: You only have two holes when the TESTHOLES macro has been used. Otherwise you have only one hole.

2. Cutting calibration

The calibration process is operated in several steps:

1) Check machine status
2) Create backup and set default settings
3) Check measurement system
4) Centerline rotation
5) Active frame Y adjustment
6) Active frame X adjustment
7) Calibration based on cutting
    - Tool Z adjustment
    - Active frame Y fine adjustment
    - Active frame X fine adjustment
    - Tool X/Y adjustment

Calibration sequence must be done in the above order.
Sequential steps may require re-calibration of identical parameters.

2.1. Check machine status

- Replace the cathode and nozzle with new ones
- Check the nozzle cap. Replace the nozzle cap when it's damaged (e.g. the opening is not round).
- Make sure that the horizontal and vertical clamps are clean and are opening smoothly.
- The torch has to be mounted at the correct height in the torch holder. Use the calibration pin to verify this.
- Check the oxygen and air pressure
  Oxygen = min. 8 bar
  *Air pressure = min. 7 bar

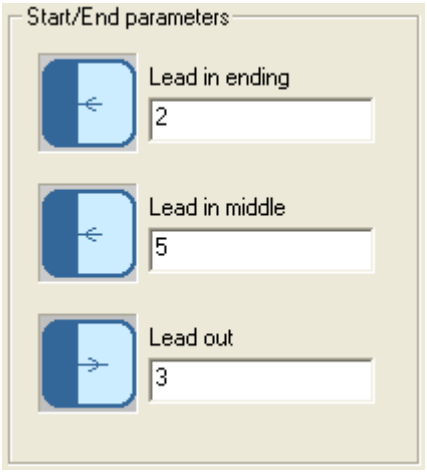
  *Some customers are using an air pressure lower than 7 bar. You have to calibrate the machine with the air pressure used in normal production.

2.2. Create backup and set default values

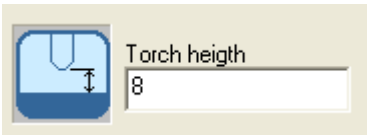
In the next paragraph you are going to change the calibration values. Write down all original values and create a backup copy of the settings folder:

C:\software\settings

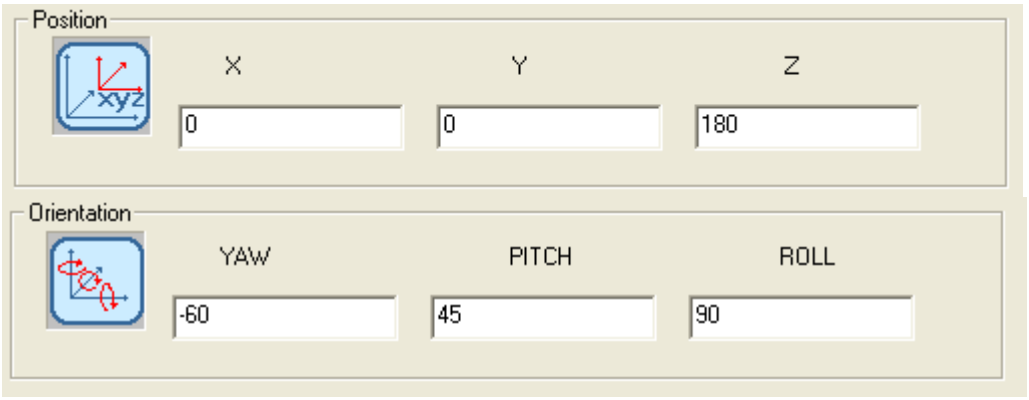
1) Log in as Administrator
2) Start the Settings Editor
3) Open [**Cutting Parameters**], and change the values to:



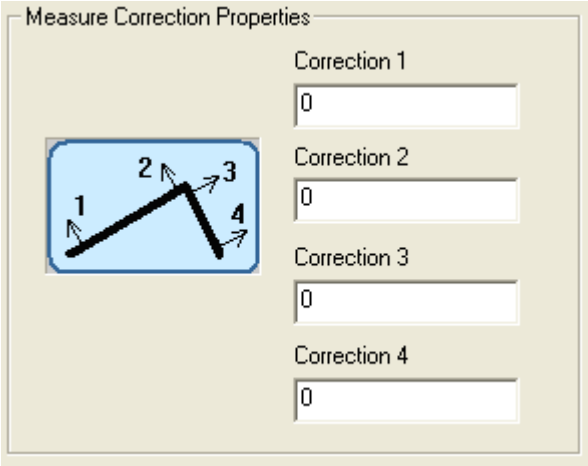
4) Open [**Tool Parameters**], and change the values:



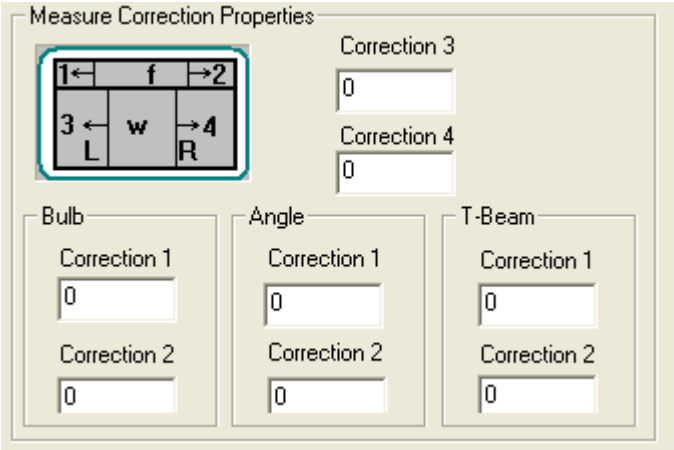
After replacement of the torch or 'torch holder' you may set the 'orientation' and 'position' back to the default values. In other situations it's better to keep the original values.



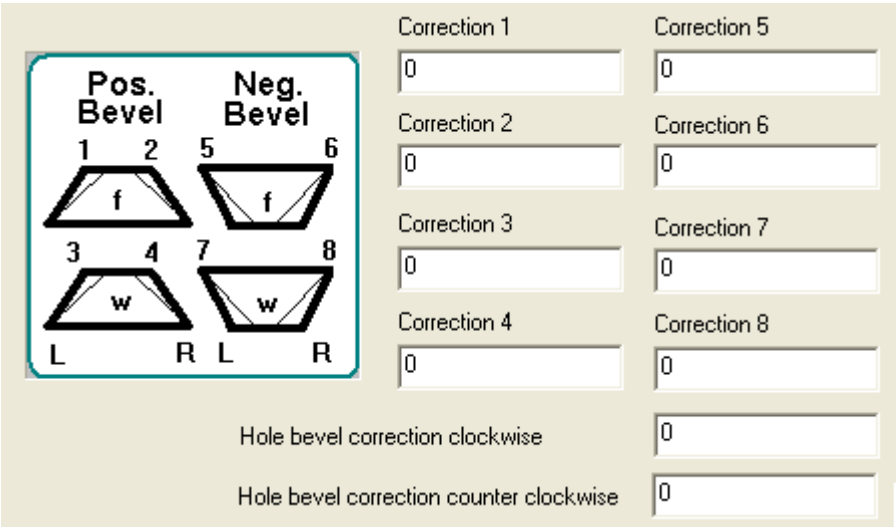
5) Open [**Machine Cutting Adjustments**], and change the values to 0:



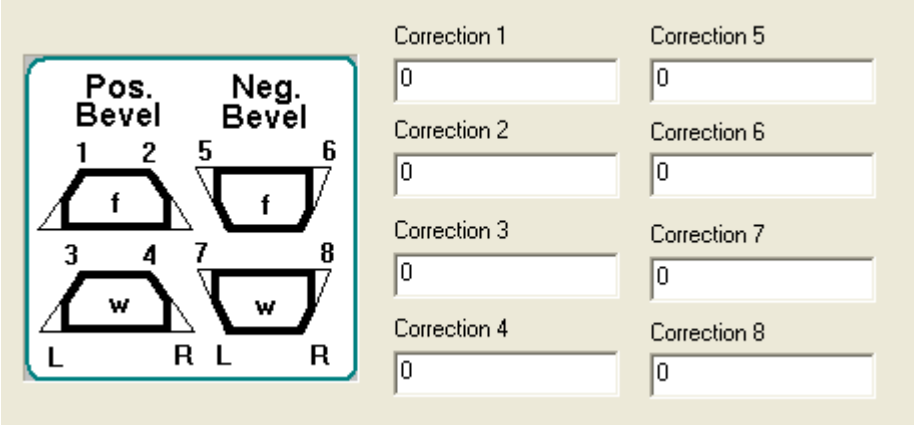
6) Open [**Cutting Alignment**], and change the values to 0:



7) Open [**Bevel Angle Correction**], and change the values to 0:

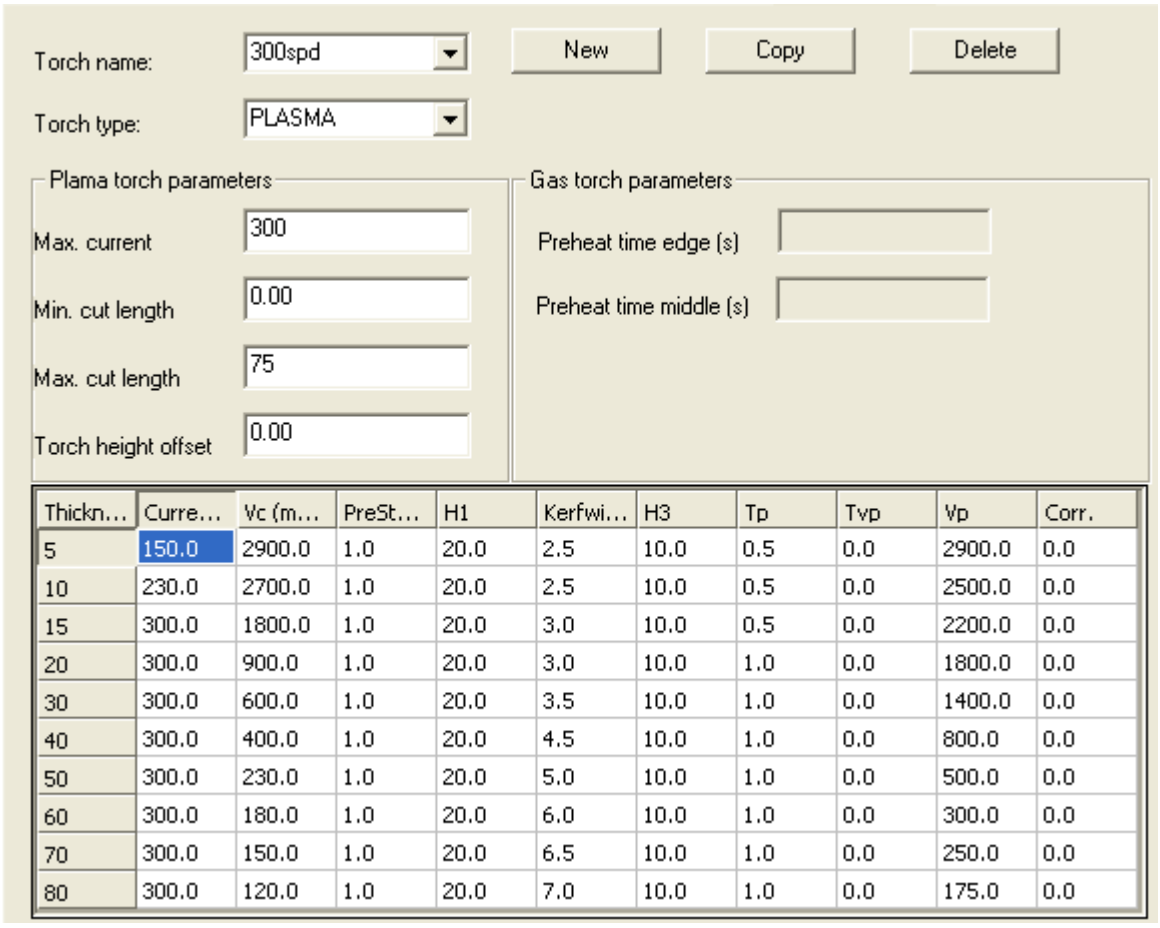


8) Open [**Bevel Melt Correction**]



9) Open [**Torch**], verify the values:

Only change the 'Torch' values to the original value when the machine has never been calibrated before.



Thickn...	Curre...	Vc (m...	PreSt...	H1	Kerfwi...	H3	Tp	Tvp	Vp	Corr.
5	150.0	2900.0	1.0	20.0	2.5	10.0	0.5	0.0	2900.0	0.0
10	230.0	2700.0	1.0	20.0	2.5	10.0	0.5	0.0	2500.0	0.0
15	300.0	1800.0	1.0	20.0	3.0	10.0	0.5	0.0	2200.0	0.0
20	300.0	900.0	1.0	20.0	3.0	10.0	1.0	0.0	1800.0	0.0
30	300.0	600.0	1.0	20.0	3.5	10.0	1.0	0.0	1400.0	0.0
40	300.0	400.0	1.0	20.0	4.5	10.0	1.0	0.0	800.0	0.0
50	300.0	230.0	1.0	20.0	5.0	10.0	1.0	0.0	500.0	0.0
60	300.0	180.0	1.0	20.0	6.0	10.0	1.0	0.0	300.0	0.0
70	300.0	150.0	1.0	20.0	6.5	10.0	1.0	0.0	250.0	0.0
80	300.0	120.0	1.0	20.0	7.0	10.0	1.0	0.0	175.0	0.0

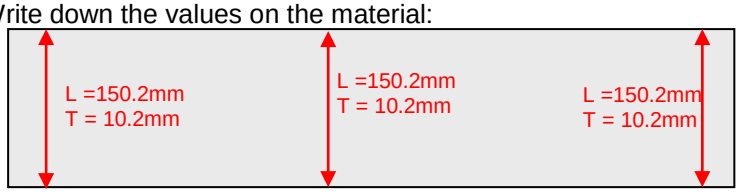
2.3. Calibration of the clamps

To verify the accuracy of the measurement clamps you need a flat bar with the following characteristics:

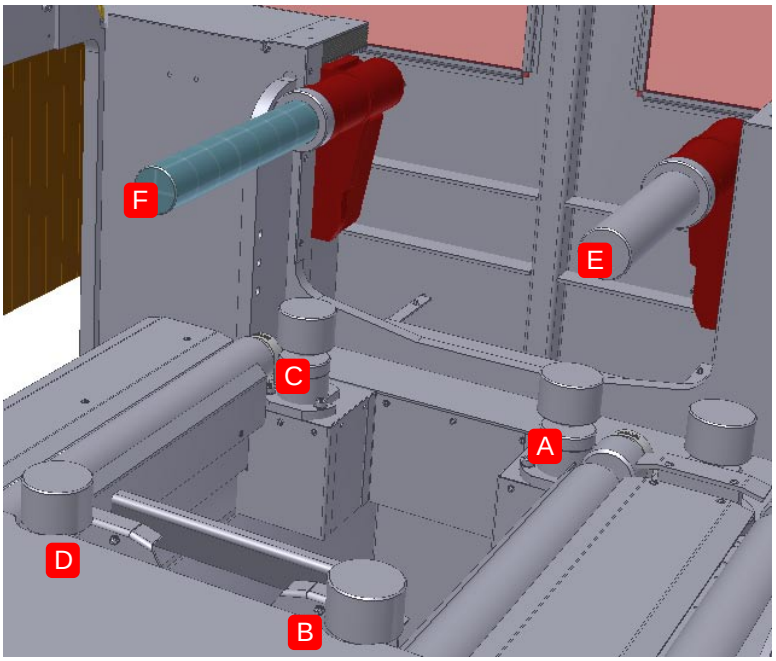
- Web size 100..200mm
- Web thickness 8..15mm
- Length 600..1000mm
- You should be able to lift the material by hand

Measure the flat bar with a caliper. Measure the web size and thickness on different locations. Try to read the caliper with an accuracy of 0.1mm.

Write down the values on the material:

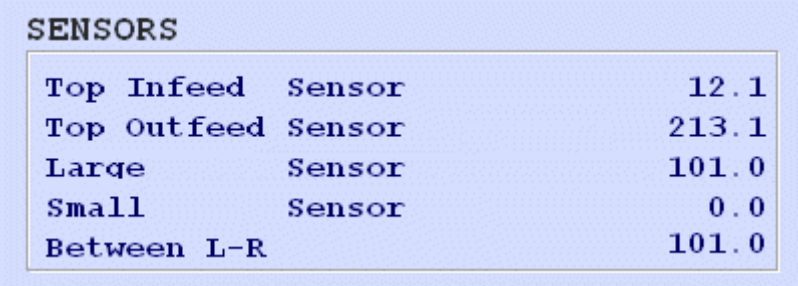


2.3.1. The clamps

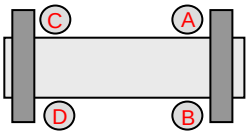


Clamp A	Horizontal clamp, infeed side (short stroke)
Clamp B:	Horizontal clamp, infeed side (long stroke)
Clamp C	Horizontal clamp, outfeed side (short stroke)
Clamp D:	Horizontal clamp, outfeed side (long stroke)
Clamp E:	Vertical infeed clamp
Clamp F:	Vertical outfeed clamp

The measurement values on the screen:



1) Place the material between the four clamps



Compare the measurement values on the screen with values measured with the caliper. You can change the measurement by changing the values in the settings file [*calibration.ini]*:

TAG in calibration.ini	Corresponds to:
LeftScaleCorr	Horizontal clamp
TopScaleCorrInf	Vertical infeed clamp
TopScaleCorrOutf	Vertical outfeed clamp

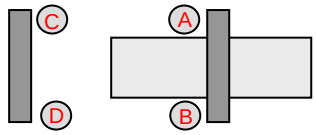
* Increase the value to increase the measured value

After changing the calibration.ini file you need to:

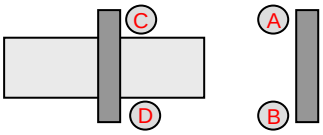
- restart the machine software
- verify the clamp measurement

2) Verify the clamp measurement for the following situations:

Material between the infeed clamps:



Material between the outfeed clamps:

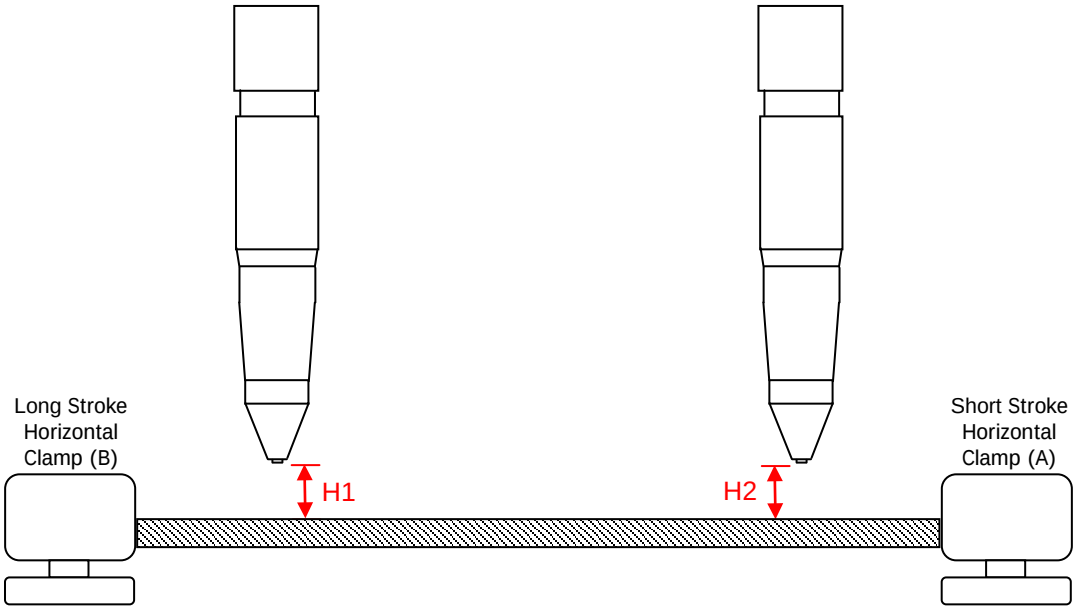


The difference in measurement between the infeed and the outfeed clamps should be within 0.5mm.

2.4. Centerline rotation

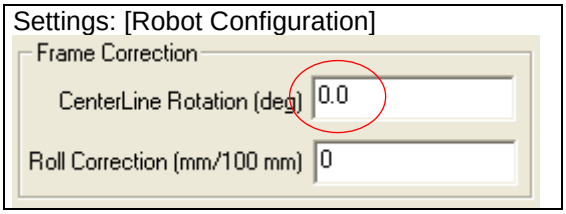
During cutting it is very important that the distance between the torch and the material remains the same. By dry-cutting the test piece CAL0.GPD we can verify this distance. Make a dry run over the material and check the distance between torch and material at the web. You can use Allen keys to measure the distance. In order to make the correct adjustments you need to be absolutely sure the material you use is straight.

1) Load the material you have selected in paragraph 1.2
2) Select CAL0.gpd
3) Prepare the machine to make a “Dry Run” (no real cutting)
4) Measure the distance between nozzle and material at the following locations:
    - Begin of the cut
    - End of the cut
5) Compare the measured values. You have to change the centerline rotation when the two values are different (differences more than 0.5 mm should be corrected). You can measure on different locations on the material to compensate material deviations (use move cut).

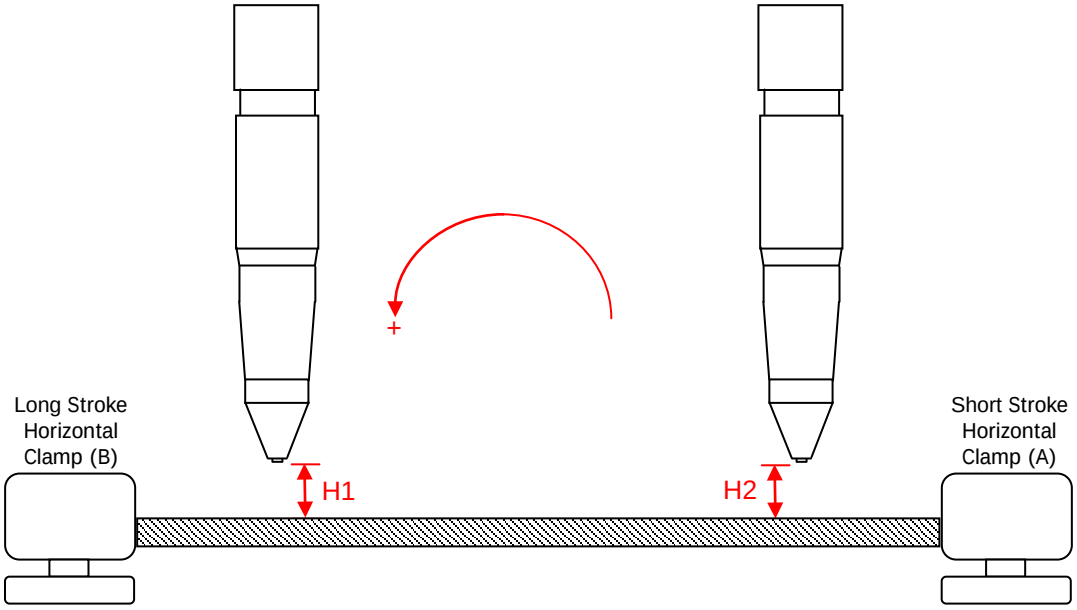


2.4.1. Centerline rotation adjustment

Settings: [Robot Configuration]

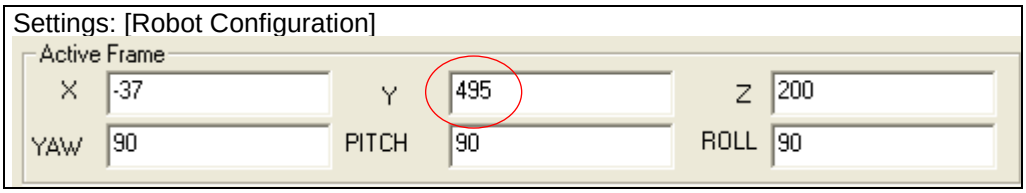


During cutting the torch height over the web should remain the same. If not, you need to make corrections under 'Robot configuration'. A positive centerline rotation will bring the torch closer to the material at the 'Long Stroke Horizontal Clamp (B/D)', see picture below

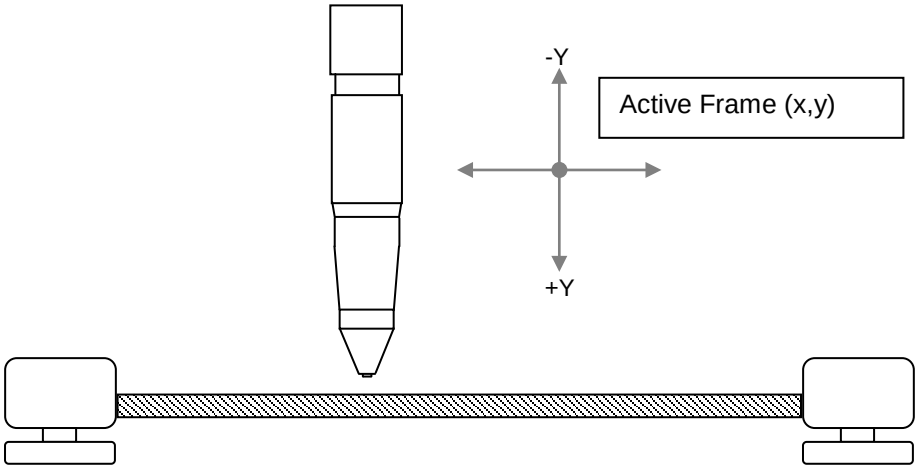


2.5. Active frame Y adjustment

The torch height has to be 8mm at the web and at the flange. If not you need to make corrections under ‘Robot configuration’

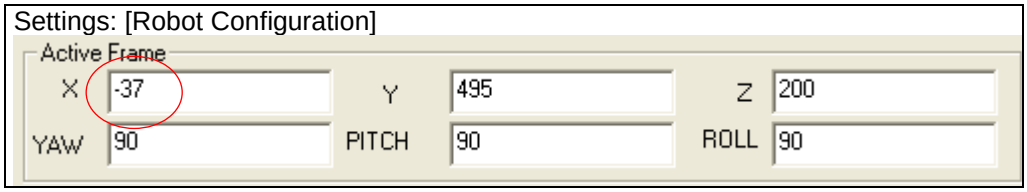


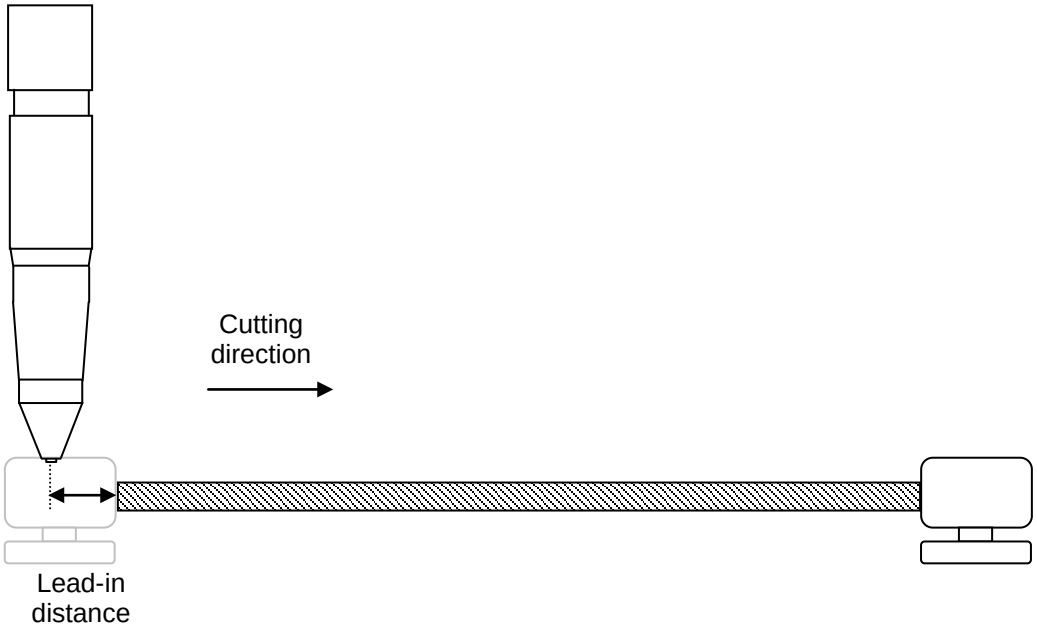
In the picture below you can see how the active frame parameters affect the torch position in respect to the material. The distance between the nozzle and material is determined by the Y-direction. If you increase the ActiveFrameY the torch will come closer to the material.



2.6. Active frame X adjustment

1) Select CAL0.gpd
2) Prepare the machine to make a “Dry Run” (no real cutting)
3) The distance between the middle of the nozzle and the edge of the material has to be 2mm (the lead-in length).
4) If necessary you can correct the distance by changing the ActiveFrameX value. If you decrease this value the torch will move towards the ‘Long Stroke Horizontal Clamp (B/D)’.





2.7. Calibration based on cutting

Always check the clamp measurements during cutting.
Only use a caliper to measure calibration pieces.
The material length during the calibration process should be at least 3m at all time.

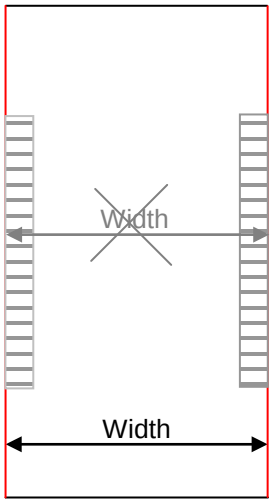
2.7.1. Tool Z calibration

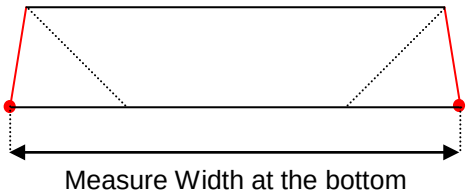
In order to calibrate the torch and 'torch holder' you need to cut calibration pieces with a bevel of +/- 40**º.** A positive bevel of 40° will force the robot to cut the first cut of a calibration piece in a positive pose and the second cut in a negative pose. (See paragraph 5 for more information on robot poses)

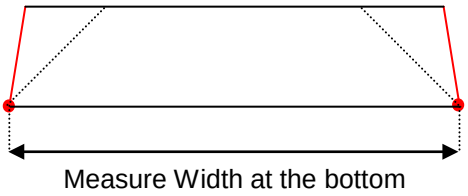
Different robot poses will affect the dimensions of the calibration piece when the tool is not calibrated correctly.

Changes in the tool calibration will also affect the active frame calibration. You may have to re-adjust the active frame again after tool calibration.

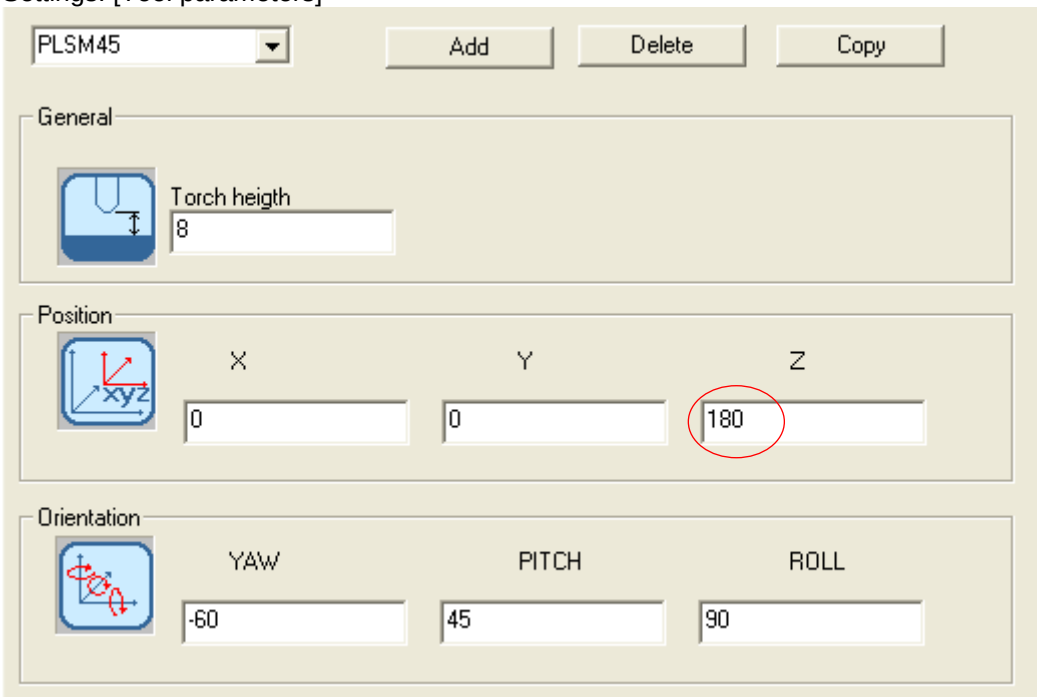
1) Cut part CAL-40.GPD
2) Cut part CAL+40.GPD
3) Measure the width of the parts (at the non beveled area). See the picture below how to measure.
4) Calculate the difference in width between the two parts.
5) Correct the tool Z value with ¼ of the difference. If you increase Z the straight section of the piece with +40° bevel will become bigger.
6) Repeat this procedure until the WIDTH of the parts is the same.





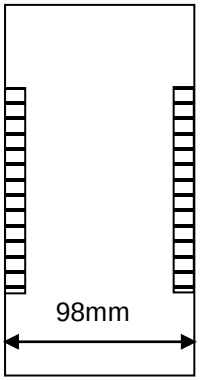


Settings: [Tool parameters]

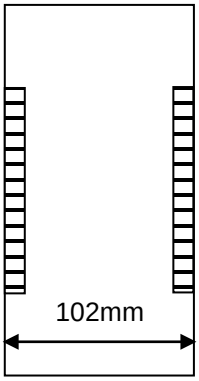


Example tool Z correction

CAL+40.GPD



CAL-40.GPD



The +40° bevel calibration piece has a width of 98mm
The -40° bevel calibration piece has a width of 102mm
The difference is 4mm, this means you have to make a correction of 1mm.
You need to decrease the Tool Z parameter since the +40° bevel calibration piece is too big.

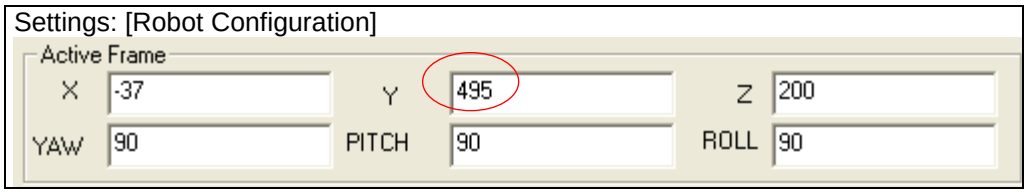
2.7.2. Active frame Y adjustment based on cutting

Tool Z calibration has to be correct before you continue.

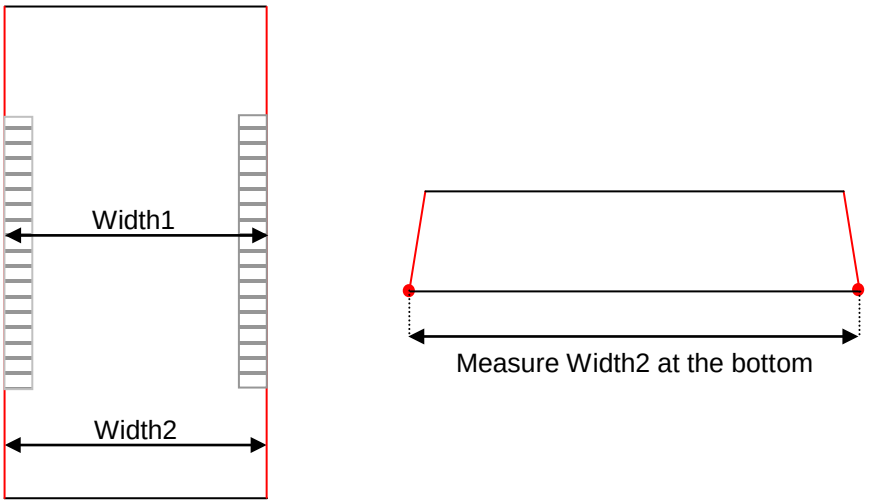
The next step is to make fine adjustments to the active frame based on actual cutting.

1) Cut part CAL+40.GPD
2) Cut part CAL-40.GPD
3) Compare the width of the beveled cut (Width1) with the width with no bevel (Width2).

   Width1 > Width2 ==> Increase the Active frame Y
   Width2 > Width1 ==> Decrease the Active frame Y



4) Repeat this procedure until Width1 and Width2 are the same



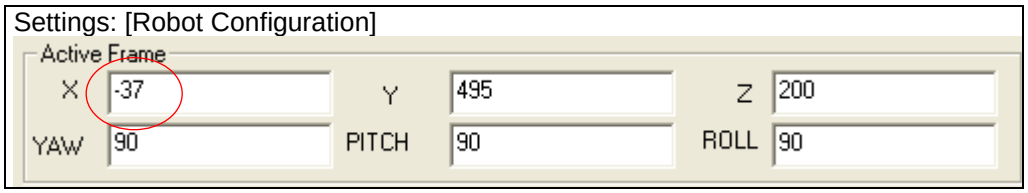
2.7.3. Active frame X adjustment based on cutting (with TESTHOLES)

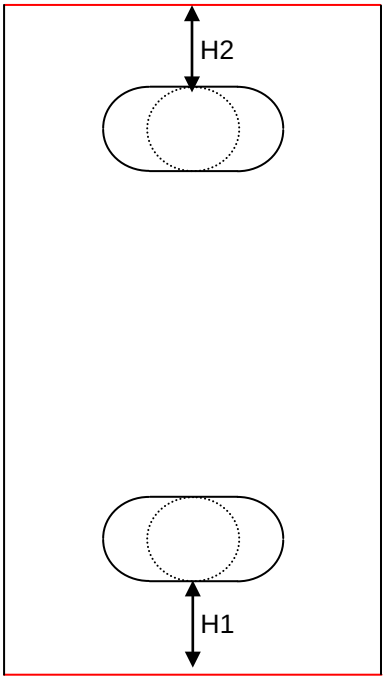
If you don't have the TESTHOLES macro you should continue the procedure at: *2.7.4 Active frame X adjustment based on cutting (with macro HO / macro D)*

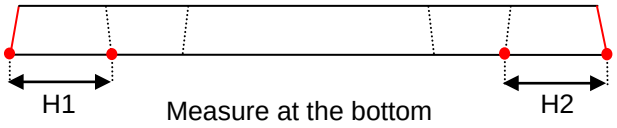
1) Select part CAL0.GPD
2) Check clamp measurements height / width
3) Verify that the hole is cut Counter Clock Wise (CCW).
4) Measure the offset from the edge (H1)
5) Measure the offset from the edge (H2)
6) Offset H1 should be the same as offset H2. You have to change the active frame X when they are not the same

   If you want the decrease H1 (or increase H2), you have to decrease the ActiveFrameX.

7) Repeat this procedure until H1 and H2 are the same







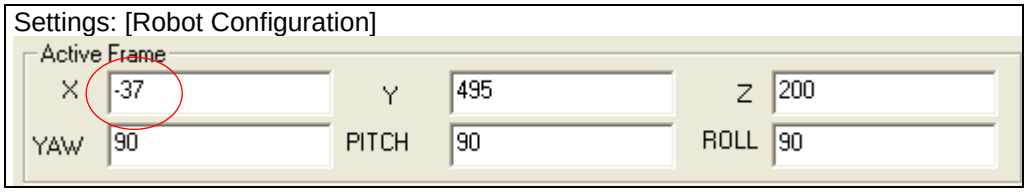
2.7.4. Active frame X adjustment based on cutting (with macro HO / macro D)

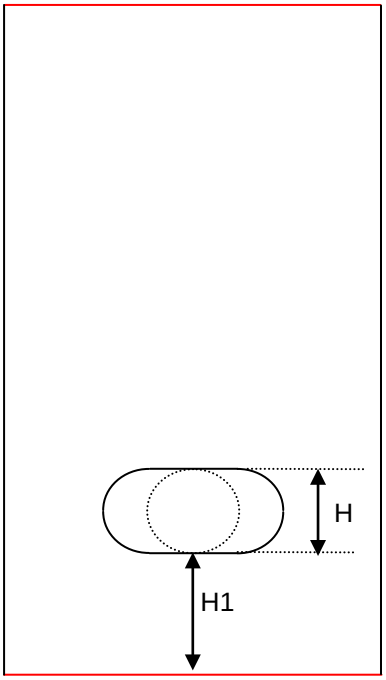
You only should perform this step when you have programmed the testpiece with macro HO or macro D. If you have used the TESTHOLES macro then you should continue the procedure at: *0 Tool X,Y* parameter

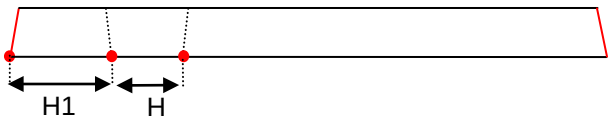
1) Select part CAL0.GPD
2) Check clamp measurements height / width
3) Verify that the hole is cut Counter Clock Wise (CCW).
4) Measure the Height of the hole (H)
5) Measure the offset from the edge (H1)
6) Calculate the middle of the hole: Hm = H1 + ½H
7) Hm should be 50. You have to change the active frame X when Hm is not 50.

   If you want the decrease H1, you have to decrease the ActiveFrameX.

8) Repeat this procedure until H1 is 50





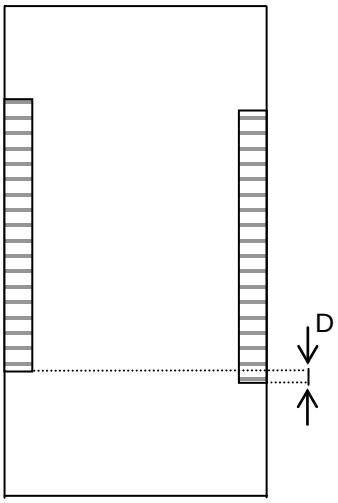


Measure at the bottom

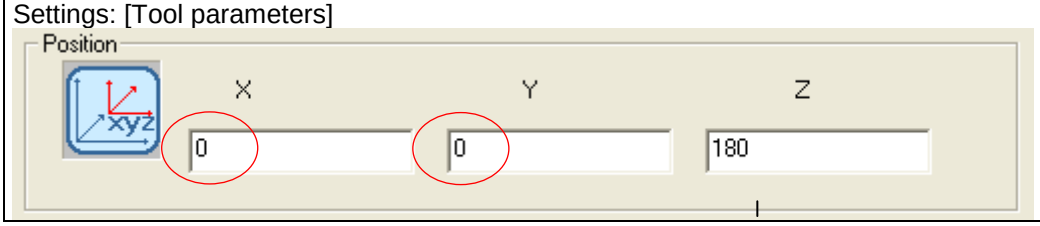
2.7.5. Tool X,Y parameter

The tool X,Y parameters affect the torch position perpendicular to the material (in cutting direction of the test pieces). If the lead-in distance to the material for the first and second web cut of the +40° calibration piece is not the same you need to correct the Tool X,Y parameters.

1) Cut CAL+40.GPD
2) If the left and right end cut are not symmetrical (D > 0), you have to modify the tool XY parameter.



Settings: [Tool parameters]



The tool X and Y parameters are linked and therefore they have to be modified as a pair, the ration between X and Y must always be +0.577, the sign of X and Y must be the same:

Mathematical Y = X*Tan(30)

If you program a positive value for X and Y and cut a the piece with +40° bevel, the torch will move away from the flange side (towards the long stroke clamping rolls) for the first and the torch will move in opposite direction for the second cut.

The actual distance the start point moves =1.15*X (mathematical X/cos(30))

3. Process parameters for the PCL machine

For the best quality HGG advices to use the following default parameters for the machine. These parameters have to be used for normal construction steel.

3.1. Torch (Speed table)

Only change the 'Torch' values to the original value when the machine has never been calibrated before.

Torch name: 300spd | New | Copy | Delete

Torch type: PLASMA

Plama torch parameters

Max. current: 300

Min. cut length: 0.00

Max. cut length: 75

Torch height offset: 0.00

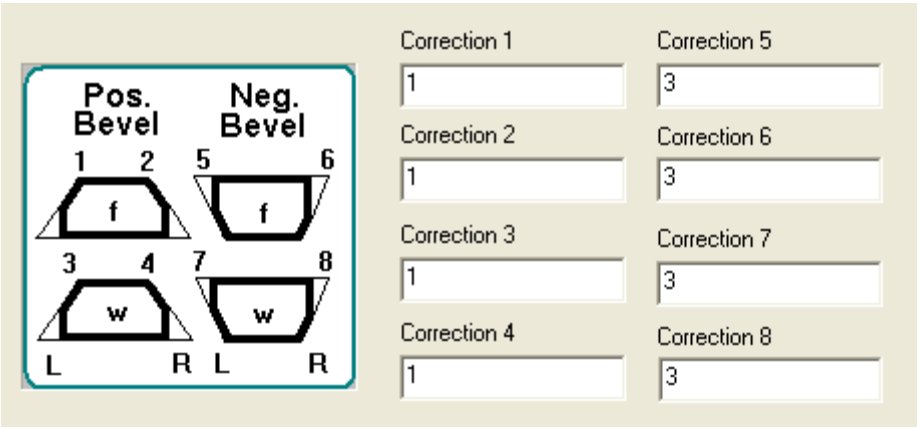
Gas torch parameters

Preheat time edge (s):

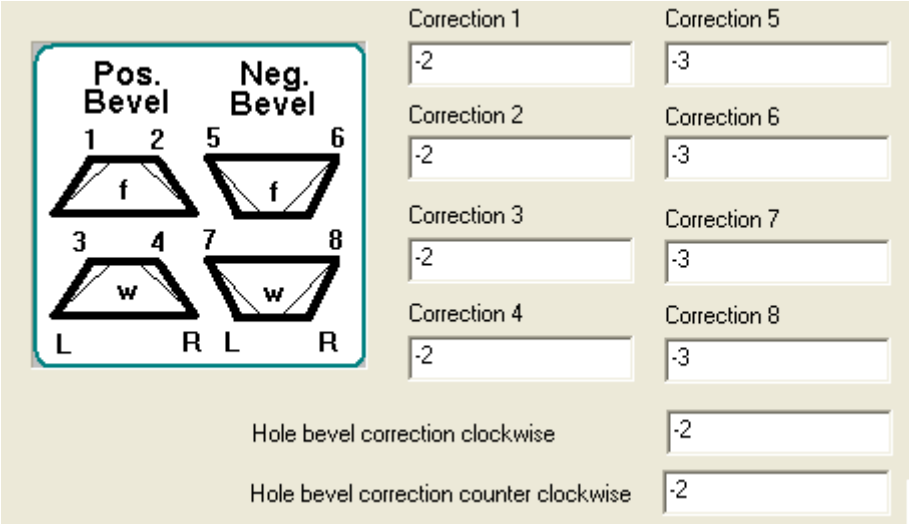
Preheat time middle (s):

Thickn...	Curre...	Vc (m...	PreSt...	H1	Kerfwi...	H3	Tp	Tvp	Vp	Corr.
5	150.0	2900.0	1.0	20.0	2.5	10.0	0.5	0.0	2900.0	0.0
10	230.0	2700.0	1.0	20.0	2.5	10.0	0.5	0.0	2500.0	0.0
15	300.0	1800.0	1.0	20.0	3.0	10.0	0.5	0.0	2200.0	0.0
20	300.0	900.0	1.0	20.0	3.0	10.0	1.0	0.0	1800.0	0.0
30	300.0	600.0	1.0	20.0	3.5	10.0	1.0	0.0	1400.0	0.0
40	300.0	400.0	1.0	20.0	4.5	10.0	1.0	0.0	800.0	0.0
50	300.0	230.0	1.0	20.0	5.0	10.0	1.0	0.0	500.0	0.0
60	300.0	180.0	1.0	20.0	6.0	10.0	1.0	0.0	300.0	0.0
70	300.0	150.0	1.0	20.0	6.5	10.0	1.0	0.0	250.0	0.0
80	300.0	120.0	1.0	20.0	7.0	10.0	1.0	0.0	175.0	0.0

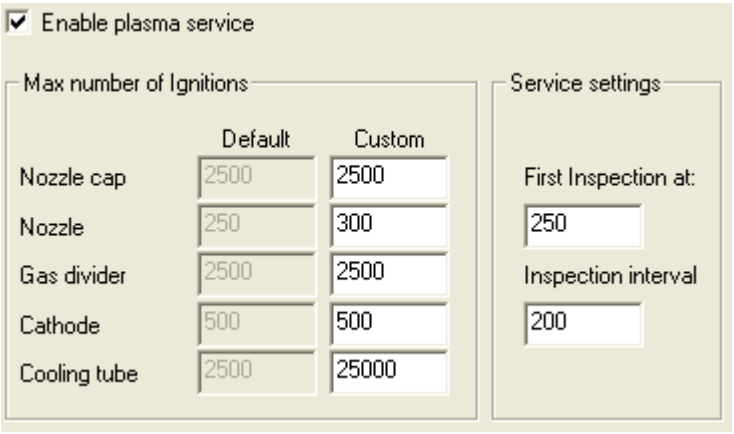
3.2. Bevel Melt Correction



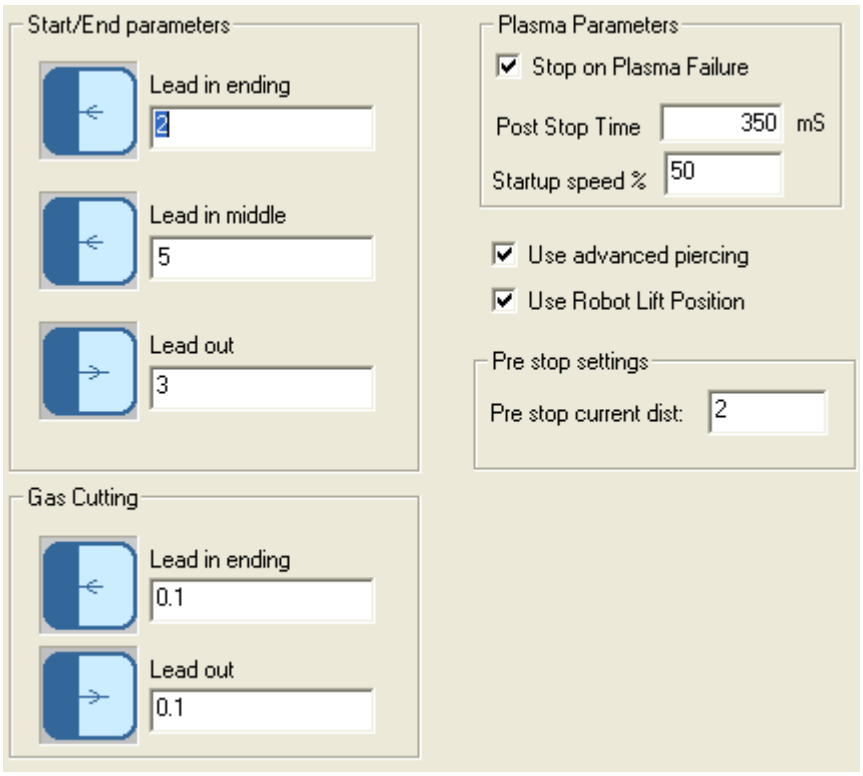
3.3. Bevel Angle Correction



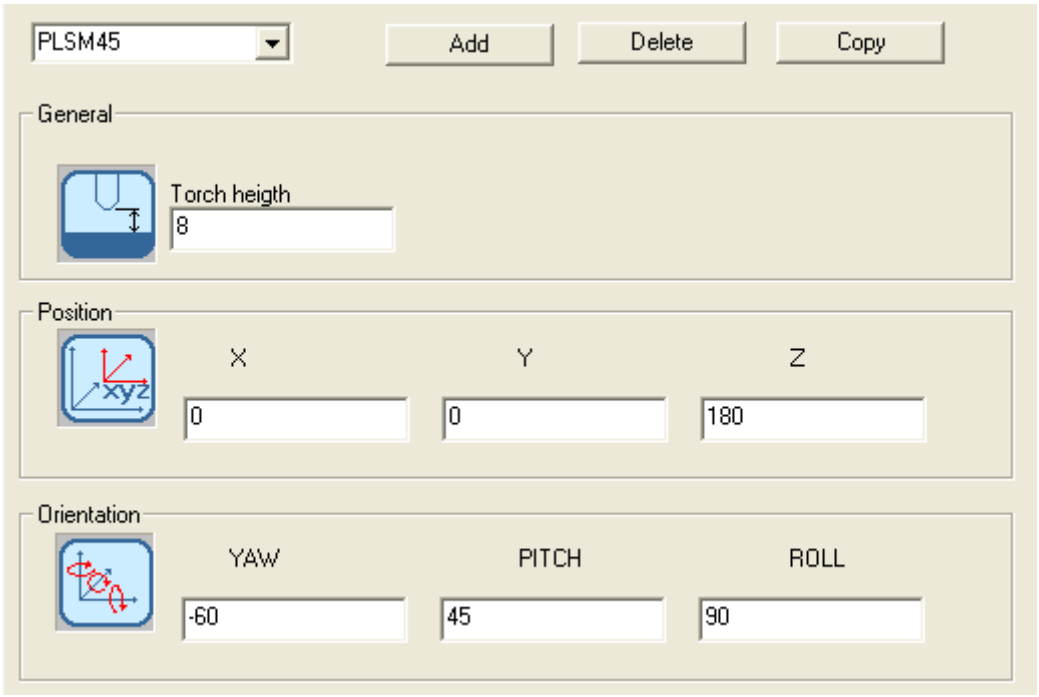
3.4. Plasma Service Configuration



3.5. Cutting parameters



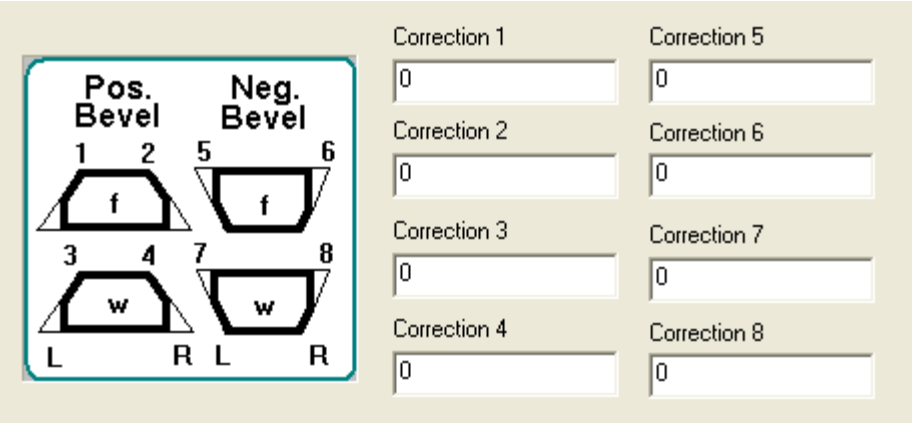
3.6. Tool parameters



4. Plasma cutting corrections explained

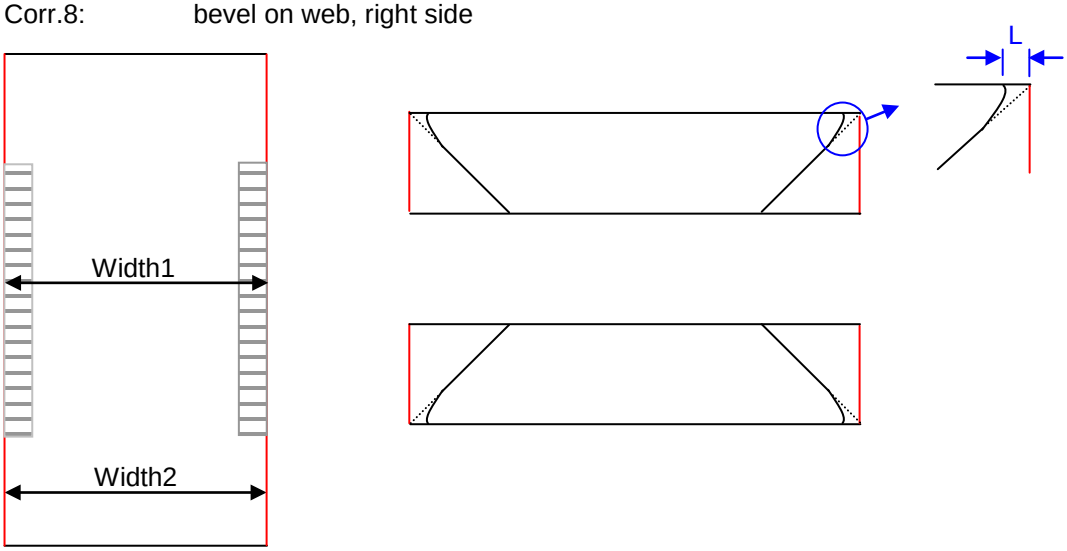
4.1. Bevel melt correction

For plasma cutting it is normal that the sharp edge of the cut slightly melts away. This applies mostly to the topside of the material for negative bevels. In some cases also the bottom side of a positive bevel might melt. This can be corrected in the ‘Bevel melt corrections parameters’.



Corrections for positive bevels:
Corr.1: bevel on flange, left side
Corr.2: bevel on flange, right side
Corr.3: bevel on web, left side
Corr.4: bevel on web, right side

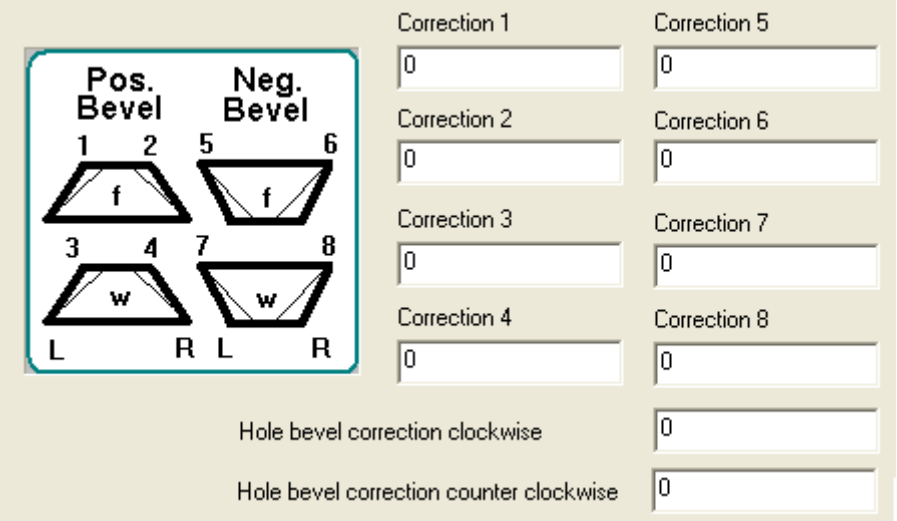
Corrections for negative bevels:
Corr.5: bevel on flange, left side
Corr.6: bevel on flange, right side
Corr.7: bevel on web, left side
Corr.8: bevel on web, right side



You should increase the related correction if width1 is smaller than width2. Only evaluate test pieces that have good cut quality.

4.2. Bevel angle correction

For plasma cutting it is normal that the cutting curve is not exactly straight. The results in a small bevel angle for straight cuts and a small bevel deviation for bevel cuts. Individual corrections can be made for web and flange, left and right end cuts and for holes.



Corrections for positive bevels:
Corr.1: cut on flange, left side
Corr.2: cut on flange, right side
Corr.3: cut on web, left side
Corr.4: cut on web, right side

Corrections for negative bevels:
Corr.5: cut on flange, left side
Corr.6: cut on flange, right side
Corr.7: cut on web, left side
Corr.8: cut on web, right side

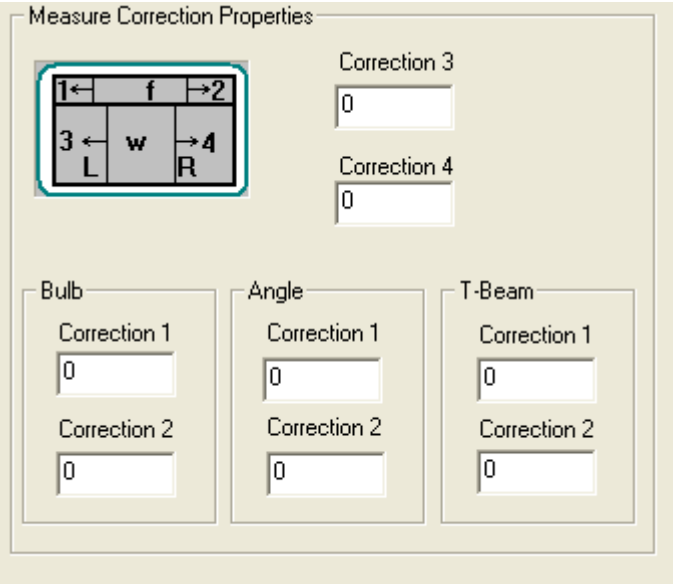
The bevel angle correction will be added to the programmed bevel.

Actual cutting angle = programmed bevel + correction

Programmed bevel	correction	Actual cutting angle
0	2	2
0	-2	-2
30	2	32
30	-2	28
-30	2	-28
-30	-2	-32

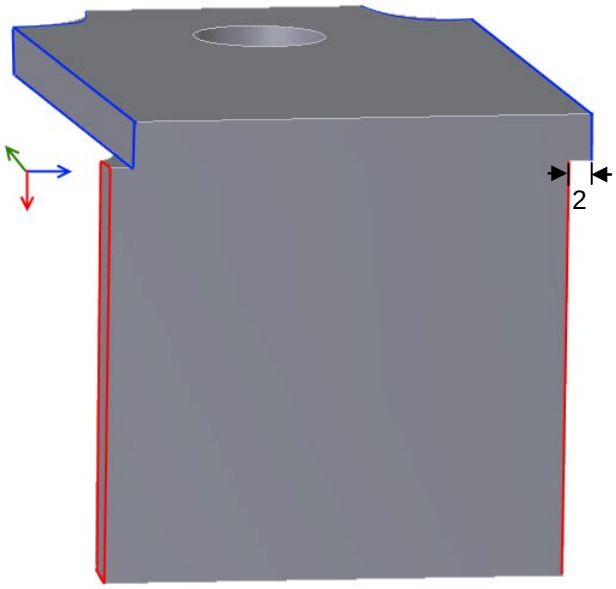
4.3. Cutting alignment:

In case the web and flange cuts are not in line you and the machine is calibrated you need to adjust the cutting alignment. In normal situations you don't have to use the cutting alignment settings.



Correction1: flange cut, left side
Correction2: flange cut, right side
Correction3: web cut, left side
Correction4: web cut, right side
*On some machine you can adjust correction 1 & 2 for different material types.

Example:



The web cut (blue) should be inline with the flange cut (red). To correct this situation you have to set:
- Correction1 = +2
- Correction2 = -2

4.4. Speed / current table

If the machine is calibrated you can make fine adjustments to the speed table. The following parameters are very important when it comes to cutting quality.

- current (Ampere)
- cutting speed (mm/min)
- kerf width

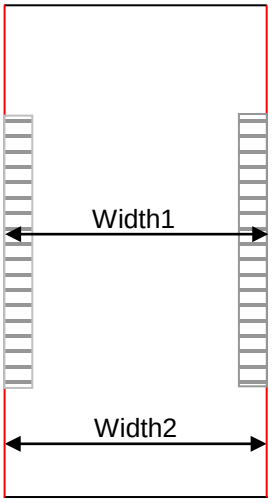
These settings are related to the wall thickness of the material.

Settings: [Torch]

Thickn...	Curre...	Vc (m...	PreSt...	H1	Kerfwi...	H3	Tp	Tvp	Vp	Corr.
5	150.0	2900.0	1.0	20.0	2.5	10.0	0.5	0.0	2900.0	0.0
10	230.0	2700.0	1.0	20.0	2.5	10.0	0.5	0.0	2500.0	0.0
15	300.0	1800.0	1.0	20.0	3.0	10.0	0.5	0.0	2200.0	0.0
20	300.0	900.0	1.0	20.0	3.0	10.0	1.0	0.0	1800.0	0.0
30	300.0	600.0	1.0	20.0	3.5	10.0	1.0	0.0	1400.0	0.0
40	300.0	400.0	1.0	20.0	4.5	10.0	1.0	0.0	800.0	0.0
50	300.0	230.0	1.0	20.0	5.0	10.0	1.0	0.0	500.0	0.0
60	300.0	180.0	1.0	20.0	6.0	10.0	1.0	0.0	300.0	0.0
70	300.0	150.0	1.0	20.0	6.5	10.0	1.0	0.0	250.0	0.0
80	300.0	120.0	1.0	20.0	7.0	10.0	1.0	0.0	175.0	0.0

4.5. Kerf width

Only change the kerf width when the machine is calibrated. Incorrect calibration may lead to unpredictable cutting quality.



If the width1 and width2 of a test piece is too small you have to increase the kerf width.

5. Robot poses

Depending on the actual cutting angle the robot will select one of 3 poses

1) neutral pose
2) positive pose
3) negative pose

5.1. Neutral pose

Neutral pose for small cutting flat bar, angle range –20 to +20

Neutral pose, cutting angle=0°

Neutral pose, cutting angle=0°

Neutral pose, cutting angle=-30°

Neutral pose, cutting angle=+30°

5.2. Positive pose

Positive pose for cutting angles towards the infeed side, angle range -5 to +45

Positive pose, cutting angle=0°

Positive, cutting angle=+40°

5.3. Negative pose

Negative pose for cutting angles towards the outfeed side, angle range +5 to -45

Negative pose, cutting angle=0°

Negative pose, cutting angle=+40°

Appendix A: Active frame axis definition