Troubleshooting Guide: When Your Tool Is Not Moving the Correct Distance

(Settings for Motors, Pinions, and Unit Values)

Potential problems

If your machine is not moving the correct distance (i.e. you tell it to move 10” in the X axis and it does not move exactly 10”) there could be several problems present.

- Your rack and pinion may be worn or the pinion gear may not be completely engaged in the rack. This should be checked before proceeding with this document. Please refer to ShopBot Docs/Maintenance/Mechanical Troubleshooting and do the first test. If it fails, work through that document first before proceeding with this one.
- The default setting in ShopBot 3 may be incorrect for your tool type. We will walk you through double checking that you are using a file that matches your tool (i.e. Using a Desktop setting file to run a PRSalpha tool will not work correctly).
- Your tool may not match the default motor and pinion configuration. This usually only happens if you have replaced a motor or pinion, have acquired a tool from someone other than us, or ordered a custom tool. We will walk you through how to determine correct settings for these tools.

Shopbot Contact Info

ShopBot Tools, Inc
3333B Industrial Dr
Durham, NC 27704
919-680-4800 or 888-680-4466
www.shopbottools.com

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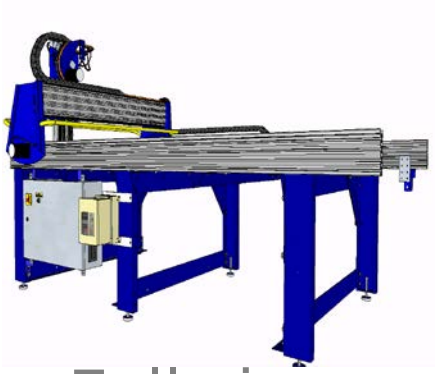
Solution 1: Identifying your ShopBot and loading the default settings

Identifying by general appearance

PRS ShopBots

Manufacturing dates: approximately 2007 to present

- The PRS (Personal Robotic System) has a large aluminum beam in the rolling gantry.
- The full size tool and the ShopBot Buddy® come in both alpha and standard configurations.
- Alpha control boxes are larger, and the serial number begins with PRSA.
- Standard control boxes are smaller and the serial number begins with PRS-S.



Full size

Full size tool with an alpha control box.

Buddy

ShopBot Buddy® tool with a standard control box.

Desktop

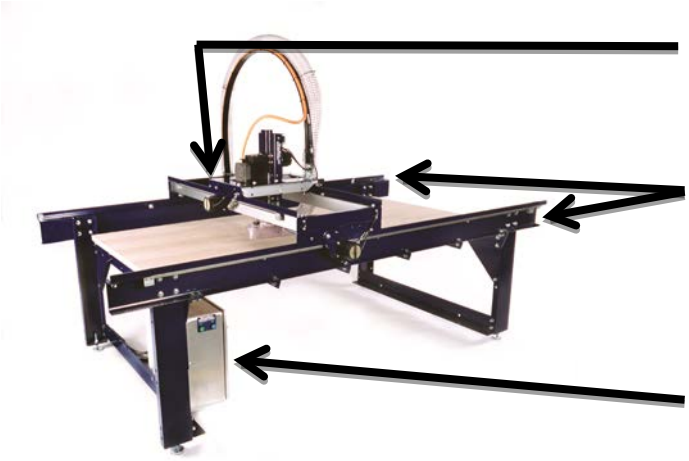
Handibot

Desktop and Handibot units with integrated control boxes.
These only come in standard configuration.

PRT ShopBots

PRT (Personal Robotic Tool) ShopBots have blue powder-coated rails with a double rail, horizontally mounted gantry. (see photo below)

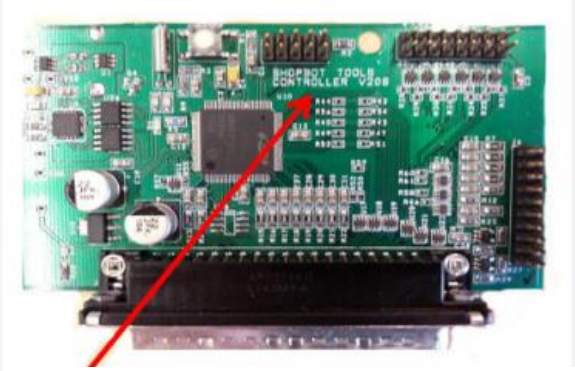
- PRTalpha tools have a large square aluminum control box with start and reset buttons integrated into the side.
- PRTstandard and V4G tools have a computer tower as the control box.
- PRTstandard tools with the RBK upgrade have the PRSstandard control box as shown on the ShopBot Buddy image on page 3.



A PRTstandard control box, which looks like a PC computer tower. These can also be black.

Identifying your machine by its control card

The control card is an essential part of your ShopBot and will determine the version of the control software your machine will support. It is also important information to provide for technical support and can be used to help identify your machine.



Version designation for “V2xx” found here.

V2xx cards

If your control box was built after 2010 or you have requested a new controller card, you probably have a **V2xx** card.

Used in:

- PRS tools built after 2010
- PRTalpha (if retrofitted)
- PRT with V4G or RBK upgrades after 2010
- PR with RBK upgrade

The control box with this version installed is connected to your computer by a USB cable with no USB to serial adapter.

XXPLOR52 cards

If your control box was built after June 2000 and before 2010 and have not upgraded your controller card, you probably have the XPLOR52 controller card.

Used in:

- PRS before 2010
- PRTalpha
- PRTstandard
- PRT with V4g or RBK upgrade before 2010

If you have a short USB to serial adapter coming off of the control board you likely have the XPLOR52 controller card. This is easily identified by looking for the ribbon cable shown.

XPLOR32 cards

Used in:

- PR ShopBots without RBK upgrades.

Tools built before 2000 are PR ShopBots and have a control board that looks like this. These use a serial cable and require a DOS-based operating system earlier than Windows XP, such as Windows 95 or Windows 98.

Note: If you have a PR/PRT tool without an upgrade and have issues with unit values, upgrading to the RBK system has many virtues, some of which is the ability to adjust driver stepping and use modern operating systems. Please refer to the document on the website for further details.

Shopbottools.com > ShopBot Docs > Accessories and Upgrades > Control Board Upgrades > Reasons to Upgrade to RBK Drivers.

http://www.shopbottools.com/ShopBotDocs/files/RBK%20Reasons%20to%20Upgrade.pdf

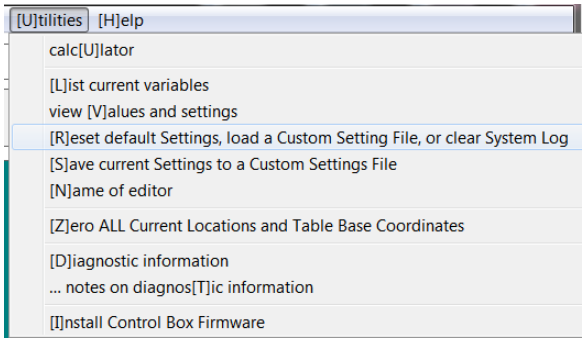
I cannot identify my ShopBot

If you need help identifying your machine please call in or email ShopBot support at 919 680 4800 or support@shopbottools.com.

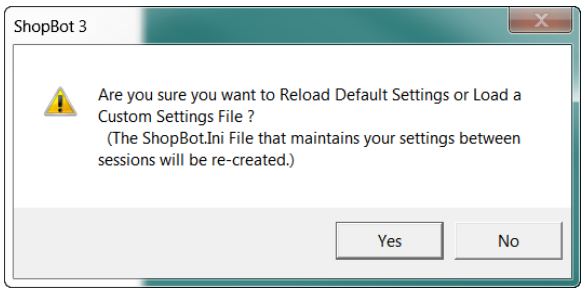
Be prepared to answer the following questions:

- What does your control box look like?
- What type of motors do you have? See section 2 for more information.
- What is the serial number of your machine? Check the control box or the circuit board inside for a white sticker that says “ShopBot controls”.
- Are the rails mounted on an aluminum extrusion or are they blue powder coated rails?
- What type of control card do you have? See the control card section of Identifying your ShopBot.

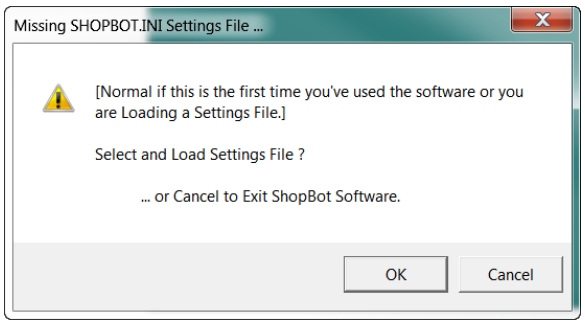
Load the default setting file



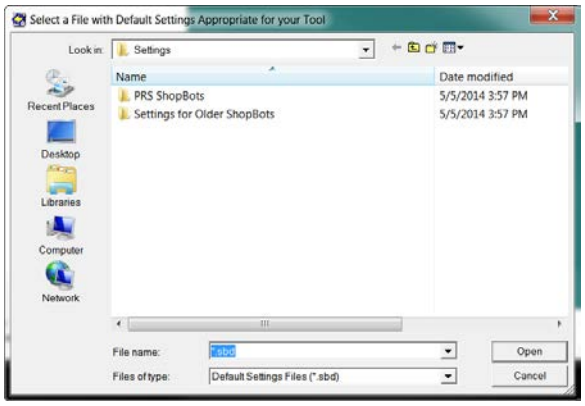
To reset ShopBot 3's defaults to these values, go to "Utilities" and choose "Reset default settings, …".



Confirm reload by clicking "Yes".

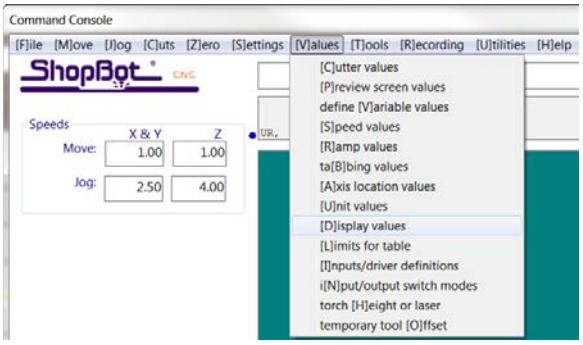


After giving affirmative answers to all additional pop-ups that may appear, the last screen is a file browser starting in the "Settings" directory.

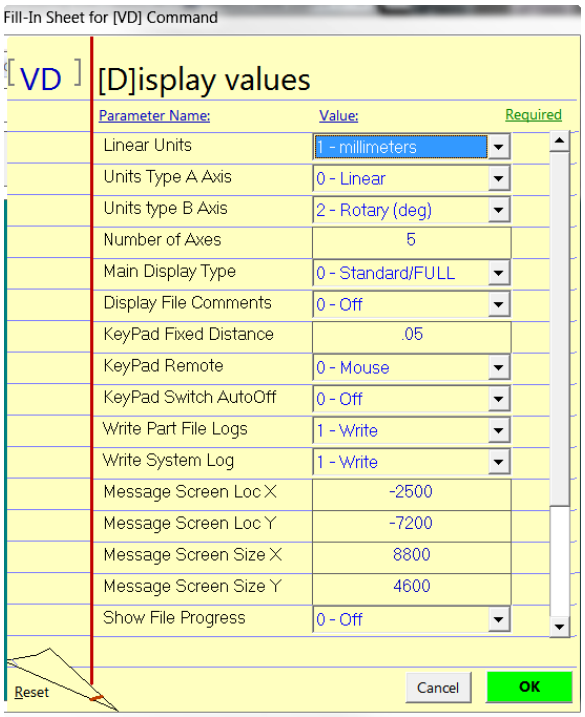


You'll be able to choose the default file that corresponds with the type of ShopBot you have. "PRS ShopBots" contains default files for Desktop, Handibot, full-size (standard) and ShopBot Buddy® (standard) machines. "Settings for older ShopBots" contains the default files for PRT machines. The files for full-size and ShopBot Buddy® machines are organized by the table size.

Metric vs. imperial



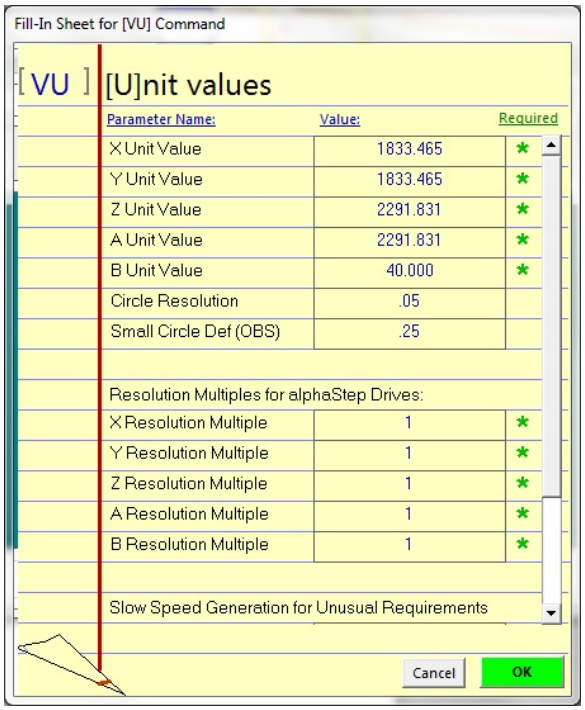
These directions are given for ShopBots using imperial units (inches). To change to metric units (mm), go into the "Values" > "Display Values" menu (VD command).



When the menu pops up, change the parameter "Linear Units" to "1 – millimeters."

Verifying the default settings for your tool

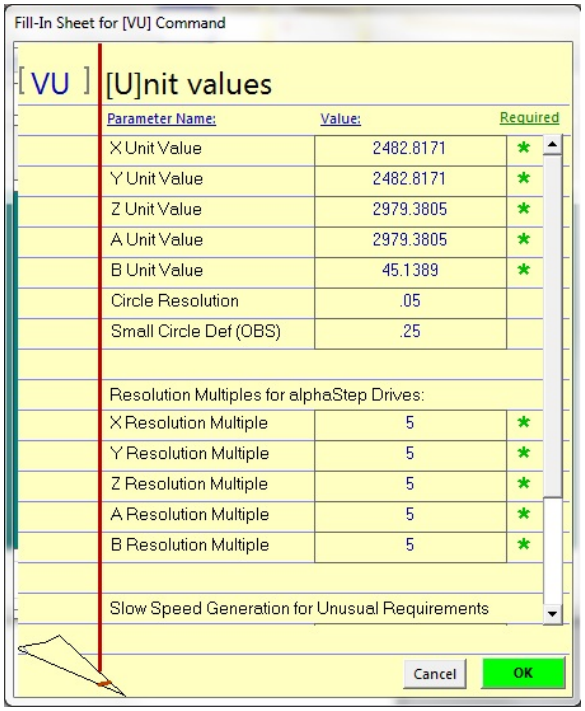
Unit values can be viewed by going into the "**V**alues" menu under "**U**nit Values" (**VU** command). Listed here are the default settings for unit values.



PRSstandard ShopBots

Your settings should have a unit value of 1833.465 (steps per inch) for the X and Y axes, and 2291.831 for the Z axis.

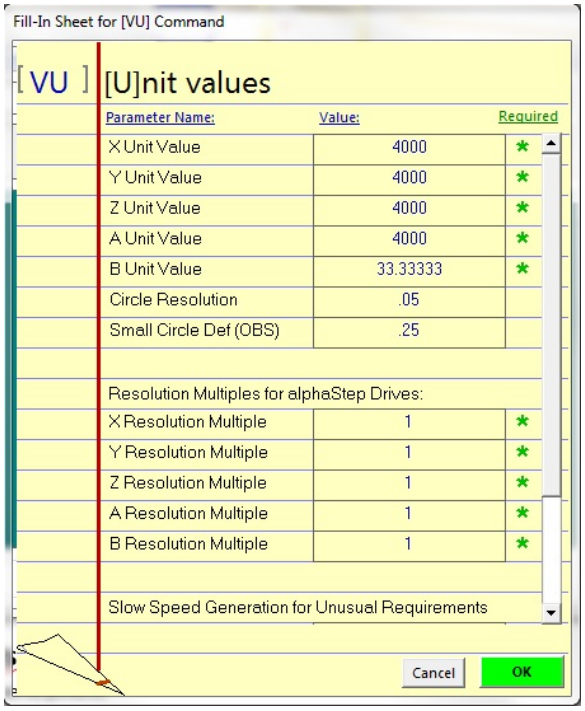
All axes should have a resolution multiple of 1.



PRSalpha ShopBots

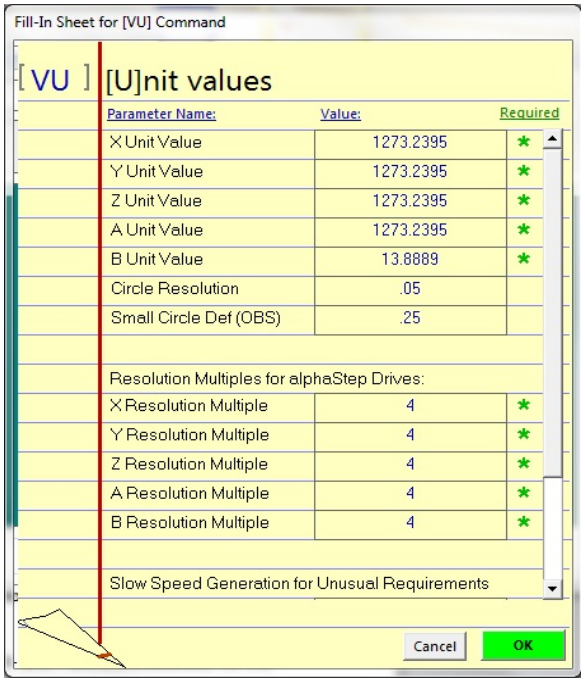
Your settings should have a unit value of 2482.8171 (steps per inch) for the X and Y axes, and 2979.3805 for the Z axis.

All axes should have a resolution multiple of 5.



Desktops and Handibots

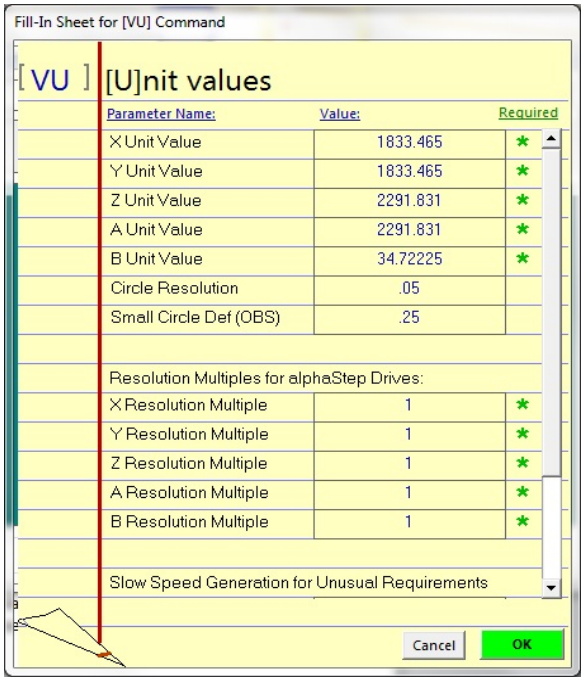
The unit value for every axis on these tools should be 4000 (steps per inch) and the resolution multiple set to 1 for every axis.



Original PRTalpha without upgrades

With direct drive motors these tools use the unit value of 1273.2395 (steps per inch) for all axes.

They also have a resolution multiple of 4 for all axes.



PRTstandard with V4G or RBK upgrade

These tools have a unit value of 1833.465 (steps per inch) for the X and Y axes and 2291.831 for the Z axis.

The resolution multiple for all axes is 1.

Solution 2 – Manually entering unit values

A unit value is a number that corresponds the amount of moves a machine must make to complete a unit. ShopBots are set up so that a unit value is the amount of moves or pulses of power to a motor that results in travel of 1". This is directly related to the driver, motor, gearbox, and pinion on your machine. For example if you compare the same assembly with two different pinions on it, one smaller and one larger, the smaller pinion actually moves less for each move than the larger pinion does because of it has a smaller diameter. A 36 tooth pinion that complete a full revolution will have travelled roughly 1.8" (its diameter) while an 18 tooth pinion will have travelled roughly 0.9". This means the larger pinion will actually have a smaller unit value, because it takes less moves to travel 1" comparatively (less than one revolution versus 1.09 revolutions for the smaller pinion).

Manually setting the unit values requires some trial and error testing, and there are two ways to test. The first procedure is the easiest and should be tried first. If it does not work you will have use the second procedure.

Procedure 1 - Adjusting unit values with measurements

With this technique, you enter a known unit value and then move the ShopBot a set distance.
If you look up the actual distance the ShopBot moves in the table below, you can determine the type of ShopBot you have and its unit values.

Procedure for standard configurations:

1. Use the "**VU**" command to temporarily enter a unit value of 1000 for the X axis.
2. Zero the X axis (**ZX**) at a known location.
3. Carefully mark the location of the X gantry so you can accurately measure how far it moves.
4. Issue a command to move the X axis 10 inches (**MX, 10**).
5. Carefully and precisely measure the distance the X gantry moved.
6. Find that value in the table below to determine the correct unit values and type of ShopBot.
7. Use the "**VU**" command to enter the correct unit values and multiplier for your ShopBot.

If your ShopBot moved:

Move length (inches)	Correct unit values	Your tool is probably a…	Multiplier	Likely Z unit value*
2.5	4000.0000	ShopBot Desktop, Handibot	1	4000.0000
4.027683	2482.8171	PRSalpha,PRTalpha7.2	5	2979.3805
5.454154	1833.4650	PRSstandard, PRTstandard_V4G, early tools	1	2291.8310
7.853982	1273.2395	PRTalpha	4	1273.2395
10.90831	916.7325	PRTstandard, 20 tooth pinion	1	916.7325
13.63538	733.3860	PRTstandard, 25 tooth pinion	1	916.7325
19.63496	509.2956	PRTstandard, early tool with direct drive, 20 tooth pinion	1	509.2956
10.00	1000.0000	(test unit value, not a likely tool)		

***requires testing**

Procedure for non-standard tool configurations

If you modify your ShopBot in some manner, such as changing the size of the pinion gears, you will have created a “custom” tool that does not fit the values above. This will require you to do some calculations.

Calculating by pinion size

If you know the size of your pinion gear, either by counting the teeth or measuring and estimating as described in procedure 2 below, you can find a correct unit value by using the following procedure:

1. Take the current unit value and multiply it by the number of teeth in the pinion gear shown in the table below for your ShopBot.
2. Divide the computed value by the number of teeth in the new pinion gear.

Default ShopBot configurations

	X axis	Y axis	Z axis
PRSstandard	25 tooth pinion	25 tooth pinion	20 tooth pinion
PRSalpha	30 tooth pinion	30 tooth pinions	25 tooth pinions
Desktop	No pinions	No pinions	No pinions
Handibot	No pinions	No pinions	No pinions
PRTalpha	20 tooth pinion	20 tooth pinion	20 tooth pinion
PRTstandard	25 tooth pinion	25 tooth pinion	30 tooth pinions

Calculating by distance

Alternatively, if you cannot determine the necessary information, you can do the following:

1. Take the current unit value and multiply by the distance specified in the move (10”).
2. Divide the computed value by the distance actually moved. This may be a rough number from measurement error so you may want to look in the unit value tables to find the correct value very close to the rough one. This would likely be the proper value to use.

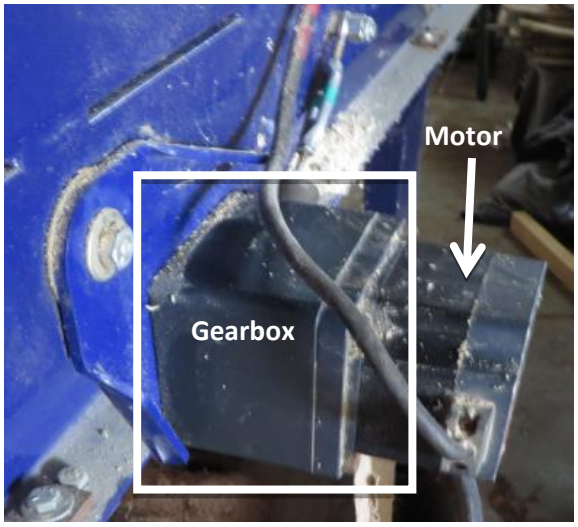
Procedure 2 - Identifying motors, pinions, and the corresponding unit values

This technique involves gathering information for each axis and then testing values. If you only have one axis that is not moving the correct distance you will only need to do this for that axis. Just make sure the motor and pinion that you check is for the correct axis.

To find the unit value for an axis you will need to know the motor's gear ratio, the number of teeth on the pinion, and the stepping of the driver. The stepping of the driver is very hard to check, so we recommend you find your motor type and pinion tooth count and then test the three different driver configurations (for ShopBot supplied drivers) until you find the one that is correct for your tool. Please be careful doing this as the tool may move further than you expect if the value is incorrect.

Identifying your motors

Look at the numbers on the motors as well as their configuration.



Note the gearbox on the motor.

7.2 gearbox (Ratio 7.2:1)
A6488-9412KTG
PK296A1A-SG7.2
A7243-9412KTG

Motor label

3.6 direct drive (Ratio 3.6:1)
A6497-9412KTG
PK296A1A-SG3.6

Identifying your pinions

If you cannot count the number of teeth on your pinion easily, you can estimate the tooth count of standard ShopBot pinions by measuring the largest diameter. **Note: Substantially worn pinions may be smaller than listed due to wear.**

Pinion tooth counts
18 teeth (.9” diameter)
20 teeth (1” diameter)
25 teeth (1.25” diameter)
30 teeth (1.5” diameter)
36 teeth (1.8” diameter)

You can also contact ShopBot support if you need help determining your unit values.
Support@ShopBottools.com or 919-680-4800

Default ShopBot configurations

These are the standard pinions and motors used on ShopBots. If your configuration is different then you will not be able to use the default unit values in the preceding default unit values table. You will then have to use the trial and error method unlined for the use of the unit value tables.

PRSstandard

Motors - A7328-9412KTG or A7243-9412KTG (older machines)
Gearbox – 3.6 ratio for both motors
Pinions
- X axis – 25 teeth
- Y axis – 25 teeth
- Z axis - 20 teeth

Resolution multiple – 1 for all axes

PRSalpha

Motors - ASM98AA-T7.2
Gearbox – 7.2 ratio
Pinions
- X axis – 30 teeth
- Y axis – 30 teeth
- Z axis - 25 teeth

Resolution multiple – 5 for all axes

Desktop/Handibot

Motors – K57M4Y
Gearbox – None
Pinions - None
Resolution multiple – 1 for all axes

PRTalpha

Motors – ASM911AA (if motor is the same as PRSalpha (ASM98AA-T7.2) use the unit values for the PRSalpha above)
Gearbox – None
Pinions
- X axis – 20 teeth
- Y axis – 20 teeth
- Z axis – 20 teeth

Resolution multiple – 4 for all axes

PRTstandard

Motor - A6497-9412KTG
Gearbox – 3.6
Pinions
- X axis – 25 teeth
- Y axis – 25 teeth
- Z axis – 30 teeth

Resolution multiple – 1 for all axes

Unit value tables

To find the unit value for an axis you will need the following information:

- The motor/gearbox assembly's gear ratio.
- The number of teeth on the pinion.
- The stepping of the driver.

If you don't know the stepping of your driver, you can use the gear ratio and pinion tooth count to find the proper unit value table and try them out.

1. Find the table that corresponds with your gearbox or motor (for direct drives).
2. Pick the number that corresponds with the pinion teeth on the axis you are adjusting.
3. Start with the 1/4 stepping driver unit value.
4. Use the "**VU**" command to enter the unit value. Ensure the resolution multiple is correct for your tool by comparing the value in the software to the default settings.
5. Zero the axis at a known location.
6. Carefully mark the location of the movable part of the axis so you can accurately measure how far it moves.
7. Issue a command to move the axis a set distance. Keep in mind that decrepancies are much easier to spot with larger distances, but you may want to start with a small value to ensure axis doesn't move further than allowed because of incorrect unit values. (I.e. it's possible if you tell the axis to move 10" it could actually move 20" or more if unit values are incorrect.)
8. Carefully and precisely measure the distance the axis actually moved.
9. If this number matches the number that you entered then you are done with this axis, if another axis needs adjusting please start from the beginning of this procedure. If the measured value is different from the input value then the unit value is not correct, please proceed to next step.
10. From the table used above find the 1/8 stepping unit value and enter it into the settings of ShopBot 3 using the "VU" command.
11. Return your axis to zero and verify that the location matches up with the marking made previously. If not rezero tool to previous mark.
12. Issue a command to move axis a set distance.
13. Carefully measure this value, if it is the same as the value you entered then this axis is done. If the value is different from the input value you will need to proceed to the next step.
14. From the table used above find the 1/16 stepping unit value and enter it into the settings of ShopBot 3 using the "VU" command.
15. Return your axis to zero and verify that the location matches up with the marking made previously. If not rezero tool to previous mark.
16. Issue a command to move axis a set distance.
17. Carefully measure this value, if it is the same as the value you entered then this axis is done. If the value is different from the input value you will need to proceed to the next step.
18. If you have tried all of the stepping values and your axis is still not moving the correct distance verify your motor type and pinion tooth count. You will then need to verify that you were using the correct unit values table for your gearbox and pinions. If everything is correct you can contact tech support at 919-680-4800 for help identifying your components and the corresponding unit values.

Default unit values (inches)

These are the values that are preloaded into the default setting files. If you do not have the default setting file these values can be entered manually or you can get the default setting files from Tech Support.

	X	Y	Z	Multiplier
PRSalpha	2482.8171	2482.8171	2979.3805	5
PRSstandard	1833.4650	1833.4650	2291.8310	1
Desktop	4000.0000	4000.0000	4000.0000	1
Handibot	4000.0000	4000.0000	4000.0000	1
PRTalpha	1273.2395	1273.2395	1273.2395	4
PRTalpha (7.2)	2482.8171	2482.8171	2979.3805	5
PRTstandard V4G or RBK	1833.4650	1833.4650	2291.8310	1

Unit values (inches)

3.6:1 gear ratio

Stepping	Number of teeth in pinion				
	18	20	25	30	36
1/4	1018.5916	916.7325	733.3860	611.1550	509.2958
1/8	2037.1833	1833.4650	1466.7720	1222.3100	1018.5920
1/16	4074.3665	3666.9300	2933.5440	2444.620	2037.1830

7.2:1 gear ratio

Stepping	Number of teeth in pinion				
	18	20	25	30	36
1/4	2037.1833	1833.4650	1466.7720	1222.3100	1018.5920
1/8	4074.3665	3666.9300	2933.5440	2444.6200	2037.1830
1/16	8148.7331	7333.8600	5867.0880	4889.2400	4074.3665

Direct drive (1:1)

Stepping	Number of teeth in pinion				
	18	20	25	30	36
1/4	282.9421	254.6479	203.7183	339.5305	141.4711
1/8	565.8842	509.2956	407.4367	169.7653	282.9421
1/16	1131.7685	1018.592	814.8733	679.0611	565.8842

Unit values (mm)

3.6:1 gear ratio

Stepping	Number of teeth in pinion				
	18	20	25	30	36
1/4	40.1020	36.0918	28.8735	24.0612	20.0510
1/8	80.2041	72.1837	57.7469	48.1224	40.1020
1/16	160.4081	144.3673	115.4939	96.2449	80.2041

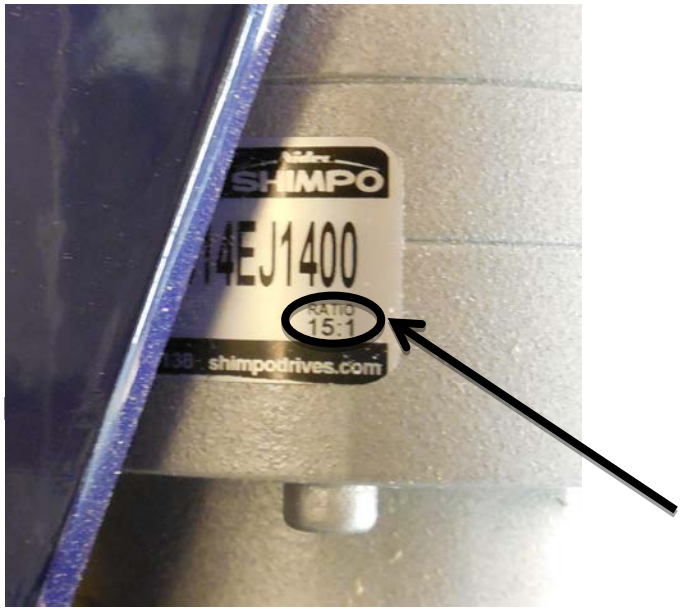
7.2:1 gear ratio

Stepping	Number of teeth in pinion				
	18	20	25	30	36
1/4	80.2041	72.1837	57.7469	48.1224	40.1020
1/8	160.4081	144.3673	115.4939	96.2449	80.2041
1/16	320.8163	288.7346	230.9877	192.4898	160.4081

Direct drive (1:1)

Stepping	Number of teeth in pinion				
	18	20	25	30	36
1/4	11.1395	10.0255	8.0204	6.6837	5.5697
1/8	22.2789	20.0510	16.0408	13.3673	11.1395
1/16	44.5578	40.1020	32.0816	26.7347	22.2789

Appendix: Indexer unit values



The gear ratio for the gearboxes should be located on the gearbox label for the larger indexers.

Unit value tables

3” indexer – 3:1 gearbox	
Alpha	13.5417 (steps per degree)
Standard	33.3333 (steps per degree)

6” indexer		
Alpha	**10:1 gearbox**	45.1389 (steps per degree)
	15:1 gearbox	67.7083 (steps per degree)
Standard	**7.2:1**	40.0000 (steps per degree)

12” indexer - Alpha	
10 to 1 gearbox	45.1389 (steps per degree)
15 to 1 gearbox	67.7083 (steps per degree)

Technical info for indexers

- Alpha motors have 1625 micro steps (model numbers that start with AS- or AS-)
- Standard motors have 4000 micro steps per revolution (if model number does not start with AS or AR) - 0.9 degrees per step with 1/10 of a step increments provided by the driver. ((360/0.9=400 steps) => (400*10=4000 micro steps))
- Standard 6” indexers are 7.2:1 – 2000 micro steps per revolution – 1.8 degrees per step (360/1.8=200 steps) with 1/10 of a step increments (200*10=2000 micro steps)
- 3” indexers have a 3:1 gear ratio (identified by belt drive gearbox that is offset from center)
- Older/current 6” and 12” alpha indexers are 10:1 gear ratios (as marked on gearbox)
- Future 6” and 12” alpha indexers are planned to be 15:1 gear ratios (as marked on gearbox)

Explanation of indexer unit value calculations

Example formulas:

((steps per revolution)*(gear ratio))/(full revolution of 360 degrees)=(# of steps drivers need to move the motor to achieve a full degree of rotation)

3” indexers – 3:1 gearbox – Alpha motor
(1625*3)/360=13.5417 (micro steps per degree)

3” indexers – 3:1 gearbox - Standard motor
(4000*3)/360=33.3333 (micro steps per degree)

6” or 12” indexer – 10:1 gearbox – Alpha motor
(1625*10)/360=45.1389 (micro steps per degree)

6” indexer – 7.2:1 gearbox – Standard motor
(2000*7.2)/360=40 (micro steps per degree)

6” or 12” indexer – 15:1 gearbox – Alpha motor
(1625*15)/360=67.7083 (micro steps per degree)