Conduit Bender Guide

Conduit Bending Basics:

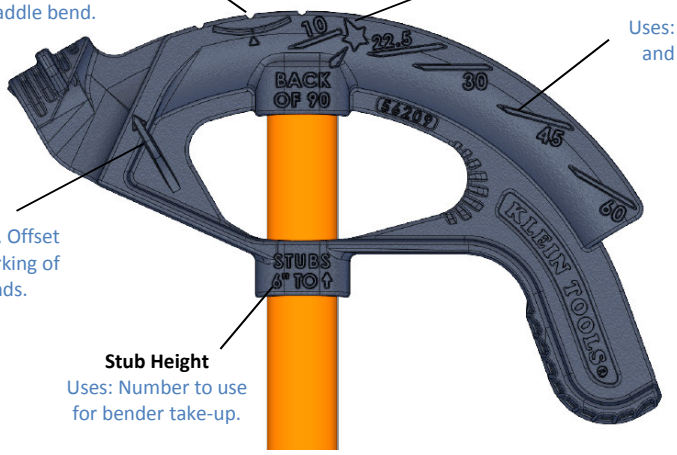
The line of Klein Tools conduit benders have been designed for performance and durability exceeding the expectations of today's professional. It is recommended to familiarize yourself with bending concepts, techniques and learn the bender's functionality to provide you a positive experience while greatly improving the overall outcome of your project.

Conduit come in two types, EMT and Rigid conduits and can be found in various sizes. Klein Tools provides conduit benders for EMT in ½", ¾", 1" and 1-¼" conduit and ½", ¾", and 1" Rigid conduit.

To aid bending when performing a ground or air bend, the benders are marked with different alignment symbols to help the operator create the bends necessary to accomplish any project. The symbols found on the Klein Tools benders are the arrow, the teardrop, the star point and angle markings. These markings are found on various sides of the bender head.

Klein Tools Ductile Iron Series:
½" EMT: #56203
¾" EMT: #56204
1" EMT: #56205

Klein Tools Aluminum Series:
½" EMT: #56206
¾" EMT: #56207



The 4 most common bends to know how to make are the 90° Stub-Up, Back to Back, Offset and the 3 Point Saddle bends. It is common to use a combination of the bender markings when making certain tube profiles. Knowing the proper technique and method of making the bends will allow you to accomplish most projects efficiently.

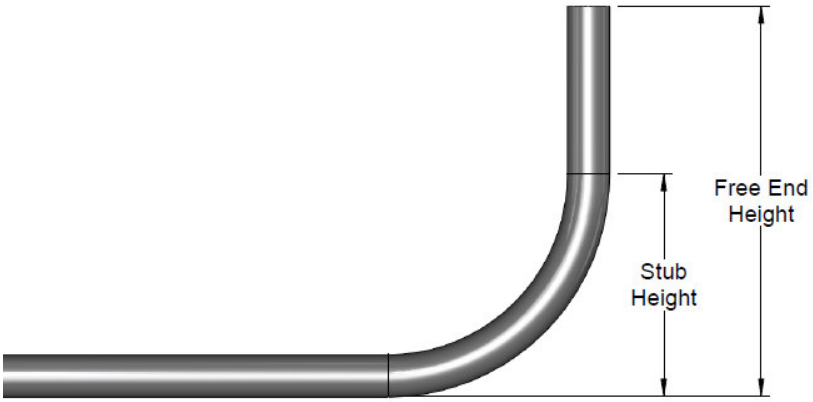
Things to remember while bending:

1. A proper bend is made by rolling the conduit about the bender in the conduit's cradle using all foot pressure.
2. Use the correct size bender for the conduit size being bent.
3. Some over bending may be required to allow for spring back of the conduit. The resting condition of the conduit is to be at the final angle desired.
4. Measure and properly mark your conduit using the tables and information provided.
5. Floor bending: Make sure conduit is secure so it does not slide prior to bending. Apply ample foot pressure to the benders heel while minimizing the use of the handle as a lever but more of a guide.
6. Air Bending: Make sure handle's hilt is secure on ground and is reinforced by your foot so it does not slide out. Make sure you are balanced and apply force close to the tool and your body controlling the tubing as you bend it around the bender's cradle making sure the conduit does not slide in the bender head.
7. To prevent injury, always wear protective gear and do not over exert.

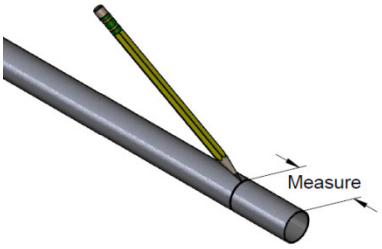
90° Stub-Up Bend:

The stub bend is made by bending a piece of conduit into an L shape or 90° bend by placing the free end (short end) of the tube to a predetermined length as indicated in the diagram below. This is the most common bend and is a building block for other bends. Common uses for this bend are: Running conduit into electrical boxes, running conduit up or down walls, running conduit into walls through floors and ceilings and making inner and outer corner turns.

Bender Take Up Table	
90° Stub-Up Bend	
Conduit Size	**Stub Height** Amount to subtract from Measurement
½" EMT	5"
¾" EMT and ½" Rigid	6"
1" EMT and ¾" Rigid	8"
1-¼" EMT and 1" Rigid	11"

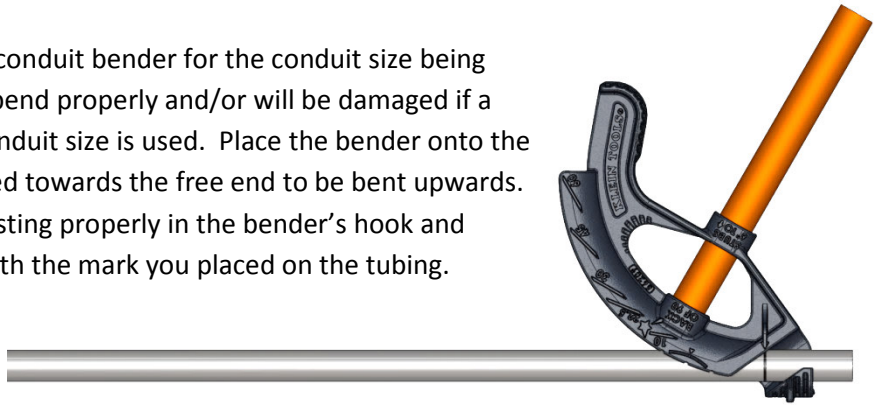


1. Determine the overall free end height of the conduit you want after the bend.
2. From the overall free height, subtract the stub height listed in the Bender Take-Up Table for the conduit size you are bending. *Klein Tools has provided the correct stub height on each bender head.*
3. On the conduit, measure from the free end to be bent up the calculated number and mark the conduit.



As an example, to bend 3/4" EMT conduit have a free end height of 8.5", the table indicates to subtract 6" from the 8.5" which leave 2.5" from the end to bend up to make the mark. *Tip: Advanced benders can lay a tape measure next to the conduit and perform the bending operations if the bend does not call for high degree of accuracy.*

4. Always use the proper size conduit bender for the conduit size being bent. The conduit will not bend properly and/or will be damaged if a mismatch of bender and conduit size is used. Place the bender onto the tubing with the hook pointed towards the free end to be bent upwards. Make sure the conduit is resting properly in the bender's hook and lineup the **arrow symbol** with the mark you placed on the tubing.



5. Keeping the conduit flat, apply ample foot pressure to the bender's heel minimizing the use of the handle as a lever, rolling up the free end into the 90° position checking the degree with a level. When done properly the free end will be at the desired height and the arrow will be at the stub height as indicated.

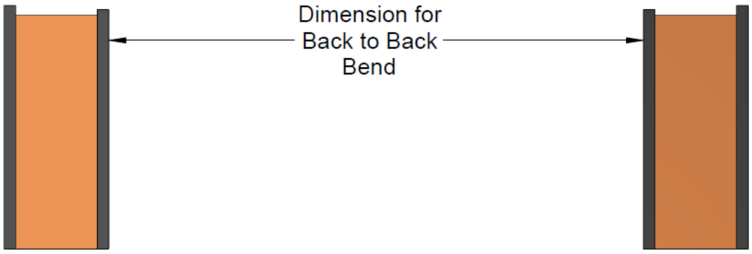
In some installations there will be a need to cut down the unbent side of the conduit to another desired length to fit the installation. Use a tube cutter for smooth precise cutting and burr removal to ensure the safety of the electrical wiring when pulled through. A hacksaw can be substituted as long as the tubing's cut edge is prepared properly.

Klein Tools Tube Cutter: **#88975 & 88977**
Klein Tools Hacksaw: **#701-10, 701 -12 &701 -S**
Klein Tools Level: **#931-6RE & 931-7RE**

Back to Back Bends:

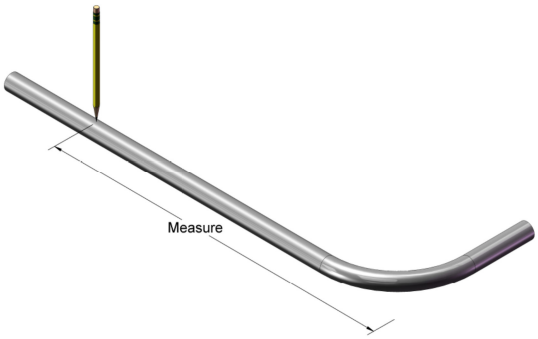
The back to back bend is the next style of bend that is needed while running electrical conduit. In reality the concept is formulated by the need to know the distance from the **back** edge of a 90° bend to a fixed point down the conduit to mark for other bend operations to meet the installation requirement. As you will see it builds on the 90° stub bend and when done the most common use of this bend will look like an elongated U.

You will need to know this bend method when you want to fit conduit between two parallel surfaces such as two walls or joists while keeping the U's outer edges of the legs touching the two surfaces. This allows for proper anchoring and a nice clean appearance.



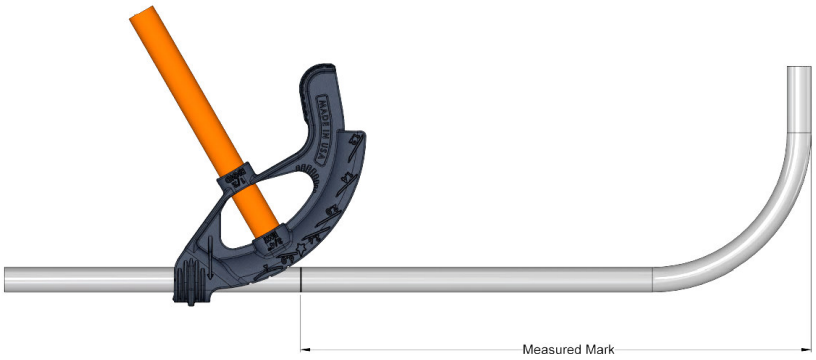
1. Determine the distance between the two parallel surfaces to get the dimension for back to back bend.

2. The first bend for the back to back bend is the 90° stub-up bend. Follow the steps from the 90° Stub-Up section to create the ideal bend for the connection on the first side.



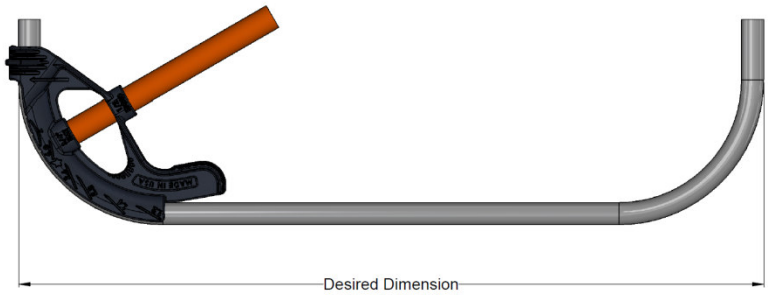
3. From the **back** edge of the 90° stub-up bend, measure the distance found in step 1 and make your mark on the conduit.

4. Place the bender on the conduit with the bender's hook facing the free end of the tube to be bent **opposite** the original bend side. Make sure the conduit is resting properly in the bender's cradle and lineup the **Star Point Symbol** with the mark you placed on the tubing.



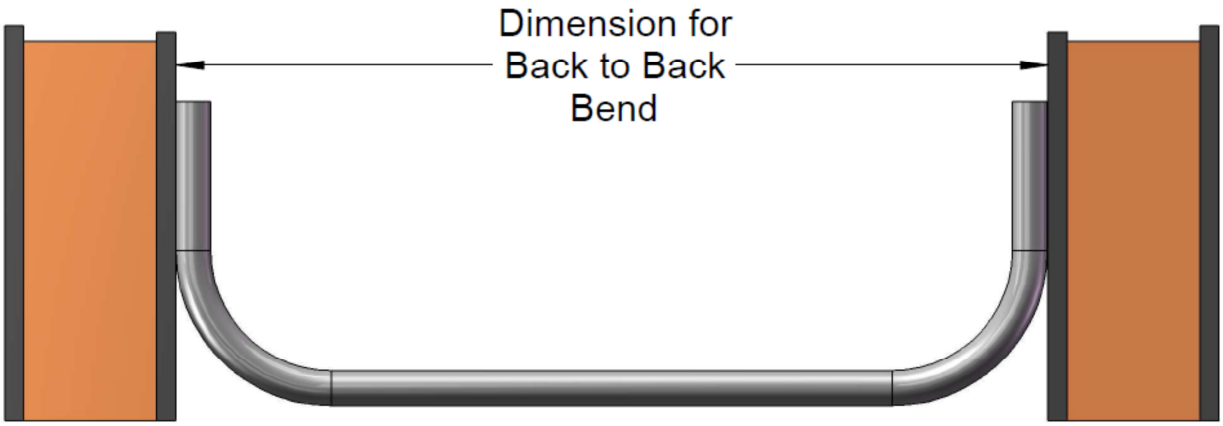
5. Keeping the conduit flat, apply ample foot pressure to the bender's heel, with minimal use of the handle as a lever, rolling up the free end into the 90° position checking the degree with a level. It is very important to keep the first 90° bend in the same plane as the new bend. If not the two legs of the U will be skewed and will not produce the desired shape. If this happens, some correcting can be done to properly align the legs depending on how out of shape they are. When the bend is done properly the conduit will lay flat and will fit inside the two surfaces measured.

In some installations there will be a need to cut down the unbent side of the conduit to another desired length to fit the installation. Use a tube cutter for smooth precise cutting and burr removal to ensure the safety of the electrical wiring when pulled through. A hacksaw can be substituted as long as the tubing's cut edge is prepared properly.



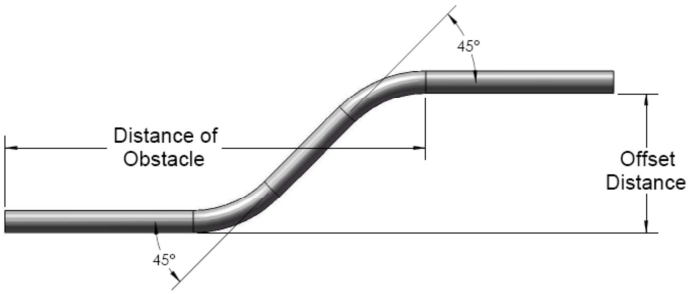
Klein Tools Tube Cutter: **#88975 & 88977**
Klein Tools Hacksaw: **#701-10, 701 -12 &701 -S**
Klein Tools Level: **#931-6RE & 931-7RE**

If the back to back distance is short (a tight U) so the bender has problems fitting to make the second bend, you may compensate by subtracting the stub height from the measured distance to fit the gap then follow step 3 to mark the calculated number on the conduit. But this time you would put the bender on the conduit with the hook facing the first bend and line up the **Arrow Symbol** as demonstrated in the Stub-Up section, step 5, with the conduit mark and proceed to make the bend as in step 5 rolling up the previously bent end up into the 90° position giving you the desired dimension. *Caution should be taken when creating the second bend. With this technique the first bend will be coming at the operator as the second bend is made.*



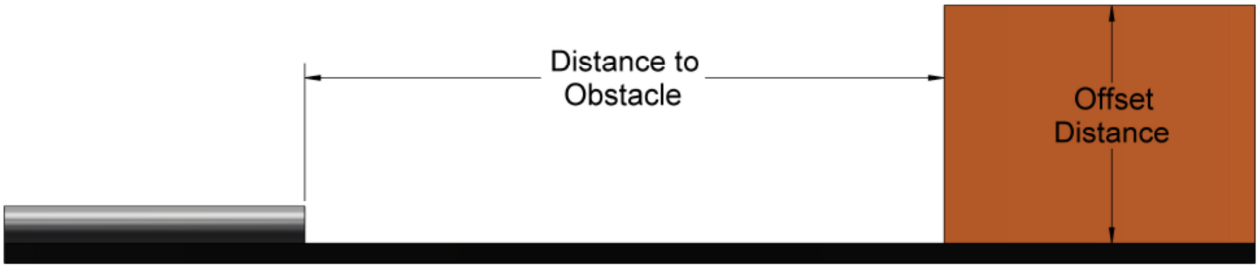
Offset Bends:

An offset bend is a style of bend that is built independently of the 90° stub and the Back to Back bend and is an important bend to know when running conduit. It is common to shift the conduit a certain distance while continuing to run parallel in the same direction as the pre-shift portion of the conduit. There are many situations that call for an offset bend. The most common uses of this bend are: staggered joists, running tight on a wall and offset into an electrical box and changes in elevation.



Offset Formula Table		
Angle of Bend	Constant Multiplier	Shrink Per Inch of Offset
10° X 10°	6	1/16 = .063
22½° X 22½°	2.6	3/16 = .188
30° X 30°	2.0	1/4 = .250
45° X 45°	1.4	3/8 = .375
60° X 60°	1.2	1/2 = .500

1. Determine/measure the offset distance necessary to clear the obstacle and how far away the offset will need to be bent from the end of the conduit.



2. Decide what angle you wish to make the offset bend and determine the proper values from the Offset Formula Table. Calculate the proper values to mark on the conduit to clear the obstacle and fit in the gap measured.

Offset Formula Table		
Angle of Bend	Constant Multiplier	Shrink Per Inch of Offset
45° X 45°	1.4	3/8 = .375

As an example, the offset distance of the obstacle is 6” and the distance to obstacle is 20”. The installation allows for a 45° X 45° offset bend. *Note: The choice of degree is usually the installer’s choice and most of the time the installation location will determine what degree will fit.*

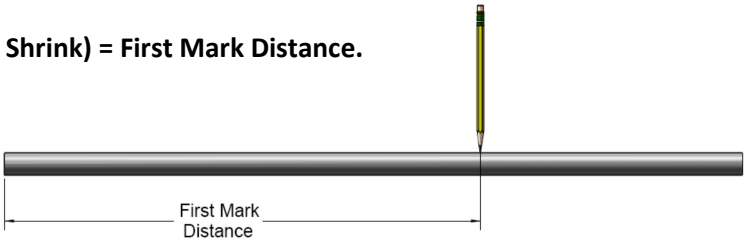
3. From the table use the 45° X 45° offset row for the values to calculate the series of markings necessary to make the proper bend. To find out where to place the first mark on the conduit, multiply the measured *Offset Distance* to clear the obstacle by the tables *Shrink/Inch* that will occur to the conduit after all the bends are made due to that offset distance or:

(Offset Distance) X (Shrink/Inch) = Total Shrink.

Example: 6" X .375 = 2.25" of total shrink.

This value is then *added* to the measured *Distance to Obstacle* number or:

(Distance to Obstacle) + (Total Shrink) = First Mark Distance.

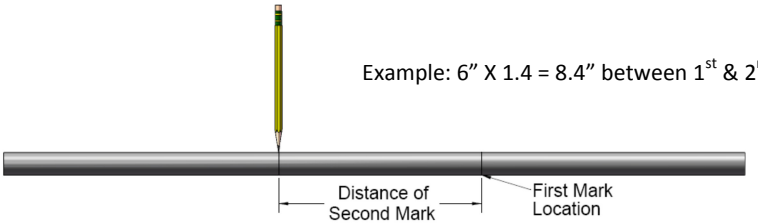


Example: 20" + 2.25" = 22.25" to make first mark.

To calculate the second mark needed on the conduit, *multiply* the measured *Offset Distance* by the *Constant Multiplier* of the table or:

(Offset Distance) X (Constant Multiplier) = Second Mark Distance (Distance between Marks).

Example: 6" X 1.4 = 8.4" between 1st & 2nd mark.



This calculated value is how far apart to make your marks from each other on the conduit and where to make your 45° bends.

4. Using the technique to align the bender on the conduit as described under the Stub-Up Section 5, Place the bender on the conduit with the hook facing away from the second mark and line up the **Arrow Symbol** up with the first mark.

45 Mark

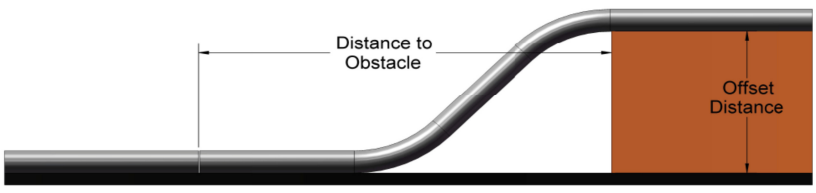
5. Keeping the conduit flat, apply ample foot pressure to the bender's heel minimizing the use of the handle as a lever, smoothly rolling up the free end until the **45° mark** is reached. When done properly the free end will be at a 45° angle from the original plane.

Note: Some over bending may be required to allow for spring back of the conduit. The resting condition of the conduit is to be at the final angle desired.

6. Keeping the bender and conduit together flip the two parts upside down and put the bender's handle hilt on the floor, balancing the conduit in the air, allow the conduit to rotate 180° in the cradle. Slide the conduit down so the first bend is moving away from the bender head, aligning the second mark as outlined before using the **Arrow Symbols** (See Stub-Up section, note 5).

7. The second bend of the offset is accomplished by performing an air-bend. Make sure the handle hilt is secure on ground and is reinforced by your foot so it does not slide out. Make sure you are balanced and apply force close to the tool and your body controlling the tubing as you bend it around the bender's cradle. Bend the free end until the **45° mark** is reached.

It is very important to keep the first 45° bend in the same plane as the new bend will be. If not, the two legs of the offset will be skewed and will not produce the desired shape. If this happens, some correcting can be done to properly align the legs depending on how out of shape they are. When the bend is done properly the conduit will lay flat and fit inside the measured distance to and clear the obstacle.

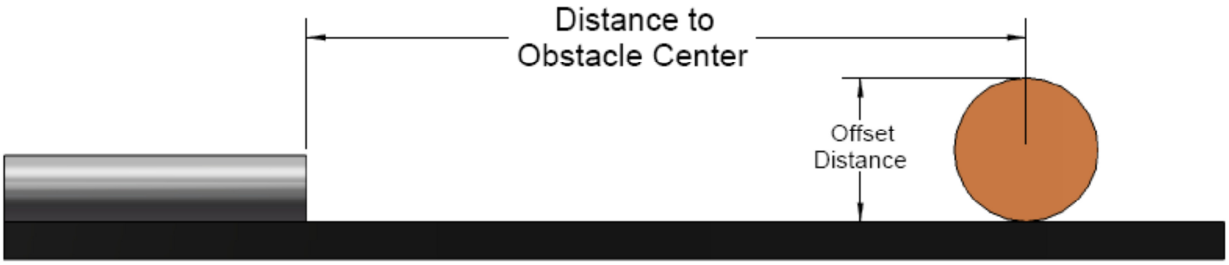


In some installations there will be a need to cut down the unbent side of the conduit to another desired length to fit the installation. Use a tube cutter for smooth precise cutting and burr removal to ensure the safety of the electrical wiring when pulled through. A hacksaw can be substituted as long as the tubing's cut edge is prepared properly.

Klein Tools Tube Cutter: #88975 & 88977
Klein Tools Hacksaw: #701-10, 701 -12 &701 -S

Three Point Saddle Bend:

The three point saddle bend is a variant of the offset bend since it is an offset bend that returns to the original in-line run after clearing an obstacle. This bend is intended to bridge over obstacles such as existing conduit or plumbing running perpendicular to the intended conduit installation.



1. Determine/measure the offset distance necessary to clear the obstacle and how far away the saddle bend will need to be from the edge of the conduit. Unlike the offset bend you must measure to the center of the obstacle to bridge over.

2. Choose the angle that will be used for the center bend. The other two return bends will be 1/2 the center angle chosen. If the center angle is 45°, the two return bends will be 22.5°. Use the table to calculate the distance between bends and how much shrink is to occur to the conduit due to the bends.

3 Point Saddle Bend Table				
Degree of Bend:	45° Center Bend 22.5° Return Bends		60° Center Bend 30° Return Bends	
Obstruction Height	Shrink Amount	Distance off Center Mark	Shrink Amount	Distance off Center Mark
Every inch Add:	3/16”	2-1/2”	1/4”	2”
1”	3/16”	2-1/2”	1/4”	2”
2”	3/8”	5”	1/2”	4”
3”	9/16”	7-1/2”	3/4”	6”
4”	3/4”	10”	1”	8”
5”	15/16”	12-1/2”	1-1/4”	10”
6”	1-1/8”	15”	1-1/2”	12”

Example: As an example, the offset distance of an obstacle is 2” and the distance to obstacle’s center point is 20”. The installation allows for a 45° saddle bend. *Note: The choice of degree is usually the installer’s choice and most of the time the installation location will determine what degree will fit.*

3. Calculate the value needed to place your first mark on the conduit. This number is determined by the *Measured Distance to Center Point* of the obstacle *plus* the *Shrink* from the 3 Point Saddle Bend Table that will occur.

(Measured Distance to Center Point) + (Shrink) = Center Mark

Example: 20” + 3/8” = 20-3/8”

4. Using the *Distance off Center Mark* values found in the table to clear a 2” obstacle, simply mark that distance from the center line in both directions or subtract this number from the center mark value for the first return bend mark and add that number to the center mark value to obtain the second return bend mark distance.

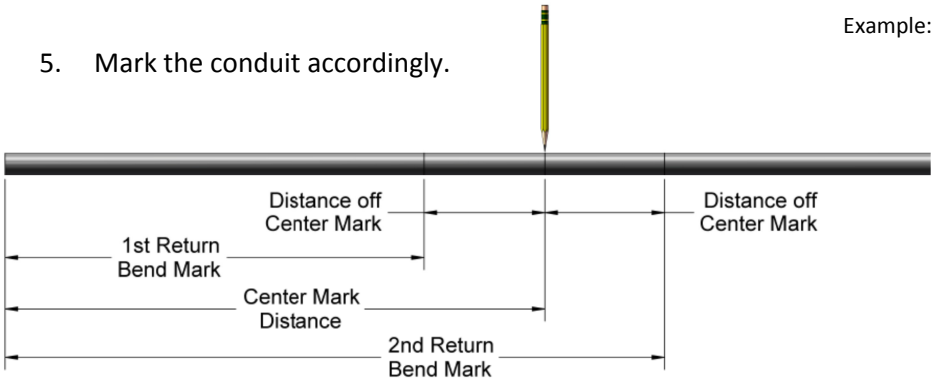
(Center Mark) – (Distance off Center Mark) = 1st Return Bend Mark

Example: (20-3/8”) – 5” = 15-3/8”

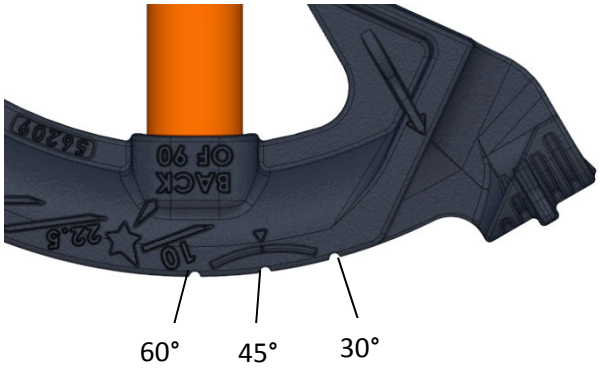
(Center Mark) + (Distance off Center Mark) = 2nd Return Bend Mark

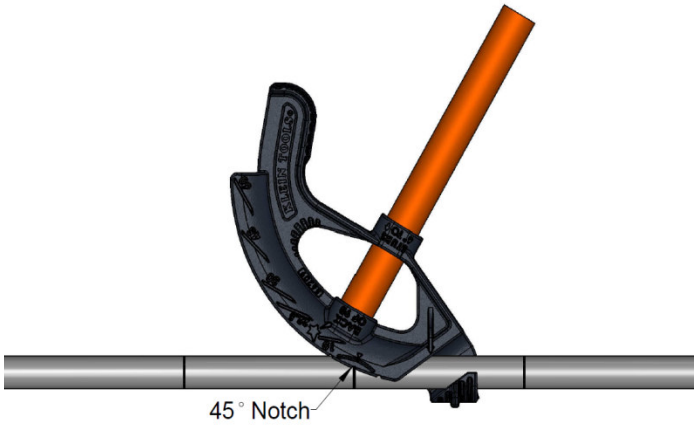
Example: (20-3/8”) + 5” = 25-3/8”

5. Mark the conduit accordingly.



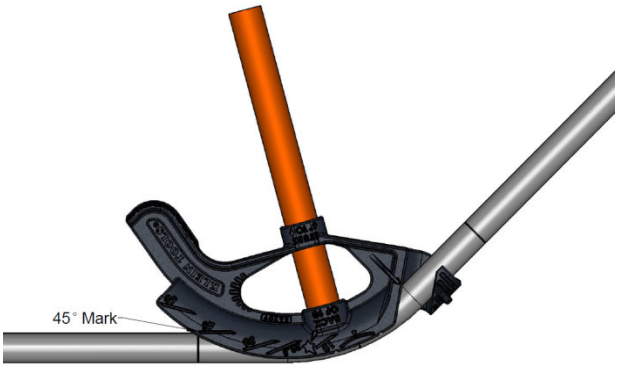
6. Place the bender on the conduit and position the appropriate **Center of Bend Rim Notch** on the center mark in the orientation shown.

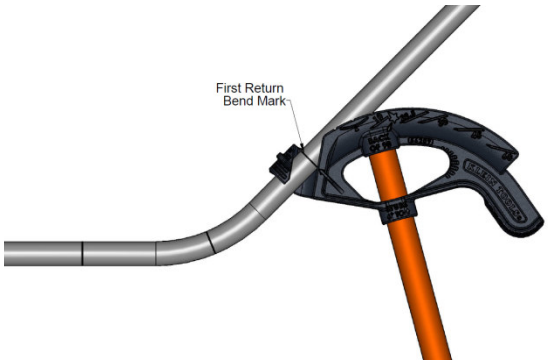




7. Keeping the conduit flat, apply ample foot pressure to the bender's heel minimizing the use of the handle as a lever, smoothly rolling up the free end until the **45° mark** is reached.

Note: Some over bending may be required to allow for spring back of the conduit. The resting condition of the conduit is to be at the final angle desired.

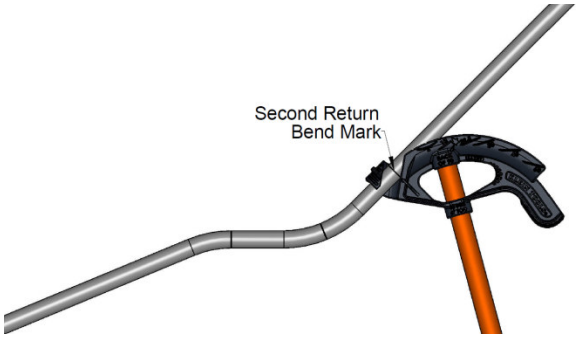




8. Keeping the bender and conduit together, flip the two parts upside down and put the bender's handle hilt on the floor, balancing the conduit in the air, allow the conduit to rotate 180° in the cradle. Slide the conduit down so the first bend is moving away from the bender head, aligning the 1st return bend mark with the **Arrow Symbol** (See Stub-Up section, note 5).

Note: Some over bending may be required to allow for spring back of the conduit. The resting condition of the conduit is to be at the final angle desired.

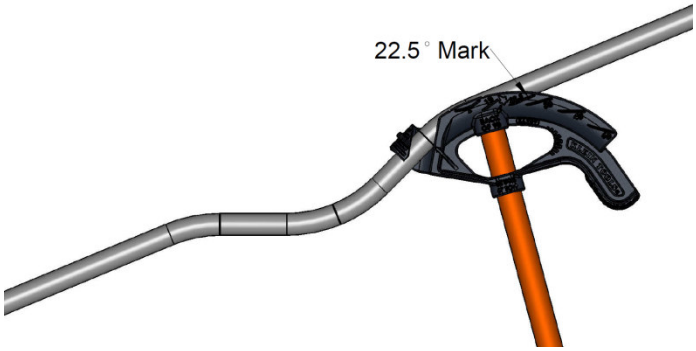
9. The second bend of the saddle bend is accomplished by performing an air-bend. Make sure handle hilt is secure on ground and is reinforced by your foot so it does not slide out. Make sure you are balanced and apply force close to the tool and your body controlling the tubing as you bend it around the bender's cradle. Bend the free end until the **22.5° mark** is reached.



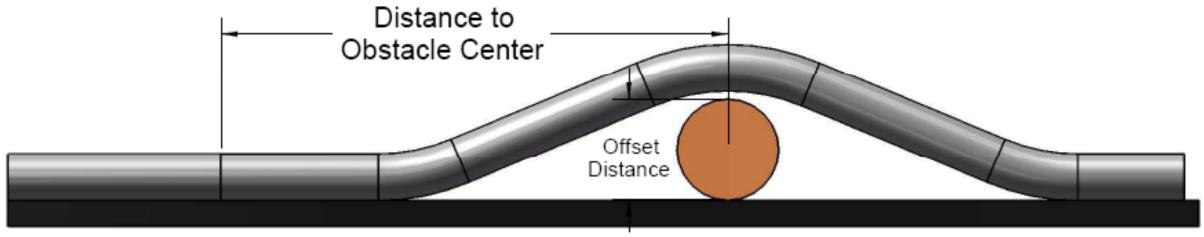
10. Remove bender and place it back on the conduit on the other side of the center bend with the hook facing the center bend as before aligning **Arrow Symbol** (See Stub-Up section, note 5). On the 2nd return bend mark.

Note: Some over bending may be required to allow for spring back of the conduit. The resting condition of the conduit is to be at the final angle desired

11. The last bend of the saddle bend is made again by performing an air-bend. Make sure handle hilt is secure on ground and is reinforced by your foot so it does not slide out. Make sure you are balanced and apply force close to the tool and your body controlling the tubing as you bend it around the bender's cradle. Bend the free end until the **22.5° mark** is reached.



It is very important to keep all the bends in the same plane. If not, the offset will be skewed and will not produce the desired shape. If this happens some correcting can be done to properly align the legs depending on how out of shape they are. When the bend is done properly the conduit will lay flat and will fit the measured distance to obstacle, clear the object and return to the original line continuing the run as desired.



In some installations there will be a need to cut down the unbent side of the conduit to another desired length to fit the installation. Use a tube cutter for smooth precise cutting and burr removal to ensure the safety of the electrical wiring when pulled through. A hacksaw can be substituted as long as the tubing's cut edge is prepared properly.

Klein Tools Tube Cutter: **#88975 & 88977**
Klein Tools Hacksaw: **#701-10, 701 -12 &701 -S**