

## Saw Tip Angles

### Matching a Saw Blade to the Machine and Materials

(Note: The language is imprecise here and the same term can mean different things. Also different terms maybe used for the same thing.) Refer to our [Saw Blade Glossary](#) for definitions and Clarification, or browse our [Saw Blade Index](#) on other saw blade articles that may be helpful.

#### Considerations

1. Know what machine or machines you will be using. Some blades work on several machines however a rip blade designed to grab material and pull it into the cut may be very unsafe if used in a radial arm saw. Sliding miter saws and radial-arm saws have a tendency to self-feed which leaves the wood torn and ragged and can sometime even grab the stock which is dangerous. The negative hook angle of radial-arm and sliding miter saw blades pushes the stock downward and against the fence to provide an extra margin of safety.
2. Know what material or materials you will be cutting. Ripping clear Fir is much different than cutting Corian®.
3. Know what is important to you in saw blade results.
  - o Typically more teeth mean cleaner cuts but a slower feed rate. See our formula for Calculating [Saw Blade Tooth Quantity and Feed Speed](#).
  - o A saw (or saw blade) has to make three kinds of cuts; the cut into the material the cut through the material and the cut as the blade exits the material. One of the toughest cuts to get right is cutting double-sided laminate on MDF so that the edges of the MDF are smooth and clean with no chipping on the laminate on either side.
  - o How much cutting will you do? A blade with a narrow side clearance and ground shoulder will give smooth cuts one at a time but will heat up rapidly in any kind of sustained cutting.

#### Getting Clean Cuts

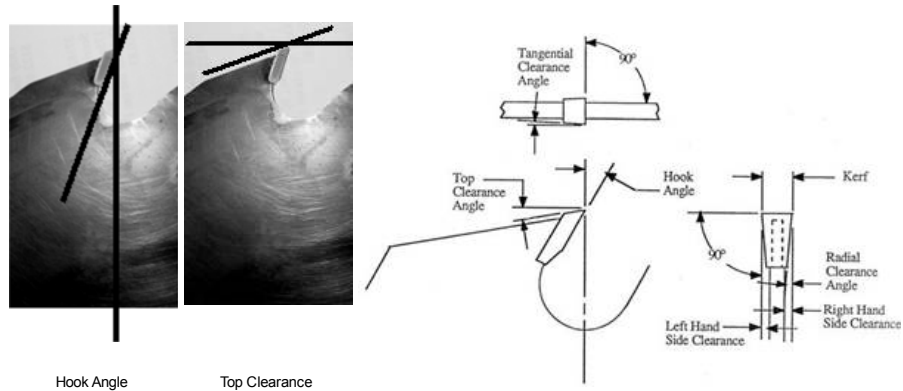
The edges of a saw blade can separate material by; shear, fiber pullout, chipping or cutting. The thinner and sharper the edge, the better it cuts.

High shear is like the blade of an axe. Low shear is like the back of the axe. A flat, square tip has low shear, is very strong and works well in soft materials. A tip with a point on one side has higher shear. The shear factor is even higher if the face is beveled. A pointed tip works better in hard or brittle material. Because there is a small surface doing the cutting, pointed tips wear faster and are more likely to break.

#### Number of Teeth

As we said above, more teeth generally give a smoother cut but cut more slowly. This is best seen in hard and brittle materials where you are forced to use a large number of teeth (high tooth count) and nibble your way through.

#### Basic Saw Blade Angles



#### Hook Angles

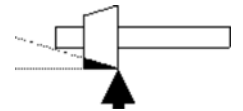
The hook angle is the amount of forward or backward lean each tooth has. A hook angle can be thought of as the angle at which the tip enters the material. If the saw tip enters the material at an angle it will be more efficient than if it slaps down flat. A 20 degree positive hook angle is used on rip blades to pull the wood into the blade. Standard hook angles range from 5 to 15 degrees positive. Steeper angles, from 18 to 22 degrees, are most effective for ripping and cutting softer materials. Hard materials require a shallow angle such as 6 degrees. Negative hook angles, usually -5 degrees, are used to prevent self-feeding of materials and give the operator maximum control over the feed of cut.

Using a saw blade with a positive hook angle to cut metal, such as aluminum trim, can be dangerous because the blade will have a strong tendency to grab the material causing the operator to lose control. To prevent self-feeding, sliding miter saws and radial-arm saws require a blade with a negative tooth angle.

In general, a blade with a positive hook angle is a faster-feeding blade and one with a negative hook is less aggressive. One thing we need to add here is that you ALWAYS want a negative hook for cutting metal and the new SystiMatic Melamine blade is a negative hook - it seems to work better for cutting Melamine.

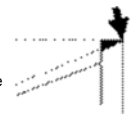
#### Tangential Clearance Angle (Side Clearance Angle)

You measure down the side of the tip and the difference it is the difference between front and back. As you cut material it gets compressed and springs back after the cutting edge passes. A steep side clearance angle gives plenty of room for the material to expand and prevents heating and burning. However a very flat side clearance angle gives a smoother cut



#### Top Clearance Angle

The Top Clearance Angle is the angle between the top of the tooth and an imaginary line tangent with the cutting circle of the blade. This angle varies according to the hardness of the material being cut, 12 degrees for hard and 15 degrees for softer materials



Cutting Angle: The angle between the upper face of the saw blade and the material being cut. Also known as a rake angle.

#### Clearance Angle

The angle between the lower face of a saw blade and the material being cut.

### Radial Clearance Angle (Radial Side Clearance)

The clearance angle on the side of the tooth. You measure down the side of the tip and it is the difference between front and back.

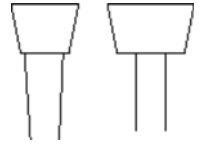


### Relief Angle

The angle the top of the tooth makes away from the cutting edge to a line tangent to the blades circumference.

### Two Kinds of Grinds (tooth shapes or tooth configurations)

The tip on the left has a very narrow side clearance. This gives good cuts but heats up rapidly and wears a great deal compared to the more conventional grind on the right.



### Saw Tip Configurations (also Styles or Grinds)

The overall shape of a saw tip is called the "grind" because it is ground in after the tip is put on the saw body.

#### FTG (Flat Top Grind)

Used on rip blades for fast, efficient cuts along the grain. A square (also Flat or Flat Top) Grind is durable and long lasting. It is used for ripping and can be used on general purpose, [thin kerf saw blades](#).

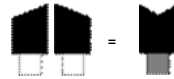


Advantages: Strong, straight cutting and easy to maintain

Disadvantages: Takes a lot of force and likely to chip or tearout on exiting cut. Not a good design for chip removal.

#### ATB (Alternate Top Bevel)

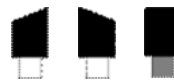
The tops of alternating teeth are beveled to one side of the blade or the other at approximately 15 degrees. This creates a sharp point and a sharper cutting edge for better cut quality without chipping or splinters. ATB is generally used cross cutting wood, plywood, veneer, hardboard, fiberboard and particle board.



Advantages: Little or not tearout and easy chip removal

Disadvantages: Hard to sharpen without expensive equipment, easy to chip and wears rapidly.

#### ATBR (ATB with Raker)



High ATB (Alternate Top Bevel with steeper angles)

Steeper bevel than the standard ATB for chip-free cuts on Melamine and plastic laminate without the use of a scoring blade. A High ATB is generally a blade with an angle over 20 degrees. It is used on brittle materials.



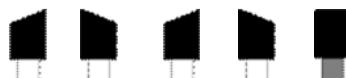
#### ATAF (Alternate Top Bevel with Alternate Face Bevels)

Besides grinding the top at an angle you can also grind the face at an angle. When combined into an ATAF (Alternate top - Alternate Face grind) you get a sharper cutting, more pointed edge. This is used on the most brittle materials. You start with alternate slants on the tops then grind the faces of the tips so that they slant as well. Standard face left below and beveled face right.



#### Combination Tooth (4&1) - Planer / Combination

Planer Combination combines 4 Alternate Top Bevel Teeth with 1 raker. The basic function of the raker tooth, which is lower than the tips of the scoring teeth and narrower. It removes the V-shaped piece of material left in the center of the cut by the alternating top bevel teeth. This tooth configuration provides a very smooth cut. Often each group is divided by a large gullet on the saw blade. The design is used on combination blades for ripping and crosscutting. You can use a simple ATB when you cut clean through but an ATB will leave a ridge down the middle of a groove. The raker tooth is lower and narrower than the ATB tips and cleans up that ridge. The raker also helps keep the blade square in the cut and the blade running straight.



Advantages: Little tear out, good chip removal and straight cutting

Disadvantages: Hard to sharpen without expensive equipment, easy to chip and wears rapidly.

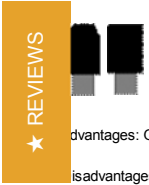
Hollow Grind (HG)

Hollow faced grind used for cutting melamine and other challenging materials. Most often used on vertical panel saws. Here we show three types. Hollow ground is most commonly the circular shape but not always. In this case 'hollow ground' refers to the grind on the top of the tip but the face can also be ground in one of these shapes.



TCG (Triple Chip Grind)

A Triple Chip Grind (TCG) has a trapezoidal tip that cuts a groove with slanting sides. This is followed up by a square top tip that makes the side of the groove square. The first tooth, or lead tooth, has a double 45 degree angle corner bevel. This is followed by a flat topped raker tooth ground lower than the lead tooth. The raker tooth removes the corners left on both sides by the beveled lead tooth. Triple Chip Grinds combines a balanced cutting force, low tooth drag and free chip flow. This helps to eliminate chipping in brittle material such as chip board, and laminates. This divides the chips to achieve smooth cuts in hard materials such as MDF, OSB, and plastics. This tooth design is also used on blades for cutting non-ferrous material. Use TCG grind when cutting plastics, aluminum, and non ferrous metals.



Advantages: Good wear, straight cutting, Low drag with good chip flow.

Disadvantages: Hard to maintain without precision equipment. Tends to produce chip outs.

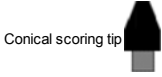
California Triple Chip (C-TCG)

Specialty tooth design for miter saws. Used in picture frame shops, window and door manufacturers or anywhere that miter saws are used.



Solid Surface Scoring Blade

Commonly used when you need clean cuts on both sides of the material. The scoring blade cuts the underside of the material. It cuts just ahead of the main blade which cuts from the top. It must be precisely aligned with the top blade. It is best if the moan and scoring blades are treated as a set and are both sharpened at the same time.



There are a great many other grinds and some of them are highly specialized. In a plant producing MDF or plywood panels the sides of the panel are trimmed after they are pressed and cooked. One side of the cut is the 4x8 sheet seen by the customer. The other side is scrap which gets reground. A saw blade in this application may have all the teeth cutting on one side.

**Conclusion:**

There are about a hundred parts to saw blade depending on how you break them down. These are the saw tip, braze alloy, gullet size and shape, shoulder size and shape, expansion slots and the saw plate or steel saw body.

There are over five thousand grades of carbide with some wearing longer and some being tougher. Some slide through the cut faster and last longer while others are much harder to break. The braze material is much like the suspension in a car. It keeps the tip on and can prevent or eliminate tip loss and breakage. The gullet has to be the right size and shape to handle all the material the tooth cuts but you need as much metal as possible for strong shoulders behind the saw tips. The size and shape of the shoulder can help control the feed rate and a bump on the shoulder can be an important safety feature to control kickback. As a saw blade heats up the outside grows more than the inside so you need expansion slots to keep the blade flat and true. Finally different saw blades are made of different kinds of steel to increase wear, toughness and flatness.

In addition to all the design considerations, some blades are just made much better than others. An easy measurement is side clearance or how far the tip sticks out from the steel body. Some blades may have a variation of as much as 0.005" from one tip to another while others will be at least ten times more precisely ground with a variation of 0.0004".