10.3.2 Render - Cycles Render Engine - Render Settings

Render Settings

- Integrator
  - Scene Settings
  - Material Settings
  - World Settings
  - Lamp Settings
  - Volume Render Settings
- Light Paths
  - Ray Types
  - Bounce Control
  - Transparency
  - Ray Visibility
- Render Layers and Passes
  - Layers
  - Lighting Passes
  - Data Passes
- Motion Blur
  - Options

Integrator

The integrator is the rendering algorithm used to compute the lighting. Cycles currently supports a path tracing integrator with direct light sampling. It works well for various lighting setups, but is not as suitable for caustics and some other complex lighting situations.

Rays are traced from the camera into the scene, bouncing around until they find a light source such as a lamp, an object emitting light, or the world background. To find lamps and surfaces emitting light, both indirect light sampling (letting the ray follow the surface BSDF) and direct light sampling (picking a light source and tracing a ray towards it) are used.

Scene Settings

Sampling

There are two integrator modes that can be used: path tracing and branched path tracing. The **path tracing integrator** is a pure path tracer; at each hit it will bounce light in one direction and pick one light to receive lighting from. This makes each individual sample faster to compute, but will typically require more samples to clean up the noise.

Render Samples
: Number of paths to trace for each pixel in the final render. As more samples are taken, the solution becomes less noisy and more accurate.

Preview Samples
: Number of samples for viewport rendering.

The **branched path tracing integrator** (formerly called non-progressive integrator) is similar, but at the first hit it will split the path for different surface components and will take all lights into account for shading instead of just one. This makes each sample slower, but will reduce noise, especially in scenes dominated by direct or one-bounce lighting. To get the same number of diffuse samples as in the path tracing integrator, note that e.g. 250 path tracing samples = 10 AA samples x 25 diffuse samples. The Sampling panel shows this total number of samples.

AA Render Samples
: Number of samples to take for each pixel in the final render. More samples will improve antialiasing.

AA Preview Samples
: Number of samples for viewport rendering.

Diffuse Samples
: Number of diffuse bounce samples to take for each AA sample.

Glossy Samples
: Number of glossy bounce samples to take for each AA sample.

Transmission Samples
: Number of transmission bounce samples to take for each AA sample.

AO Samples
: Number of ambient occlusion samples to take for each AA sample.

Mesh Light Samples
: Number of mesh light samples to take for each AA sample.

Subsurface Samples
: Number of subsurface scattering samples to take for each AA sample.

For both integrators the noise pattern can be controlled.

Seed
Random number generator seed; each different value gives a different noise pattern.

Bounces

Max Bounces
Maximum number of light bounces. For best quality, this should be set to the maximum. However, in practice, it may be good to set it to lower values for faster rendering. Setting it to maximum 0 bounces results in direct lighting only.

Min Bounces
Minimum number of light bounces for each path, after which the integrator uses Russian Roulette to terminate paths that contribute less to the image. Setting this higher gives less noise, but may also increase render time considerably. For a low number of bounces, it’s strongly recommended to set this equal to the maximum number of bounces.

Diffuse Bounces
Maximum number of diffuse bounces.

Glossy Bounces
Maximum number of glossy bounces.

Transmission Bounces
Maximum number of transmission bounces.

Transparency

Transparency Max
Maximum number of transparency bounces.

Transparency Min
Minimum number of transparency bounces, after which Russian Roulette termination is used.

Transparent Shadows
For direct light sampling, use transparency of surfaces in between to produce shadows affected by transparency of those surfaces.

Tricks

No Caustics
While in principle path tracing supports rendering of caustics with a sufficient number of samples, in practice it may be inefficient to the point that there is just too much noise. This option makes it possible to disable them entirely.

Filter Glossy

When using a value higher than 0.0, this will blur glossy reflections after blurry bounces, to reduce noise at the cost of accuracy. 1.0 is a good starting value to tweak.

Some light paths have a low probability of being found while contributing much light to the pixel. As a result these light paths will be found in some pixels and not in others, causing fireflies. An example of such a difficult path might be a small light that is causing a small specular highlight on a sharp glossy material, which we are seeing through a rough glossy material. In fact in such a case we practically have a caustic.

With path tracing it is difficult to find the specular highlight, but if we increase the roughness on the

material, the highlight gets bigger and softer, and so easier to find. Often this blurring will hardly be noticeable, because we are seeing it through a blurry material anyway, but there are also cases where this will lead to a loss of detail in lighting.

Clamp Samples

This option will clamp all samples to a maximum intensity they can contribute to the pixel, again to reduce noise at the cost of accuracy. With value 0.0 this option is disabled; lower values clamp more light away.

If the image has fireflies, there will be samples that contribute very high values to pixels, and this option provides a way to limit that. However note that as you clamp out such values, bright colors in other places where there is no noise will be lost as well. So this is a balance between reducing the noise and keeping the image from losing its intended bright colors.

Material Settings

Multiple Importance Sample

By default objects with emitting materials use both direct and indirect light sampling methods, but in some cases it may lead to less noise overall to disable direct light sampling for some materials. This can be done by disabling the *Multiple Importance Sample* option. This is especially useful on large objects that emit little light compared to other light sources.

This option will only have an influence if the material contains an emission node; it will be automatically disabled otherwise.

World Settings

Multiple Importance Sample
By default lighting from the world is computed solely with indirect light sampling. However for more complex environment maps this can be too noisy, as sampling the BSDF may not easily find the highlights in the environment map image. By enabling this option, the world background will be sampled as a lamp, with lighter parts automatically given more samples.

Map Resolution
When Multiple Importance Sample is enabled, this specifies the size of the importance map (resolution x resolution). Before rendering starts, an importance map is generated by “baking” a grayscale image from the world shader. This will then be used to determine which parts of the background are light and so should receive more samples than darker parts. Higher resolutions will result in more accurate sampling but take more setup time and memory.

Lamp Settings

Multiple Importance Sample
By default lamps use only direct light sampling. For area lights and sharp glossy reflections, however, this can be noisy, and enabling this option will enable indirect light sampling to be used in addition to reduce noise.

Samples
For the branch path tracing integrator, this specifies the number of direct light samples per AA sample. Point lamps might need only one sample, while area lamps typically need more.

Max Bounces
The maximum amount of bounces this light will contribute to the scene.
Portal
Only available for Area lamps. This setting enables area lamps to function as a light portal, helping to sample the environment lamp and therefore improving convergence. Note that this will make the area lamp itself invisible.

Volume Render Settings

The scene has these settings:

Step Size
Distance between volume shader samples when rendering the volume. Lower values give more accurate and detailed results but also increased render time.
Max Steps
Maximum number of steps through the volume before giving up, to protect from extremely long render times with big objects or small step sizes.

The world and materials have the following setting:

Homogeneous Volume
Assume volume has the same density everywhere (not using any textures), for faster rendering. For example absorption in a glass object would typically not have any textures, and by knowing this we can avoid taking small steps to sample the volume shader.
Sampling Method
Options are “Multiple Importance”, “Distance” or “Equiangular”. If you’ve got a pretty dense volume that’s lit from far away then distance sampling is usually more efficient. If you’ve got a light inside or near the volume then equiangular sampling is better. If you have a combination of both, then the multiple importance sampling will be better.

Light Paths

Ray Types

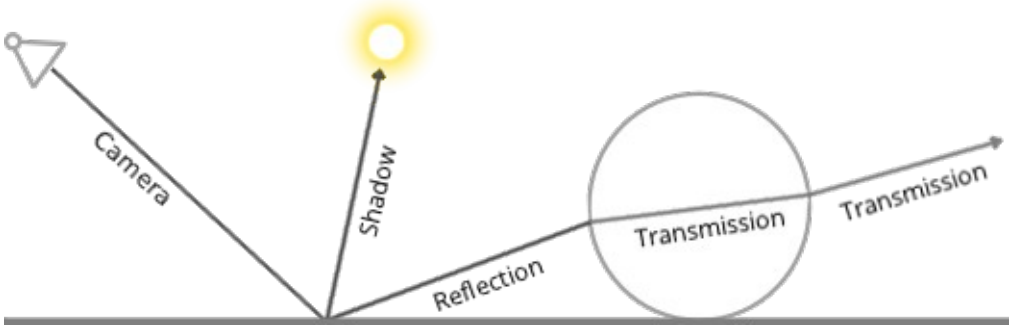
Ray types can be divided into four categories:

- Camera: the ray comes straight from the camera
- Reflection: the ray is generated by a reflection off a surface
- Transmission: the ray is generated by a transmission through a surface
- Shadow: the ray is used for (transparent) shadows

Reflection and transmission rays can further have these properties:

- Diffuse: the ray is generated by a diffuse reflection or transmission (translucency)
- Glossy: the ray is generated by a glossy specular reflection or transmission
- Singular: the ray is generated by a perfectly sharp reflection or transmission

The Light Path node can be used to find out the type of ray the shading is being computed for.



Bounce Control

The maximum number of light bounces can be controlled manually. While ideally this should be infinite, in practice a smaller number of bounces may be sufficient, or some light interactions may be intentionally left out for faster convergence. The number of diffuse reflection, glossy reflection and transmission bounces can also be controlled individually.

Light paths are terminated probabilistically when specifying a minimum number of light bounces lower than the maximum. In that case paths longer than minimum will be randomly stopped when they are expected to contribute less light to the image. This will still converge to the same image, but renders faster while possibly being noisier.

A common source of noise is caustics, which are diffuse bounces followed by a glossy bounce (assuming we start from the camera). An option is available to disable these entirely.

Transparency

The transparent BSDF shader is given special treatment. When a ray passes through it, light passes straight on, as if there was no geometry there. The ray type does not change when passing through a transparent BSDF.

Alpha pass output is also different for the transparent BSDF. Other transmission BSDF s are considered opaque, because they change the light direction. As such they can’t be used for alpha-over compositing, while this is possible with the transparent BSDF.

The maximum number of transparent bounces is controlled separately from other bounces. It is also possible to use probabilistic termination of transparent bounces, which might help rendering many layers of transparency.

Note that while semantically the ray passes through as if no geometry was hit, rendering performance is affected as each transparency step requires executing the shader and tracing a ray.

Ray Visibility

Objects can be set to be invisible to particular ray types:

- Camera
- Diffuse reflection
- Glossy reflection
- Transmission
- Shadow

This can be used, for example, to make an emitting mesh invisible to camera rays. For duplicators, visibility is

inherited; if the parent object is hidden for some ray types, the children will be hidden for these too.

In terms of performance, using these options is more efficient that using a shader node setup that achieves the same effect. Objects invisible to a certain ray will be skipped in ray traversal already, leading to fewer rays cast and shaders executed.

Render Layers and Passes

Layers

This section covers only the Render Layer settings appropriate for the Blender Render engine. For the engine-independent settings, see *this section*.

Exclude
: Scene layers are shared between all render layers; however sometimes it's useful to leave out some object influence for a particular render layer. That's what this option allows you to do.

Lighting Passes

Diffuse Direct
: Direct lighting from diffuse BSDFs. We define direct lighting as coming from lamps, emitting surfaces, the background, or ambient occlusion after a single reflection or transmission off a surface. BSDF color is not included in this pass.

Diffuse Indirect
: Indirect lighting from diffuse BSDFs. We define indirect lighting as coming from lamps, emitting surfaces or the background after more than one reflection or transmission off a surface. BSDF color is not included in this pass.

Diffuse Color
: Color weights of diffuse BSDFs. These weights are the color input socket for BSDF nodes, modified by any Mix and Add Shader nodes.

Glossy Direct, Indirect, Color
: Same as above, but for glossy BSDFs.

Transmission Direct, Indirect, Color
: Same as above, but for transmission BSDFs.

Subsurface Direct, Indirect, Color
: Same as above, but for subsurface BSDFs.

Emission
: Emission from directly visible surfaces.

Environment
: Emission from the directly visible background. When the film is set to transparent, this can be used to get the environment color and composite it back in.

Shadow
: Shadows from lamp objects.

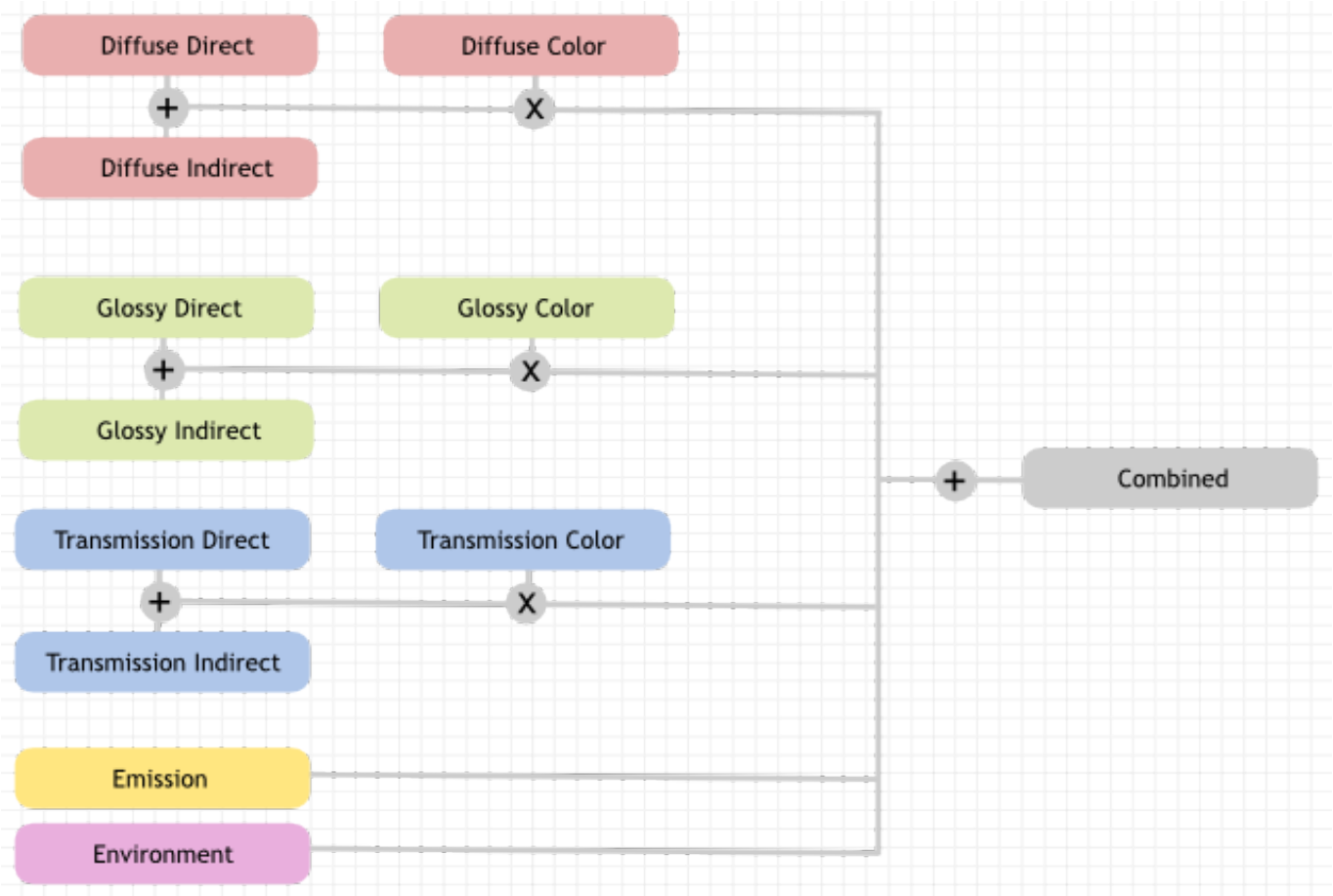
Ambient Occlusion
: Ambient occlusion from directly visible surfaces. BSDF color or AO factor is not included; i.e. it gives a 'normalized' value between 0 and 1.

Note

Transparent BSDFs are given special treatment. A fully transparent surface is treated as if there is no surface there at all; a partially transparent surface is treated as if only part of the light rays can pass through. This means it is not included in the Transmission passes; for that a glass BSDF with index of refraction 1.0 can be used.

Combining

All these lighting passes can be combined to produce the final image as follows:



Data Passes

Combined

The final combination of render passes with everything included.

Z

Distance in BU to any visible surfaces.

Note

The Z pass only uses one sample. When depth values need to be blended in case of motion blur or DOF, use the mist pass.

Mist

Distance to visible surfaces, mapped to the 0.0-1.0 range. When enabled, settings are in Properties ‣ World ‣ Mist Pass.

Normal
Surface normal used for shading.

Vector
Motion vectors for the vector blur node. The four components consist of 2D vectors giving the motion towards the next and previous frame position in pixel space.

UV
Default render UV coordinates.

Object Index
Pass index of object.

Material Index
Pass index of material.

The Z, Object Index and Material Index passes are not anti-aliased.

Alpha Threshold
Z, Index, normal, UV and vector passes are only affected by surfaces with alpha transparency equal to or higher than this threshold. With value 0.0 the first surface hit will always write to these passes, regardless of transparency. With higher values surfaces that are mostly transparent can be skipped until an opaque surface is encountered.

Motion Blur

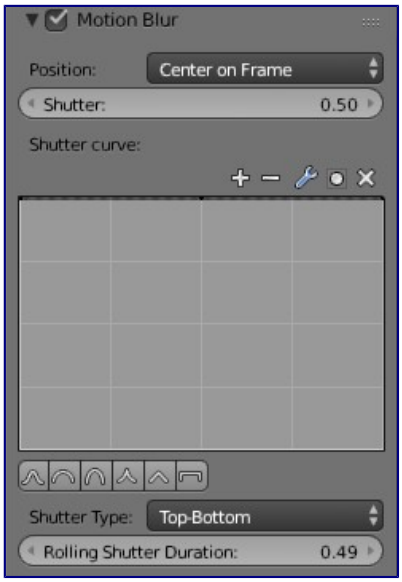
Blender's animations are by default rendered as a sequence of *perfectly still* images. While great for stop-motion and time-lapses, this is unrealistic, since fast-moving objects do appear to be blurred in the direction of motion, both in a movie frame and in a photograph from a real-world camera.

Cycles Motion Blur Example

Note

If there are particles or other physics system in a scene, be sure to bake them before rendering, otherwise you might not get correct or consistent motion.

Options



Cycles Motion Blur Settings

Position

Controls at what point the shutter opens in relation to the frame.

- End on frame
- Center on frame
- Start on frame

Shutter Speed
Time between frames over which motion blur is computed. Shutter time 1.0 blurs over the length of 1 frame, 2.0 over the length of two frames, from the previous to the next.

Shutter Curve
Curve defining how the shutter opens and closes.

Shutter Type

Replicates CMOS cameras by rendering a rolling shutter effect using scanlines.

- Top Bottom: Renders rolling shutter from the top of the image from the bottom.

Rolling Shutter Duration
Controls balance between pure rolling shutter effect and pure motion blur effect. With zero being no rolling shutter and one being all rolling shutter.

Warning

An object modifier setup that changes mesh topology over time will cause severe problems.

Common examples of this are animated booleans, defomation before edge-split, remesh, skin or decimate modifiers.