LESSON
8

Compressors and Limiters

After completing this lesson, the student should be familiar with the following concepts:

- Compressors are devices which change the dynamic range of a signal by attenuating signals whose volume exceeds a user set threshold in a user set ratio. Once the loudest volumes have been attenuated, the entire signal's volume can be boosted to a higher level using the makeup gain control.
- Compressors are used to make signals seem more present and punchy in a mix.
- Compressors and limiters can be a hardware device or a software device.
- Limiters are simply compressors whose compression ratio is permanently set to infinity to one.
- Limiters are used to reduce sudden and brief peaks in program material. Like compressors, their function allows us to significantly increase the overall level of the signal.
- Limiters are best used on an entire mix rather than an individual instrument.
- When the threshold on a compressor is set too low and the ratio is set to high, the compressor will begin to attenuate the volume in an unmusical way (pumping).
- Most compressors and limiters offer attack and release controls which determine how fast the unit begins to attenuate a signal's volume and how quickly it ceases to attenuate respectively.

Glossary for this Lesson:

Attack- A control found on compressors and limiters which allows the user to set the amount of time it takes the unit to increase it the amount of attenuation.

Attenuate- To decrease or turn down.

Compressor- A device which attenuates the volume of an incoming signal in a user specified ratio. Attenuation begins once the level of the input signal exceeds a designated threshold, specified in decibels. This process decreases the signal's overall dynamic range. When the signal's overall volume is then boosted, the net result is that the signal becomes louder.

Decibel- A logarithmic metric unit of measure of volume in the air and gain in electronic circuits.

Dynamic Level- The current volume level.

Dynamic Range- The scope of dynamic levels throughout the duration of a signal.

Gain Reduction Meter- A series of lights or similar contrivance which allows the user to monitor a compressor or limiter's level of attenuation.

Limiter- A compressor whose compression ratio is permanently set to infinity to one. The resultant device attenuates the volume of incoming signals so that they cannot exceed the threshold setting. This is very useful for decreasing the volume of the very loudest momentary peaks in a signal.

Makeup Gain- The output gain of a compressor which is used to raise the volume of the entire mix. This gain stage is used to compensate or 'make up' for the compressor's gain reduction.

Ratio- The control on a compressor which determines the ratio of decibels input to decibels output. Compression ratios are always expressed as a real number to one. Very high compression ratios can cause compressors to attenuate a signal in an unmusical way resulting in a phenomenon called 'pumping'. A limiter is simply a compressor whose ratio is permanently set to infinity to one. Pumping on a limiter is avoided by carefully setting the threshold control so that the limiter only acts on peaks in the program signal.

Release- A control on a compressor or limiter which controls how long it takes the device to stop reducing the signal's gain.

Threshold- A control on a compressor or limiter which determines when the device begins to attenuate the volume of an incoming signal.

LESSON 8

Compressors and Limters

When playing the piano, dynamic signs such as forte, piano, and mezzo forte tell us how loud or soft to play the music. Our dynamic level is our volume level. Our dynamic range is the difference between the softest volume and the loudest volume we use during a song. In a recording studio, we have specialized processors which allow us to control the dynamic levels of signals. Two of the most basic dynamics processors are compressors and limiters. The two devices are actually very similar as we will soon discover.

One thing that sets popular music recordings aside from classical music recordings is that pop recordings have a more consistent dynamic level. Rather than having some passages which are really soft and other passages which are really loud, pop recordings are loud all of the time, even in the 'soft' sections of a song. The device which helps us to keep the volume consistent is a compressor. What does a compressor do and how does it do it? Before we can answer these questions, we need a little background in compressors.

The word compress means to squeeze together or make smaller. If you want to get the water out of a wet sponge, you could squash it between your hands or compress it to get the water out.

How Loud Are You?

We already know that compressors change a signal's volume. In order to understand how compressors work, we need to understand more about volume. Volume is measured in decibels. The abbreviation for decibels is dB. The higher the decibel number, the louder the sound. Every time a sound gets ten decibels louder, the sound actually gets ten times louder! If a sound gets loud enough, it can permanently damage your hearing. It is very important to protect your ears from loud sounds. You can see some examples of how loud different sounds are on the chart titled "How Loud is Loud?' in the lower right-hand corner of this page.

What Does A Compressor Do?

A compressor allows us to make an entire recording seem louder. It does this by doing the exact opposite of what you'd expect: it turns down the volume. A compressor turns down the volume only when the volume of the input signal gets to a certain level that you set. This level is called the threshold. Threshold is measured in decibels since we measure volume in decibels. On a compressor, how we set the threshold depends on how loud the original signal was recorded.

On recorders, we use a different kind of decibel measurement, but we still call it decibels. In the real world, there is actually no limit to how loud sounds can get, but there is a limit to the volume of sounds that we can record. On a recorder, 0 dB is the loudest sound we can record. Sounds softer than 0 dB are represented with negative numbers. The higher the number, the softer that sound is. -20 dB is a good starting setting for threshold for most recordings. Remember that the compressor will not start to turn down the volume until the incoming volume reaches the threshold level you set.

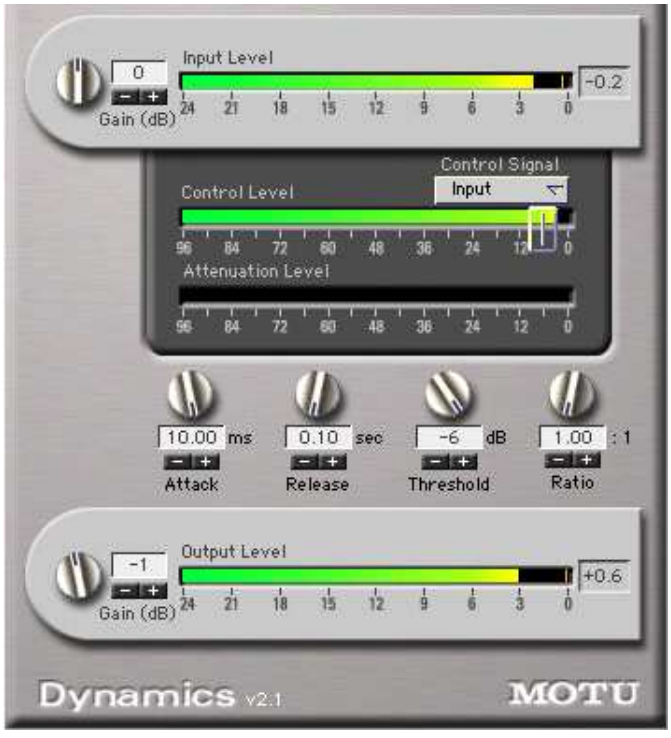
How Loud Is Loud?

120 dB- The threshold of pain. Sounds this loud actually hurt when you hear them. This is the typical volume of a rock concert (some are as loud as 150 dB).
110 dB - An orchestra playing fortissimo
90 dB - You can have permanent hearing damage if you listen to sounds 90 dB or higher long enough.
70 dB- street traffic
60 dB- typical conversation
40 dB - A quiet school classroom
20 dB - A whisper
0 dB- The softest sound you can hear

How's Your Attenuation Span?

The word attenuate means decrease. If you attenuate the volume on your TV, you turn the volume down. A compressor attenuates the volume of a signal. The compressor attenuates the volume of a signal in a ratio. A ratio is a set of two numbers separated by a colon. 2:1 (two to one) is an example of a ratio. When we talk about the ratios that compressors use, the first number in the ratio is for decibels coming in, and the second number is for decibels coming out. The second number is always one. If we set the compressor's ratio to 2:1, then the compressor will only put out one decibel for every two decibels that come in. This doesn't mean that compressors always put out one decibel. The ratio is just an example of what the compressor is going to do. With a 2:1 setting, if the input signal is 10 dB, the compressor will only put out 5 dB, because ten is two times larger than five, just like two is two times larger than one. If 30 dB comes in, only 15 dB comes out. With a 2:1 ratio, how many decibels comes out when 4 dB comes in? The answer is 2 dB because 4 is two times larger than 2.

You can set different compression ratios using the ratio knob. You can see an example of the ratio knob on the software compressor at the bottom of this page. 2:1 is a good starting point, but you can use heavier ratios for some sounds. 3:1, 4:1, and even 6:1 are common ratios. It is important to be careful not to set the ratio too high or the threshold too low. This will cause the compressor to attenuate the signal too much in an unmusical way that sounds very unnatural and unpleasant. This is called 'pumping.'



Some compressors (mostly software compressors) display a graph of the current compression ratio. You can see one such graph on the next page. These compressors usually place a large dot on the graph to indicate how much volume is coming in and how much volume is going out. The dot moves as the volume level of the signal changes, giving you a visual confirmation of what the compressor is doing.

Compressors usually have a meter on them that shows how much they are attenuating the signal. This is called the gain reduction meter. Can you find the gain reduction meter on the compressor software on this page?

Attack And Release

Most compressors offer attack and release controls. The attack control determines how long it takes the compressor to turn down the volume. Instead of suddenly jerking the volume down, the attack control lets us set the amount of time it takes the compressor to get to the current level of attenuation. Likewise, we wouldn't want the volume to suddenly snap back up once the signal gets lower than the threshold, so most compressors have a release control which determines the amount of time it takes for the compressor to get from its current level of attenuation to no attenuation.

Sometimes compressors offer an automatic feature which sets the attack and release times for you. The automatic setting is often a pretty good place to start if you are unsure of how to set the attack and release controls. When you manually set the controls, you usually want to set them so that the attenuation begins and ends in a musical way. If the attack and

release controls are set properly, you shouldn't be able to hear the compressor doing its job.

Make Up And Be Friends

So far we have learned that compressors begin to attenuate or turn down the volume when the input signal gets louder than the threshold volume, which is measured in decibels. The volume is turned down in a ratio, which measures the amount of volume coming in and the volume coming out. We also learned that compressors make the whole mix louder. It might seem like compressors would make the whole mix softer, but that is not the case.

The last control on a compressor is the output level, which is often called makeup gain. This control allows you to raise the volume of the signal so that the loudest parts of the signal are close to 0 dB, which is the loudest signal that we can use in a recorder. This control makes up for the amount of volume lost when the compressor attenuates the signal. Since the compressor attenuated the loudest parts of the signal but didn't attenuate the softest parts, there isn't as much difference between the loud parts and the soft parts. The compressor has allowed us to turn up the soft parts of the music while keeping the loud parts loud.

You Pay For What You Get

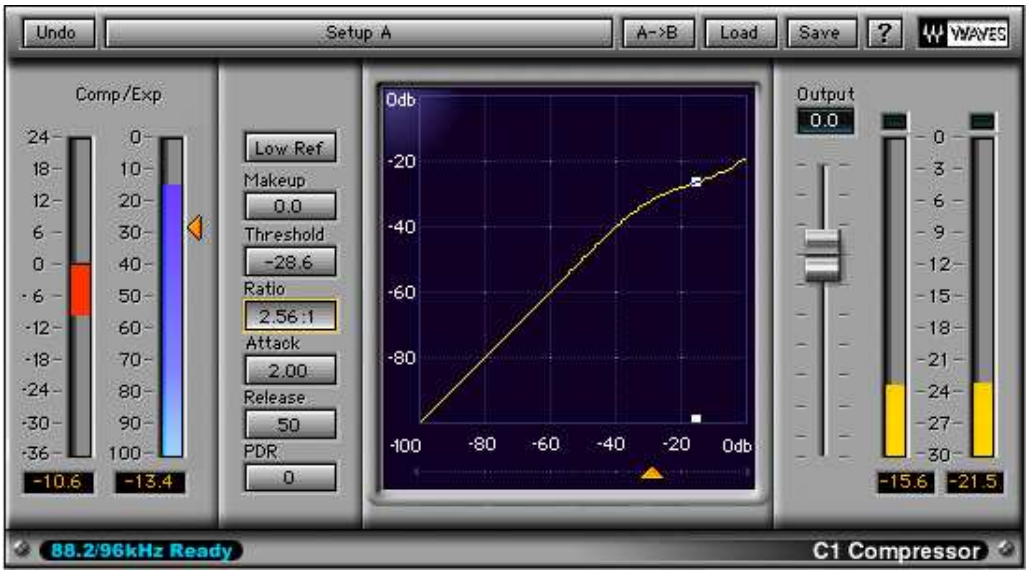
Compressors span a wide range of prices. Like the other effects we have seen so far, compressors can be a piece of hardware that does nothing but compress, a feature of an effects unit which can also generate other effects such as reverb and chorus, or a software program. You can expect to pay anywhere from $40 to $5,000 for a hardware compressor that does nothing but compress. There is such a huge price difference because of the quality of the components used in the manufacture of the compressor, and how musically the compressor responds. A Boss compressor ($40) will compress the dynamic range of a signal just like a $5,000 Manley tube compressor, but the sound will be changed as well, and not for the better. On the other hand, you can be quite clumsy with your use of a very high-end compressor and still achieve very musical results. A top-notch compressor sounds musical no matter what your settings. The moral of the story? You get what you pay for.

Software compressors usually fall somewhere in between these two extremes, but the get what you pay for rule still applies here. There is a reason that expensive software compressors are expensive. This rule generally holds true of all audio equipment.

How Are Compressors Used?

Unlike the effects we have learned about so far, we must connect compressors and limiters to a mixer's inserts, not to its aux sends and returns. We don't want to compress the dynamic range of just part of a sound. That won't help anything. We need to compress all of a signal. Also, unless we intend to compress an entire mix, we usually only want one sound going through a compressor.

Compressors are used to make signals more present and punchy (make them sound closer and stronger). Generally, we compress instruments which



we want to hear prominently in a mix such as a singer's voice or a lead guitar line. It is also common to gently compress the entire mix to make it sound more punchy and lively. To compress the entire mix, we can connect the mixer's main outputs to the inputs on the compressor. Some mixers also have master inserts, which allow you to connect devices which affect all of the mixer's channels.

Setting The Limits

Limiters are some of the most useful devices in a studio for making a mix sound great. A limiter is simply a compressor with its ratio permanently set to infinity to one. This means that no matter how many decibels come in, only one decibel will come out. When you are using the limiter, this means that the volume can't get any louder than whatever volume you set as your threshold volume. You can see the Waves L1 limiter at the bottom of this page. This software limiter is the most popular limiter in the whole world.

Limiters can protect you against stupid mistakes in a studio or on stage that would destroy speakers, amplifiers, and most importantly, your hearing. If there is sudden feedback or another loud noise, the limiter will not let the volume get louder than the threshold setting.

DID YOU KNOW?

Some really fancy mixers have excellent compressors and limiters built right into every channel! While this is really convenient, it really can drive the cost of a mixer through the roof. It is like not only buying a big expensive 72-input mixer, but also buying 72 compressors to go with it! It is no wonder some mixers cost more than a house!

Secondly, limiters can be used to attenuate the peaks in a sound. Compressors can do a good job of controlling the overall volume of a mix, but at the times when the volume suddenly gets loud for just a moment (think of snare drum hits, cymbal crashes, or special sound effects) we need to turn down the volume in a much higher ratio than is musically useful for the rest of the mix. This is where the limiter comes in. You can preset a specific volume level (the threshold) which is the limit on how loud the mix can get. When set properly, the limiter should just affect the very loudest portions of the mix, and it shouldn't stay on very long.

Many compressors allow you to set their ratio to infinity to one, meaning that they can function as either a compressor or a limiter. Better compressors offer both a compressor and a separate limiter all in one. Software usually lets us compress or limit. A few programs let you do both with one program. Generally, two separate programs are used to compress and limit a signal.

Limiters are best used on an entire mix rather than on an individual channel. Like compressors, limiters are usually connected to a mixer's inserts.

Let's Review

1. What does a compressor do and how does it help us in the studio?

2. What does the threshold control do and how is this measured? What does the ratio control do? What does the makeup gain control do? What do the attack and release controls do and how are they measured?

3. What is a limiter and how does it help us in the studio?

4. Why do some compressors cost thousands of dollars while others are much cheaper?

5. How is volume measured in the air and in a mixer?

6. If compressors and limiters actually turn the volume down, how do they help us to make a signal louder?

Words to Know: Do you know the meaning of these words?

Attack	Decibel	Gain Reduction Meter	Ratio
Attenuate	Dynamic Level	Limiter	Release
Compressor	Dynamic Range	Makeup Gain	Threshold

Experiments:

1. Connect a hardware compressor to an insert on a channel. Connect a microphone to that channel's input. Experiment with different threshold and ratio settings. What happens when the threshold is set very high? When it is set very low? What happens when the ratio control is set very high or very low?

2. With a musical threshold and ratio setting, try changing the attack and release times. What happens to the gain reduction meter?

3. Try using the compressor as a limiter. What happens when you set the threshold too low? Can you find a setting of the threshold that just reduces the loudest volume peaks?

4. Now try compressing and limiting an entire mix. What settings are most effective? What happens if you set the threshold too low and the ratio too high?