String Tension 101

Modern music has become so sub-divided and fragmented that there is no longer one turn-key string solution for every playing style or desired sound. At one point in time, there were no standardized string gauges, but John D'Addario Sr. changed all that in 1939 with the introduction of light, medium and heavy gauges for acoustic instruments. Throughout most of the 20th century, standardized electric and acoustic guitar gauges were sufficient for needs. Occasionally, new gauges (often hybrids of existing sets), were created for specific purposes and string offerings from manufacturers became immense. However, today there are so many popular styles and trends that it is often necessary for players to go outside of standard gauge sets to get the effect they desire. Whether it's open tunings, drop tunings, baritone guitars, 5-string guitars, 7-string guitars or a variety of other reasons, many players are opting to go their own way and customize their string selection and sound. Go to Tension Guide

Why Do You Need To Know About String Tension?

D'Addario receives hundreds of inquiries each year from players who have questions or problems to solve related to string gauges or tensions. To assist players in determining the appropriate string for their needs, we created the Online String Tension Guide, a complete book of charts for determining the appropriate string to be used in just about any situation. The guide includes formulas for determining string tension for any string on any instrument type or scale length using three basic measurements: the Unit Weight, the Scale Length of the instrument, and the Frequency of the string. If scientific formulas aren't your strong point, we have pitch/tension charts for just about every string we make, including electric guitar, acoustic guitar, classical guitar, and bass guitar.

$$\mathbf{T}\ (\text{Tension}) = (UW \times (2 \times L \times F)^2) / 386.4$$

String Tension Facts and Figures

Before we dig in to examples of how to determine various string tensions, here is a brief summary of what string tension is and what effect it has on your instrument and your playing.

Guitar Fingerboard Layout

(Standard Tuning)

	Nut / Open	1st Fret	2nd Fret	3rd Fret	4th Fret
1st String	e' - 329.6 Hz	f' - 349.2 Hz	f#' - 370.0 Hz	g' - 392.0 Hz	g#' - 415.3 Hz
2nd String	b - 246.9 Hz	c - 261.6 Hz	c#' - 277.2 Hz	d' - 393.7 Hz	d#' - 311.1 Hz
3rd String	g - 196.0 Hz	g# - 207.7 Hz	a - 220.0 Hz	a# - 233.1 Hz	b - 246.9 Hz
4th String	d - 146.8 Hz	d# - 155.6 Hz	e - 164.8 Hz	f - 174.6 Hz	f# - 185.0 Hz
5th String	A - 110.0 Hz	A# - 116.5 Hz	B - 123.5 Hz	c - 130.8 Hz	c# - 138.6 Hz
6th String	E - 82.4 Hz	F - 87.3 Hz	F# - 92.5 Hz	G - 98.0 Hz	G# - 103.8 Hz

String tension is determined by vibrating length, mass, and pitch. The string diameter alone does not determine a string's tension. By using different raw materials (nickelplated steel or phosphor bronze, etc.) or by varying the ratio between the core and the wrap wire, two strings with the same diameter, tuned to the same pitch, could have two different tensions.

There are many factors other than string gauge that determine the actual and perceived string tension on your instrument:

- Scale length, or the distance between the nut and the saddle. The longer the scale, the higher the tension is for the same string tuned to the same pitch – for example, a standard Fender™ guitar at 25½" scale has more string tension and will feel stiffer than a standard Gibson™ 24¾" scale guitar, even if both are tuned to the same standard pitch. Some players adjust for this by using slightly heavier gauges on shorter scale guitar than on longer scale guitars.

Acoustic/Electric/Classical Guitar = 25 1/2"
Electric Bass Guitar (Superlong Scale) = 36"
Electric Bass Guitar (Long Scale) = 34"
Electric Bass Guitar (Medium Scale) = 32"
Electric Bass Guitar (Short Scale) = 30"
Mandolin = 13 7/8"
Mandola = 15 7/8"
Mandocello = 25"
Mandobass = 42"
Banjo = 26 1/4" (19 5/8" for 5th string)

- The flexibility of the instrument top and neck.
- The string break-angle at the nut and saddle/bridge.
- String height or "action" as adjusted at the saddle.
- Truss rod adjustment (neck relief).

Note: Before deciding on a string gauge, be sure your instrument is properly "set up." Unusually high action can change the way the string tension feels and can also result in poor intonation.

How to Measure String Tension

String tension is measured in pounds of pull per string. When all of the tensions of each string are added up, you get the "set tension" for that set. If, for example, you want to change the tuning of one string, you should try to select a string gauge that will offer a similar tension to the string you are replacing, but can be tuned to the desired pitch.

Here is an example of how to use this tension guide:

Let's say you play a D'Addario EXL110 set, which is made up of the following strings:

Note	Diameter (inches)	Tension (in lbs.)
E	.010 plain	16.2
B	.013 plain	15.4
G	.017 plain	16.6
D	.026 wound	18.4
A	.036 wound	19.5
E	.046 wound	17.5

Now, if you want to drop tune your low E down to D, here's how you determine the correct string diameter to replace the low E:

1. Find the correct alloy and string type chart. In this case, an XL wound nickelplated steel string.
2. Find the current string on the XL nickelplated steel chart and find the current pitch column E.

XL - Nickelplated Steel Round Wound

	Item#	Unit Weight	c	B	A	G	F	E	D	C
	NW039	.00027932	32.2	28.7	22.8	18.1	14.3	12.8	10.1	8.0
	NW042	.00032279	37.2	33.1	26.3	20.9	16.6	14.8	11.7	9.3
	NW044	.00035182	40.5	36.1	28.7	22.7	18.0	16.1	12.8	10.1
#1	NW046	.00038216	44.0	39.2	31.1	24.7	19.6	17.5	13.9	11.0
	NW048	.00041382	47.7	42.5	33.7	26.8	21.2	18.9	15.0	11.9
	NW049	.00043014	49.5	44.2	35.0	27.8	22.1	19.7	15.6	12.4
#2	NW052	.00048109	55.4	49.4	39.2	31.1	24.7	22.0	17.4	13.9

3. Move down from E to your desired new pitch of D on the chart column. (See #1)
4. Under the D column, locate the tension measurement that is closest to the standard set tuning, which in this case is 17.5 lbs. (See #2)
5. Reference the accompanying string gauge that closely matches 17.5 lbs, which in this case is NW052 at 17.4 lbs.
6. Therefore, the correct string to use for drop D tuning is an NW052.

Using this method, you can substitute for any string in a set or custom-design gauges for open tunings. Fully understanding string tension can be a valuable tool in improving your instrument's performance and increasing the variety of tonal and textural options you have.