



# Guitar harmonics; an overview in diagram

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## Abstract

This document lists the natural harmonics of the 6-string guitar. It summarizes the mechanism for generating natural harmonics on a fretted string, then shows all possible natural harmonics for each string in guitar standard tuning and in ascending pitch order. Finally, the mechanism for generating artificial harmonics is shown.

## 1 Introduction

For a recent composition for electric guitar and string orchestra, *Redo Or Undo Last Action* (October 2018; more information on my website and YouTube channel) I needed an overview of the *natural harmonics* for a guitar in standard tuning, preferably in order of ascending pitch. So I decided to create a figure that shows the harmonics in staff notation, compiling and reshuffling information from books in my library.

The sources are in the reference list at the end of the document and include books about the guitar specifically such as [1], [2] and [3]. Guitar harmonics are also described in textbooks on orchestration and music notation, including [4] and [5].

This document starts with a diagram that illustrates the mechanism for generating natural harmonics on a fretted guitar string. Then there is the figure with the overview of all possible natural harmonics in ascending order for the guitar in *standard tuning*.

## 2 The natural harmonics of a guitar string

The guitar string is shown in Fig. 1. This diagram holds for a fretted string in any tuning, with an open string pitch that has fundamental frequency  $f$ . The 24 frets are indicated from left to right, from low to high notes over a chromatic range of two octaves. For this string we may generate the second to fifth harmonic above the fundamental frequency by touching, not pressing, the string at specific frets, as shown in the diagram. Some harmonics may be generated at multiple fret numbers.

From the figure we see that the second harmonic with frequency  $2f$  is generated at the 12th fret, at the string midpoint. This yields a pitch an octave above the fundamental frequency, i.e., an octave above the open string pitch. The third harmonic with frequency  $3f$  is generated at either  $\frac{1}{3}$  or  $\frac{2}{3}$  of the string length (measured from either end). This is equivalent to the fret

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## GUITAR STRING NATURAL HARMONICS

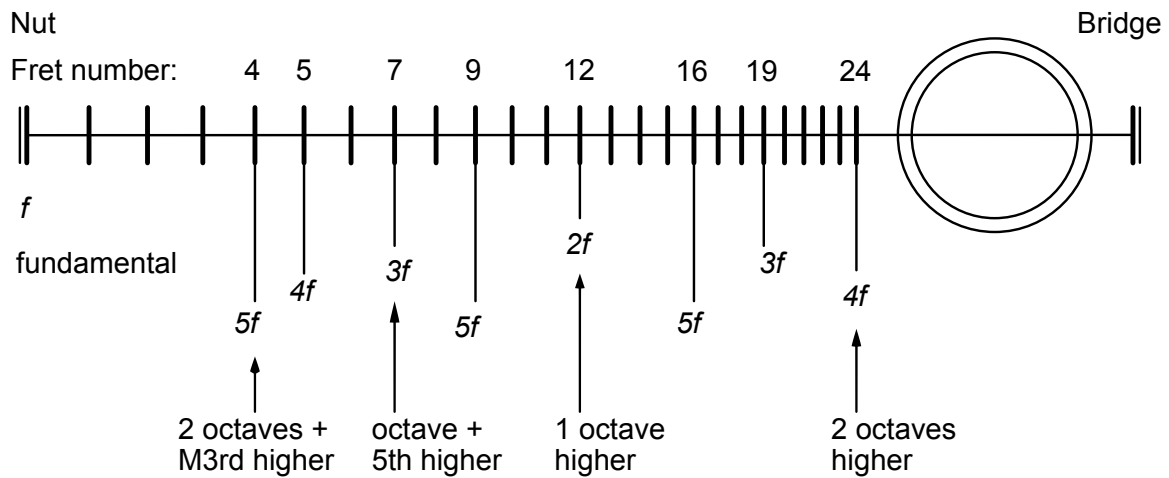


Figure 1: The natural harmonics of a guitar string.

numbers 7 and 19 and will lead to a pitch an octave plus a perfect fifth above the open string pitch. Likewise the fourth harmonic  $4f$  is generated at fret numbers 5 and 24, corresponding to the string length proportions  $\frac{1}{4}$  and  $\frac{3}{4}$  and sounds at two octaves above the fundamental pitch. And, finally, the fifth harmonic  $5f$  is the pitch at two octaves plus major 3rd above the open string tuning, and is generated by touching fret numbers 4, 9, or 16, at string length ratios  $\frac{1}{5}$ ,  $\frac{2}{5}$  or  $\frac{3}{5}$ .

### 3 An overview of guitar harmonics in standard tuning

Based on the natural harmonics generation mechanism described in Section 2 we may list all possible harmonics for a 6-string guitar in standard tuning, i.e.,  $E-A-D-G-B-E$ . This overview is shown in Fig. 2, that shows the various notes and fret numbers for the five natural harmonics for each guitar string at the top. The six strings are listed from lowest, string VI with tuning  $E3$ , to highest, i.e., string I with tuning  $E5$  (written pitch, sounding an octave below). For each harmonic the lower note is touched by the left hand finger (partial dampening of the string at this specific position), the upper pitch indicates the sounding pitch of the harmonic.

Then the overview shows the sounding natural harmonics in ascending pitch order. A number of these can be achieved in multiple ways; these are marked with the +-sign. Finally, the figure shows how to generate *artificial harmonics* at either the next higher octave or at two octaves above. This is a more complex playing technique that involves both hands in the sense that the left hand finger presses the lower note, with the right hand finger touching the upper note (diamond-shaped notehead), while also plucking the string with a different right hand finger.





## 4 Conclusion

This overview may come handy when composing or arranging music for guitar. Presenting the natural harmonics in ascending pitch order enables quick lookup of the options available. However, one also has to consider the playing technique consequences when either writing successions of harmonics (natural and/or artificial) and the juxtaposition of regular playing and harmonics; there may be wide left hand leaps along the neck. Do not forget the option of two simultaneous harmonics, but then the spacing along the fret numbers is also important.

The limitation of this document is that it only shows natural harmonics for the standard tuning of a 6-string guitar.

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### References

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