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> *There's a harmonic on fret 5, 7, and 12.*
> *That's all I know!*

Sounds familiar? That's only skimming the surface of the tip of the iceberg! From the classical guitar repertoire to contemporary music, harmonics have long been around in guitar. Over the last decades, harmonics have taken centre stage with innovating guitarists making them a part of their musical identity. Lenny Breau, Eddie Van Halen, Brent Mason, Tommy Emmanuel, or Tim Henson are just a few names that come to mind. Nevertheless, the use of harmonics remains limited to adding colour or a touch of magic. Together, we are going to lift the veil on this **instrument within the instrument**, so that you too can confidently explore harmonics in all their splendour. Exciting times to be a guitarist!

Harmonics are a mysterious bunch. They don't behave like "regular" notes. A harmonic can be produced between frets, not just above the fret. But where is the marker for it? A harmonic can sound totally different than the fretboard note it sits on. But what pitch is it at? A harmonic can be found all over the string, it may even "live" beyond the fretboard. Come again? Playing a harmonic can be punishing and hazardous. But how can it be played with consistency? These barriers must be overcome to give harmonics a chance.

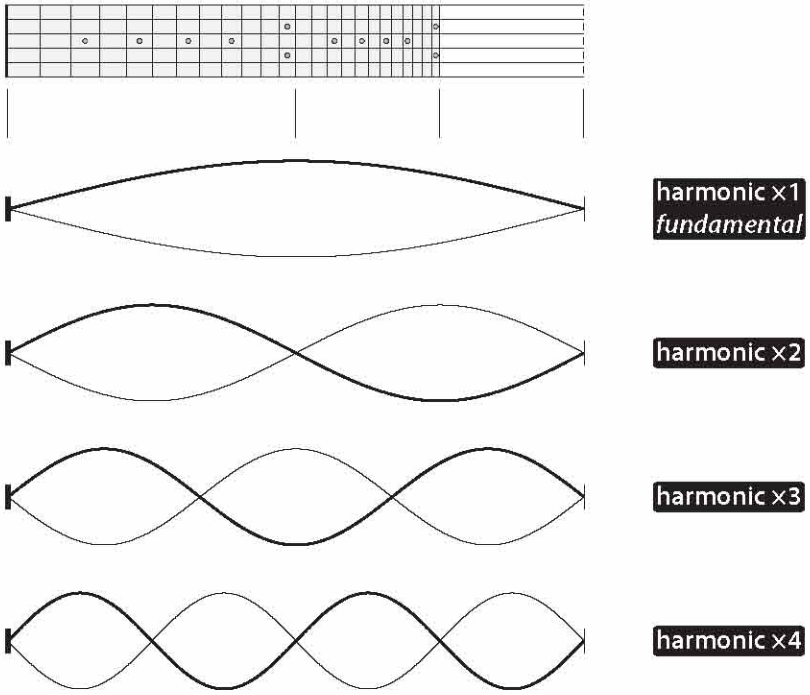
Disoriented? Understandably so. Our knowledge of harmonics is sketchy at best and we are just happy to grab a chime here and there. Whether the harmonic is in the key, is in the right octave, or is a particular target note, that is over our head! Learning harmonics is hard, to make them sing is even harder.

We are going to chip away at the problem inch by inch, from the ground up. To do this well, we must step into fields other than music. If we stayed within the confines of music alone, you would have to take too much at face value to truly gain an understanding of harmonics. ***Harmonics DNA* sits at the junction of music, physics, and cognition.** But this book is written for the musician and the guitarist foremost, so rest assured that while the book will tickle your brain cells at times, we will be taking baby steps, with a fair share of hand-holding.

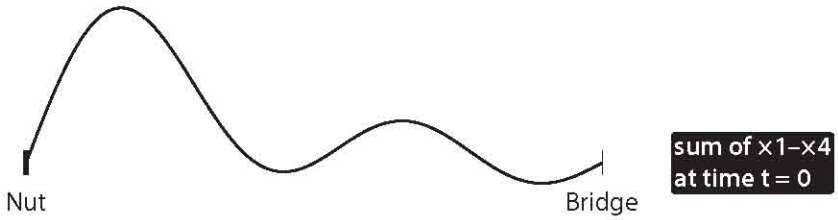
The book puts harmonics under the microscope and examines them from every angle:

- **Physics.** The mechanics of how harmonics come to be on the string. Some of their fundamental properties and parameters of interest.
- **Layout.** Multiple ways to view harmonics on the guitar, presented as reference charts.
- **Notation.** Introducing a new notation system for harmonics. To learn, teach, or communicate around harmonics, we must speak a common language.
- **Technique.** Inventory of ways to execute harmonics on guitar, plus how to use our growing knowledge of harmonics to play better harmonics.
- **Harmonics smarts.** Taking advantage of the properties of harmonics to turn them into a potent, versatile musical tool.
- **Applications.** Practical usage of harmonics for the setup of the instrument.
- **Cognition.** Insights into how the listener hears sound. Our hearing "has its ways" and as hi-fi as it is, it colours the sound we hear. Harmonics put us in the front seat of how sound is processed.
- **Sound laboratory.** Turning audio of harmonics into numbers and graphs. Quantifying and visualising what we hear helps consolidate concepts in the book and debunk ideas we took for granted.
- **Audio files.** A number of chapters come with supporting audio. They are an integral part of the book.

The book introduces several novel ideas and approaches to harmonics. All share the goal of making learning easier and enabling everything that can be done with harmonics.



The diagram showed each harmonic alone. Each harmonic vibration represents a component of the string's motion. While these vibrations exist, they are not visible as such. What we see is the composite vibration. If the string vibration only contained the first four harmonics, the string shape for the same snapshot in time would look like this (add the four thick line waveforms together):



ATTENTION **Do not mix up the fundamental vibration of the string and the vibrating string.** The fundamental is a single sine wave with a pitch of its own (single frequency). The vibrating string is the superposition of an infinite number of sine waves (multiple frequencies), including the fundamental, with a perceived pitch that is the same as the fundamental's pitch. Even though we use them interchangeably, frequency is not pitch!

DIVIDING TIME, DIVIDING SPACE

Harmonics are all about division. There is a singular relationship between a harmonic as it evolves in time (at a point on the string) and as it evolves in space (over the entire string). The two are linked.

- Over time, harmonic ×N vibrates at a rate of N times the rate of the fundamental ×1. So if a point on the string vibrates at the fundamental rate of 110 Hz (the point swings back and forth 110 times in 1

Distinguishing fret 3'9 from fret 4 appears to be a moot point. It is not! No finger can position itself with such pinpoint accuracy on the string but once you hear it, you know! The point is that choking the node right behind fret 4 produces a clearer harmonic than choking it right over fret 4. That is why fret 3'9 matters. For precise harmonic node positions all over the string, refer to the table in the Decimal Node Positions chapter.

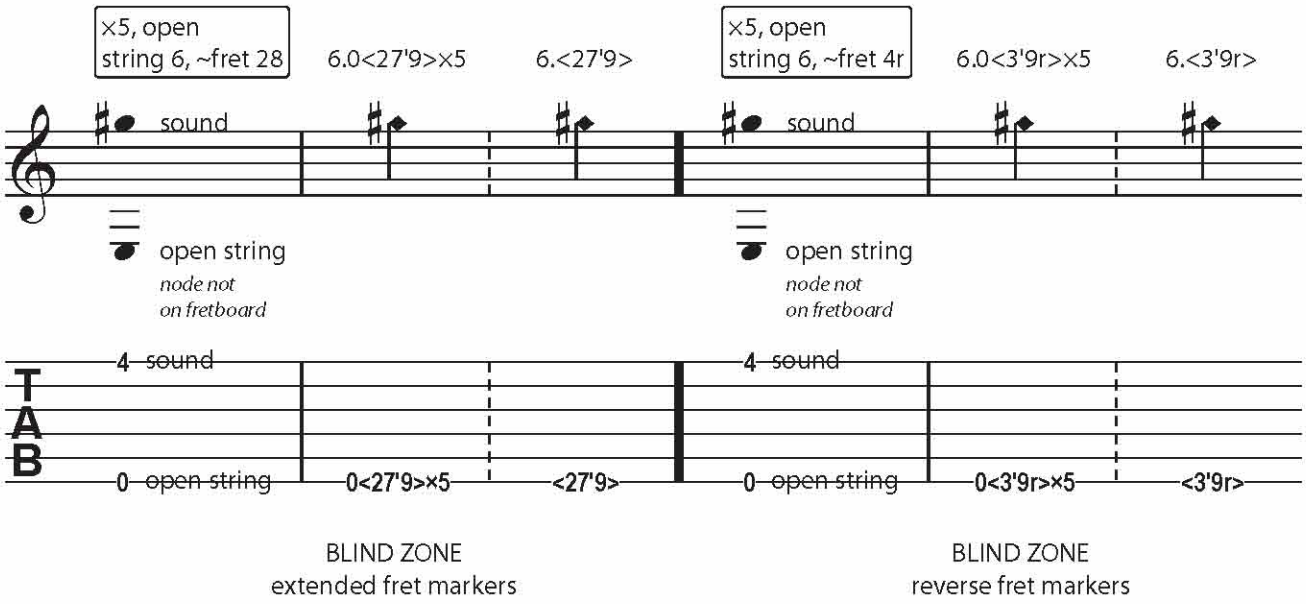
BLIND ZONE

For a node in the blind zone, **extended fret markers** are on duty. Fret number is assigned just like for a harmonic node on the fretboard. In our example, this time with the node for ×5 in the blind zone, the natural harmonic version is spelt: 6.0<27'9>×5 or 6.<27'9>. With a stopped note at fret 2, the artificial harmonic version of the same node is spelt: 6.2<29'9>×5 or 6.2<29'9>.

Occasionally, you might prefer to use **reverse fret markers**. In the rare case your node sits close to the bridge, this is your only option. Fret number is assigned as usual, with the addition of the suffix "r" for reverse. Taking the same example again, the natural harmonic version is spelt: 6.0<3'9r>×5 or 6.<3'9r>. Reverse fret markers lose their appeal for artificial harmonics. This is why extended fret markers are the preferred notation format in the blind zone.

How can we determine the correct fret position with respect to reverse fret markers? For natural harmonics, the position is the same as the corresponding node near the nut (symmetry). So the node at fret 3'9 becomes 3'9r in the blind zone. For artificial harmonics, there are two ways to go about it. One way is to measure the distance between the stopped fret and the mirror image node (near the nut), and transfer that same distance onto the reverse fret markers. The other way involves calculating the exact position with respect to reverse fret markers (with formulas). In our example, natural harmonic ×5 at fret 3'9 translates into artificial harmonic at fret 3'4r when the string is stopped at fret 2. It is spelt 6.2<3'4r>×5 or 6.2<3'4r>.

The example shows the same node written two ways: first with extended fret markers (preferred), then with reverse fret markers. Existing notation (staff and TAB) would collapse here as the node, which is not over the fretboard, cannot be associated with any fret!



Attention A node on the fretboard can suddenly find itself in the blind zone! For example, the open E

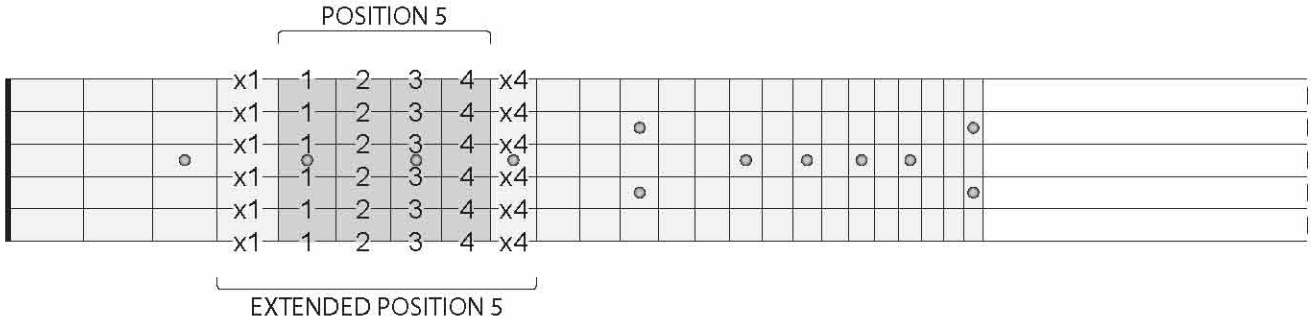
16 NODES FOR POSITION PLAYING

Being able to think in position is an important part of playing the guitar. The deeper your knowledge of the fretboard, the more you can do in one position without shifting your fret-hand. If harmonics could be played in position (with the fret-hand), it would reinforce our goal of making the harmonic a note like any other and facilitate "grabbing a chime" with minimal disruption to technique. The fret-hand could fret a node just as it can fret a note and the pluck-hand would pluck or pick as usual!

POSITION

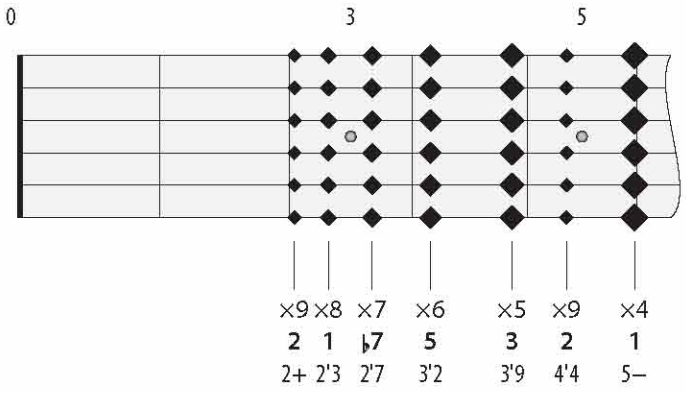
A *position* is a range of four consecutive frets across all strings. It can be extended by one fret on each side, resulting in a six-fret area referred to as an *extended position*. So position 5 refers to frets 5–8 (4 frets × 6 strings = 24 notes). Extended position 5 refers to frets 4–9 (6 frets × 6 strings = 36 notes).

Each finger is assigned to a fret, the same for all strings. In position 5, finger 1 is assigned fret 5, finger 2 is assigned fret 6, and so on. Extended position 5 is covered without changing hand positions but by stretching finger 1 (x1, as in extended finger 1) to reach for fret 4 and finger 4 (x4) to reach for fret 9.



LIMITED CHOICE

Can harmonics be played in position? Yes, essentially by using nodes within frets 0–5. The diagram presents a map of nodes that live on frets 0–5 for harmonics ×2–×9. Warm up your ring and pinky fingers, pick a position (like position 5), transpose the map to that position, and give these nodes a try. Stop the string at fret 5 with finger 1 (or barre/half-barre) and choke the node with finger 3 or 4. Pluck as usual with the pluck-hand. You will find that the fretting finger may need to press the string firmly. To avoid plucking a node and dampening the harmonic, pluck close to the bridge for these harmonics.



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