Intonation Tool Software: I.T.S™

User's Manual

By
TL

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We wish to thank you for having chosen our product, welcome in the family owners of this Intonation Tool Software (I.T.S. software) for musical instrument of the following kinds: Stringed instrument with fret or fretless:

➢ **Electric guitars**
➢ **Electric bass guitars**
➢ **Violin and more ...**

This user manual is made to help you making the intonation adjustment of your instrument.

Principal characteristics:

✔ Calculation accuracy corresponding to a theoretical frequency deviation of the string tuning in the range of 0.01 Cents[1]
✔ Scale Length: This software accepts scale lengths from 0.8 to 40 Inches.
✔ Reference fret number for fretted musical instrument: 24 or a lower fret number. For fretless musical instruments(It can be changed to **Nut to point** by clicking on the label.)

(1) The cent is a logarithmic unit of measure used to express small musical intervals, and even if the interval of one cent is too small to be heard between successive notes, it is important to target a higher accuracy in order to obtain a clean sound, which is particularly sensitive when several strings are played together for harmonious result.
This 0,01 Cents accuracy of the tuning is verified on a guitar with a scale length of 25,5" (647,7 mm), for a measurement made at the 12th fret.

⚠ **Caution**: When changing a string, be sure to take all the necessary precautions in order to exclude any risk of injury or the degradation of your devices. The ends of string are sharp, please remember to minimize any future risk for the final user, by cutting these ends as short as possible near mechanics.

Waste disposal: Do not dispose of electrical appliances, they must be collected separately and submitted to recycling environmentally , refer to European Directive 2012/19 / EU and instructions on electronic waste and electronic (DEEE) and the transposition into law of your country .

Summary

I.   Tools needed to use I.T.S™:

✔ a frequency tuner showing accurate deviation in Cents;
✔ an adapted caliper like the top one, with rounded ends for external point measurement:

✔ adapted driver(s) for your instrument needs, for the truss rod, adjustable bridge's saddle and for action of strings;
✔ gauge thickness could be useful to tune the action of strings;
✔ Basic tool to tune your musical instrument;
✔ A computer with a free USB 2 (or 1.1) slot with JavaTM 7 minimum installed (See the "Quick Start Guide" file).

Definitions:

Open string: The string included between its contact points with the nut and the saddle on the bridge.
String Action: The shortest distance between surfaces of the reference fret and the string.
Scale Length: Standard length given by the manufacturer of the musical instrument, or, this is twice the distance between the nut and the 12th fret.

II. Software overview

The Intonation Tool Software : ITS ™ is designed to help you get the most accurate intonation technically possible for your musical instrument (electric guitar, electric bass guitar and so on).

As a tuner is required to adjust the resonant frequency of each string as ITS allows setting just notes along the neck, or to adjust on the fingerboard the position of notes between several strings for fretless instruments.

Through the process of setting one of its kind, ITS can adjust the intonation with a maximum precision of 0.01 cents deviation.

High precision adjustment eliminates the audible beats between close frequencies, thus improving sound quality. To the ear, the instrument will sound just longer and this has the direct effect of extending the life of the strings.
ITS stores the input data and allows quick and easy adjustment for the same instrument or even string parameters.

1. Main panel

Main				
Scale Length:	Frequency:	Ref. Fret N°:	String Action:	
0.0 Inches	440.0 Hz	12.0 Fret	0.0 ‰	
2nd Wound Dia.:	1st Wound Dia.:	String | Core Size:	Length subtracted:	
0.0 ‰	0.0 ‰	0.0 ‰	0.0 Inches	
Apply				
Tension:	Unit Weight:	Target Deviation:	Open String L. [-Ls]:	
0.0 Pounds	0.0 lb/in	0.0 ¢	0.0 Inches	
Break Point:	Loudness:	Inharmonicity:	Measured Dev.:	
0.0 %	0.0 Indice	0.0 B	0.0 ¢	

a) Input description:

This software is fully automated to make the work as easiest as possible, this means that each user input values are saved or at default stay in memories during the work session.

Scale Length: Scale Length is for a fretted instrument with equal temperament the distance between half of the 12th fret and the nut, multiplied by two (also given by the manufacturer of your musical instruments).

Frequency: This is the open string frequency at which the string is tuned.

Ref. Fret N° | **Nut to Point**: This defines the position from the nut for the stretched frequency, used for frequency deviation and string action measurements. This can be the top of a fret or a contact point on the fingerboard (Change the mode by clicking on the label).

String Action: This is the shortest distance between the side of the open string and its contact point with the reference fret, or on the fingerboard (for the fretless musical instruments).

2nd Wound diameter: this is used to enter the diameter of the overall double wound string (See Appendix II.i).

1st Wound diameter: This is used to enter the overall diameter of single wound string or the diameter of single wound string of a double wound string (See Appendix II.i).

String | **Core Size**: This is used to enter the plain string diameter or the core size of wounded strings (See Appendix II.i).

Length Subtracted: This is a value which will be subtracted to the open string length of the string, getting easiest the way to tune the open string length with a caliper. (See Appendix III,ii.)

Target deviation: It gives the possibility to make custom or compensated temperament.

Open String [-Ls]: This is the length of the open string less the Length subtracted (See Appendix bellow). After calculation it is used to adjust the open string length.

Measured deviation: It must be entered to correct the default during the calculation process.

b) Output description:

Tension: It is the calculated tension of the open string length.

Unit weight: It shows the mass per unit length, this input allows the use of a custom unit length, at 0 it is automatically calculated.

Target deviation: Used for custom or compensated temperaments, it shows the targeted deviation of frequency (in Cents).

Open String [-Ls]: The length of the open string less the Length subtracted, after calculation, it shows the value for adjustment of the open string length.

Break Point: This give the estimated tension in percent applied on the string before it breaks (at 100%).

Loudness: It is an indication of the volume of the open string.

Inharmonicity: It is used to calculate partials harmonics of a string under known conditions, lowest this number is, less there is inhamonicity.

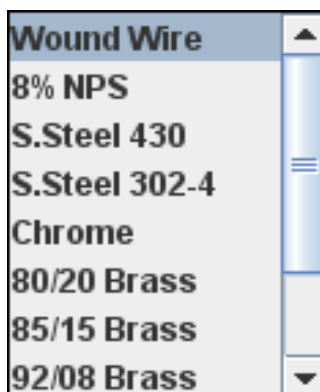## 2. The String type selectors and materials
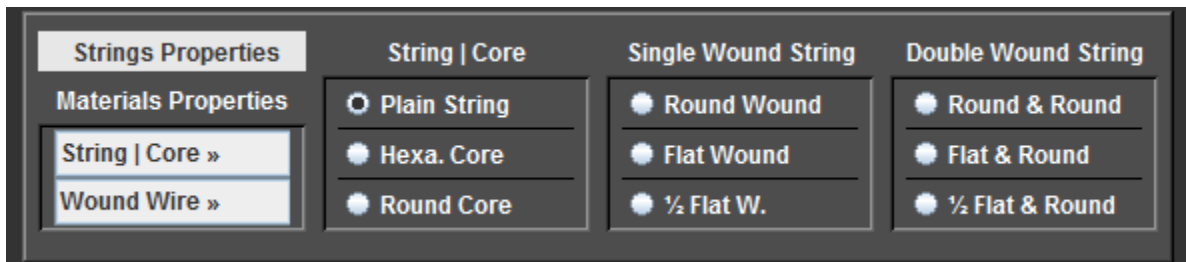
a) Materials Properties

This two item box let you define the core and wire materials properties used for your strings.

String | Core:
There are here common string or core materials used by manufacturers.
Steel&Tinned are simply for plain string Steel and for core of wound string in tinned steel.

Wound Wire:
This is a partial list of materials choice for wound wire.
There is in addition, Nickel, Phosphor Bronze and Copper.

b) String | Core

Plain string: Check box for simple string (the string has no wound wire).

Round Core: Check box for round core for wound string.

Hexagonal Shape: Check box for hexagonal core for wound string.

c) Single Wound String

Round Wound: Check box for round wire wound around the core.

Flat wound: Check box for rectangular wire wound around the core.

½ flat wound: Check box for round wire wound around the core and flatted.
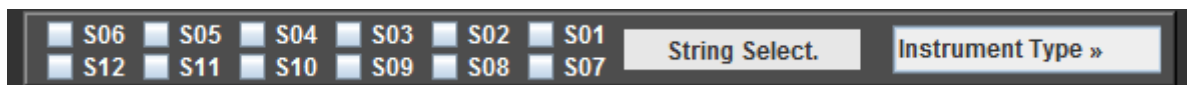
d) Double Wound String

Round & Round: Check box for when the 1st and 2nd wound wire are round shaped

Flat & Round: Check box for when the 1st wound wire is round shaped and the second is rectangular shaped.

½ flat & Round: Check box for when the 1st and 2nd wound wire are round and the 2nd one is flattened on its side.

3. *String Selectors by Instrument Type*

 At the left, this are selectors for fundamental frequencies used per string, each frequency can be customized by changing the input of the Frequency in the main panel and confirmed by doing a click on "Apply" bar.

> **Note**: In **global settings** mod (when all frequency selectors are unselected) the frequency case let you enter the overall frequency reference, this mean that if you detune this frequency of one semitone, all frequencies of selectors will be detuned of one semitone. Anyway, each frequency can be changed as personal setting and will have priority on global settings, so, changing the reference frequency after, customized frequencies will not affected.

4. *Load/Save, Reset, info-bar and System Units*
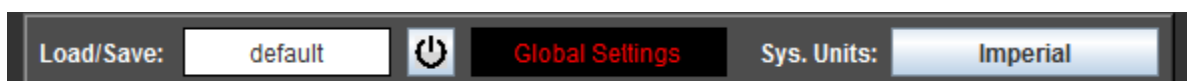
a) Load/Save

 Saving a configuration file: "Load/Save" box will let you enter the name of the file into which your configuration will be automatically saved (each time you do a click on the "Result" or "Apply" button).

Loading a configuration file: By changing the file name and by doing a click on the Apply or Result bar, the software will load the configuration file, if the file do not exist, the software will create a new configuration file.

b) Reset

-The **reset** button let you erase all your parameters for this file.

c) Info-bar

-The display information give you some information on the state.

d) Sys. Units

"**Sys. Units**" button gives you the ability to change the system units to be used between Metric and Imperial.

Note: The reference system units have to be chosen during the "global settings" state. ("Global setting" is the state when all frequencies buttons are unselected.) Anyway, it will let you enter a value in a different unit than the one used with global settings or it will convert the values to the desired unit.

III.   Tuning with Intonation Tool:

1. Calibration process

Fingerboard curvature and strings action must be done, if you use a vibrato bridge, block it before beginning this process.

1. Measure and enter all inputs values in the corresponding box;
2. Enter the Open String Length measured with the caliper (if the "Length subtracted" input is used);
3. Measure the frequency deviation at the reference fret or position used on the fingerboard and enter it in Cents into the "Default deviation" input box;
4. Click on the "Result" bar and wait for the "Done" message on the info bar;
5. When done, tune your caliper with the Open String Length [-Ls] value and set the new saddle position on the bridge.

> Options:
> A. The Input Length Subtracted [Ls] permits the use of a shorter caliper If [Ls] is used, enter the caliper measurement in the Open String Length - [Ls] input box. After calculation, the Open String Length -[Ls] value is used to calibrate the caliper for setting the Open String length on the Musical Instrument.
>
> B. For different Musical Temperament than equal, you can enter the specific Targeted deviation for the reference fret in the corresponding case.

Check the intonation of the string at the reference fret or position on the fingerboard and it should be done!

i. Setup Global Settings

The optional but useful state "Global Settings" is active each time you start the Software or by unselecting all string selectors (See chapter II.3).

This Global setting let you define the general inputs which are the same for several strings. This will give the same inputs values, for all strings, which have to be tuned later with Intonation Tool Software.

This process acts on the Scale Length, overall reference frequency, String action,, Length subtracted, type of string and their material properties.

So, start the Intonation Tool Software, in "global settings" (See "info bar" state, chapter II.4):

1. Enter the Scale Length value for the instrument which will be tuned.
2. Entering a different Frequency than 440 Hz in global setting mode will allow you to customize the overall input frequencies for your instrument, if you want for example the instrument to be tuned one semitone under standard tuning, simply lower the 440Hz reference of one semitone and select the corresponding instrument, each frequency from the quick frequency selectors will be lowered of one semitone.
3. Enter the Fret reference (or for fretless instrument, point to nut) will let you choose the defined point on the neck where will be measured the frequency deviation, commonly this point is at half of the Scale Length (Fret number 12).
4. Enter the String action measured at the reference fret chosen earlier, the distance is the shortest between the surfaces of the open string and its contact point on the reference fret (or for fretless instrument, the contact point on the fingerboard).
5. Enter the Length subtracted [Ls], (See Appendix III.ii for more informations on how to define it).
6. Choose the material properties for the Strings I Core and wound wires of your wound strings.
7. Select the shape of the cores used for wound strings.
8. Select wound strings type and the shape of wound wires.
9. To finish click on the "Result" bar.

After that, each string will be studied one by one and tuned the same way by entering their "others" characteristics for the string to be tuned.

i.   Measurement of Strings Diameters

a. For plain String simply measure the diameter of the string.

b. For single wound String, there will be two measures: The overall Single wound diameter (1st Wound Diameter) and the core Size or diameter (hexagonal or round shape).

c. For double wound String, there will be 3 parameters: The overall diameter "Double Wound Dia." (2nd Wound Diameter), the single wound diameter (1st Wound Diameter) and the core size.
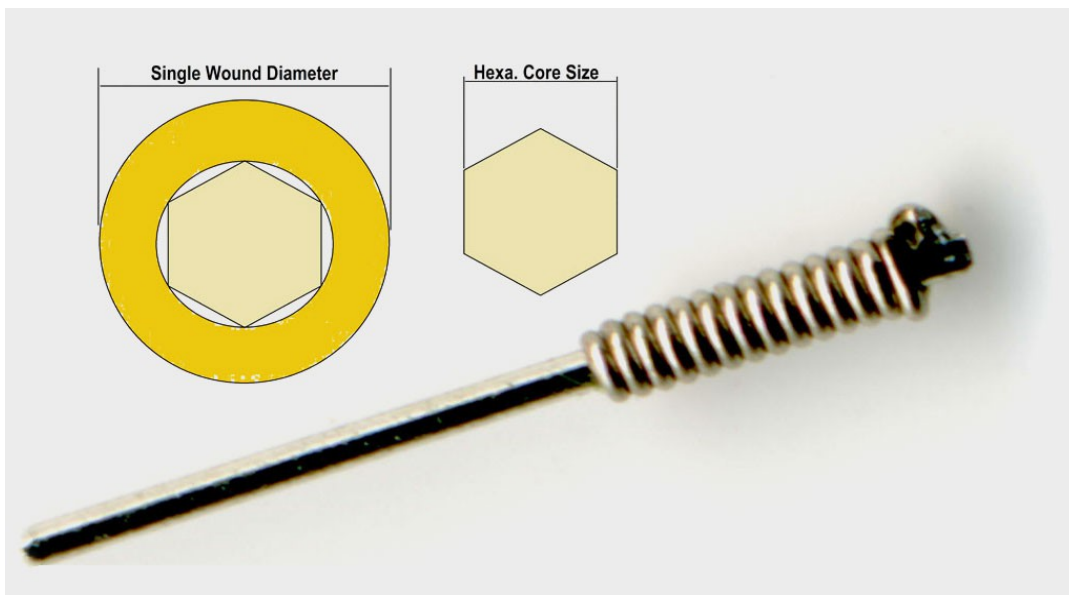
Note: It is better to use more than one of the same strings together to measure each diameter, so the measurement will be more right, in other case the calliper could make some deformations on the string which will give you bad measurement. The shape of the core could be given by manufacturer or found with a microscope, a good scanner, a good camera or with a light and the number of flash seen by turn.

 When you've selected your strings gauge for your instrument and tuned the action of your strings under tension, you are ready to begin the intonation tool work.

i. *Calculation of the deviation in Cents between two frequencies (If a frequency-meter is used) :*

Deviation in Cents « e » :

$$e\,(Cents)=1200\times\frac{\log\times(\frac{f}{fo})}{\log(2)}$$

f → Measured frequency
fo → Targeted frequency

ii. *Calculation of the « Length subtracted » value*

This program aimed to adjust the length of the open string to adjust the intonation of the musical instrument, « Length subtracted » corresponds to the lengths that do not varies, while the measure taken with the caliper, it is variable and changes between the measure and the value after calculation with I.T.S™, to adjust the position of the bridge.

Using the entry « Subtracted Length » allows the use of a shorter calipers that if one were to use only the actual length of the open string.
Let:

$$L=Ls+Lm$$

L → Open String Length : distance distance between the nut and the saddle on the bridge
Ls → « Length subtracted », sum of the fixed lengths from the open string (see below);
Lm → Variable length measured with a caliper or length to use after calculation, to adjust the total length of the open string. Measurement taken between the side of the saddle and the side of the last fret, value to enter in the « Open String Length [-Ls] ».

Calculation of the « **Length subtracted** » **Ls** :

$$Ls=a+b+c+d$$

Ex : Ls = 485,775 + 2,794 / 2 + 15,24 + 10 = 512,412 mm

a → distance between the nut and the center of the last fret (used to make measurement with the calipers, see calculation below)
b → half-width of the fret, let the width of the fret equals to 2,794 mm, b will be equal to 1,397 mm.
c → distance of the contact point of the caliper on the bridge, and the contact point of the string on the saddle. (measurement taken parallel to the string)
d → width of the tip of the caliper, in our example page 4, it is 10 mm.

Calculation of the fixed length between the nut and the last fret:

$$a=d-\frac{d}{2^{(\frac{n}{12})}}$$

Ex : a = 647,7 – 647,7/[2^(24/12)] = 485,775 mm (between the nut and the middle of the fret)

d → scale length given by the manufacturer of your musical instrument, or this is the distance between the nut and the 12th fret multiplied by 2.
n → n[ème] fret number against which will be taken the measurement,

We hope you will be fully satisfied by this tool as we are and it will continue to be used.

IV.   Known Issue:

◆   Unit weigh found inside result for ½ flat wound strings could be particularly different from the given or measured unit weight;

◆   Some time the software could not respond or found an answer, simply change a little the input value if it happens and it will work;

◆   It appears that there is bad new string which has to be replaced by other new one sometime:

◆   Appearance may be a bit different following operating systems.

But it works well!

CUSTOMER NOTE :

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www.omade-tl.com OMADE TL 500 CHE DES MOINES 01420 CORBONOD, France Phone : +33.611.427.825 E-mail : info@omade-tl.com		Requirement: - A caliper or similar measurement and calibration tool; - A tuner showing deviation in cents or a frequency meter; - Basic tool to tune your musical instrument; - A computer with a free USB 2 (or 1.1) slot with Java™ 7 minimum installed.