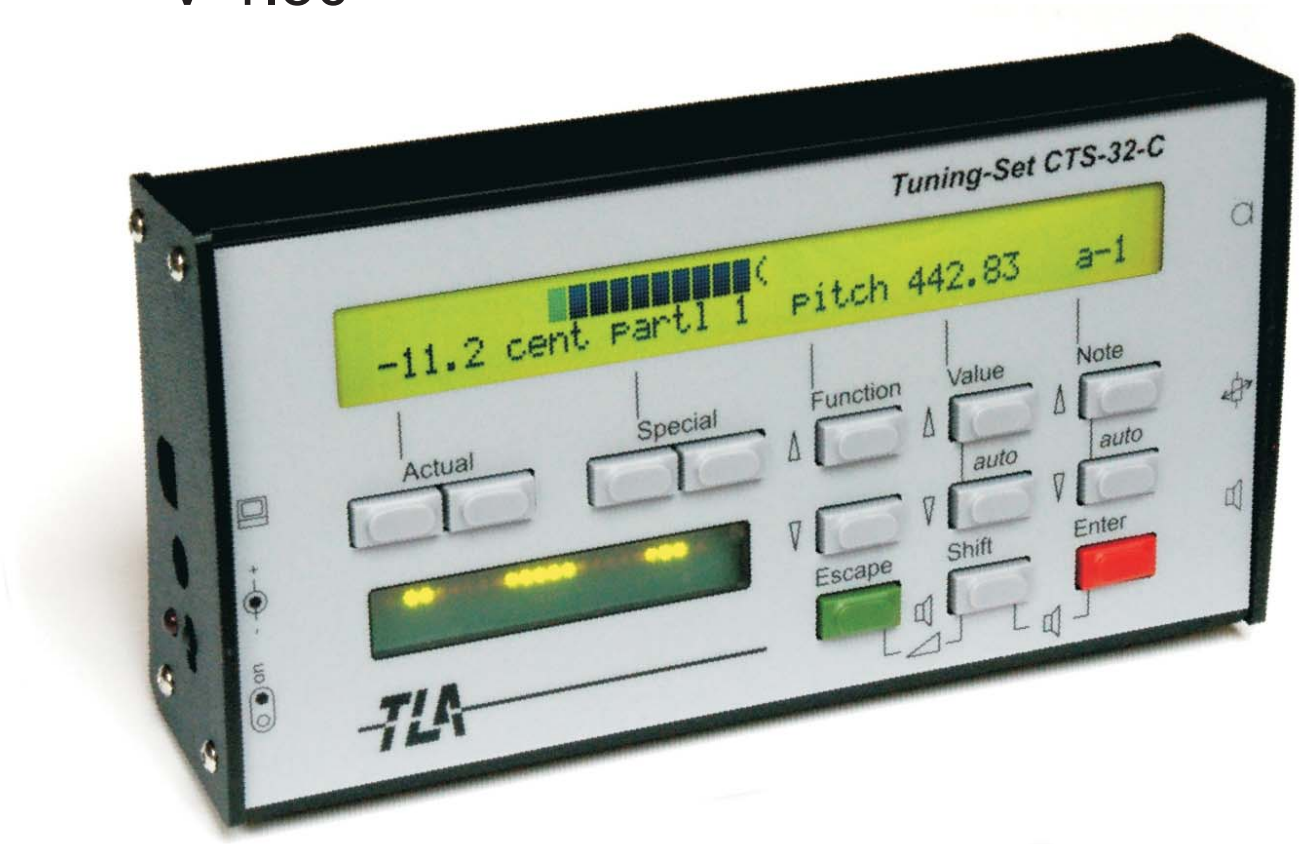
TLA

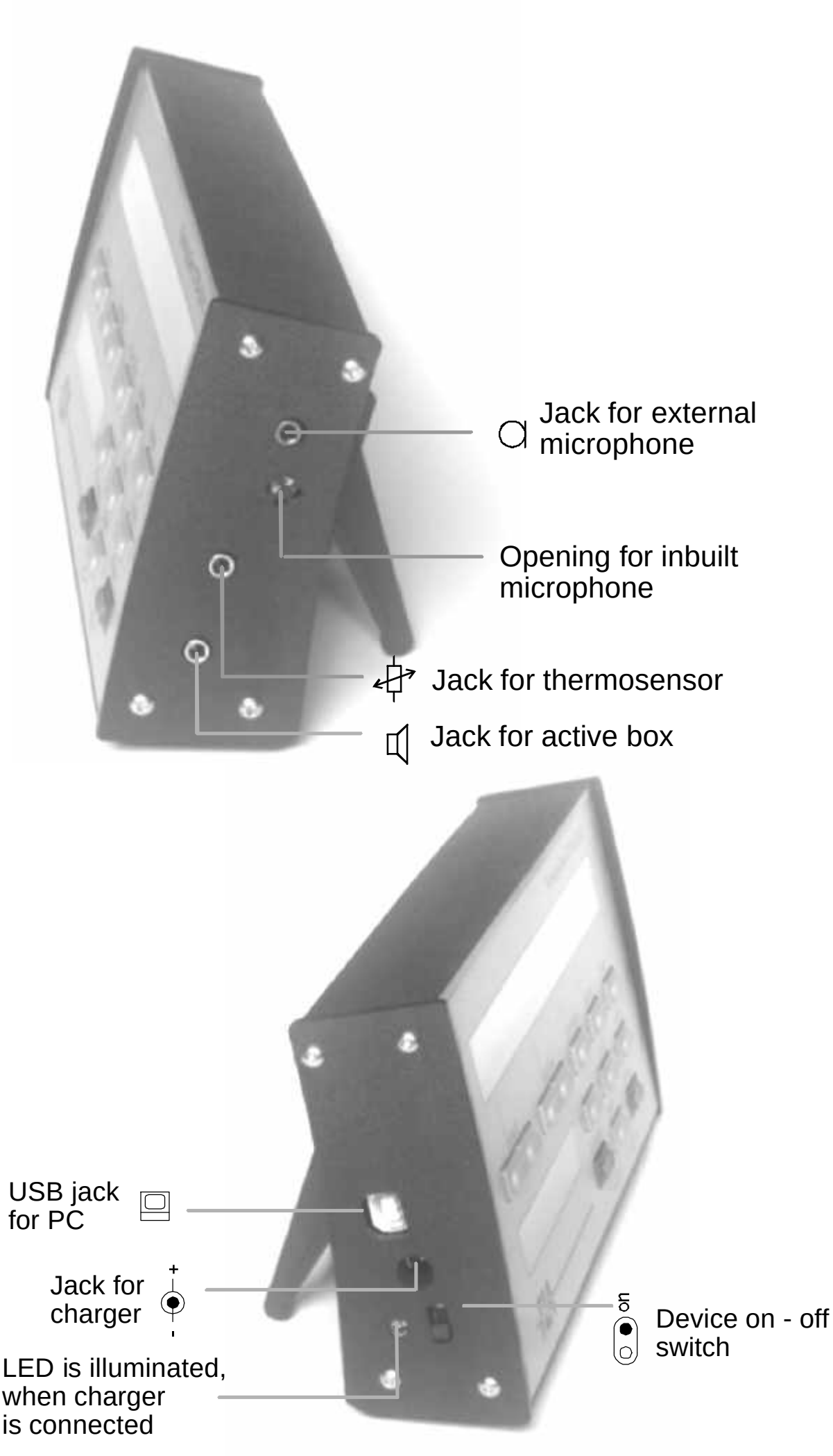
Manual

V 1.50

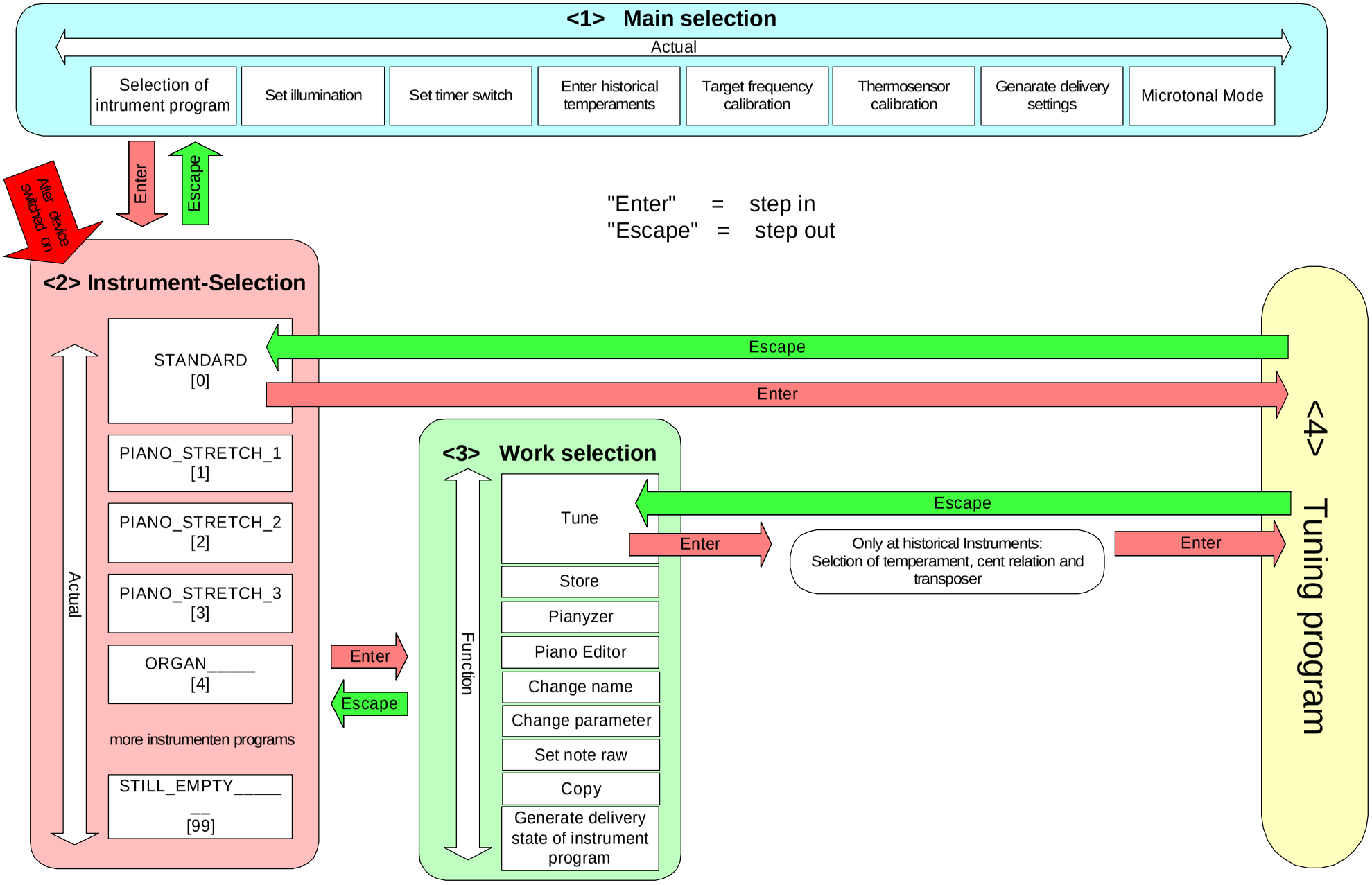


Tuning-Set CTS-32-C

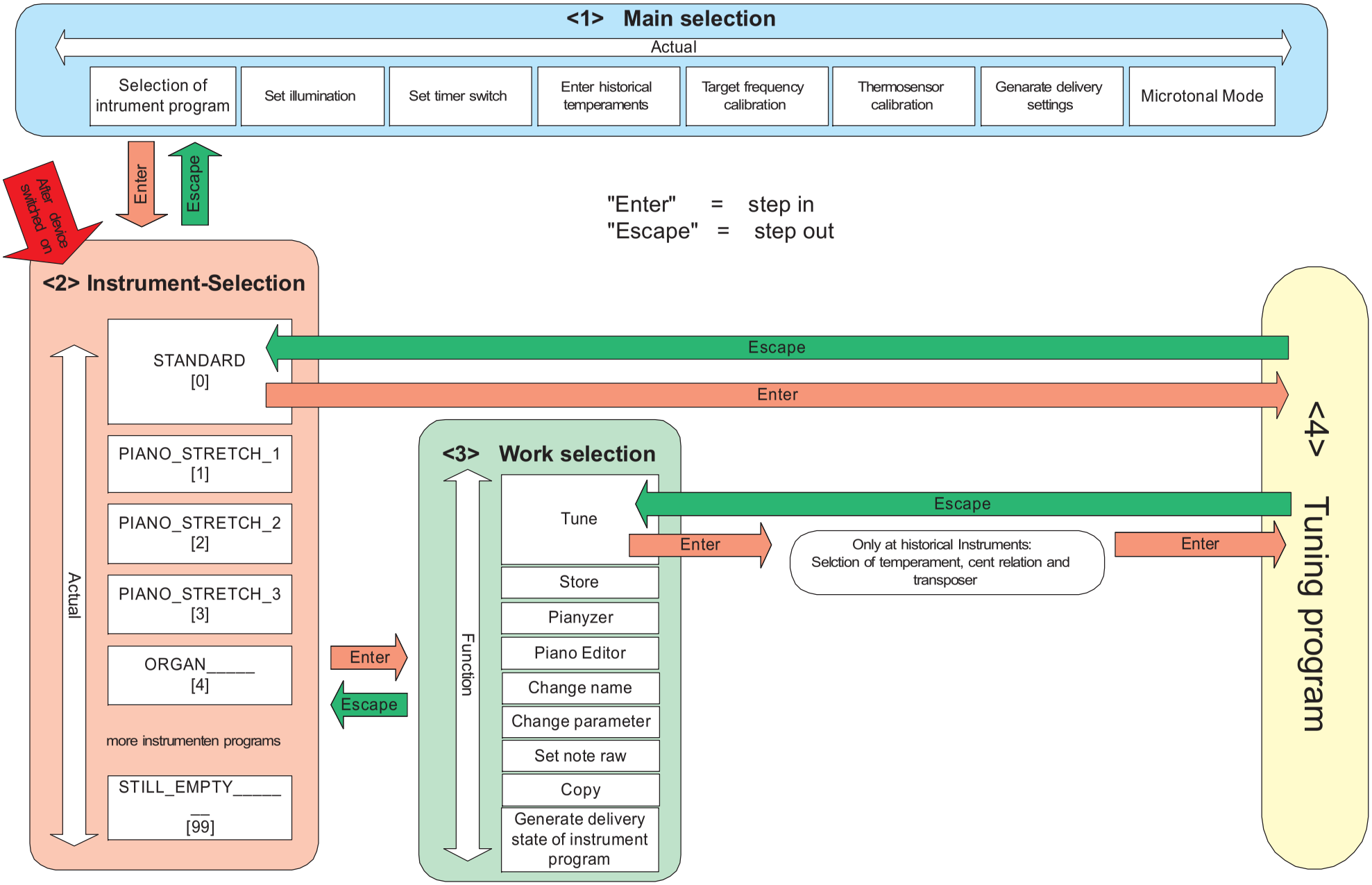
E


Jack for external microphone
Opening for inbuilt microphone
Jack for thermosensor
Jack for active box
USB jack for PC
Jack for charger
+
-
on
Device on - off switch
LED is illuminated, when charger is connected

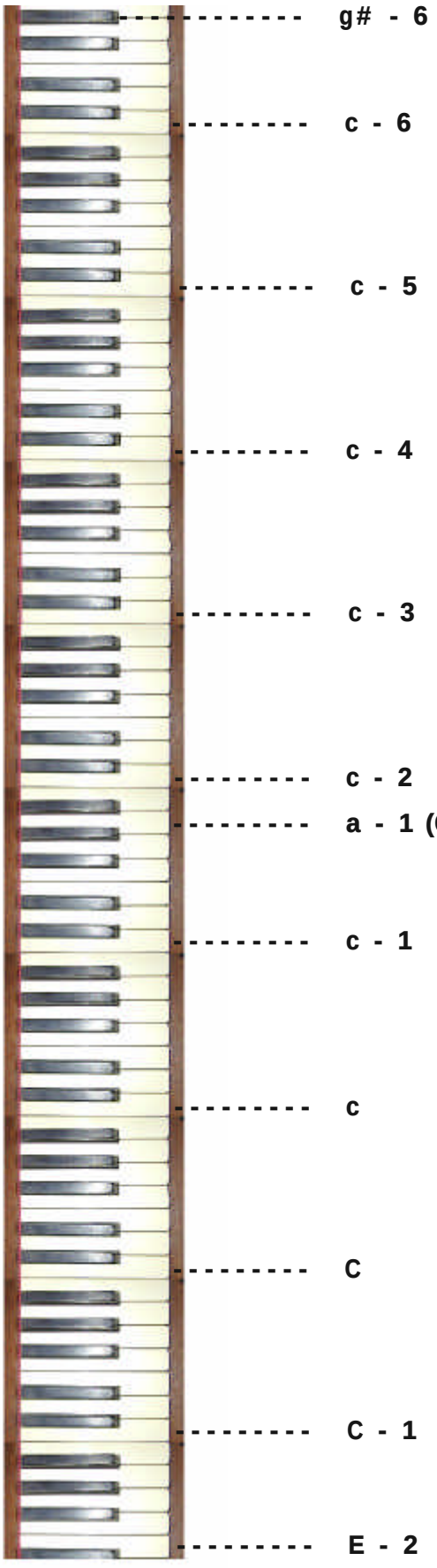
Operating scheme for Tuning Set CTS-32-C

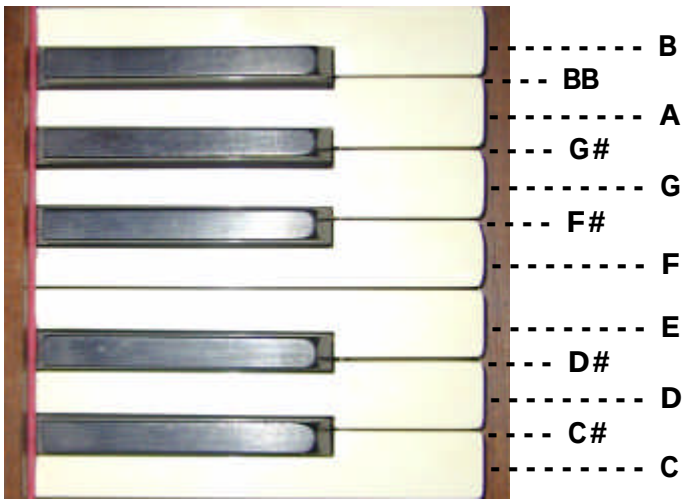


Operating scheme for Tuning Set CTS-32-C



The note indication





Index

1 Start-up of the tuning device

1.1 Power supply

The Tuning Set CTS-32-L is equipped with 4 chargeable NiMH battery (1.2 Volt > 2000 mAh). The operating period with one battery charge lasts approx. 10 hours. Once the batteries are low, the stroke "LOW BAT" appears in the LC-display. In order to avoid a deep discharging of the chargeable battery, the device automatically shuts off. The battery is recharged with the help of the supplied plug-in transformer. The battery is fully replenished after approx. 14 hours. During the charging period, the small lamp for charge control is illuminated. The instrument can be operated without risk during the recharging process.

Should the operating period with one battery charge decrease at some point to much less than 8 operating hours, this may occur for the following reasons.

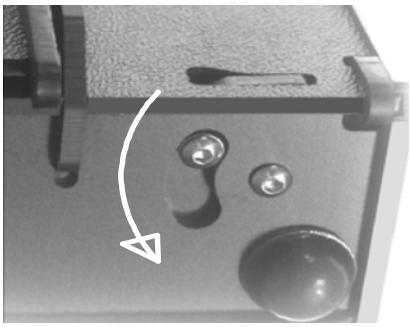
1. The battery is defect. Measure to be taken: Install new battery. You can buy NiMH batteries at your local radio or computer shop.

2. The charger is defect. Measure to be taken: Replace the charger.

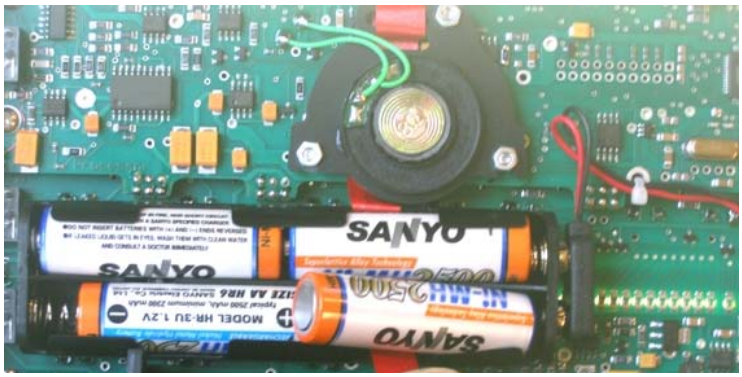
3. The Tuning Set is defect. Measure to be taken: Charger and tuning set should be sent in for maintenance.

1.2 Replacing the battery

1. Open both closures on the underside



Replace batteries and pay attention to the correct polarity. **Please use only rechargeable NiMh batteries**. Non-Rechargeable Batteries are leaking when the AC adapter is plugged in. The acid will destroy the device.
.



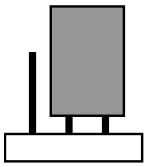
1.3 The recording...

... occurs by means of a built-in condenser microphone on the right side of the instrument. For measurements for which the volume of the tone of the instrument plays a role, it is recommended to use a special microphone for measurements. The microphone plug (3.5mm jack) can be plugged into the jack which is also found on the right-hand side of the instrument.

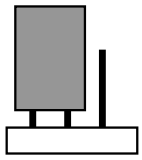
1.3.1 Auxiliary power for the microphone

The external condenser microphones MIKE-R and MIKE-E requires an auxiliary power. This requires a jumper setting in the device according to the following figure.

Jumper position for normal micro-phones without auxiliary power.



Jumper position for microphone MIKE-R und MIKE-E (with auxiliary power)



Jumper

2 Operation of the device

The device is started up through the shift switch on the right-hand side. For approx. 1 second, the program version appears in the display, followed by the below image:

```
<2>   instrument-selction, then <Enter>
■■■STANDARD_______ [ 0]
```

Actual

If you find not your language please read chapter 3.1.

The inscription of the buttons on the front panel is designated to the actual tuning of instrument and is not immediately related to the operation process. At this point, the operating system is in the state of the instrument selection. The signs: „■■■“ in the display symbolize that it is now possible to make changes with the underlying pair of buttons. With the button pair “Actual” one can select a tuning program for a particular music instrument. The program then automatically effects all application settings that are essential to your tuning task.

In order to become familiar with the tuning device, you may test the button functions without any risk. Misoperation can do no actual harm to the unit. The device can be reset to the state of delivery (see chapter 3.2).

Now please refer to the supplied “Operating scheme for CTS 32-C”. You may see this operating scheme as a type of “road map”. You are currently situated right after “instrument selection”, at the point where the slanted arrow is shown. In the following operating examples, do not attempt to try to learn the button sequences by heart, but simply follow the individual steps of the operating scheme. This will allow you to recognize the logic behind the operation of the Tuning Set CTS-32-L.

If you have not yet pressed the button “Actual”, the instrument program STANDARD_____[0] is still selected.

From this position you can directly access the tuning program by pressing “Enter”. The following indicator appears:

```
                ()_
  0  cent partl 1 pitch 440.00  a-1
```

After pressing the „Escape“ button the following indicator appears:

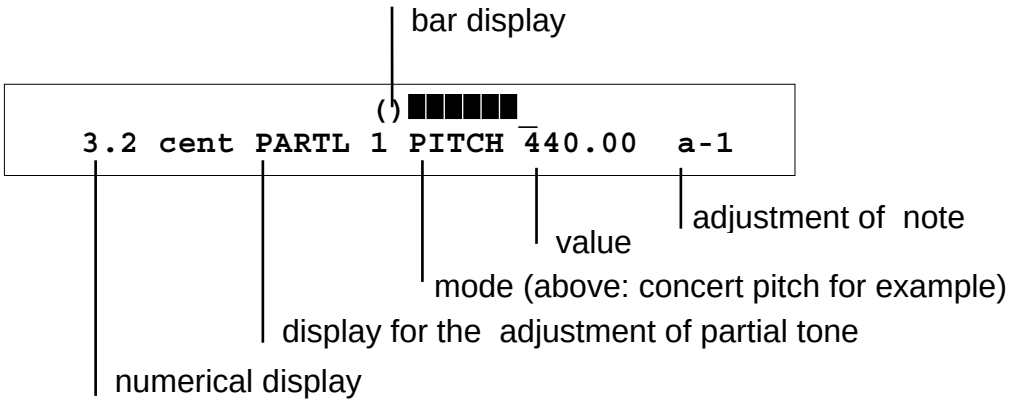
```
leave tuning program ?
yes: <Escape>          no: <Enter>
```

With „Escape“ you return to the instrument selection mode.
With „Enter“ the tuning program is reactivated.

For all other instrument programs (except „STANDARD____[0]“) the tuning program cannot be accessed directly from the instrument selection mode. For these programs several functions must first be adjusted. The operating details for this will follow in the chapter 2.2

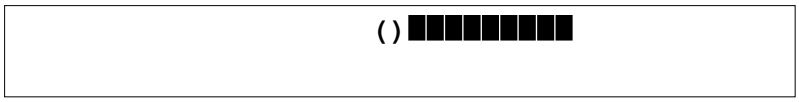
2.1 The tuning program

... serves for the actual tuning of the music instrument previously selected in the instrument selection. The indicator for this is set up as follows:



The individual elements of the indicator are described below.

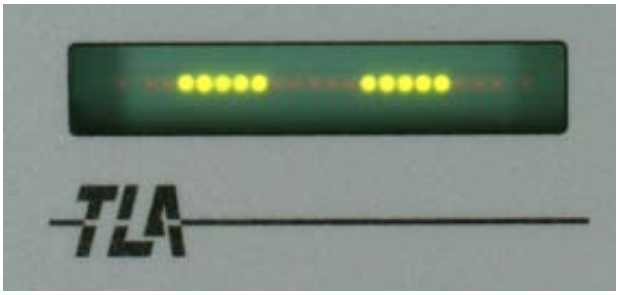
2.1.1 Bar display



The arrow points to the right if the tone played is too high and to the left if it is too low.
The resolution of the bar display can be adjusted as described in chapter 2.1.6.8 .

A level indication of partial tones in this field is possible too. (see chapter 2.1.6.6).

2.1.2 Strobo display



While playing the tone adjusted in the Tuning Set, two fields in green lighting are created in the strobo display. Always in relation to the height or depth of the tone, these fields move to the right or left accordingly. When the tone comes closer to its target value, the movement becomes slower. At the moment the tone is correct, the fields stop moving.

2.1.3 Numerical display for pitch

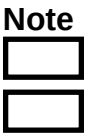
In this display, the pitch or target frequency of the note which is played is constantly shown.

Actual

With the button pair “Actual”, the form in which it is displayed can be designated as follows:

cent:	in cent (one cent corresponds to one hundredth of a half-tone step)
beat:	in hertz as difference of beats between target frequency and true frequency
ftru:	in hertz as absolute frequency
ftgt:	display of target frequency in hertz
pl:	theoretical pipe length (mm)
dl:	pipe length correction value (mm)
h/16	16th part of a semitone step

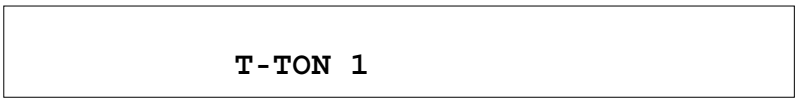
2.1.4 Tone adjustment

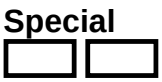


With the above button pair, the tone that you intend to tune is adjusted.

By shortly pressing the upper button, you progress upwards in steps of one semitone. With the lower button you move to a lower level. When the button is kept pressed, the function repeats itself accordingly until the button is released. This is equally valid for all other buttons. Furthermore, if you keep the “Shift” button pressed while activating “Note”, the program moves on in steps of one octave. If both buttons are activated at the same time, the switching to another note occurs automatically from this point on. The name of the note then appears in brackets in the display.

2.1.5 Special keys

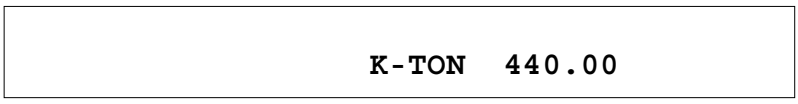


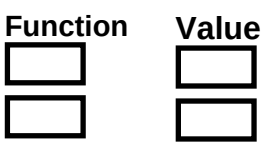


With this button pair you can operate the following functions:

1. The selection of a partial tone (normal case). For particularly low tones or tones with a weak fundamental wave it may be useful to do the tuning with a higher partial tone (See chapter 4.7)
2. If you keep the “Shift” button pressed while activating "Special keys, the actual note adjustment will be changed by a predefined number of semitone steps. (See chapter 2.3.3.9)
3. Additionally, this button pair can be used for the tone adjustment within pre-defined tone sequensces. Further details are found in chapter 2.3.3.5 and 2.3.7.

2.1.6 The functions (settings) of tuning program





The button pair “function” allows selection of a setting.

With the button pair “value” you adjust the value according to the setting.

By keeping the Shift button pressed, the changes in numerical values occur in bigger steps. The following chapters will describe the different settings.

2.1.6.1 PITCH (concert pitch)

The concert pitch is the principal reference tone for all other tones of a particular tuning task. It is linked to the tone a' and is adjustable from 220 to 880 Hz in steps of 0.01Hz. If both Value buttons are pressed simultaneously, the concert pitch is automatically adjusted to the tone played at that moment.

2.1.6.2 CENTS (cent mode)

The target frequency of the tuning device can be transformed by +- 150 cent in steps of 0.1 cent. If both Value buttons are pressed, the cent mode is automatically adjusted to the tone played at that moment. The cent mode is automatically changed by several of the instrument programs. More details on this subject are found in chapter: 2.2.

2.1.6.3 BEAT (beats)

The beats to the actual target frequency can be selected through this function. Adjustable +- 100.0 Hz in steps of 0.1 Hz.

2.1.6.4 INTVL (Interval)

The target frequency can be shifted by one purely tuned interval. Modes: SECOND, THIRD, FIFTH, SEPTIM ...

2.1.6.5 h/16 (16th semitonestep)

The target frequency can be changed by 16th part of a semitone. (+/-32 16th semitones)

2.1.6.6 BARGR (mode of bar display)

Here you will control the mode of the bar display (additional see chapter 2.3.3.8).:

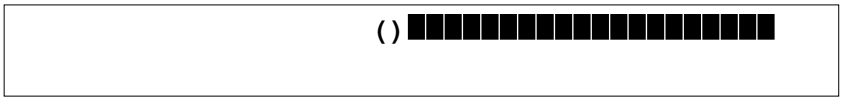
Level:	Indication of frequency deviation and partial tone level.
Full:	Indication of frequency deviation.
Sen:	Indication of frequency deviation, degree centigrade and thermosensor cents (only if thermosensor connected)

2.1.6.7 AMPL (Amplification)

The amplification of the signal coming from the microphone can be adjusted by this function. Adjustable from 1 to 8. If both "Value" buttons are pressed simultaneously, the amplification is automatically adapted to the tone played at that moment. Exception: Several of the instrument programs change the amplification automatically depending on the height of the tone.

2.1.6.8 RESOL (resolution)

The resolution of the "bar display" for frequency deviations can be adjusted through this setting.



A setting of 10 means a full scale of 10 Cent.
A setting of 200 means a full scale of 200 Cent.

Adjustable 10…200 Cent.

2.1.6.9 GATE (gate time)

Small value: The display reacts very rapidly, whereby the spreading of the measurement values are relatively large-scale.

High value: The display reactions become slower, the spreading of the measurement values is accordingly smaller.

Adjustable 50..1000 milliseconds

2.1.7 How to save the settings

If you leave the tuning program with "Escape" the following settings will be saved and assigned to the active instrument program:

Mode of the numerical display,
Concert pitch (pitch),
Mode of bar display (bargr),
Amplification (ampl),
Resolution of bar display (resol),
Torzeit (gate).

2.1.8 The audible tone

How to adjust the volume:

Keep the “Shift” button pressed and continue tapping “Escape" until you have the desired volume.

By pressing the "Enter" button you can switch the sound on or off.

2.2 The instrument programs

Each music instrument sets its specific requirements regarding the functions of a tuning device. With the aim of getting optimum usage from the Tuning Set CTS-32-C for all instruments, a memory for 99 instrument programs was installed in the unit. These tuning programs automatically accomplish an extensive amount of adjustments of the tuning device for you. For all current instrument types, instrument programs are already installed in the Tuning Set CTS-32-C as supplied. With the help of the mentioned instrument programs, the complete tuning scope of an already tuned instrument, can be recorded and registered tone by tone, precise to the 1/10th of a cent. Any temperament can be reproduced by this method.

When tuning instruments with thick strings such as pianos and grand piano, stretching the tuning becomes necessary. This implies that different from the standard tuning mode, the high tones must be tuned higher and the low tones accordingly lower. We will discuss this further in Part 4.5 of the Operating Instructions. For users who want to deal with intense piano tunings, we recommend the chapters 2.3.5 and 2.3.6. “Pianyzer” and “Piano Editor”.

The instrument program for pianos ensures that the Tuning Set CTS-32-C is adjusted in a way that, based on stretching diagrams (tone stretching) which are incorporated in the system, it is capable of automatically considering and registering these deviations.

For these tone stretching tasks, each of the 99 instrument programs possesses a memory space for each tone capable of registering a deviation of up to ±150,0 cent per tone.

A total of three piano instrument programs with a variety of tone stretchings are installed in the unit as supplied. You may find the diagrams on the appendix of the operating Instructions.

Especially for the low tones of the piano it no longer makes sense to use the fundamental wave for the measurements. Here the measuring takes place through a higher partial tone (harmonic wave). For the selection of the partial tone, each of the 99 instrument programs contains a memory space in which 1 of 16 tones are chosen as basis for the measurement for each note. The Tuning Set CTS-32-C automatically switches to the pre-selected partial tone mode.

For some instruments - as for example pianos – it is of advantage to adapt the gain of the microphone amplifier to the loudness of the instrument. This gain function can be adjusted in 8 steps. All 99 instrument programs possess a memory cell for microphone amplification for each note. When the tone played is changed, the Tuning Set CTS-32-C automatically switches to the predefined gain.

2.2.1 Using the installed instrument programs

Whenever the unit is switched on, it is initially in the instrument selection mode. From there one can select one of the instrument programs with the help of the “Actual” button.

```
<2>   instrument-selection, then <Enter>
■■■ STANDARD_______ [ 0]
```

Actual

2.2.1.1 Piano

The selection of the optimal stretching depends on various parameters of the instrument to be tuned. The individual preferences of the musician also play a vital role.

The three built-in stretchings found in the system are the result of trials, during which various pianos were tuned by ear, and subsequently measured. The stretching most suited to match your particular requirements must be tried out by you first. For your first attempts, we recommend that you try the stretching 3. For this please apply the following:

Select the instrument program "PIANO_SRETCH_03" with “Actual” button and confirm with “Enter”. Indication:

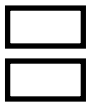
```
<3>         work-selction, then <Enter>
PIANO_STRETCH_03 ■■■tune
```

Press “Enter” once more and the unit will switch to the desired tuning program.

```
                    ()■■■■■■_
   0.0 cent T-TON 1 K-TON 440.00  a-1
```

First it is useful to define the current concert pitch of the instrument.

Value



For this purpose shortly press both “Value” buttons simultaneously.

The display now shows the concert pitch in brackets. If you were now to play the note ‘a’, the program’s concert pitch is automatically adjusted to the note played. If you chose to measure the concert pitch very precisely, you can bring the strobo display to a halt by repeatedly pressing the “Value” button. The concert pitch now can be read and thereafter adjusted. When applying this function, the current concert pitch should be not more than 10 Hz higher than the previously selected one, in order to avoid warping the instrument or tearing strings during the tuning task.

You may now begin with the actual tuning by starting with the tone a–1 and aligning all 3 strings of the chorus. Next follows g#–1, g1, f#–1, etc.

The deviation from the standard tuning caused by tone stretching is shown in cent above the „Value“-button.

For the two lowest octaves, the partial tone mode changes to the second or the fourth partial tone. For this reason, it is important that the tuning set always has the correct octave setting. The best way to avoid inaccurate settings is to progress in steps of semitones while tuning the instrument.

After finishing the tuning of the bass, the discant is tuned by starting with b-1.

2.2.1.2 Organ equal temperament (ORGAN_EQUAL_TEMP)

The selection of a historical temperament, before entering into the tuning program is omitted here.

The settings of cents, partial note and microphone amplification will be preserved while changing the note.

The thermosensor reference is fixed to 20°centigrade, the cent rate is fixed to 3.2 Cent per degree centigrade. (Thermosensor reference and cent rate see chapter 2.3.3.6 and 2.3.3.7. The pipe length reference value is set to 391.0 mm (see chapter 2.3.3.10 and 4.6)

2.2.1.3 Organ historical (ORGAN_HISTORICAL)

The desired historical temperament (see chapter 4.4), the <cent-reference> and the <transposer> can be adjusted before entering the tuning program.

The cent adjustment will be determined by the selected historical temperament. All other settings are the same as "organ equal temperament".

2.2.1.4 Harpsichord

The desired historical temperament (see chapter 4.4), the <cent-reference> and the <transposer> can be adjusted before entering the tuning program.

The cent adjustment will be determined by the selected historical temperament. In the lowest octave, the tuning is done on the basis of the fourth partial tone and in the second lowest octave, through the second partial tone. Here, tone stretching was not preprogrammed, as the inharmonicity is comparably unnoticeable due to the relatively thin, long strings of the instrument. The adjustment of the gain of the microphone amplifier occurs automatically.

2.2.1.5 Harpsichord_415

The same as harpsichord, but with concert pitch 415 Hz.

2.2.1.6 Accordion

Cent adjustment, partial and microphone amplification will be controlled by memory. The program was designed as a basis for creating your own programs, which are assigned to special instruments. Further details are found in chapter 2.3.

2.2.1.7 Guitare and diatonical raw

These programs was designed as example for entering tone sequences. (see chapter 2.3.7.). The buttons "special" are used here, to adjust the note.

2.2.1.8 Recorder

Cent adjustment, partial and microphone amplification will be controlled by key.

2.3 Creating an individual instrument program

The easiest way to create a new instrument program is to copy a similar, already existing program and to then change and adapt it to ones own requirements.

2.3.1 Copying an existing instrument program

For this task, please select an instrument program as described in chapter 2.2.1. As for example:

```
<3>         work-selction, then <Enter>
PIANO_STRETCH_03[ 3] ■■■tune
```

To obtain the copy function press the upper “function” button until the following command appears in the display:

```
<3>         work-selction, then <Enter>
PIANO_STRETCH_03[ 3] ■■■copy instrument
```

Function

By pressing “Enter” the following indicator is shown:

```
    PIANO_STRETCH_03_[ 3] copy to
■■■ STILL_EMPTY_____[12] with<Enter>
```

Actual

With the “Actual” button pair you now can select a free memory space, for example No. 22.

```
    PIANO_STRETCH_03_[ 3] copy to
■■■ STILL_EMPTY_____[22] with<Enter>
```

After pressing “Enter” the following indicator is shown:

```
STILL_EMPTY_____[22] write over ???
yes: <Shift+Function>       no: <Escape>
```

Now keep the die „Shift“ button pressed while at the same time pressing the upper “function” button.

```
<3>         work-selction, then <Enter>
PIANO_STRETCH_03[22] ■■■copy instrument
```

The copy is now number 22 in memory. In order to distinguish the original from the copy it is recommended to change the title, which will be described in the following chapter.

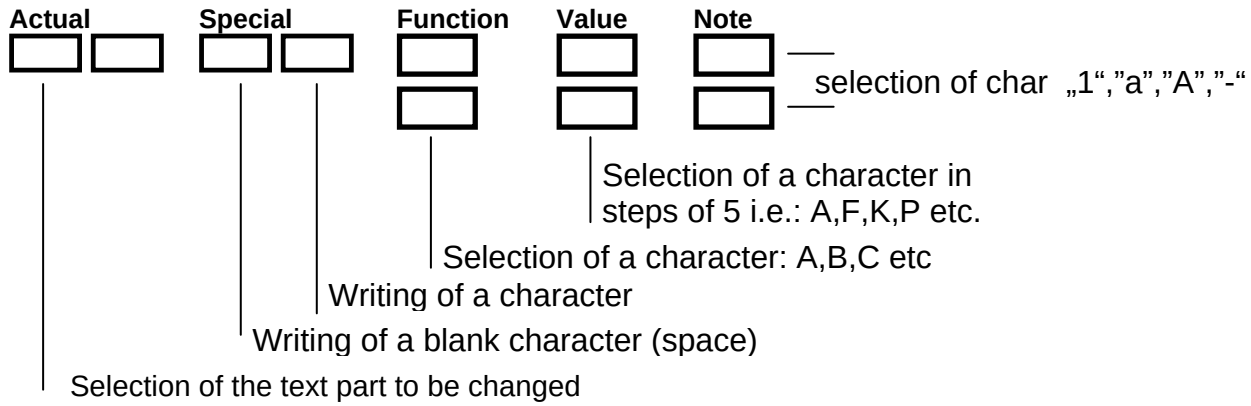
2.3.2 Changing the name of an instrument program

With the button pair „Function“ now select the option „change name“ and then press “Enter”.

```
<3>         work-selction, then <Enter>
PIANO_STRETCH_03[22] ■■■change name
```

The text „PIANO_STRETCH_3_“ can now be changed according to your wishes. Thereby, the buttons have the following functions:

```
change name:              PIANO_STRETCH_03
<-- -->  ■--> *-->  -->A
```



In this example we want to change „PIANO_STRETCH_03“ into „PIANO_STRETCH_5C:

Select text part by pressing the right „Actual“ button until the display indicates the following:

```
change name:              PIANO_STRETCH_03
<-- -->  ■--> *--> ---------------->0
```

Select with „Note“ buttons in the char “1”:

```
change name:              PIANO_STRETCH_03
<-- -->  ■--> *--> ---------------->1
```

Keeping pressing the „Function“ button until the char „5“ is selected:

```
change name:              PIANO_STRETCH_03
<-- -->  ■--> *--> ---------------->5
```

By pressing the right „Special“ button (*-->), the char „3“ is written in the text to be changed:

```
change name:              PIANO_STRETCH_53
<-- -->  ■--> *--> ---------------->5
```

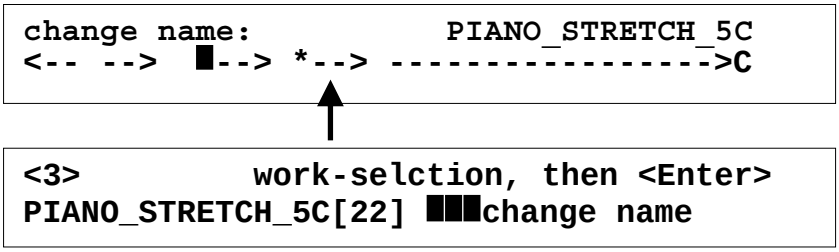
Select with „Note“ buttons in the char “A”:

```
change name:              PIANO_STRETCH_53
<-- -->  ■--> *--> ---------------->A
```

Then press the upper „Function“ button until the character „C“ is selected:

```
change name:              PIANO_STRETCH_53
<-- -->  ■--> *--> ---------------->C
```

By pressing the right „Special“ button (*-->), the char „C“ is written in the text to be changed:

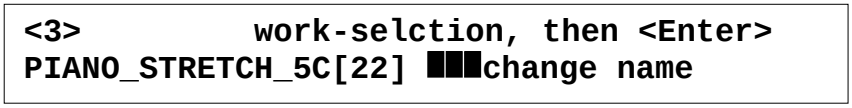


After pressing the „Enter“ button, the change of name is confirmed and stored.

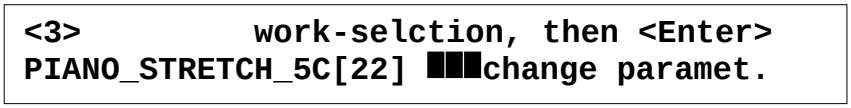
2.3.3 Changing the parameter of an instrument program

Each instrument program contains different parameters which allow the optimal adaptation of the device to the application in question. We now want to change the parameters of the program of which the name was changed in the section above.

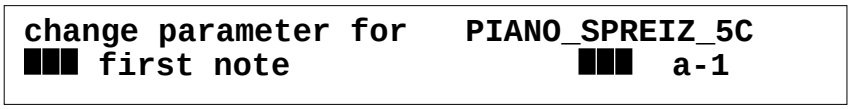
For this purpose, please select the example instrument program as described in chapter 2.2.1.

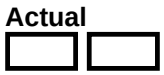


In order to change the parameters, search the following indicator by means of the „Function“ button pair:



After pressing the „Enter“ button and pressing "shift" + "function", the following indicator appears in the display:





The button pair „Actual“ serves to select the parameter to be changed.

The button pair „Function“ serves to change the setting.

In the following chapters the functions of the various parameters are described:

2.3.3.1 First note

The tone selected in the beginning of the tuning program. Adjustable C-2 ... g#6.

2.3.3.2 Historical temperament

Off: The tuning is set to equal temperament.
There is no selection of temperament when you enter the tune program.

On: You can select an historical temperament before you enter the tune program.

2.3.3.3 Amplification

Herein one can adjust in which way the amplification of the incoming microphone signals can be controlled.

„memory“ the amplification is controlled tone by tone via the memory bank according to the active instrument program.

„button“ the adjustment of the amplification is effected by means of the button. See chapter: 2.1.6.7

„automatic“ the adjustment of the amplification occurs automatically

2.3.3.4 Cent adjustment

Herein one can adjust in which mode the cent adjustments should occur. Settings:

„memory“: the cent adjustment is controlled tone by tone via the memory bank according to the active instrument program.

„button“ cent adjustment occurs directly by means of the button.

2.3.3.5 Special-Keys (Function of the two Special-Keys)

Herein one can select the function that can be controlled by the "special" keys.

„partial-memory“: the partial tone is controlled tone by tone via the memory bank according to the active instrument program.

„special-button“ partial tone adjustment occurs only by means of the button. When you change the note the old partial setting remains.

“tone raw” The partial tone adjustment occurs tone by tone via the memory bank. The button pair „special“ is used for the adjustment of tones according to a specific sequence of notes. See chapter 2.3.7.

"Chorus" With the special keys one can switch back and forth to the next instrument program. See chapter 3.3

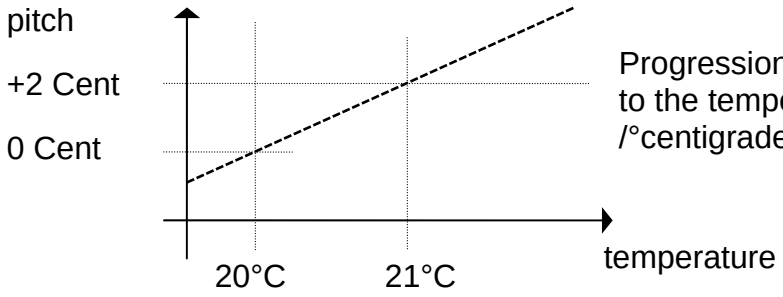
„Off“ The partial tone adjustment occurs tone by tone via the memory bank and cannot be changed with the button pair „special“

2.3.3.6 Thermosensor rate

When a thermosensor is connected, one can adjust herein by how many cent per degree in centigrade the tone height is to be adapted. Adjustable: ±10.0 cent in steps of 1/10 cent.

2.3.3.7 Thermosensor reference

When a thermosensor connected, this function allows the adjustment of at how many degrees in centigrade the thermosensor values are fixed.



Progression of the tone height in relation to the temperature (rate = 2 Cent /°centigrade, reference 20° centigrade)

2.3.3.8 Bar display

Mode of bar display

Level: Indication of frequency deviation and partial tone level.

Full: Indication of frequency deviation.

thsen: Indication of frequency deviation,
degree centigrade and thermosensor cents (only if thermosensor connected)

produ All buttons except the note buttons, will be locked, to avoid incorrect operation.
This is useful if the tuning set will be used in a factory.

2.3.3.9 Semitone steps

Herein one can enter the number of semitone steps which will be switched by keeping the Shift button pressed while activating “Special”.

2.3.3.10 Length reference

Herein one can enter the reference length for the calculation organ pipe corrections.
See also chapter 4.6

2.3.3.11 Write protection

„ON“: The stored instrument programs cannot be overwritten.
„OFF“: No write protection function

2.3.4 Storage of a particular stretching of an already tuned instrument

Each instrument program is assigned a memory bank. There you can store cent values for the whole tone range of your instrument, tone by tone.

For this purpose, please select an instrument program, if you have not yet done so, in which you intend to record the stretching.

You can choose for instance, the program we use as an example, which you have already copied.

```
<3>         work-selction, then <Enter>
PIANO_STRETCH_5C[22] ■■■tune
```

For storage search the following display with help of the two „function“ buttons:

```
<3>         work-selction, then <Enter>
PIANO_STRETCH_5C[22] ■■■store
```

After activating the “Enter” key, the following indicator appears in the display.

```
PIANO_STRETCH_5C[22] change ?
yes: <Shift+Function>     no: <Escape>
```

Now press the „Shift“ + „Function“ buttons.

You will now be requested to align the tuning device to the concert pitch a1 of the instrument to be stored.

```
        +■■■■■■     meassure pitch
   0.0 cent partl 1 pitch 440.00  a-1
```

Now align the concert pitch of the tuning device to your instrument by playing the tone indicated (in this example a’) and then changing the concert pitch via the “Value” buttons, to the effect that the strobo display is balanced. For this the automatic function is very helpful, which can be activated by pressing both “Value” buttons simultaneously (also see chapter 2.1.6.1)

Next please press the “Enter” key and observe the following display:

```
        +■■■■■■     store stretching
   0.0 cent partl 1 CENTS   0.0    a-1
```

Now adjust the tone setting with help of the „Note“ buttons to the lowest tone of your instrument, for instance this would be C-1 for a piano. Now play this note. With the „Special“ button, you then select the partial tone which presents the clearest indicator on the strobo display.

Via the „Value“ buttons you then adapt the tuning device to the tone played. For this task also, the automatic function, which is activated by pressing both “Value” buttons simultaneously, can be very helpful. Once the tuning device is adapted (which implies that the strobo display is balanced), the necessary cents correspond to those displayed above the “Value” buttons.

Now press the “Enter” key. The current setting of the device for that particular tone is now stored. The unit then automatically switches to the next tone. You may now repeat this procedure as described until all notes of your instrument are stored.

If so required during this procedure, you may switch to „AMPL“ with help of the „Function“ buttons. This allows you to alter the microphone amplification in order to achieve a better display quality. The microphone amplification is also stored tone by tone.

2.3.5 How to produce a piano stretching by instrument analysis (Pianyzer)

Using the „Pianyzer“ (Piano Analyzer) you get more beautiful piano tunings. Here the stretching of the instrument will be optimized individually.

If you have practiced, you need for the analysis less than 5 minutes. Due to the interference-free analog strobe display you get a safe, reproducible result.

By measuring the cent-deviation of certain partials of 5 special tones, reference values are determined. (See the sample diagram of an individual piano stretching at the end of chapter 2.3.6). Based on these support-values, an optimized stretching will be calculated and stored. To this end, the device makes all settings automatically. Important! For all measurements, please damp with a felt wedge the string chorus so, that sounds just one string.

To work with the Analyzer, do the following:

After switching on the unit, look for an unused instrument program i.e. „STILL_EMPTY____[15]“. There you search the function "pianyzer" with the "function" keys“. Now keep the die „Shift“ button pressed while at the same time tapping the upper “function” button, to skip the write protection.

Select the highest tone of your piano which has a 2 string chorus. Then press Enter.

```
highest    2-string-tone            < d  >
                                      ■■■
```

Select the highest tone of your piano which has a 1 string chorus. Then press Enter.

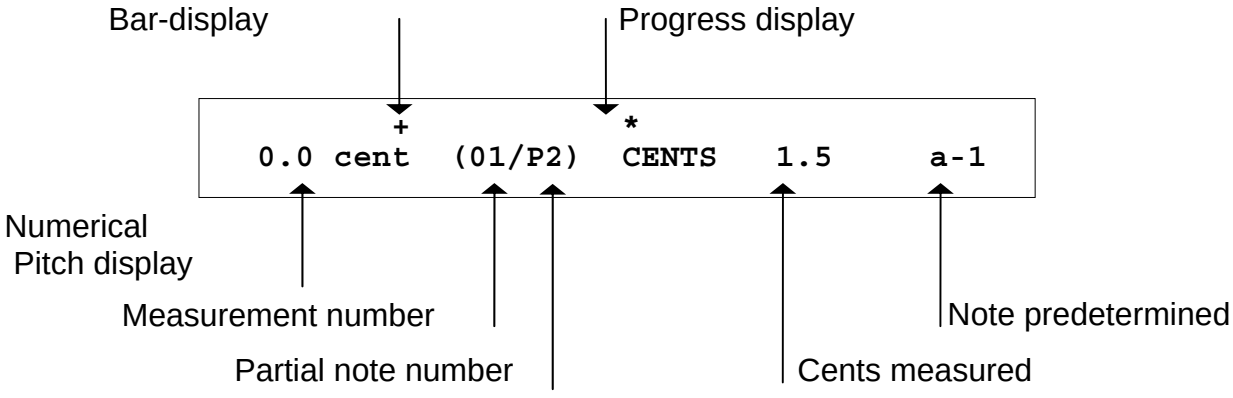
```
highest    1-string-tone            <G#-1>
                                      ■■■
```

Play the note "a-1" to measure the concert pitch of your instrument and use the "Value" buttons to align the tuner .

```
          +              meassure pitch
   0.0 cent (01/P1)   1 pitch 440.00  a-1
```

Note: At this time you already can tune the chorus of "a-1" to your desired pitch and align the tuner again.

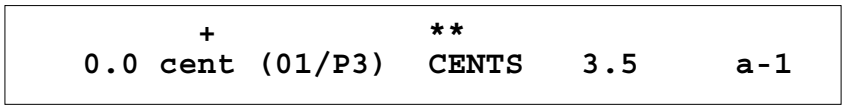
By pressing the "E " you are starting with the measurement of the individual partials of the piano-analysis. The indicator for this is structured as follows:



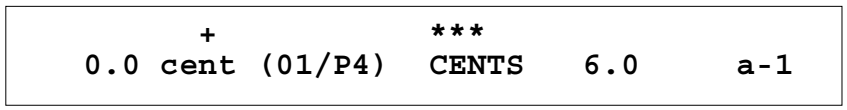
Start now with the measurements (you now measure the second partial of a-1). To do this, play the note which is automatically adjusted by the tuner (right now a_1) and align the tuners frequency until the movement of the strobo display is stopped.

For fine adjustment use the "Value " buttons. For rough adjustment, you hold the "Shift" button and tap one of the keys "Value ". Pressing both buttons, "Value" at the same time, starts an automatic scan. The audible tone can also be used. Press "Enter ".

Play the specified note (for the moment again a_1, since you now measure the 3rd partial of a-1 and align the tuner again. Press "Enter".

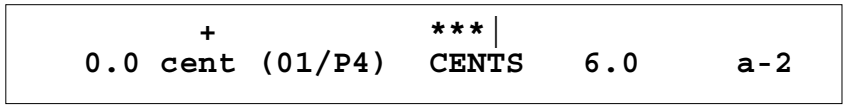


Play the specified note (for the moment again a_1, since you now measure the 4rd partial of a-1) and align the tuner again. Press "Enter".



Then press "Enter". The tuner will now continue to the next note. It then emits a short beep and for 1 second „next note“ is indicated on the display.

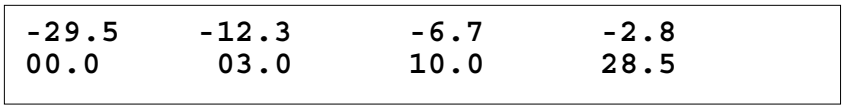
Play the specified note (for the moment again a_2, since you now measure the fundamental tone of a-2) and align the tuner again. Press "Enter".



Certainly, you now know how the device pretends the operating steps. Now perform all measurements.

Important note: When the instrument is grossly out of tune, immediately after the tuner changes the note, you should align the strings of the actual note with the tuning hammer to the tuner. This is necessary because the inharmonicity of the piano string depends on its tension. This, however, only be carried out immediately after the change of tone. So just before the measurements 5 / 9 /, 13 / and 17/

After the last measurement you get this display. This are eight cents-values (support values), that were determined automatically on the basis of previous measurements.



Press „Enter“. The device calculates the piano stretching and stores them. To start with the real work of piano tuning, search the function "tune" with the "function" buttons. Then it goes on, as described in Section 2.2.1.1.

Note: Within the “pianyzer”- procedure, you can use the "special" buttons for back steps.

2.3.6 How to produce a piano stretching by entering of support values (Piano Editor)

The tones with the cent's for calculating the stretching, the sake of simplicity, will be referred to as "support note". Using the piano editor, the cents of the support-notes, you can enter by hand, rather than be determined by the analyzer (see sample diagram at the end of the chapter).

Note: The piano editor allows you to edit the cents of the supporting notes, which were previously generated by the piano analyzer.

After switching on the unit, look for an unused instrument program as i.e. “STILL_EMPTY__[15]“. There you search the option " PIANO-EDITOR " using the "function" buttons, and keep the die „Shift“ button pressed while at the same time tapping the upper “function” button, to skip the write protection.

Select the highest tone of your piano which has a 2 string chorus. Then press Enter.

```
highest    2-string-tone            < d  >
                                      ■■■
```

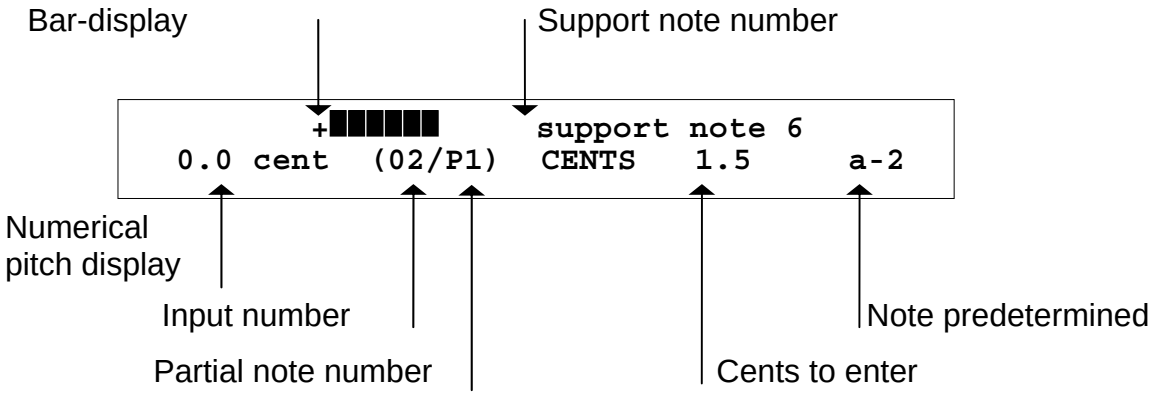
Select the highest tone of your piano which has a 1 string chorus. Then press Enter.

```
highest    1-string-tone            <G#-1>
                                      ■■■
```

Play the note "a-1" to measure the concert pitch of your instrument and use the "Value" buttons to align the tuner .

```
          +■■■■■■     meassure pitch
   0.0 cent (01/P1)  1 pitch 440.00  a-1
```

By pressing the "E " you are starting to enter the cents’s of the support notes. The indicator for this is structured as follows:



Now, you enter the cents of the indicated support-note "a-2" with the "value" buttons. In this way, you have the opportunity to tune the support-note by ear and to transfer the cents to the device.

After this input, press "Enter" and enter the cents for "a-3 ".

```
          +          support note 7
  0.0 cent  (03/P1)  CENTS   1.5     a-3
```

Certainly, you now know how the device pretends the operating steps. Now perform all inputs.

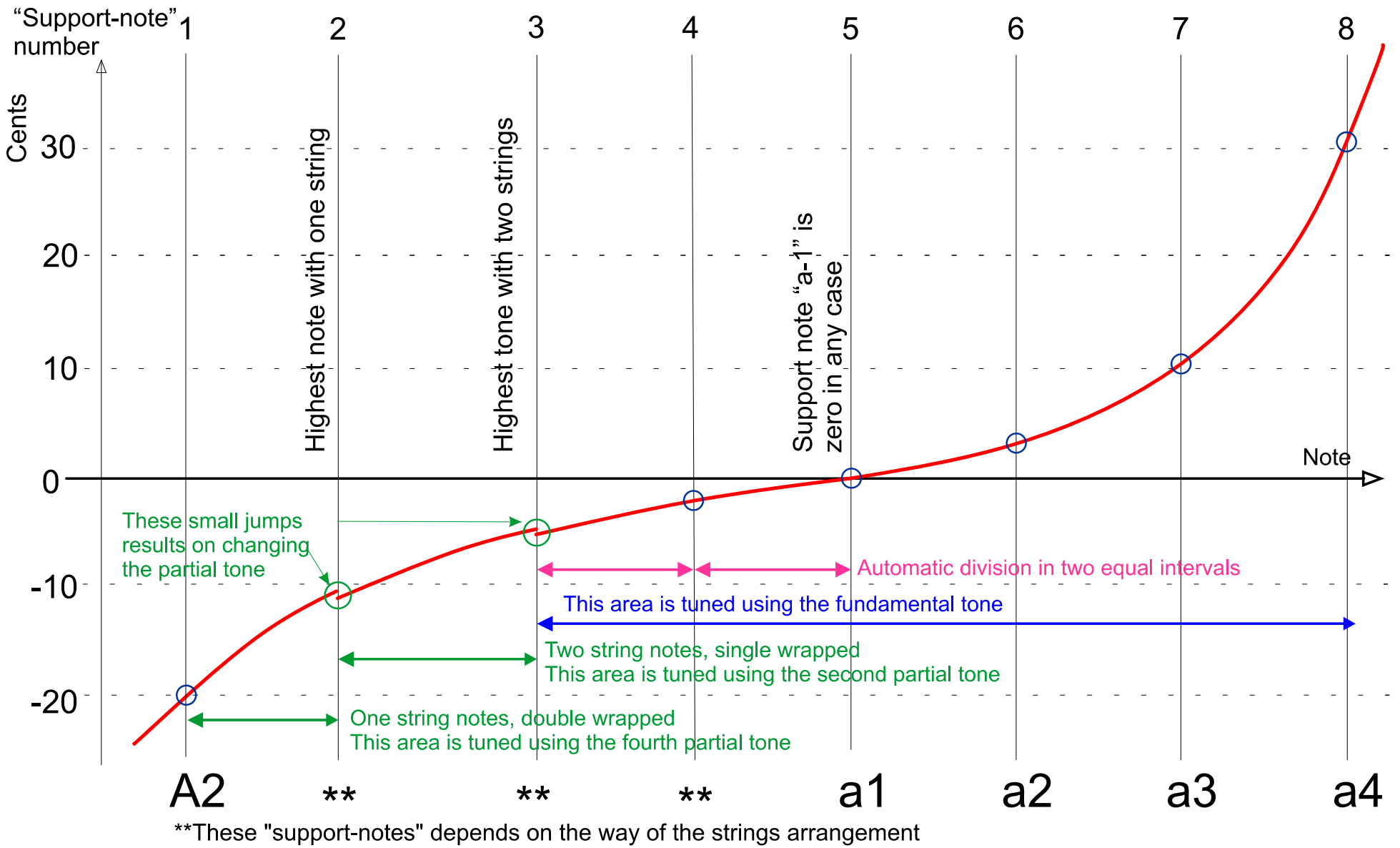
After the last input you get the following display. This are eight cents-values (support values), that were the result of your input.

```
-29.5    -12.3     -6.7      -2.8
00.0      03.0     10.0      28.5
```

Press „Enter“. The device calculates the piano stretching and stores them. To start with the real work of piano tuning, search the function "tune" with the "function" buttons. Then it goes on, as described in Section 2.2.1.1.

Note: Within the “piano-editor”- procedure, you can use the "special" buttons for back steps.

Diagram of a piano stretching that was generated with the Pianyzer



**These "support-notes" depends on the way of the strings arrangement

2.3.7 How to create a tone sequence (tone raw)

In a factory or for special music instruments, it could be useful to set a predefined sequence of tones. In each of the 99 instrument programs you can store one tone raw. If a tone raw is set, the note adjustment works via the "special" keys.

To set a tone raw, apply the following (For example we will take our instrument program number 22 again)

Search the following display with help of the two „function“ buttons:

```
<3>         work-selction, then <Enter>
PIANO_STRETCH_5C[22] ■■■set note raw
```

After pressing the „Enter“ button and pressing "shift" + "function", the following indicator appears in the display:

```
use special keys for tone raw ?
yes: <Shift+Function>     no: <Escape>
```

By pressing "Escape" you will the application. By pressing "Enter" note switching will be assigned to the "special" keys. (See also chapter 2.3.3.5).

Go ahead with "Enter". With the "note" key you will select now the first note of your sequence.

```
First note          ■■■ a-1
```

Press "Enter" again.

Now start with step [01] entering the semitone steps of your note raw.

```
Set note raw
■■■step[01]         ■■■semitone  0
```

With "Enter" you will quit the application.

2.3.8 Resetting one single instrument program to factory settings

All device settings in the example we have made, can be undone. In this case all the other instrument programs remain unchanged. Operate as follows:

Search the following display with help of the two „function“ buttons:

```
<3>         work-selction, then <Enter>
PIANO_STRETCH_5C[22] ■■■reset instrum
```

After pressing "Enter" and then "Shift" + "Function" your instrument program will be reset.

```
<3>         work-selction, then <Enter>
STILL_EMPTY_____[22] ■■■reset instrum
```

2.3.9 How to save the concert pitch

See chapter 2.1.7

2.4 The main selection

When the device is first started up, it is in the instrument selection mode.

If at this point you press the “ESC” key, the main selection is activated. You will obtain the following indicator:

```
<1>         main selction, then <Enter>
■■■instrument program selection
```

With the two „Actual“ buttons you now can select one of the options described below.

2.4.1 Illumination

off: The illumination is always switched off.

power save: If you don't press any key for a longer time span, the illumination turns off.

always on The illumination is always switched on.

2.4.2 Timer turn off

If you don't press any key for a longer time span the device may turn off automatically. 10 seconds before turning off, a beep will sound.

off: The device remains turned on.

5/10/15 minutes: Device will turn off after 5, 10 or 15 minutes.

2.4.3 How to enter historical temperaments

Each historical temperament will be mapped in one memory bank. This memory bank provides for each of the 12 semitones of an octave a location for a cent value. If you are using an historical temperament, the cent values will repeat every octave. The instrument programs may access the self stored temperaments in the same way as the firmly stored temperaments.

Number 1… 69 for firmly stored temperaments
Number 69...99 for self stored temperaments.

Attention!!!

Please don't enter your temperaments into the memory for stretching assigned to a single instrument program (chapter 2.3.4). The cent values of stretching and temperament would be summed. It leads to confusion if you are using firmly stored temperaments.

After selection you have the following indication:

```
      Temperament selection, then <Enter>
███STILL_EMPTY_______  [70]
```

Now select a memory number (28 … 99) for your own temperament.

After pressing the "Enter" button, you can enter a name assigned to your historical temperament, similar as already described in chapter 2.3.2.

Next you will receive the following indication in the display: You will now be requested to align the tuning device to the concert pitch a1 of the instrument to be stored.

```
        +▄▄▄▄▄▄    meassure pitch
  0.0 cent partl 1 pitch 440.00  a-1
```

If you only intend to enter a theoretical temperament, skip this option by pressing "Enter".

If you want to store the temperament of an already tuned instrument, align the concert pitch of the tuning device to your instrument by playing the tone indicated (in this example a') and then changing the concert pitch via the "Value" buttons, to the effect that the strobo display is balanced.

Next please press the "Enter" key and observe the following display:

```
        +▄▄▄▄▄▄    store temp.hist
  0.0 cent partl 1 pitch 440.00  bb-1
```

Now the note adjustment automatically jumps to the note "bb". Via the „Value" buttons you then adapt the desired cent value to this tone. Now press the "Enter" key. The current setting of the device for that particular tone is now stored. The unit then automatically switches to the next tone "b". You may now repeat this procedure as described until all 11 notes of the octave are stored. The note 'a' will be skipped and its cent value set to zero. This is technically required. (See also chapter 4.4)

2.4.4 Calibration of Target-Frequency

The device as delivered is calibrated with a precision of 3 ppm. As the time base of the unit is operated through a clock crystal, further calibration is actually not necessarily required.

For calibration a 10000 hertz frequency gauge with an amplitude of maximum 200 milli volt is connected at the microphone input.

If you select this option you will receive following indication:

```
calibration with mit 10000 Hz
...  then <Enter>     ■■■      0 ppm
```

With help of the „Value“ button you align the device to the effect that the strobo display is in balance. A precision of 3 ppm is achieved when a field in the strobo display does not move beyond the indicator within 66 seconds. Once the device is aligned press „Enter“ and the calibration task is completed and stored.

By pressing "Enter" the calibration is stored.

2.4.5 Calibration of thermosensor input

For calibration, connect thermosensor; after selecting the option "calibration" the following indicator appears in the display.

```
23.2°Celsius     correction 0.0°
                            ■■■
```

The thermosensor offset now can be altered until the temperature shown above corresponds to the temperature of the comparison thermometer. When leaving this function with „Escape“ or „Enter“ the calibration is stored.

2.4.6 How to reset the device to factory settings

After pressing the Enter button, follow the instructions on the LC-display. See also section 3.2..

2.4.7 Microtonal Mode

Microtonal music uses microtonal intervals, i.e. intervals that are smaller than a semitone. Many compositions in the 20th and 21 Century use microtones. Here, for example, the octave is divided in 17, 19, 24, 31, 53, 72 temperament-steps or divided asymmetrically in different sizes.

The micro-tonal mode has been implemented in the CTS-32-C V1.30. This created the opportunity to use different tone systems (tone-scales) or to design your own scales in a convenient manner.

A detailed guide for using the micro-tonal mode, you can find on the Internet at www.tuning-set.de.

3 Miscellaneous

3.1 How to setup the language

The Tuning Set CTS-32-C supports the English, German and French language. You may select the language, as described below:

1. Switch off the device.
2. While keeping the "Shift" button pressed, switch on the device.

Then follow the instructions on the display.

3.2 Resetting the device to factory settings

Operate as follows:

1. Switch off the device.
2. While keeping the buttons “Escape“, "Shift" and “Enter“ simultaneously pressed, switch on the device.

Then follow the instructions on the display.

3.3 Tremolo tuning.

Supported by rapid exchange between two instrument programs.

To this end, you can use two consecutive instrument programs. Into the first instrument program you will store a stretching for the deeper tones of the tremolo, the second on will contain the stretching for the higher tones.

The special key switch to mode "CHOR" (See chapter 2.3.3.5)

In tune mode you quickly can change between the cent values of two consecutive instrument programs using the "special" keys.

3.4 PC data transmission

All settings that you've stored in the CTS-32-C you can save on a PC and store it back or transmit it to another device.

To this end, you can install the software from the Internet (***http://www.tuninng-set.de***) or from the enclosed CD. You also will find a detailed manual there.

4 Basic Information

4.1 Equal temperament

The standard tuning of the Tuning Set is the most frequently used equal temperament. The following example shows exactly how it is conceived mathematically:

Target value: the concert pitch a' should be 440,00 Hertz

The frequency of the chromatic semitone steps are calculated accordingly:

b' = 440,00 Hz * $\sqrt[12]{2}$ = 466,16 Hz $\sqrt[12]{2}$ = 1,0594631

h' = 466,16 Hz * $\sqrt[12]{2}$ = 493,88 Hz etc.

Target value: the concert pitch a' should be 442,00 Hertz
The result would be:

b' = 442,00 Hz * $\sqrt[12]{2}$ = 468,28 Hz

h' = 468,28 Hz * $\sqrt[12]{2}$ = 496,13 Hz etc.

4.2 The “cent” unit

The "cent" is a unit for frequency relations; a semitone step is divided geometrically into 100 parts. The following calculation demonstrates how the “cent” unit is mathematically defined:

The frequency 440.00 Hertz are to be raised by 1 cent:

440.00 Hz * $\sqrt[1200]{2}$ = 440,26 Hz

The frequency 440.00 Hertz are to be raised by 5 cent:

$$440.00\ Hz * \sqrt[1200/5]{2} = 441.27\ Hz$$

The frequency 440.00 Hertz are to be raised by 100 cent, which means by one semitone:

$$440.00\ Hz * \sqrt[1200/100]{2} = 440.00\ Hz * \sqrt[12]{2} = 466.16\ Hz$$

The frequency 466,16 Hertz are to be lowered by 100 cent, which means by one semitone:

$$466.16\ Hz : \sqrt[1200/100]{2} = 466.16\ Hz : \sqrt[12]{2} = 440.00\ Hz$$

4.3 The target frequency of the Tuning Set

The microprocessor installed in the Tuning Set creates the target frequency as shown in the following equation:

$$f = \frac{k}{16} * 2^{\,o + \frac{n}{12} + \frac{c}{1200}}$$

Wherein:
f. Target frequency
c: Cent adjustment
n: Tone number (a = 0, b = 1...gis = 11)
k: Concert pitch setting (220 Hz... 880 Hz)
o: Octave (1 = A-2(27,5 Hz)...9= a-5(7040 Hz)

4.4 Cent adjustment of historical temperaments

Please refer to the information as listed in the attached tabloid.

4.4.1 Cent reference function

All temperament tables pre-programmed in the tuning device are conceived to the effect that for the tone “a” the cent deviation equals zero. The cent reference therefore is "a". In some cases it is recommendable to adapt this cent reference to a tone other than “a”. If a different tone is defined as cent reference for the tuning device, the cent values in the temperament tables are also raised or lowered by the same amount for each tone, with the result that the cent reference for that particular tone equals zero.

Example: cent deviations of the "Kirnberger III" temperament with the cent reference setting =

a	bb	b	c	c#	d	d#	e	f	f#	g	g#
0	+6,5	-1,5	+10,5	+0,5	+3,5	+4,5	-3,5	+8,5	+0,5	+7,0	+2,5

For the cent reference setting = "c" 10,5 cent are subtracted from all above amounts:

a	b	h	c	c#	d	d#	e	f	f#	g	g#
10,5	-4,0	-12,0	0	-10,0	-7,0	-6,0	-14,0	-2,0	-10,0	-3,5	-8,0

4.4.2 Transposer

The transposer allows the transposition of all temperament tables into another key system.

If for example the command transpose “a” to "c" (A --> C) is entered, the cent values of the cent tables are transferred 3 semitones to the right. It should be noted, that the cent reference function also is in effect and the cent values of the tables are recalculated, so that for the cent reference tone the cent value is = 0.

Example: cent reference = “a” , transposes “a” to “c”:

Original table of the Kirnberger-III temperament:

a	b	h	c	c#	d	d#	e	f	f#	g	g#
0	+6,5	-1,5	+10,5	+0,5	+3,5	+4,5	-3,5	+8,5	+0,5	+7,0	+2,5

First the table is transposed by 3 semitone steps to the right:

a	b	h	c	c#	d	d#	e	f	f#	g	g#
0,5	+7,0	+2,5	0	+6,5	-1,5	+10,5	+0,5	+3,5	+4,5	-3,5	+8,5

It is then recalculated to match the cent reference = “a” (-0,5 cent):

a	b	h	c	c#	d	d#	e	f	f#	g	g#
0	+6,5	+2,0	-0,5	+6,0	-2,0	+10,0	0	+3,0	+4,0	-4,0	+8,0

4.5 Stretchings

Striking a string on a piano produces a tone consisting of several harmonics (partials), which are not in tune with their fundamentals.

For example, the tone produced by a piano string for tone a' can consist of a 440 Hz fundamental, with a second harmonic at 881 Hz and a fourth harmonic at 1768 Hz. If the partials had a harmonic proportion of frequency to each other, the second harmonic would have a value of 880 Hertz and the fourth harmonic 1760 Hertz. However, in our example the second harmonic is one Hertz and the fourth harmonic 8 Hertz higher than demanded by theory.

This is known as the "inharmonicity" of a piano string. It is caused by the flexural strength of the string and can be different from instrument to instrument. This inharmonicity explains why, on an upright piano or on a grand piano, the bass has to be tuned lower and the discant must be tuned higher.

The three different stretchings of the octaves pre-programmed in the Tuning Set were achieved through extensive test with various upright and grand pianos. The diagrams of these stretchings (PIANO_STRETCH_1 thru 3) are found on the last page.

In the lowest octave (A 2 to G#) the Tuning Set responds to the fourth harmonic, and in the octave (A 1 to g#) to the second harmonic. This is the reason for the two discontinuities in the beginning of the graphs.

You can combine the stretchings with temperaments as you please. If you select a temperament and a stretching at the same time, in the tuning mode, the Tuning-Set will add the temperament cents to those of the stretching.

For users who want to deal with intense piano tunings, we recommend the chapters 2.3.5 and 2.3.6. “Pianyzer” and “Piano Editor”.

4.6 Correction of organ pipe length automatically

The tuning of an organ pipe will be measured, and the variation in dimension to reach the correct tuning, will be calculated automatically by the tuning-set.

For this reason a “reverence length” is introduced as a parameter of the instrument programs. This value refers to the pitch a’. The default value of the reverence length is 390.1 mm (half wave length of air at 440 Hz and 20 °C). See also chapter 2.3.3.10

First the theoretical pipe length (lp) will be calculculatet by the tuning set with the formula:

lp = (f_pitch / f_target) * reference length

During the measure the correction length (ld) will be calculated continuously by the formula:

ld = lp – (f_pitch / f_true * reference length

With the keys “Actual” you can achieve the display of “lp” or “ld” in the tuning program.

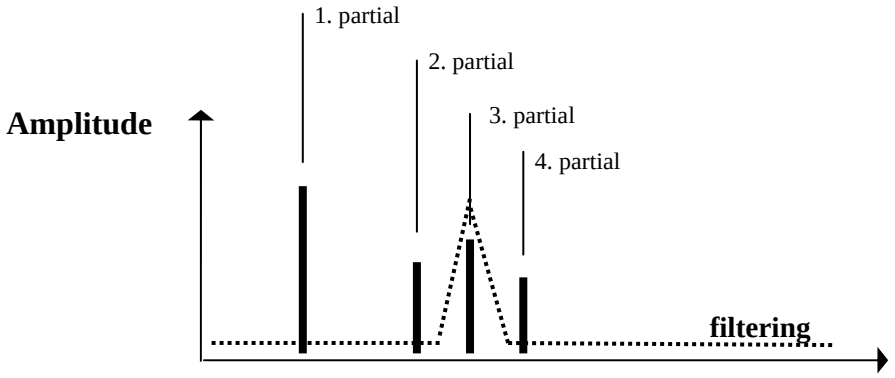
4.7 Filtering of partials

The low susceptibility to disturbance of the TLA Tuning Set display is achieved among other things through a band pass filter (64 dB per octave) installed in the device. This filter suppresses all incoming signals of the microphone except the frequency of the tone to be tuned.

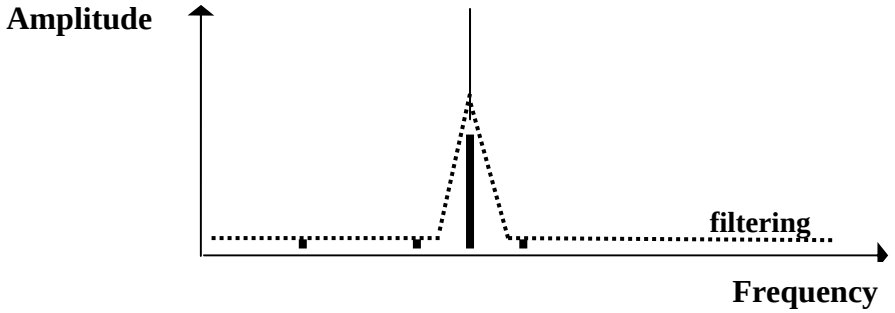
Only the frequency of the partial, which is adjusted in the set, passes the filter. This makes it possible, for example, to measure the amplitude of individual partials selectively, i.e., the inharmonicity of a piano string.

Example: Filtering of the third partial

Filter input signal



Filter output signal



4.8 Limitation of values

The Tuning Set works in a frequency range of 20 Hz to 15000 Hz.

All adjustments of tone, concert pitch, cent or partial with a frequency result outside this range, are suppressed.

For example, it is not possible to use the first partial on the deepest note „C_2“ or to use the second partial of the highest note g#_6.

5 Technical data

Tuning Range: 20...15000 Hz (9,5 octaves)

Accuracy: absolute and relative < 0.1 Cent (1/1000 semitone step !).

Display : 1. LCD-bar, resolution adjustable from 10 cent up to 200 Cent(max. gauge). **2.** Numerical either as cent (resolution 0.1 cent, range ±250.0 cent), as beats (resolution 0.01 hertz) or as absolute frequency (resolution 0.01 hertz), as pipe length correction or 16-th part of semitone **3.** electronic strobo display

Memory hold function for LCD-bar- and digital display: When the note falls silent, the last tune display is held;

Level of partial note: LCD-bar display

Concert-Pitch: Adjustable 220.00...880.00 Hertz in steps of 0.01 hertz with button or by automatic search function.

Adjustment of cents: With button ± 150.0 cent in steps of 0.1 cent or with automatic search function or through instrument program.

Adjustment of beats: ±50.0 hertz in steps of 0.1 hertz**.**

Purely Tuned Intervals: Second, third, fifth, seventh

Partials: From fundamental to 16-th harmonic wave

Adjustment of microphone gain: Automatically, manually or through instrument program.

Display: Contrasted LC-display with LED-background illumination.

Microphone: Built-in condenser microphone and jack for external microphone 200...600 Ohm.

Audible tone: Available in the tuning programs. Adjustable in 6 volume steps. Jack for external activ box.

Thermosensor input: The cent rate for this is adjustable in steps of 0.1 cent per degree centigrade. The absolute reference is adjustable in steps of 1 degree centigrade.

PC Interface: USB with virtual COM-Port.

Historical Temperaments: Memory for 99 temperaments. 71 temperaments can be programmed by the user himself and supplied with a 16-character name. 28 standard temperaments are pre-installed at delivery of the unit.

Instrument programs: Memory space for 99 instrument programs. Instrument programs for all standard instruments are already pre-installed at delivery. Each instrument program contains the following adjustment data:

Name of instrument program

Memory in every of the 99 instrument programs

Cent memory ±150.0 cent to store stretchings, for example for piano (120 cells per instrument program)

Memory for harmonics. To select the harmonics for the measuring of each note.(120 cells per instrument program)

Memory for microphone gain. To select the microphone gain for the measuring of each note.(120 cells per instrument program)

Memory for the semi tone steps for a predefined sequence of notes. (50 cells)

Instrument program parameter:

Concert pitch
Firs note after calling a instrument program.
Historical temperament
Cent reference for the historical temperament
Transposer for the historical temperament
Resolution of bar display
Gate time for measuring frequency

Mode for adjustment of microphone gain (memory, button, automatic)
Mode for cent adjustment (memory, button)
Mode for special-keys (memory, button, sequence, chorus, Off)
Thermosensor cent rate
Thermosensor reference
Reference value for pipe length correction
Write protection (On/Off)

Microtonal mode (microtonale scales):

Memory for 4 microtonal systems (tone.scales). 17, 19, and 24 tone step temperaments are already implemented and a tone scale with a pure twelfth interval divided into 19 tone steps. For each of the 4 microtonal scales is implemented:

Name of the microtonal scale (16 char).

Memory, for the microtonal scale.

Memory for 240 tone-steps -5700 to 6300 Cent to enter self-designed tone systems

Parameter.

Concert pitch
First note to start tuning.
Resolution oft he bar-display.
Gate time for measurement.
Thermosensor cent rate.
Thermosensor reference.
Reference length for calculation of organpipe length.
Write protection (on/off).

Filter circuit: 64 dB per octave

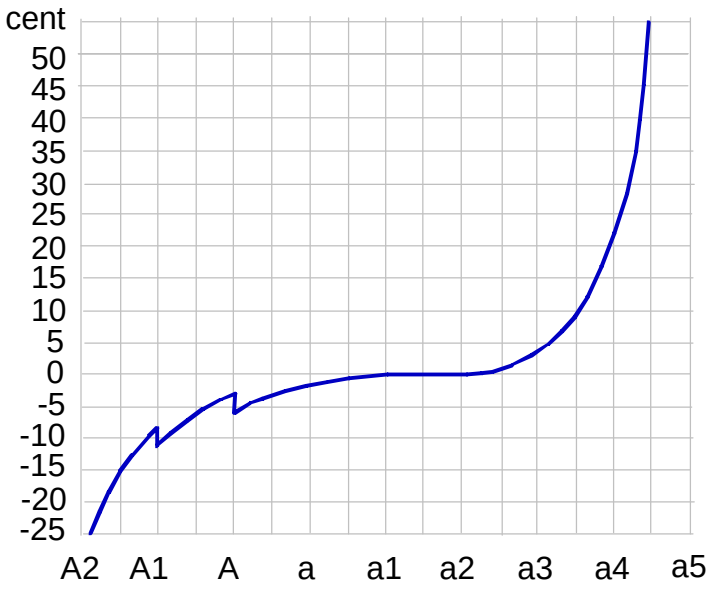
Electricity supply: 4 * Mignon NiMH battery 1.2 volt /2000 mAh or higher. Service life span: approximately 10 hours with one charge. Time needed for recharge: 14 hours with plug-in transformer.

Plug-in transformer: 7.5V/400mA DC stabilized

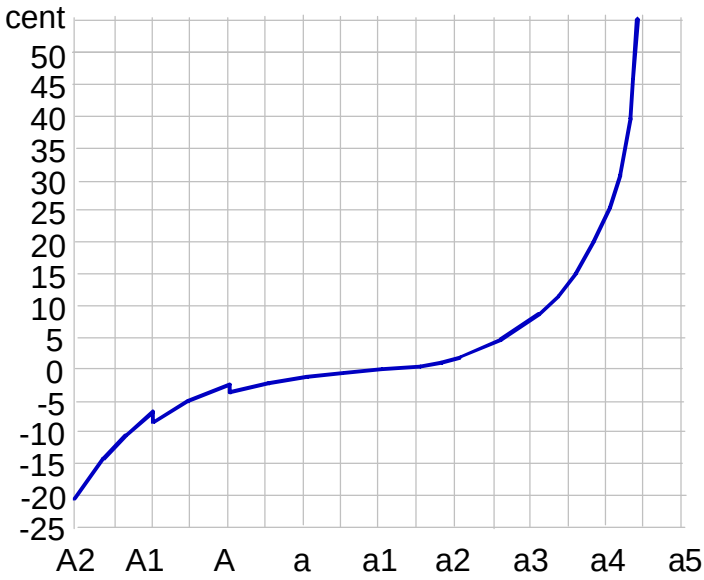
Dimensions and weight: 200 x 103 x 50 mm / 560g

Diagrams of piano stretchings

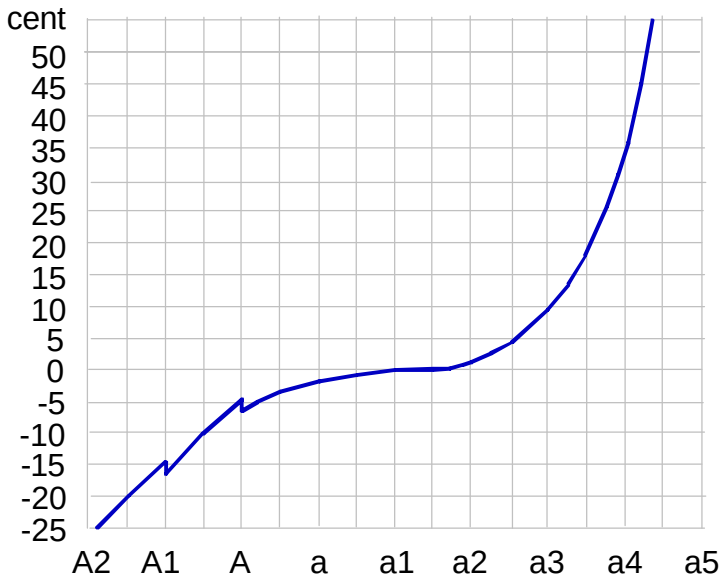
Piano-Stretching 1.



Piano-Stretching 2.



Piano-Stretching 3.



Cent-values of the historical temperaments

		A	B	Bb	C	C#	D	D#	E	F	F#	G	G#
1	EQUAL TEMPERAMENT	0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
2	AMMERBACH_1_Lpz_	0	8,2	3,9	6,1	-4,2	4,0	6,3	2,0	4,2	-0,1	8,1	-2,2
3	AMMERBACH_2_Lpz_	0	5,2	-2,1	6,1	-8,2	4,0	9,3	-2,0	4,2	-4,1	8,1	-10,2
4	ANONYMUS_(Pyth.)	0	-9,8	-17,6	-5,9	-35,2	-2,0	9,8	-19,6	-7,8	-15,6	-3,9	-33,2
5	BACH/BARNES_1/6_	0	6,0	0,0	6,0	0,0	2,0	4,0	-2,0	8,0	-2,0	4,0	2,0
6	BACH/KELLNER_1/6	0	4,0	-1,0	8,0	-1,5	2,5	2,5	-2,5	6,0	-3,5	5,5	0,5
7	BACH/Lehmann/E.M	0	3,9	0,0	5,9	3,9	2,0	3,9	-2,0	7,8	2,0	3,9	3,9
8	BACH/ Lehmann/M.S	0	5,8	-3,9	5,8	-0,2	2,0	3,9	-1,9	7,3	-0,9	3,9	-1,9
9	BACH/SCHUBIG.1/6	0	2,9	-4,9	4,9	-2,9	4,9	1,0	-4,9	4,9	-4,9	4,9	-1,0
10	BENDELER___1739	0	2,0	-2,0	6,0	2,0	4,0	0,0	2,0	4,0	0,0	2,0	4,0
11	BERMUDO_J._1555_	0	-6,2	0,3	-2,3	-1,8	-2,0	-8,2	-1,7	-4,3	-3,8	-0,3	0,2
12	v.BIEZEN_UM_1970	0	5,9	-3,9	5,9	0,0	2,0	3,9	-2,0	7,8	-2,0	3,9	2,0
13	CHAUMONT_1696___	0	7,8	-7,8	11,7	-15,6	3,9	0,0	-3,9	15,6	-11,7	7,8	-19,6
14	BRUDER/P.VIER___	0	1,0	-5,0	3,0	-2,0	5,0	0,0	-6,0	2,0	-3,5	4,5	-1,0
15	de_CAUS_S._1615_	0	11,7	3,9	15,6	-13,6	-1,9	-9,8	2,0	13,6	-15,6	17,5	-11,7
16	DOM_BEDOS_1770__	0	20,5	-4,5	11,5	-13,5	2,5	22,5	-2,5	13,5	-11,0	9,0	16,0
17	ERL.TRAKTAT_1454	0	-7,8	-15,2	-3,9	-13,7	-2,0	-9,8	-17,6	-5,9	-15,6	-2,0	-11,7
18	ESTREICHER_Anier	0	7,8	-7,8	5,9	-9,8	-2,0	5,9	-3,9	9,8	-11,7	2,0	-7,8
19	EULER_L._1707-83	0	-7,8	3,9	15,6	-13,7	19,6	-9,8	2,0	13,7	5,9	17,6	-11,7
20	FOGLIANO_L._1529	0	22,5	4,0	15,5	-13,5	8,5	31,0	2,0	13,5	-4,5	17,5	-11,5
21	GALILEI_V._1581_	0	-1,0	-2,0	9,5	8,5	7,5	6,0	5,0	4,0	3,0	2,0	1,0
22	GARDINO_HARMONIC	0	4,0	-3,0	1,0	-4,0	0,0	4,0	-2,0	3,0	-4,0	0,0	1,0
23	GRABALOS_um_1800	0	20,0	-2,5	12,0	-16,8	4,0	16,7	-8,5	10,7	-15,7	2,5	-13,0
24	GRAMMATEUS_1518_	0	-9,8	3,9	-5,9	-3,9	-2,0	0,0	2,0	-7,8	-5,9	-3,9	-2,0
25	KAYSER J.1694-99	0	6,4	-6,8	10,3	-2,9	3,5	2,7	-3,4	8,3	-4,9	6,9	0,9
26	KEPPLER_J.__1619	0	11,7	-17,6	-5,9	-13,7	-2,0	9,8	-19,6	-7,8	-15,6	-3,9	-11,7
27	KIRNBERGER_I____	0	11,7	3,9	15,6	5,9	19,6	9,8	2,0	13,7	5,9	17,6	7,8
28	KIRNBERGER_II___	0	1,0	-6,8	4,9	-4,9	8,8	-1,0	-8,8	2,9	-4,9	6,9	-2,9
29	KIRNBERGER_III__	0	6,4	-1,4	10,3	0,5	3,4	4,4	-3,4	8,3	-1,5	6,9	2,4
30	LAMBERT/SCHUGK__	0	3,6	-2,8	4,2	-2,3	1,4	1,7	-1,4	5,6	-4,2	2,8	-0,3
31	MALCOLM_____	0	4,9	3,9	15,6	20,5	19,6	12,7	2,0	13,7	18,6	17,6	10,8
32	MARPURG_____1776	0	34,1	4,0	16,0	-14,2	20,1	32,1	1,9	14,0	6,0	18,2	-11,3
33	MATTHESON_J.____	0	33,0	4,0	15,5	-13,5	19,5	-10,0	2,0	13,5	6,0	17,5	-11,5
34	MERCADIER_____	0	9,8	-7,8	11,7	-9,8	3,9	2,0	-3,9	15,6	-11,7	7,8	-7,8
35	MERSENNE_M. 1636	0	1,7	3,4	5,1	1,7	-1,7	-5,1	-8,6	-6,8	-5,1	-3,4	-1,7
36	MISXA_2005_____	0	6,0	-2,0	6,0	-3,0	2,0	3,0	-2,0	8,0	-4,0	3,0	-3,0
37	MITTELT._bE/#G__	0	17,1	-6,9	10,3	-13,7	3,5	20,6	-3,4	13,7	-10,2	6,9	-17,1
38	MITTELT._#D/bA__	0	17,1	-6,9	10,3	-13,7	3,4	-20,6	-3,4	13,7	-10,3	6,9	24,0
39	NASARRE_____	0	5,9	-7,8	7,8	-15,6	3,9	3,9	-3,9	7,8	-11,7	7,8	-19,6
40	NEIDHARD_f._Dorf	0	2,0	-2,0	5,9	0,0	2,0	2,0	-2,0	3,9	-2,0	3,9	2,0
41	NEIDHARD_f.kl.St	0	6,0	2,0	6,0	2,0	2,0	4,0	0,0	6,0	2,0	4,0	2,0
42	NEIDHARD_f.gr.St	0	3,9	2,0	5,9	2,0	2,0	3,9	0,0	3,9	2,0	3,9	2,0
43	PYTAGORAEN__	0	-9,8	3,9	-5,9	7,8	-2,0	-11,7	2,0	-7,8	5,9	-3,9	9,8
44	RAMEAU/SCHUGK___	0	8,0	-8,0	11,5	-4,0	4,0	0,0	-4,0	15,5	-6,0	-8,0	-2,0
45	RAMEAU/SCHUBIGER	0	19,6	-7,8	11,7	-3,9	3,9	7,8	-3,9	15,6	-5,9	7,8	-2,0
46	RAMIS_PAREIA1482	0	11,7	3,9	15,6	7,8	-2,0	9,8	2,0	13,7	5,9	17,6	7,8
47	REINHARD_A._1604	0	-1,0	3,9	15,6	14,6	19,6	8,4	2,0	13,7	12,6	17,6	6,4
48	SALINAS_1577____	0	25,9	-10,2	15,6	-20,8	5,0	31,1	-5,0	20,9	-15,6	10,3	36,4
49	SCHLICK_I_1511__	0	7,8	-3,9	5,9	-3,9	2,0	7,8	-2,0	7,8	-3,9	3,9	2,0
50	SCHLICK/BILLETER	0	10,1	-4,0	8,1	-6,2	3,0	10,2	-1,9	9,9	-4,8	6,1	6,0
51	SCHLICK/H.VOGEL_	0	9,0	-5,5	8,0	-6,5	2,5	2,5	-3,0	11,0	-8,0	5,5	-4,5
52	SCHNEEGASS_1590_	0	15,7	-4,3	10,2	-9,0	4,3	18,3	-1,4	11,1	-8,6	6,2	-14,5
53	SILBERM./P.VIER_	0	6,0	-4,0	6,0	-4,0	2,0	0,0	-2,0	8,0	-6,0	4,0	-2,0
54	SILBERMANN_I_1/5	0	10,8	-3,9	6,8	-7,8	2,9	12,7	-2,0	8,8	-5,9	4,9	-9,8
55	SILBERMANN_II___	0	8,1	-2,9	4,9	-6,2	1,9	10,2	-0,9	7,1	-4,8	3,0	-7,9
56	SILBERM/BILL.1/5	0	10,8	-4,7	4,9	-7,9	5,0	13,0	-5,0	8,2	-4,8	5,1	-11,0
57	SOLANO_1779_1/6_	0	2,0	-2,0	6,0	-10,0	4,0	0,0	-4,0	4,0	-6,0	8,0	-14,0
58	SOLANO_1779_Mean	0	20,0	-2,0	12,0	-10,0	4,0	24,0	-4,0	16,0	-6,0	8,0	-14,0
59	STANHOPE_1801___	0	5,9	-3,9	9,8	0,0	5,9	3,9	-5,9	7,8	-1,9	11,7	1,9
60	TARTINI_____	0	-2,0	4,0	-6,0	4,0	-2,0	0,0	2,0	-4,0	6,0	-4,0	2,0
61	TROST_J.C._1677	0	-11,0	-19,0	-7,0	-36,0	-3,0	9,0	-20,0	-6,0	-15,0	-4,0	-33,0
62	VALOTTI_um_1754_	0	5,8	-3,9	5,8	-0,2	2,0	3,9	-1,9	7,8	-1,9	3,9	1,9
63	VERHEIJDEN_1600_	0	11,7	-4,7	7,0	-9,4	2,3	14,0	-2,3	9,4	-7,0	4,7	-11,7
64	WERCKMEISTER_III	0	7,8	3,9	11,7	2,0	3,9	5,9	2,0	9,8	0,0	7,8	3,9
65	WERCKMEISTER__IV	0	13,6	-3,9	9,7	-7,8	5,8	3,8	2,0	7,7	-1,9	3,8	-5,9
66	WERCKMEISTER___V	0	1,9	-1,9	-0,1	-3,8	3,9	-0,1	-3,9	3,9	0,1	1,9	-7,8
67	WERCKMEISTER__VI	0	2,0	-1,0	2,0	-1,5	1,5	-3,5	-3,0	4,0	1,0	4,0	-5,5
68	YOUNG/VALL.TART.	0	2,0	-3,9	5,9	-3,9	2,0	0,0	-2,0	3,9	-5,9	3,9	-2,0
69	ZARLINO_G._1558_	0	21,1	-8,5	12,5	-17,0	4,3	25,3	-4,4	16,8	-12,8	8,5	29,3

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