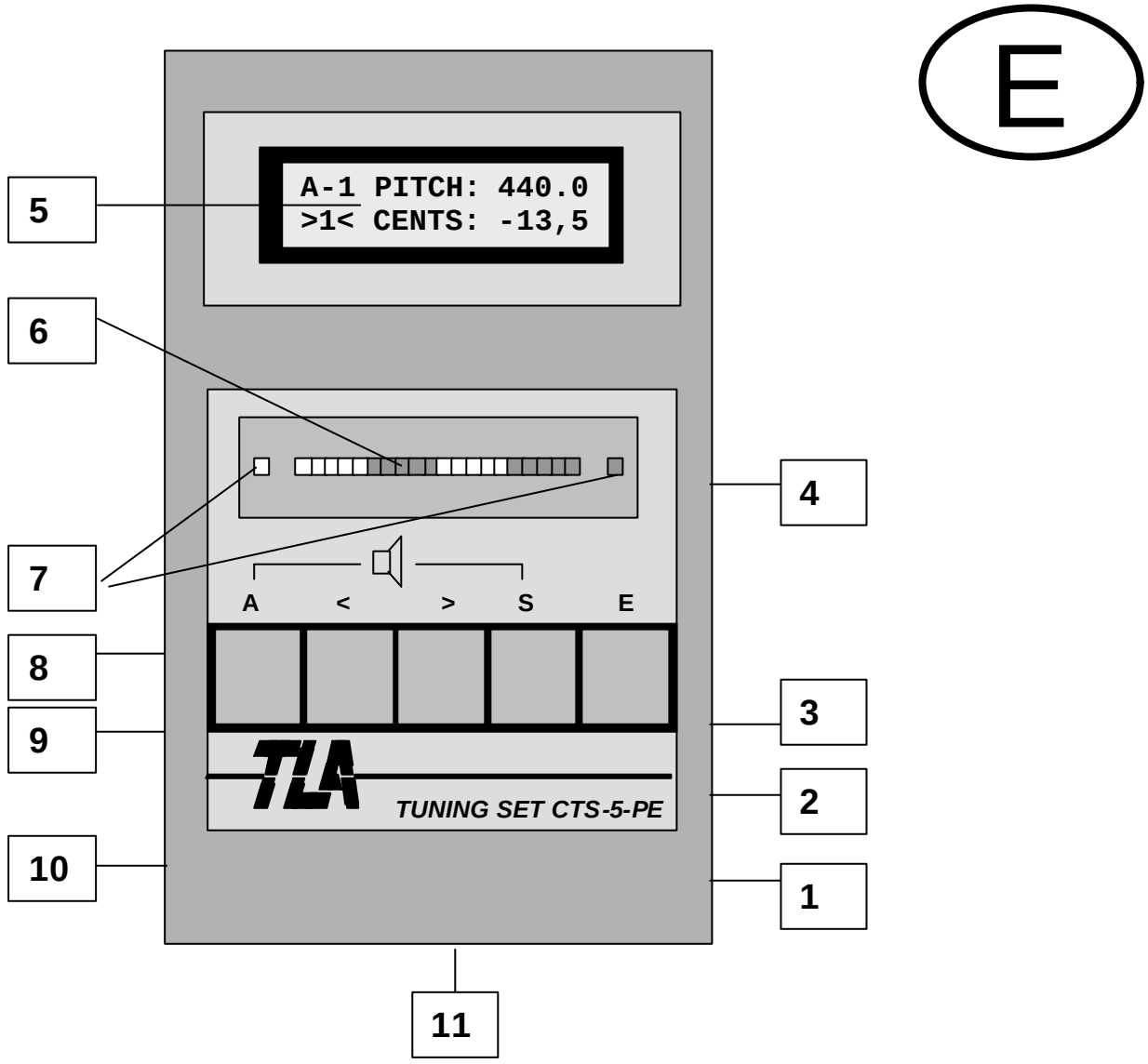
Tuning Set CTS-5 / CTS-5-P / CTS-5-PE



1. *SOCKET FOR NET ADAPTOR OR BATTERY LOADER*
2. *LOADING INDICATOR LED (CTS-5-P AND CTS-5-PE ONLY)*
3. *ON/OFF SLIDE-SWITCH*
4. *SOCKET FOR EXTERNAL DEVICES (CTS-5-PE ONLY)*
5. *LC-DISPLAY*
6. *STROBOSCOPIC DISPLAY*
7. *GOOD/BAD INDICATOR LED*
8. *EXTERNAL MICROPHONE SOCKET*
9. *ÖPENING FOR BUILT-IN CONDENSER-MICROPHONE*
10. *SENSITIVITY SLIDE-SWITCH*
11. *MEMORY MODULE BAY (CTS-5-PE ONLY)*

OPERATING INSTRUCTIONS FOR TUNING SET CTS-5, CTS-5-P AND CTS-5-PE

Congratulations on the purchase of your Tuning Set CTS-5. It will make the tuning of all kinds of musical instruments much easier. Part 1 of these operating instructions contains general information about the Tuning Set. Part 2 gives examples on how to learn the most important functions, and part 3 is for those of you who want to know all about this Tuning Set.

P A R T 1

GENERAL OPERATING INSTRUCTIONS

1.1 POWER

This paragraph applies to the Tuning Set CTS-5 only:

The Tuning Set CTS-5 can be operated with a plug-in transformer, or with battery power. Four batteries type Mignon 1.5 Volt are needed for approx. 10 hours of operation. When the batteries are empty, the LC-Display will show "BATTERY". For frequent battery operation a rechargeable set of nickel-cadmium (NICAD) cells, type Mignon 1.2 Volt, with a battery charger is advisable, and should be available at your local radio dealer. With NICAD cells, the Tuning Set should run approx. 6 hours on one charge.
WARNING: The socket for the plug-in transformer cannot be used as a socket for the battery charger. The batteries are automatically disconnected when the plug-in transformer is used.

WARNING ! CHECK THE POLARITY WHEN REPLACING BATTERIES.
THE WRONG POLARITY CAN DAMAGE THE TUNING SET.

This paragraph applies to the Tuning Sets CTS-5-P and CTS-5-PE only:

The Tuning Sets CTS-5-P and CTS-5-PE come with four rechargeable NICAD batteries. With one load you may operate the sets for approx. 6 hours.
When the batteries are empty, the LC-Display will show "LOW-BATT.", and, to avoid a complete battery discharge, the Tuning Set will shut down automatically. The set's plug-in transformer recharges the batteries completely in approx. 14 hours. While the batteries are being loaded, the loading indicator LED is lit, and the Tuning Sets may be operated.

W A R N I N G !

Never operate the Tuning Set when the batteries are removed.
Only use rechargeable NICAD batteries, type 1.2 Volt.
If you ever need to replace the batteries, check the polarities.

If one battery load is significantly shorter than 6 hours, please check the following:

1. The battery terminals are corroded.
   Correction: Remove and reinsert the batteries several times,

   this should eliminate the corrosion.

2. The batteries are defective.
   Correction: Replace the batteries.

3. The plug-in transformer/loader is defective.
   Correction: Return the plug-in transformer with the Tuning Set.

1.2 SWITCHING-ON THE TUNING SET.

Switch on the Tuning Set with the slide switch on the right side of the Tuning Set. For approx. one second you see the program version, and then the following indication:

Should one of the next two indications appear, please go to the next paragraph.

1.3 SELECTION OF LANGUAGE FOR OPERATOR GUIDANCE

Your Tuning Set can converse with you in German, French, or English. Select the desired language as follows:

1. Turn off the Tuning Set.

2. While with the left hand depressing and holding the key "S", switch on the Tuning Set. Continue depressing the key "S" until you see a rotating display of the letters D, F, and GB.

For German, press the key "E", while "D" is being displayed.

For French, press the key "E", while "F" is being displayed.

For English, press the key "E", while "GB" is being displayed.

From then on the operator guidance language displayed by the Tuning Set is in the language you have selected. Switching the Tuning Set on or off does not change the language.

1.4 INTRODUCTION TO THE DIAGRAM FOR MODES OF OPERATION

The Tuning Set is basically operated with the keys "<", ">", and "E". With the basic keys you can find your way through the included Diagram for Modes of Operation, like on a 'city map'. You are now, after turning on the Tuning Set, in the upper left hand corner, shown by the big black arrow. With the keys "<" and ">" you can move to the left and right, and select one of the following modes:

>1< TUNING Tuning with the strobe display
>2< PITCH Mode for standard pitch adjustment
>3< CENTMESS Measuring or adjustment of a tone in cent
>4< TEMPERATURE Mode for historical temperaments
>5< STRETCHING Mode for tuning pianos
>6< INTERVAL Mode for tuning of pure intervals (CTS-5-P and PE only)
>7< STORAGE Storage of piano tunings and temperatures (CTS-5-P and PE only).

With the key "E" you can move downward on the diagram. The selected mode is activated. If you press the key "E" again, you will move upward, and are leaving the activated mode.

Selecting the wrong key or mode will not damage the Tuning Set. The stored temperatures and stretchings are protected and cannot be erased or changed by depression of a wrong key. In order to become acquainted with the Tuning Set, please play and experiment with the keys to your heart's content.

To quickly familiarize yourself with the Tuning Set, follow the examples given in part 2 on a musical instrument, and closely stick to the guidance.

Don't try to memorize the key sequences in the examples. Try to understand the operation of the Tuning Set by tracing the example steps on the diagram.
Note the arrow in the lower, right hand corner of the LC-Display:

When this arrow appears, the keys ">" and "<" are used for mode selection. You are then at the highest operating level of the diagram for operation modes.

The text in the display then shows you what you may do with the keys "<" and ">", after you have depressed the key "E":

>1< TUNING	Select a tone
>2< PITCH	Adjust a standard pitch
>3< CENTMESS	Measure or adjust a tone in cent
>4< TEMPERATURE	Select a historical temperament
>5< STRETCHING	Select a piano-stretching
>6< INTERVAL	Tune a pure interval (CTS-5-P and PE only)
>7< STORAGE	Store a tuning or temperature (CTS-5-P and PE only).

Pressing the key "E" makes the arrow disappear. The Tuning Set is now in the selected mode. With the keys "<" and ">" you can now carry out your previously selected mode.

Again pressing the key "E" makes the arrow reappear, and you have left the mode. With the keys "<" and ">" you may select a new mode of operation.
The input or adjustment made within a mode will remain intact after you exit the mode.

An exception is mode Number 7 (STORAGE). This mode cannot be left by pressing key "E", but only by simultaneous depression of keys "E" and "S".

All inputs or adjustments made in the operation modes will not be erased by turning the Tuning Set on or off. One exception is the standard pitch, which automatically resets to a1 after the Tuning Set is turned on.

1.5 ERASING ALL INPUTS

Should you have stumbled in your first walking trials, and put in a non desired setting, you may return to the original settings contained in the Tuning Set upon delivery, by using the 'monkey clutch' or dump:

Standard pitch:	440 Hz
Temperature:	Equal Temperament
Stretching:	None
Interval (CTS-5-P and PE only):	None
Transpose Function and Cent Relate Function:	Off

The memory content for Temperatures and Stretchings will not be erased by the 'dump'.

....and this is how to do it:

Turn off the Tuning Set. Simultaneously depress keys "A" and "E" with the left hand until you have switched on the Tuning Set with your right hand.
Continue holding the keys until the LC-Display indicates:

BASIC ADJUSTMENT IS DONE

The 'monkey clutch' was made so difficult to prevent an accidental dumping of the inputs and settings.

1.6 TIMER SWITCH

A timer was installed in the Tuning Set, to save battery power. If you don't use the set for twenty minutes, it will automatically turn off.
Before shutdown it will set off several short accoustical signals. This allows you to prevent shutdown by depressing one of the five keys. If the Tuning Set automatically turned off, you may restart it with the on/off lever on the right side by switching it off and on. You may turn off the timer completely (see chapter 3.7).

1.7 SENSITIVITY ADJUSTMENT OF THE BUILT-IN MICROPHONE AMPLIFIER

You may reduce the sensitivity of the built-in microphone amplifier with the slide switch located on the left side of the Tuning Set. You may need this especially for the low tones of a piano. The optimal setting of this switch and the optimal placement of the Tuning Set must be found during the tuning process.

P A R T 2

OPERATING EXAMPLES

2.1 TUNING, STANDARD EQUAL TEMPERAMENT, STANDARD PITCH 440 HERTZ

Normally a musical instrument is tuned in standard equal temperament. The standard concert pitch a', on which the complete level of pitch is based, is often tuned to a frequency of 440 Hertz. This is the mode with the fewest operational steps. Therefore let us take this mode for our first example.

Switch on CTS-5.

Display:

>1< TUNING >

Tap key "E" briefly.

Display:

a 1 PITCH: 440.0 >1< CENTS: 00.0

Now strike the tone a' on your instrument. Two green illuminated sets of beads appear on the stroboscopic display. The beads move to the left if the tone is too low, or to the right if the tone is

too high. As the tone approaches the desired pitch, the movements will slow down. At the correct pitch the beads will stop moving.

You can recognize larger frequency deviations, when one of two green dots on the left or right of the stroboscopic display is lit. Depending on whether the desired tone is too high or too low, either the right or the left dot will be lit continuously. If neither of these dots shines, the tone played is at the desired pitch of less than ñ2 cent (*).

(*) This value is changeable. See chapter 3.7.

For tuning the next higher semi-tone, tap key ">" briefly. This raises the CTS-5 by one semi-tone.

```
b 1 PITCH: 440.0
>1< CENTS:   00.0
```

Similarly, if you tap key "<", you lower the CTS-5 by one semi-tone.

```
a 1 PITCH: 440.0
>1< CENTS:  00.0
```

Constantly depressing key "S" and simultaneously tapping key ">" briefly, will raise CTS-5 by one octave.

```
a 2 PITCH: 440.0
>1< CENTS:   00.0
```

Constantly depressing key "S" and simultaneously tapping key "<" briefly, will lower CTS-5 by one octave.

```
a 1 PITCH: 440.0
1< CENTS:    00.0
```

If you depress either key "<" or ">" constantly, the desired function will repeat itself every 0.5 seconds.

Now depress key "A":

```
a 1 PITCH 440.0
>1A< CENTS: 00.0
```

AUTOMATIC MODE

The CTS-5 now automatically follows the tone level of the played tone. The automated switching was intentionally limited to two semi-tone steps (*), to avoid undesired tuning of partial tones. For the same reason the AUTOMATIC MODE is not available for the two lowest octaves.

Again depressing key "A" switches off the AUTOMATIC MODE.

If you constantly depress key "S" and tap key "A", you can hear the selected tone over the built-in loudspeaker. The same key combination will turn off the tone. (Only available in CTS-5-P and PE)

(*) This limitation can be switched off. See chapter 3.7 for details.

2.2 PRESETTING OF THE STANDARD PITCH

The standard pitch of the CTS-5 may be adjusted from 380.0 to 470.0 Hertz.
After switching on the CTS-5.

```
>1<  TUNING   ->
```

Press key ">" once.

```
>2<  PITCH    ->
```

Press key "E".

```
a 1 PITCH: 440.0
>2< CENTS:  00.0
```

By tapping key ">" you can raise the standard pitch by 1/10th Hertz

```
a 1 PITCH: 440.1
>2< CENTS:  00.0
```

By tapping key "<" you can lower the standard pitch by 1/10th Hertz.

```
a 1 PITCH: 440.0
>2< CENTS:  00.0
```

If you constantly depress key "S" and simultaneously tap key ">", you will raise the standard pitch by one cent.

```
a 1 PITCH: 441.0
>2< CENTS:  00.0
```

If you constantly depress key "S" and simultaneously tap key "<", you will lower the standard pitch by one cent.

```
a 1 PITCH: 440.0
>2< CENTS:  00.0
```

If you wish to adjust the standard pitch to 443.2, for example, you tap keys "S" and ">" three times, and the key ">" twice.

```
a 1 PITCH: 443.2
>2< CENTS:  00.0
```

To start tuning with the adjusted standard pitch you must now leave the standard pitch program and activate the tuning program. The adjusted standard pitch will be taken over into the tuning program.

Press key "E".

```
>2< PITCH     ->
```

Press key "<" once.

```
>1< TUNING    ->
```

Press key "E".

```
a 1 PITCH: 443.2
>1< cents:  00.0
```

Now you may start tuning with the newly adjusted standard pitch.

2.3 MEASURING THE STANDARD PITCH OF AN INSTRUMENT

Enter, like in the above example, into the standard pitch program.

For instance

```
a 1 PITCH: 440.0
>2< CENTS:  00.0
```

Tap the key "A".

```
a 1 PITCH: 440.0
>2A<CENTS:  00.0
```

AUTOMATIC MODE

When you now strike the tone a1 on your instrument, the standard pitch program of the CTS-5 starts to adjust to the played tone. The tone to be measured must be played until the stroboscopic display almost or completely comes to a stop (tones of short duration must be stricken repeatedly). Now press the key "A" again, preferably while the tone is still heard. This will turn off the AUTOMATIC MODE.

If necessary, adjust the CTS-5 to the correct tone, by tapping the keys "<" or ">", until the stroboscopic display is standing still, while the tone is being played. Only then the CTS-5 is adjusted to the correct value.

You may now read the measured standard pitch on the LC-Display.

2.4 MEASURING A TONE'S CENT DEVIATION

The unit of measure CENT is used in accoustics for the deviation of a tone from a basic frequency. A cent is about one hundredths of a semi-tone step.
The exact value is described in Part 3 of these Operating Instructions.

Please use Program Number 3 for cent measuring. Its procedure is the same as that for measuring the standard pitch.

The cent-adjustment of the CTS-5 always relates to the previously adjusted tone and standard pitch.

NOTE: STANDARD PITCH PROGRAM AND CENT MEASURING PROGRAM.

You may change the actual tone setting in these programs as follows:

Simultaneously and continuously depress keys "E" and "S", and then tap the keys "<" or ">".

2.5 PIANO TUNING

First things first: We cannot overemphasize the fact that piano tuning requires experience. If it is done without the necessary knowledge and skills, the piano may be irreparably damaged. In one tuning, a piano should never be raised or lowered by more than 30 cent.

When tuning pianos and grand pianos, the stretching of tune has to be considered for various reasons, i.e. that in deviation from the standard tune, high tones have to be tuned higher, and bass tones lower. We will discuss this further in Part 3 of the Operating Instructions. The Tuning Set CTS-5 may be adjusted so that, based on stretching diagrams, which are incorporated in the CTS-5 program, these deviations or stretchings are automatically considered.

Several stretchings are available in the Tuning Set. Five are permanently programmed. The remainder you may choose and enter yourself, using Program Number 7 (MEMORY) (Only for CTS-5-P and PE). You may find the diagrams of the five permanently programmed stretchings in Part 3 of the Operating Instructions.

The choice of the optimal stretching depends on various parameters of the instrument to be tuned. Another important consideration is the preference of the musician.

The five built-in stretchings are the result of trials, during which various pianos were tuned by ear, and subsequently measured. The stretching most suitable for your requirement must be tried by you first, considering that the weak and middle stretching is more suitable for pianos with large measure (concert grand piano). We recommend that in your first attempts you try the Stretching Number 3 (strong). For this, the Tuning Set is used as follows:

Switch on the Tuning Set.

Tap key ">" 4 times.

Tap key "E".

Using keys "<" or ">" you may select one of the following stretchings.

Number 1 (SLIGHT)	Bass and Descant stretched slightly.
Number 2 (MODERATE)	Bass and Descant stetched.
Number 3 (STRONG 1)	Bass and Descant stretched heavily.
Number 4 (STRONG 2)	Bass weak, center portion stretched heavily.
Number 5 (STRONG 3)	Center portion stretched heavily.

Three Self-Programmable Stretchings (CTS-5-P and PE only):

Number 6 (Memory S01)
Number 7 (Memory S02)
Number 8 (Memory S03)

12 Further Self-Programmable Stretchings in the exchangeable memory module (CTS-5-PE only):

Number 9 (Memory SE04)
....
Number 20 (Memory SE15)

In this example we will obtain Stretching Number 3:

Tap key ">" 3 times

```
PRONOUNCED1
NUMBER      00
```

Tap key "E"

```
>5< STRETCHING ->
```

Tap key "<" 4 times Blinking Confirms

```
 PRONOUNCED1
>1< TUNING   ->
```

Tap key "E"

```
 a1   PITCH: 440.0
>1<  CENTS:  00.0
```

Now you may start tuning. Start with tone a' and tune all three strings. Continue with b', h', c'', etc. At one of the higher tones you may see the following display (for example):

```
 b 2 PITCH: 440.0
 >1< CENTS: +00.5
```

The Tuning Set is now considering preselected stretching. Any deviation from standard tune is indicated in CENTS on the lower display line.

After you have finished tuning the descant, start tuning downward beginning with g#'. The deeper tones will automatically be tuned lower according to the preselected stretching. The deviation again shows on the lower line of the display.

In this particular mode, the cent-adjustment follows a function, which is dependent on the octave range. It is therefore very important to ascertain the correct octave range on the Tuning Set. Errors can be avoided by progressing in semi-tone steps.

2.6 PRESETTING OF HISTORICAL TEMPERAMENTS

Friends of historical instruments can use TUNING SET CTS-5 for 16 different historical temperaments. In the CTS-5-P an additional 12 temperaments may be programmed by you in Program Number 7. In the exchangeable memory-module of the CTS-5-PE you may add another 20 temperaments.

In the following example the instrument is tuned to "WERCKMEISTER III":

Switch on the Tuning Set.

```
>1< TUNING    ->
```

Tap key ">" 3 times.

```
>4< HIST.TEMP.->
```

Tap key "E".

```
EQUAL TEMPERAMENT
>4<     NUMBER 00
```

Using keys "<" or ">" you may now select a temperature:

Number 00 Equal Temperament (Normal Setting)
Number 01 KirnbergerIII
Number 02 WerckmeisterIII
Number 03 Meantone
Number 04 Neidhard (1724)
Number 05 Neidhard (1729)
Number 06 Valotti
Number 07 Silbermann
Number 08 Silbermann by P. Vier
Number 09 Bruder by P. Vier
Number 10 Bach (Barnes)
Number 11 Bach (Kellner)
Number 12 Rameau
Number 13 Lambert (1774)
Number 14 Young (1800)
Number 15 Schlick (H. Vogel)
Number 16 Pythagorean

12 Self Programmable Temperaments (CTS-5-P and PE only):

Number 17 Memory T01
...
Number 28 Memory T12

Self Programmable Temparaments in the Exchangeable Module (CTS-5-PE only)

Number 29 Memory TE13
...
Number 48 Memory TE32

To preset the Werckmeister Temperament, tap key ">" twice.

```
WERCKMEISTER-III
>4<    NUMBER 02
```

Tap key "E".

```
>4< HIST.TEMP.->
```

Tap key "<" 3 times Blinking →

```
 WERCKMEISTER-III
>1< TUNING    ->
```

Tap key "E".

```
a 1 PITCH: 440.0
 >1< CENTS:  00.0
```

Now you may start tuning. The cent-deviation of the historical temperament to the equal temperament is shown on the lower line of the display, i.e.

```
b 1 PITCH: 440.0
>1< CENTS: +07.5
```

The CENT deviations of the various historical temperaments are listed in part 2 of the operating instructions.

2.7 TUNING OF PURELY TUNED INTERVALS (CTS-5-P and PE only)

If you wish to raise the setting of the Tuning Set by an equally tempered interval (TERZ, quint, etc.) higher than the basic setting, you may use the "Interval Program" of Tuning Sets CTS-5-P and PE to raise the Tuning by the respective factors (5:1, 3:1, etc.).

In this example we will raise the setting of the Tuning Set by a purely tuned quint., i.e., by the factor of 3:2.

Switch on the Tuning Set.

```
>1< TUNING    ->
```

Tap key "<" twice.

```
>6< INTERVAL   ->
```

Tap key "E".

```
NONE        1:1
>6<  NUMBER 00
```

Tap key ">" 3 times.

```
FIFTH       3:2
>6<    NUMBER 03
```

Tap key "E".

```
>6< INTERVAL  ->
```

Tap key ">" twice.

Blinking ⟶

```
QUINT       3:2
>6< TUNING    ->
```

Tap key "E".

```
a 1 PITCH:  440.0
>6  CENTS:   00.0
```

The Tuning Set is now tuned a pure quint higher. You may start tuning.

(The frequency of the current pitch is 440Hz*3/2).

When you use the interval program please note that the tuning area (27.5 Hz through 6645 Hz) cannot be expanded through the interval function. The Tuning Set cannot be set outside this range.

2.8 STORAGE OF STRETCHINGS AND TEMPERAMENTS (CTS-5-P and PE only)

To refresh your already considerable knowledge of the CTS-5...

Stretchings are functions, which encompass the entire tone range of an instrument. For each tone (spanning its entire range) in the Tuning Set there is a cent value. One stretching therefore contains storage space for a total of 8*12=96 CENT values. You may input three such stretchings into the Tuning Set. Each exchangeable storage module of the CTS-5-PE contains additional storage space for 12 stretchings. On the other hand, a temperament relates only to the 12 semi-tones of an octave, and therefore only contains 12 cent values. These cent values are then repeated for each octave, considering that the cent deviation for the tone "a", as program-necessitated, is always zero (See Function of cent Relationship and Transposition in Part 3.4 of the operating instructions). You may input 12 such temperaments into the CTS-5-P. The exchangeable storage module of the CTS-5-PE contains additional storage space for 20 additional temperaments.

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

Your temperaments and stretchings will be stored permanently, even if you remove the batteries.

To quickly familiarize yourself with the memory functions, follow the examples on a musical instrument. Use the included "Diagram for Memory Mode" to find your way through the menus.

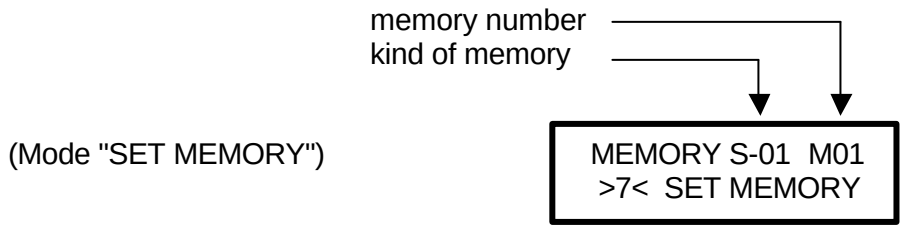
Switch on the Tuning Set and select mode Number 7 "MEMORY ->". After tapping key "E" this message will appear (in 3 stages):

ATTENTION, MEMORY WILL BE WRITTEN GO AHEAD: A + E

You can still leave the memory mode without changing the memory, by tapping key "<" or ">".

You can leave the memory mode at any time, by pressing keys "S" and "E" simultaneously.

Go ahead by pressing key "A" and "E" simultaneously:



Now select a memory by tapping key "<" or ">".

Available in CTS-5-P and PE:

MEMORY S-01 to S-03 for stretchings

MEMORY T-01 to T-12 for temperaments

In the exchangeable memory module (CTS-5-PE only):

MEMORY SE-04 to SE-15 for stretchings

MEMORY TE-13 to TE-32 for temperaments

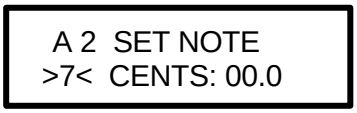
In this example we will store a piano tuning into "MEMORY S 02". We therefore search for this display with the keys "<" and ">" :

"MEMORY S-02" is now selected. By tapping key "E" this memory becomes active. The device switches its tone automatically to "a'", and enters the "SET PITCH" mode:

Now we have to calibrate the Tuning Set's standard pitch to the standard pitch of the musical instrument. You therefore have to measure the standard pitch (as in example 2.3).

This calibration should be done very carefully. The stroboscopic display must come to a complete stop when the tone a' is played on the musical instrument. The exact calibration is very important because all cent deviation values to be stored will relate to this standard pitch.

When this mesurement is finished, press key "E". The device will enter the "SET NOTE" mode:



The Tuning Set automatically switches to the tone A 2, the deepest tone.

With the keys "<" or ">" you can select the tone to be to stored, but please do not use these keys yet! Press key "E"; the Tuning Set will enter the "SET CENT" mode:

Now play the tone A 2 on your musical instrument and take a cent deviation measurement. (as in example 2.4):

When you have finished this measurement, press key "E" to store the indicated cent deviation value. This will be acknowledged with a short beep from the device. The next display appears for about one second:

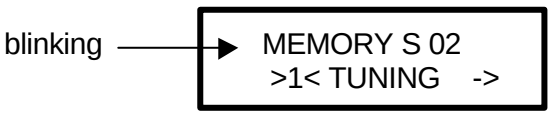
The device automatically switches to the next semi-tone:

Now measure the cent deviation value of the tone Bb 2, then press key "E".

To store the whole tuning of your musical instrument, repeat this operation until all tones are stored. When the last tone has been stored, you will probably want to test the stored stretching (i.e. all stored tones). Briefly press the keys "S" and "E" simultaneously, to get back to the "SET NOTE" mode. With the keys "<" or ">" you can select each tone again, in order to test it.

Individual cent deviation values may be corrected at any time. In the "SET TONE" mode, select the tone you wish to change. Then enter the "SET CENT" mode by pressing key "E". There you can set (or measure) the new cent deviation value. It will be stored by pressing key "E" again.

You can leave the mode "SET CENT" by pressing keys "S" and "E" simultaneously. When you are finished testing, you can leave the memory mode by pressing keys "S" and "E" simultaneously again. The last used memory function is now the active tuning function on the Tuning Set. It apears on the display when you select mode ">1< TUNING ->".



If you wish to choose another stretching or temperament, you can select it as described in the examples 2.5 and 2.6.

Storing a temperament is similar to storing a stretching. To summarisize:

"SET MEMORY": Select a memory of kind "MEMORY T- ...".

"SET PITCH": Measure the standard pitch very carefully!

"SET NOTE": In this mode the device automatically switches to the tone b'. It is not possible to enter a cent deviation value for to tone "a". Its cent deviation is always automatically set to zero. If you try to enter the tone "a", the display "a = CENT REF" appears for aprox. 1 second. After that the Tuning Set switches to the next tone. It is an inherent part of the Cent Relationship and Transposition Function that the reference tone "a" has no cent deviation (See Cent Relationship and Transposition function in part 3 of the operating instructions).

"SET CENT": The procedure here is the same as for storing a stretching.

ATTENTION !!!

If you store important data into the Tuning Set, we suggest that you write down these values. Then, in the unlikely event of a problem occurring with the memory, you can restore your old values after the device has been repaired.

The range of cent deviation is limited to ñ63.5 cent in the memory mode.

2.9 COMBINING INDIVIDUAL MODES

All modes can be combined. For instance, you can enter any standard pitch in mode 2 ("PITCH") and subsequently test a chosen tone in relation to this in mode 3 ("CENT-MEAS").

The functions Stretching, Temperament and Interval may be combined, even those that you have stored yourself.

You can use every function with every standard pitch.

P A R T 3

For all those who wish to learn more about Tuning Set CST-5 we will discuss the basic facts on the following pages.

3.1 THE EQUAL TEMPERAMENT

The Equal Temperament is the most frequently used temperament, it is the basic tuning of CTS-5. The following example shows its mathematical theory.

Given that standard pitch a' is 440.0 Hertz, then oscillations of the chromatic semi-tone steps are calculated as follows:

bb' = 440.00 Hz * $12\sqrt{2}$ = 466.16 Hz $12\sqrt{2}$ = 1.0594631

b' = 466.16 Hz * $12\sqrt{2}$ = 493.88 Hz

etc.

When the standard pitch a' is 442.00 Hertz:

bb' = 442.00 Hz * $12\sqrt{2}$ = 468.28 Hz

b' = 468.28 Hz * $12\sqrt{2}$ = 496.13 Hz

etc.

3.2 THE CENT VALUE

Cent is a value for proportions of frequencies. A semi- tone is geometrically divided into 100 parts (= 100 cent). The following example will show how the cent-value is defined mathematically. The frequency of oscillations is given with 440.0 Hertz and is to be increased by 1 cent:

440.00 Hz * $1200\sqrt{2}$ = 440.26 Hz

The frequency of oscillation is given with 440.00 Hertz is to be increased by 5 cent.

440.00 Hz * $(1200/5)\sqrt{2}$ = 441.27 Hz

The frequency of 440.00 Hertz is to be increased by 100 cent (= 1 semi-tone).

440.00 Hz * $(1200/100)\sqrt{2}$ = 440.00 Hz * $12\sqrt{2}$ = 466.16 Hz

The frequency of 466.16 Hertz is to be lowered by 100 cent (= 1 semi-tone).

466.16 Hz : $(1200/100)\sqrt{2}$ = 466.16 Hz : $12\sqrt{2}$ = 440.00 Hz

3.3 NOMINAL FREQUENCY GENERATION OF TUNING SET CTS-5

Tuning Set CTS-5 contains a microprocessor which generates the nominal frequency (f) according to the following equation.

c: "cent" - presetting (+-99.5)
n: number of tone (a=0, bb=1, ... g#=11)
k: standard pitch presetting (380.0 ... 470.0 Hz)
o: octave (1=A2/110Hz, 2=A1/220Hz, ... 6=a4/3520Hz)

$$f = \frac{k}{4} * 2^{o + \frac{n}{12} + \frac{c}{1200}}$$

3.4 PRE- SETTING OF CENT IN HISTORICAL TEMPERAMENTS

The following tables are permanently stored in the Tuning Set CTS-5

Number 00 Equal Temperament (normal adjustment)
Number 01 Kirnberger-III
Number 02 Werckmeister-III
Number 03 Meantone
Number 04 Neidhard (1724)
Number 05 Neidhard (1729)
Number 06 Valotti
Number 07 Silbermann
Number 08 Silbermann (P.Vier)
Number 09 Bruder (P.Vier)
Number 10 Bach (Barnes)
Number 11 Bach (Kellner)
Number 12 Rameau
Number 13 Lambert(1774)
Number 14 Young (1800)
Number 15 Schlick(H.Vogel)
Number 16 Pythagorean

	a	bb	b	c	c#	d	d#	e	f	f#	g	g#
01	0	+6.5	-1.5	+10.5	+0.5	+3.5	+4.5	-3.5	+8.5	+0.5	+7.0	+2.5
02	0	+7.5	+4.0	+12.0	+2.0	+4.0	+6.0	+2.0	+9.5	0	+8.0	+4.0
03	0	+17.5	-7.0	+10.5	-13.5	+2.5	+20.5	-3.5	+13.5	-10.0	+7.0	-17.0
04	0	+4.0	+2.0	+6.0	+2.0	+2.0	+4.0	0	+4.0	+2.0	+2.0	+2.0
05	0	+6.0	+2.0	+6.0	+2.0	+2.0	+4.0	0	+6.0	+2.0	+4.0	+2.0
06	0	+6.0	-4.0	+6.0	0	+2.0	+4.0	-2.0	+8.0	-2.0	+4.0	+2.0
07	0	+10.0	-4.0	+6.0	-8.0	+2.0	+12.0	-2.0	+8.0	-6.0	+4.0	-9.5
08	0	+6.0	-4.0	+6.0	-4.0	+2.0	0	-2.0	+8.0	-6.0	+4.0	-2.0
09	0	+1.0	-5.0	+3.0	-2.0	+5.0	0	-6.0	+2.0	-3.5	+4.5	-1.0
10	0	+6.0	0	+6.0	0	+2.0	+4.0	-2.0	+8.0	-2.0	+4.0	+2.0
11	0	+4.0	-1.0	+8.0	-1.5	+2.5	+2.5	-2.5	+6.0	-3.5	+5.5	+0.5
12	0	+8.0	-8.0	+11.5	-4.0	+4.0	0	-4.0	+15.5	-6.0	+8.0	-2.0
13	0	+3.5	-3.0	+4.0	-2.0	+1.5	+2.0	-1.5	+6.0	-4.0	+3.0	-0.5
14	0	+2.0	-4.0	+6.0	-4.0	+2.0	0	-2.0	+4.0	-6.0	+4.0	-2.0
15	0	+9.0	-5.5	+8.0	-6.5	+2.5	+2.5	-3.0	+11.0	-8.0	+5.5	-4.5
16	0	-10.0	+4.0	-6.0	+8.0	-2.0	-12.0	+2.0	-8.0	+6.0	-4.0	+9.5

3.4.1 THE CENT-RELATION FUNCTION

All temperament tables in the CTS-5 (including the self stored one) are calculated so that the cent deviation of the tone "a" is zero. We may say that "a" is the "cent relation tone". Sometimes other cent relation tones will be required. If you use a cent relation tone other than "a" on the CTS-5, every cent deviation value in the current temperament table will be increased or decreased by the same value, so that the cent relation tone will have the cent deviation value zero.

Example:

The current temperament is "Kirnberger III", the selected cent relation tone is "a" (i.e. cent relation function is not active):

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

By using cent relation tone = "c" all cent values will be lowered by 10.5 cent.

a	bb	b	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

The description of how to select the cent relation tone is in chapter 3.4.3.

3.4.2 THE TRANSPOSER

With the transposer you may transpose the selected temperament into any key. For example, if you need to transpose from key "a" to key "c", all cent deviation values of the temperament table have to be rotated three semi-tones to the right.

Example: transposition "a" to "c" (cent relation tone = "a"),

temperament "Kirnberger III"

Cent deviation table of "Kirnberger III"

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

first, the table will be rotated by 3 semi-tone steps to the right

a	bb	b	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

The cent relation function then sets the cent relation tone (in this example tone "a") to 0, lowering every cent value by 0.5 cent.

a	bb	b	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

The instruction of how to use the transposer is found in chapter 3.4.3.

3.4.3 THE AJUSTMENT OF CENT RELATION FUNCTION AND TRANSPOSER

Use mode 4 "TEMP. HIST" for this. First select a temperament. The display will be similar to the following:

```
WERCKMEISTER-III
 >4<   NUMBER  02
```

Now press keys "S" and "E" briefly and simultaneously:

```
CENT REF.:   A
>4<
```

Select the cent relation tone with the keys "<" or ">" . Then press key "E":

```
 TRANSP. A --> A
>4<
```

Select the transposition tone with the keys "<" or ">" . Then press key "E":

```
>4< TEMP. HIST->
```

Select mode 1 with the keys "<" or ">":

blinking: KIRNBERGER III
CENT REF D
TRANSP A --> C

```
>1< TUNING    ->
```

After pressing key "E" you can start tuning.

3.6 CENT SETTINGS FOR PIANO TUNING

Striking a string on a piano produces a tone consisting of several harmonics 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 frequencies 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 in theory.

This is known as the "In harmonicity" of a piano string. It is caused by the stiffness of the string and can be different from instrument to instrument. This inharmonicity explains why, on a piano, the bass has to be tuned lower than the theoretical frequency and the descant higher. The five different stretchings of the octaves have been developed through extensive tests with various upright and grand pianos. The diagrams of these stretchings may be found on the last page.

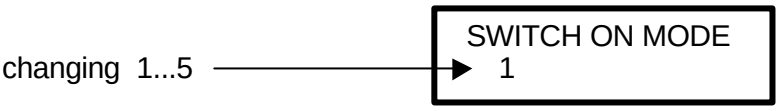
In the lowest octave (A 2 to G#) the Tuning Set responds to the fourth harmonic, and in the octave (A 1 to g#) to the second harmonic. This is the reason for the two discontinuities in the graphs.

3.7 SPECIAL ADJUSTMENTS

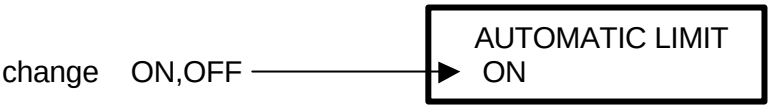
In the same way that a language can be selected, it is possible to change some other attributes of the set, so that you can optimize the CTS-5 for your application. The adjustments will be permanently stored, even if the device is switched off. Operate as follows:

1. Switch off the device.

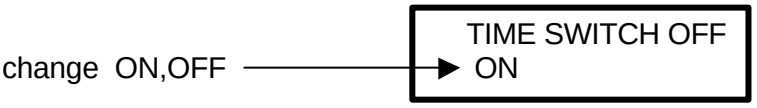
2. Hold key "A" pressed, while switching on the device, and keep it pressed until the following display appears:



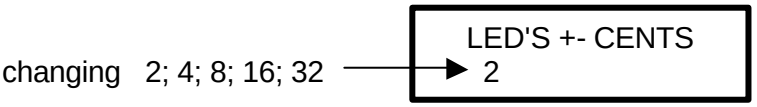
You can now select the mode number which is to appear when the device is switched on. If you need for example mode 2 "PITCH", press key "E" when the number "2" is displayed. Then the device will change automatically to the next function:



Here you can switch off the mechanism which limits the automatic tone-switching function to two semi-tone steps. We would advise you, only to switch this off, when musical intruments with a dominating fundamental tone are to be tuned (for example recorders). To switch the limit off, press key "E" at the moment when "OFF" is displayed. To switch it on press key "E" at the moment when "ON" is displayed. Then the device will change automatically to the next function:



On: If you don't use the set for twenty minutes, it will automatically turn off. Off: No timer switch will be active. Next display:



Here you can adjust the precision of the good\bad indicator LED's. For example if you want a precision of ñ8 cent, you press key "E" at the moment when "8" is displayed.

Now that all adjustments are made, so the Tuning Set switches to the normal user mode.

TECHNICAL DATA TUNING SET CTS-5, CTS-5-P, CTS-5-PE

Tuning Range: 8 octaves

Fundamental tone to g#-5 (110 to 6644.9 Hz)
2nd harmonic -1 to G# (55 to 103.8 Hz)
4th harmonic -2 to G#-1 (27.5 to 51.9 Hz)

Tuning Deviaton Display: 1. electronic strobo display for fine tuning; 2. Good/bad indicator ñ2; ñ4; ñ8; ñ16; ñ32 cent (adjustible). 3. Digital +/- 99.5 cent on LC-Display.

Accuracy: Absolute and relative 1/4 cent (1/400 semi-tone)

Operating Remperature Range: 0 to 40 øC (32 to 105 øF)

Temperaments: equal temperament, Kirnberger-III, Werckmeister-III, meantone, Neidhard (1724), Neidhard (1729), Valotti, Silbermann, Silbermann (nach P.Vier), Bruder (nach P. Vier), Bach(Barnes), Bach (Kellner), Rameau, Lambert (1774), Young (1800), Schlick(H.Vogel), pythagoraen. Additional CTS-5-P: 12 memory temperaments. Additional CTS-5-PE: 20 memory temperaments in replacable memory module

Stretchings (piano tuning functions): 5 built-in stretchings. Additional CTS-5-P: 3 memory stretchings. Additional CTS-5-PE: 12 additional memory stretchings in replacable memory module

Pitch a': Adjustable between 380 Hz and 470 Hz in steps of 0.1 Hertz. Automatic tracing function for Standard Pitch.

LC - Text Display: Adjustable to English, German or French output.

Microphone: built-in condenser microphone and socket for external microphone or pickup (200...600 Ohm).

Purely Tuned Intervals (only CTS-5-P and CTS-5-PE): Second 8:9, 4:9, 2:9, 1:9; third 4:5, 2:5, 1:5, 1:10; fifth 2:3, 1:3, 1:6, 1:12; seventh 4:7, 2:7, 1:7, 1:14; octave 1:2, 1:4, 1:8, 1:16.

Audible tone: available in all tuning programs.

Power Supply (CTS-5): mains adaptor or batteries (4 * Mignon 1.5 Volt)

Power Supply (CTS-5-P and CTS-5-PE): 4 x 1.2 V / 0.5 Ah rechargable NiCad batteries (Mignon), time for charging 14 h with net adaptor using the built-in socket. Operation time with one charge is about 6 h. The device may be used during the charging procedure.

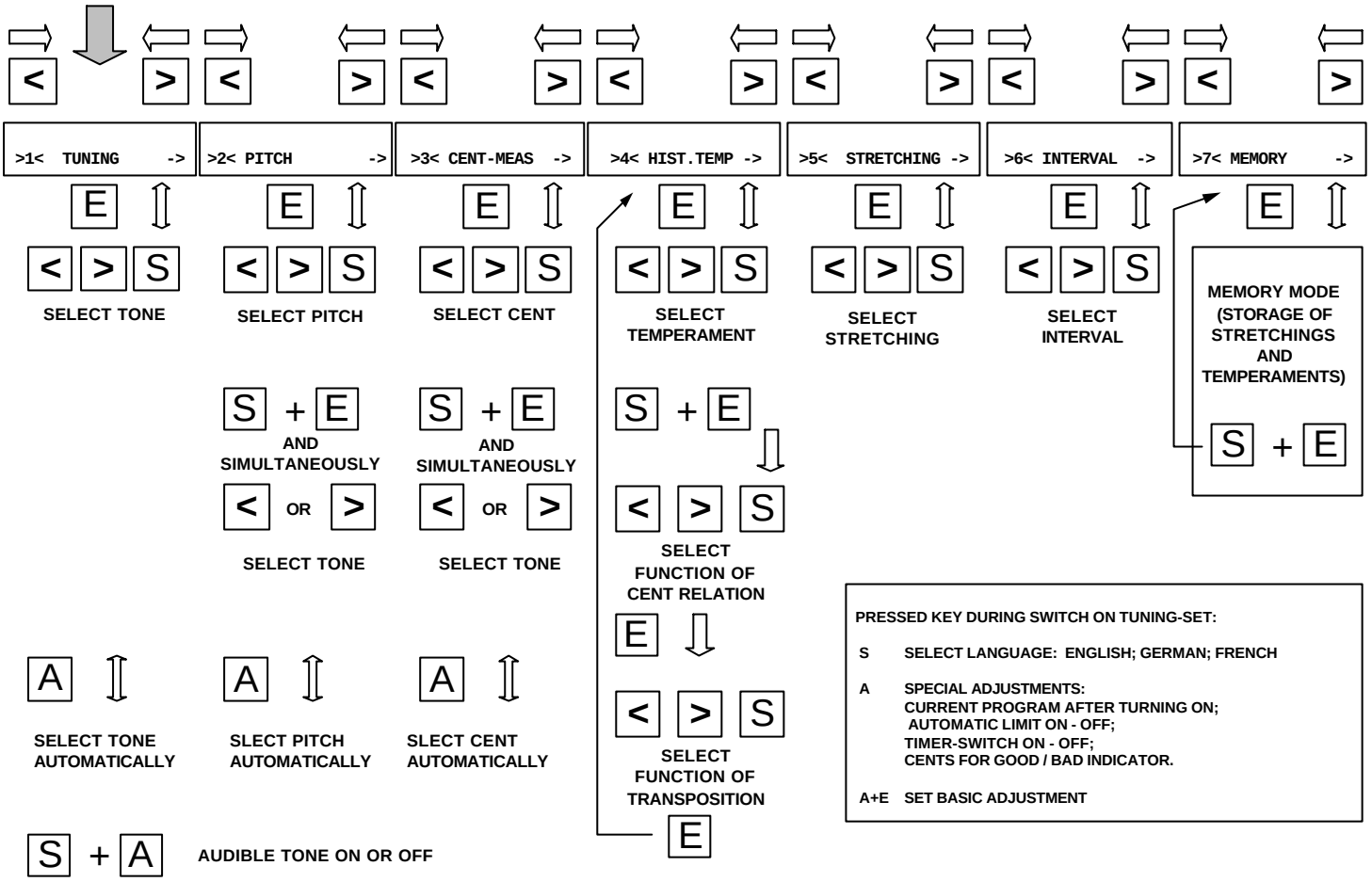
Data of the net adaptor: 8 Volt regulated, min 200 mA; coaxial-plug 5*2mm, positive outside.

Filter Circuit: Band pass filter suppression 64 dB per octave

Special Features of CTS-5-PE: Connector for remote control; connector for output of reference frequency; RS-232 V24 interface for transfer of stretchings and temperaments to a personal computer (see description of CTS-5-PE interface).

Dimensions and Weights: 180 x 100 x 45 mm / ca. 400 g

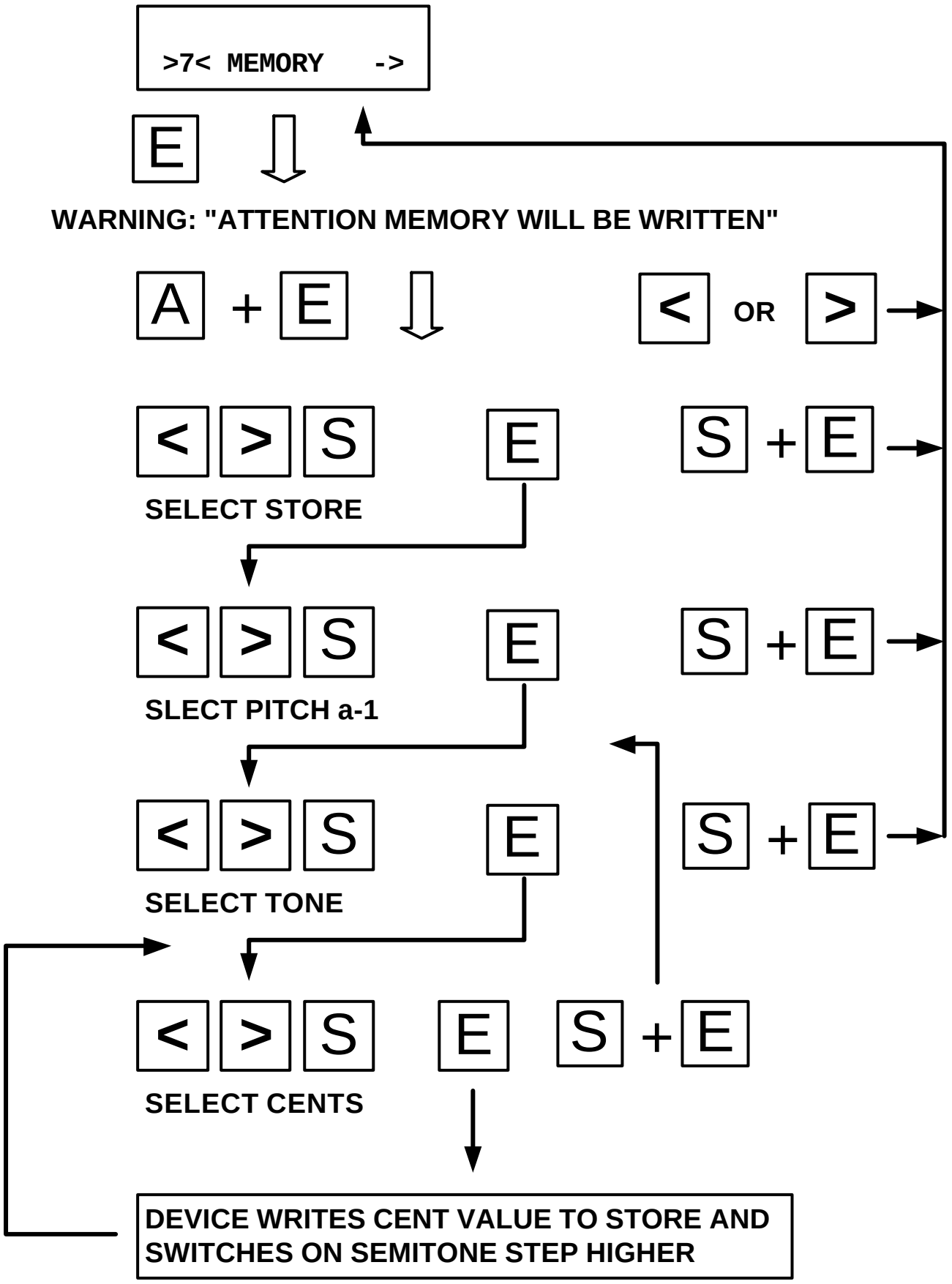
Diagram for modes of operation CTS-5, CTS-5-P and CTS-5-PE



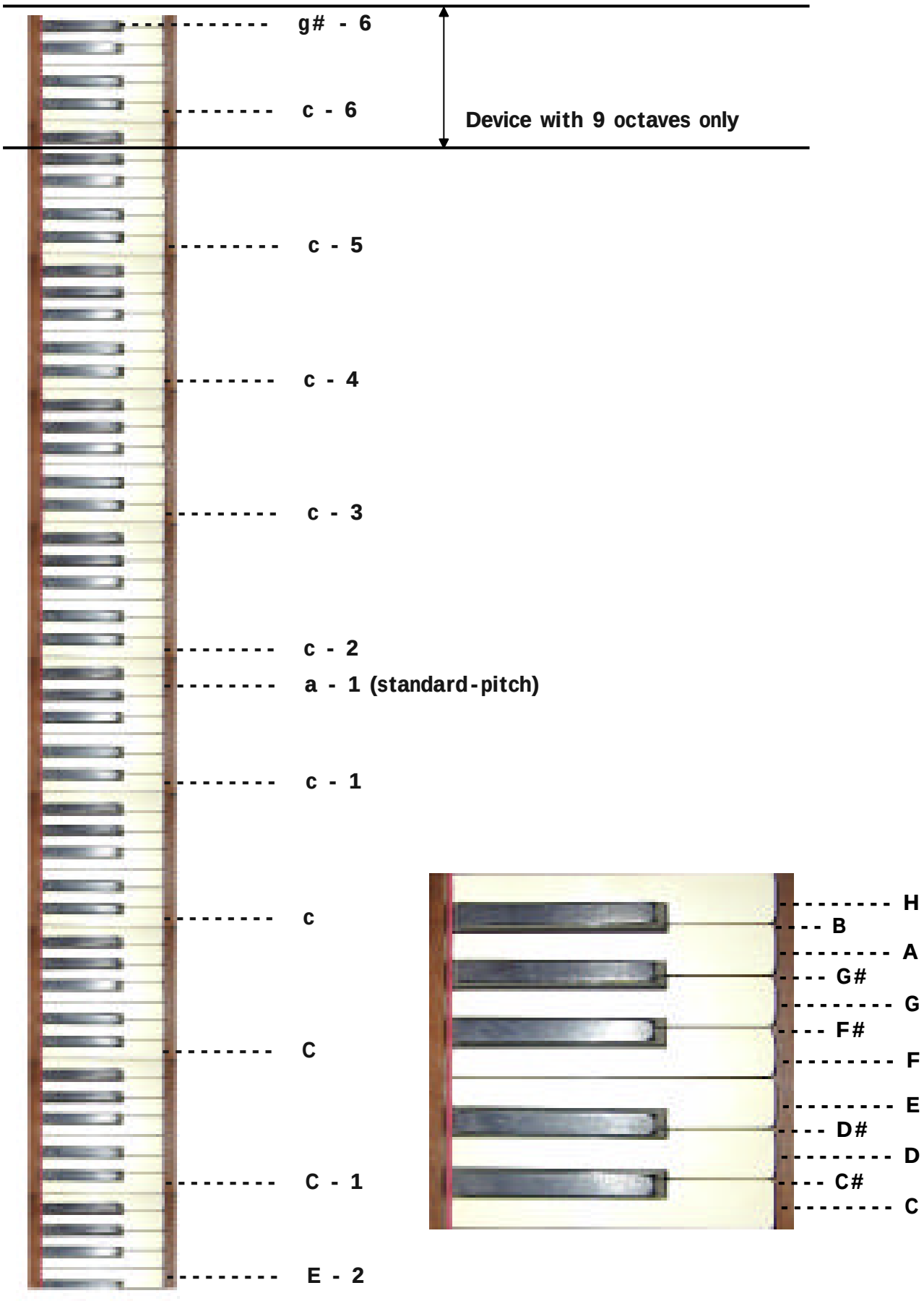
PRESSED KEY DURING SWITCH ON TUNING-SET:

S	SELECT LANGUAGE: ENGLISH; GERMAN; FRENCH
A	SPECIAL ADJUSTMENTS: CURRENT PROGRAM AFTER TURNING ON; AUTOMATIC LIMIT ON - OFF; TIMER-SWITCH ON - OFF; CENTS FOR GOOD / BAD INDICATOR.
A+E	SET BASIC ADJUSTMENT

Diagram for memory-mode (CTS-5-P and CTS-5-PE only)

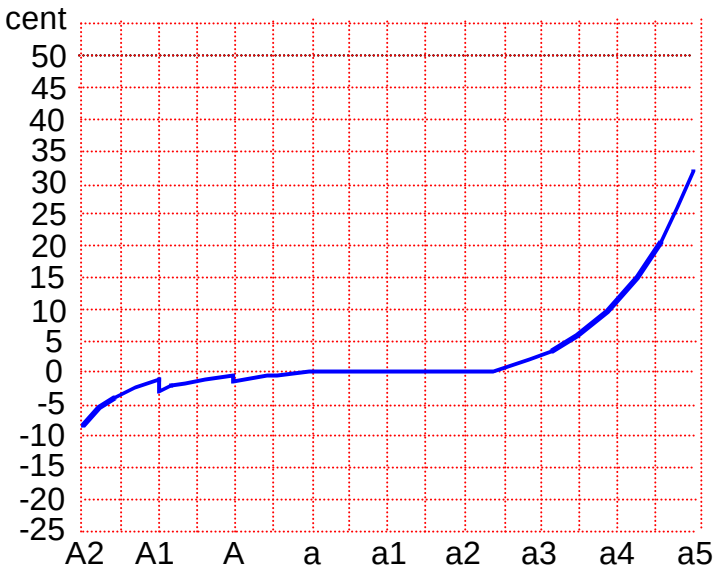


The notes represented on the LC-Display

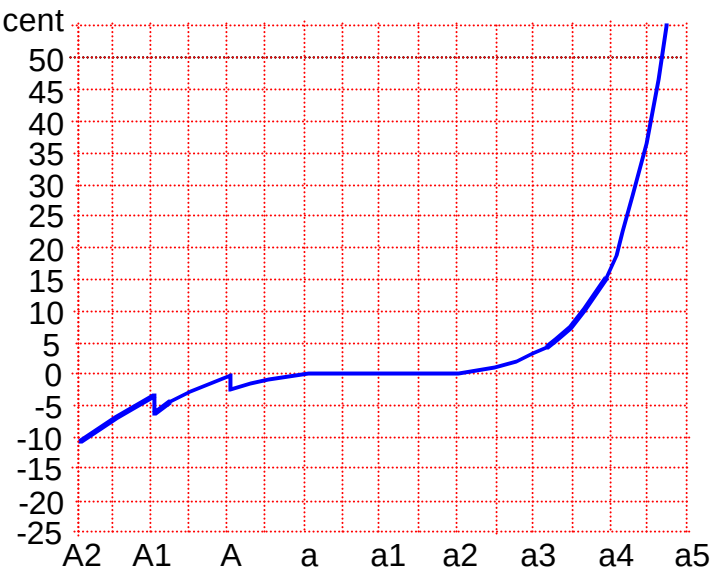


Diagrams of stretchings which are stored firmly in the CTS-5

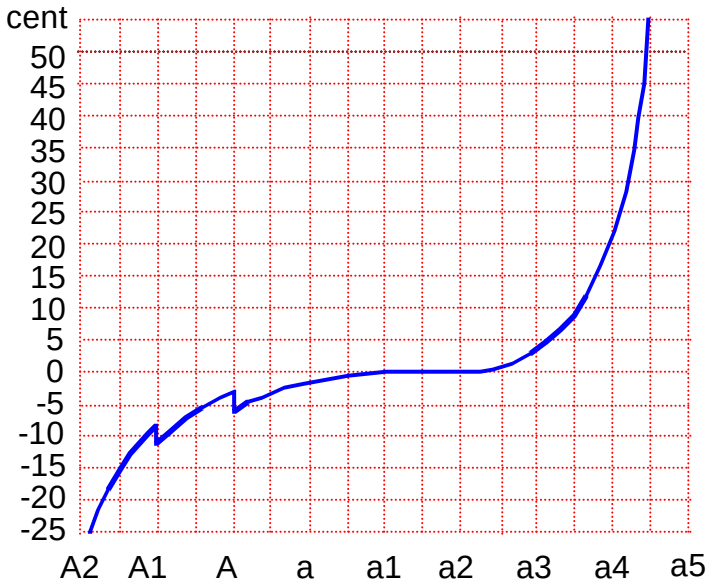
1.



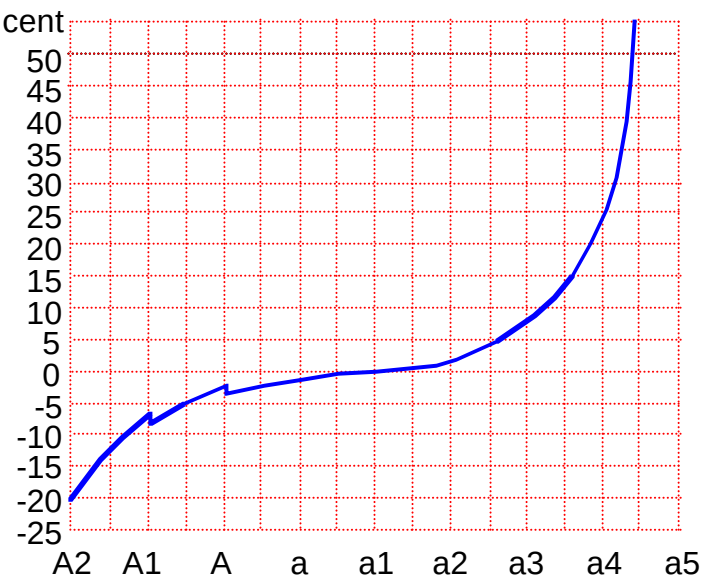
2.



3.



4.



5.