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Revisionsnummer 3 (25.Feb. 2006)
Identitätsnummer 1 (2.Jan. 2006)

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II. About this manual



This manual introduces you to the application of the Articulograph AG500 as well as the accompanying controlling program. As a user, you should read all chapters before the first use of the device as a matter of principle.



This manual is to be considered as a part of the Articulograph AG500 and must be at the user's disposal during the product's entire lifespan. The manual must be passed on to every subsequent owner or user of the Articulograph AG500. It must be ensured that, where necessary, every received addendum is included in the instructions.

III. Extent of delivery

1. 3-dimensional Articulograph AG500 with 12 channels - series-no nn-nn-nn

- 1 AG500 Carrier DGH for the AG500 with components inside
- 1 AG500 EMA_Cube with holder
- One computer "IDAnn" IP: 192.168.1.1nn" to control the transmitter and receiver electronic
- 2 * Media converter with cable
- AG500_Power-Supply series-no nn-nn
- AG500_Transmitter DTC6 series-no: nn-nn
- AG500_Receiver PSR12 series-no:nn-nn
- AG500_Sybox - series-no nn-nn
- Sybox cable
- Led-test adapter
- Power supply 5 V
- AG500 EMA_Cube series-no: nn-nn
- Calibration Unit AG500 Circal series-no: nn-nn
- 3 calibration magazines
- 1 Circal cable
- AG500 Carrier DGH for the AG500 series-no: nn-nn-nn
- Tray fixed to the carrier to hold the Receiver PSR12
- 12 sensors HS220-L165-S or HQ220-L165-S
- package of fuses
- Grounding cable with clip
- Torx wrench,
- Socket wrench
- set of hexagon keys

IV. Technical specifications of the Articulograph AG500

A. Powersupply PSM12V

230 V ~ 50 - 60 Hz 0,4 A

B. EMA Cube

$1,3 \times 10^{-6} - 16,7 \times 10^{-6}$ T

$7,5 \times 10^3 - 13,5 \times 10^3$ Hz

C. Receiver PSR12

12 V --- 3,5 A

D. Transmitter DTC6

12 V --- 3,5 A

V. Demands to the safety of the Articulograph AG500

A. Definitely to be considered !



The Articulograph AG500 is NOT a medical device in the sense of the medical device law. Therefore, it may solely be used for research, and not be utilized for diagnostic or therapeutic purposes. For instance, it is not adequate to assess exact measurements of the oral cavity for tooth reconstructions.



This manual is limited to technical descriptions. Furthermore, please consider all regulations and indications for the application of technical devices on the human.



Should the Articulograph AG500 be utilized for purposes other than those defined in -



Purpose of the Articulograph AG500 - chapter VII

the manufacturer does not assume any responsibility, and is not liable for respective consequential damage. The manufacturer does not assume any responsibility for the interpretation of the delivered data, and its application. There is no liability for potential consequential damage.



Definitely consider the contraindications mentioned below. Each of them has to be excluded !



Test persons with medical appliances (e.g. pace makers) - chapter VIII.A

Electromagnetic hypersensitivity - chapter VIII.B

Caustrophobia - chapter VIII.C

Immunocompromised and/or infectious test persons - chapter VIII.D



To be considered in case of use of accessories others than those supplied by Carstens Medizinelektronik GmbH:



Employment of accessories - chapter V.E

Use of accessories - chapter V.F



Before starting up the Articulograph AG500 you have to carefully read the instructions mentioned here:



- Test persons with medical appliances (e.g. pace makers) - chapter IX.A
- Prerequisites for starting up the Articulograph AG500 - chapter IX.B
- Important criteria for choosing the Articulograph AG500's location - chapter IX.C
- Transport of the Articulograph AG500 - chapter IX.D



This manual introduces you to the application of the Articulograph AG500 as well as the accompanying controlling program. As a user, you should read all chapters before the first use of the device as a matter of principle.



This manual is to be considered as a part of the Articulograph AG500 and must be at the user's disposal during the product's entire lifespan. The manual must be passed on to every subsequent owner or user of the Articulograph AG500. It must be ensured that, where necessary, every received addendum is included in the instructions.



Please verify whether additional national requirements of your own country should be considered before utilizing the Articulograph AG500, and whether the AG500 also complies with these requirements.



Please note restrictions of disturbance liability of the AG500 such as:



- Electromagnetic disturbances. - chapter V.G.1
- Overvoltage protection - chapter V.G.2



Sources of danger:



- The transmitter coils generate high voltage! – chapter VI.A
- The cases may not be opened – chapter VI.B
- Electromagnetic field – chapter VI.C
- Electromagnetic radiation – chapter VI.D
- Structural safety – chapter VI.E



The Articulograph AG500 has to be disposed as „Elektronikschrott“.

B. Classification of the Articulograph AG500



The AG500 fulfills the requirements of the latest legislation concerning safety of work equipment and consumer products (GPSG) and the 73/23/EEG guideline (low voltage guidelines) as well as the law concerning the electromagnetic compatibility of equipment (EMVG) and the 89/336/EEG guideline (EMV guideline).

It has been tested in accordance to DIN EN 61010 1 (safety regulations for electronic measurement, control, regulation and laboratory units, general requirements) and DIN EN 61326 (electrical equipment for control technology and “laboratory use” –requirements on electromagnetic compatibility). The respective mark of conformity is located on the back of the device.

The AG500 is a device of the protection class I according to DIN EN 60335 1 (safety of electronic devices for domestic use and similar purposes Part 1: general requirements). The sensors HS220 L 165 S and HQ220-L165-S production run fulfill the requirements of the law concerning the reorganization of safety regarding work equipment and “Verbraucherprodukte” (GPSG) and the 73/23/EEG guideline (low voltage guidelines) and have been tested according to DIN EN 61010 1 (safety regulations for electronic measurement, control, regulation, and laboratory units, general requirements).



Please verify whether additional national requirements of your own country should be considered before utilizing the Articulograph AG500, and whether the AG500 also complies with these requirements.

C. Performance data



Herewith the manufacturer affirms that the Articulograph AG500 has been designed, manufactured and packaged in such a manner, that its purpose can be fulfilled under normal application conditions.

The Articulograph AG500 does not deliver an unequivocal result for all possible sensor positions and orientations. There are combinations of X,Y, Z, Phi and Theta for which a sensor does not offer utilizable results.

For this reason, a threshold value for the functional efficiency of the device cannot be determined. The quality of the measured amplitudes determines the extent of the regions that do not provide unequivocal results.

Disturbances of 120 digit in one sample (5ms) or disturbances of 10 digit for 1 second do not represent a noticeable detriment in position calculations.



magnetic field measurements on the Articulograph AG500 - [MagFldStrength2.pdf](#)

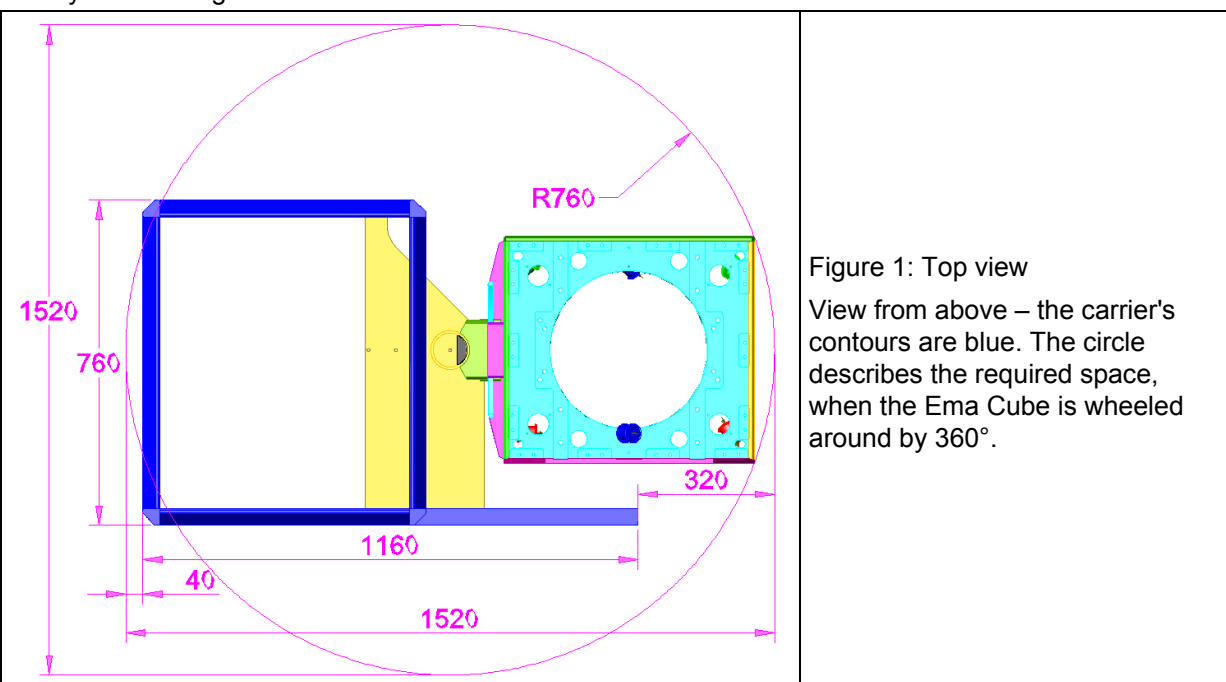
The generated magnetic field has $1.25\mu\text{T}$ in the measurement range's center and a maximum of $16.66\mu\text{T}$ near the red No_6 coil.

D. Extensions and weight of the Articulograph AG500


The carrier is 1160mm long and 760mm wide. The wheels can protude by 30mm, depending on their orientation. The Ema Cube can be shifted to a height of 2030mm. Once the circal has been mounted, the result is a height of 2390mm.


before mounting the circal, the Ema Cube's height must be diminished by 165mm in order to amount to the permitted height of 2225mm.


The Ema Cube can be rotated, so that the required space exceeds the carrier's measures. Weight of the system 130 kg



E. Employment of accessories


 All additional equipment that is connected to the interfaces of the device must be proven compliant to the demands of the standards DIN EN 61010 1 and DIN EN 61326.

 A substitution of components or an extension with additional devices is not intended by the manufacturer. Whoever wishes to do this nevertheless, does this on his or her own responsibility, and is furthermore responsible to remain compliant to these standards with the accordant configuration.

 It must be emphasized in this place, that the Articulograph AG500's compatibility with other devices cannot be guaranteed in general, and must be checked in the individual case by the user. For further information please contact the Carstens Medizinelektronik GmbH's technical service.


F. Use of accessories

 **All accessories used in connection with the AG500 must provably posses a CE-hallmark.**

 It must be emphasized in this place that compatibility cannot be guaranteed in reference to the use of accessories in connection with the Articulograph AG500, and must be tested and checked by the user. The manufacturer does not assume any responsibility for this and is not liable for consequential damage. The manufacture guarantees a complete compatibility of the AG500 with the sensors HS220-L165-S and HQ220-L165-S.



Carstens Medizinelektronik GmbH - <http://www.articulograph.de>

 **to select the physiological glue for attaching the sensors, you can find non-binding suggestions of experienced Articulograph users on the Carstens Medizinelektronik GmbH website.**


For further information please contact the Carstens Medizinelektronik technical service.

G. Disturbance liability of the AG5001.

1. Electromagnetic disturbances.


Whenever other electronic devices are operating in immediate proximity during the use of the Articulograph AG500, a trouble-free course of the articulographic examination cannot be guaranteed.

The AG500's disturbance liability was tested by subjecting it to high-frequency radiation of 1 V/m. Therefore, a disturbance liability according to DIN EN 61326 cannot be guaranteed at higher intensities of extraneous radiation.

 **It remains in the user's responsibility to provide for controlled electromagnetic surroundings.**

2. Overvoltage protection

The socket panel, which provides all functional units of the Articulograph AG500 with voltage, contains an overvoltage protection filter.

 When the green control lamp ceases to shine on the over voltage protection module's cover, the over voltage protection module must be exchanged. Please turn to the Carstens Medizinelektronik GmbH technical service in this case. Do not remove the socket panel from the carrier, in any case, and do not manipulate the over voltage protection module, or exchange it yourself!

3. Demands on the Environment of the AG500

Avoid strong variations in temperature, for these would cause inaccuracies. There should be no electrically conductive material close to the EMA Cube. Small parts have little or no influence. However, an aluminium coated insulation material inside the wall has a great influence because of its large surface .

Electromagnetic disturbance emission may have an influence to measuring results. There should be no fluorescent lamps burning close to the EMA Cube.

Do not expose the EMA Cube to heat or direct sunlight. That could lead to deformations, which would make an exchange of the EMA Cube necessary.

For all other aspects, normal laboratory environment is required.

4. Stability of the software

Some of the AG500 programs establish a network connection to the Articulograph AG500 . These programs are: ageSysUpdate, mc5cal, mc5recorder, mcDiag and ageSysControl.

You must not run more than one of these programs at a time!

H. The Articulograph AG500's application on human subjects

The treatment and application of the sensors are described in chapter XV.A.3 . The Articulograph AG500's development is based on the University Göttingen department of neurophysiology research findings.

VI. Sources of danger

A. The transmitter coils generate high voltage!

Check the condition of the transmitter coils before switching on. Do not switch on the device if any of the transmitter coils are damaged. The high-voltage lead-wires are well-isolated, and, therefore, safe, as long as the transmitter is not damaged.

B. The cases may not be opened

The cases contained in the Articulograph AG500 may only be opened by trained, qualified personnel. Before opening the power-supply, it is imperative to unplug the mains plug because otherwise perilous over-voltage persists in the device.

C. Electromagnetic field

The magnetic field, which is generated by the transmitter coils, is a low-frequency field (7.5 to 13.75 kHz) with wave lengths of about 30km. An absorption of energy from the human body only takes place in the high-frequency range. Long-term effects do not need to be considered because of the relatively short exposition- time of the test person in the magnetic field.



Measurement of magnetic fields on the Articulograph AG500 - [MagFldStrength2.pdf](#)

The measurement resulted in the following data:

position	frequency [Hz]	amplitude [digits]	field strength [μ T]	percentage of threshold value [%]
center	---	---	1,25	5
KU_S1	12500	24139	11,1	36
KO_S4	11250	23022	13,1	45
SR_S5	8750	23966	11,66	30
SL_S3	13750	24370	8,85	36
NR_S6	10000	23029	16,66	60
NL_S2	7500	23236	13,3	36

The table describes the center of the measurement range and a measuring point close to each transmitter. Furthermore, the preset transmission frequencies and the amplitude have been listed. The column to the left shows the result in proportion to the permitted value for 8 hours.

For more information on the biological tolerance of electromagnetic fields, turn to the following body of rules and regulations: DIN VDE 0848-4/A3 (07/95): "Exposition von Menschen in elektromagnetischen Feldern" ("Exposure of humans in electromagnetic fields") accident prevention regulation UVV BGR B1126.

BimSchV: „Verordnung über elektromagnetische Felder“ („Regulations concerning electromagnetic fields“)

Corresponding references to other bodies of rules and regulations are available in Hasegawa-Johnson, M.

Electromagnetic exposure safety of the Carstens Articulograph AG100

J Acoust Soc Am 1998 Oct; 104(4): 2529-32

To reduce potential adverse effects to a minimum, be careful to position the test person's head before measuring as exactly as possible into the center of the magnetic field. During a measurement, the test person's head should not carry out any avoidable, speech-independent movements of the head or changes of posture.

D. Electromagnetic radiation

Because the Articulograph AG500 contains electronic devices (computer, power-supply, transmitter, receiver), it generates electromagnetic radiation. However, the test person is not located in immediate proximity to these live-voltage devices.

The Articulograph AG500 fulfills the mandatory values of the guideline DIN EN 61326. Therefore, adverse effects caused by electromagnetic radiation have been reduced to an acceptable degree.

E. Structural safety

Before the circal can be mounted onto the Ema Cube, the stability has to be improved. For this purpose, the wheels are secured in the northwest direction as in Figure 2. The height of the Ema Cube must be lowered, so that the plastic tube does not begin above the carrier (see Figure 3).

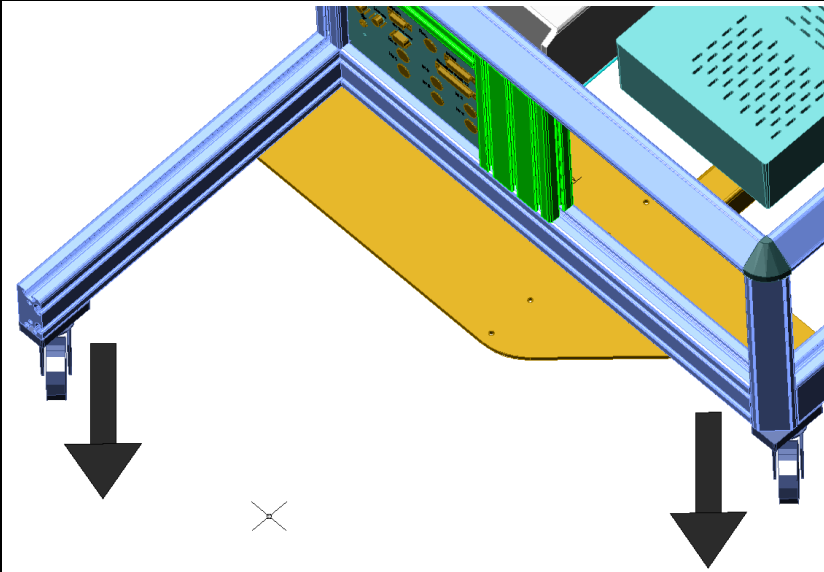


Figure 2:
Before mounting the circal, the wheels must be secured.

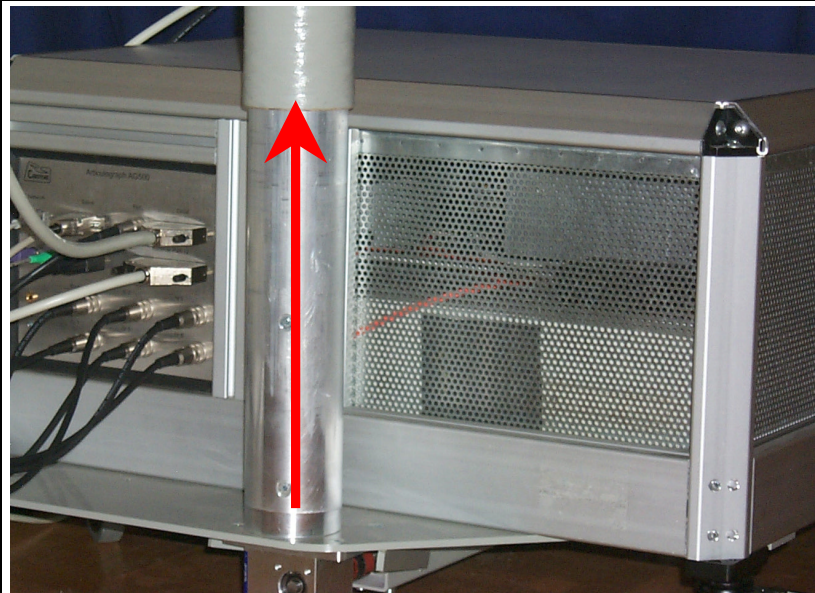


Figure 3:
Before mounting the circal, the height of the Ema Cube must be lowered.

VII. Purpose of the Articulograph AG500

The Articulograph AG500 allows digital recording, presentation and interpretation of the articulator's movements (tip of the tongue, base of the tongue, lips, lower jaw, velum) in the process of speaking. To this end, the device registers the positions of sensors which are attached to the test person's respective articulators with physiological glue before attempting the measurement.

The Articulograph AG500's operating mode is based on the principle of inductive distance measurement. 6 transmitter coils, which are arranged in the EMA Cube in a defined layout, generate an alternating magnetic field with various frequencies. The test person's head with the sensors attached to the articulators is positioned within the spherical measurement range.

Caused by the applied magnetic field, AC voltages are induced in the sensors, that are registered as analog signals. Because the induced voltage depends on the respective sensor's distance to the transmitter coils, the positions of the sensors (and, therefore, the also the positions of the respective articulators) can be determined within the measurement range.

Both the transmitter coil's activation and the processing of the registered signals are computer-controlled with software designed specially for this purpose. The signals become digitized and are evaluated in respect to chronological or geometrical factors together with the synchronously recorded acoustic signal. Speech-independent movements of the head are subtracted from the calculation via marks of reference, so that solely the articulator's movements are recorded. The measuring point are depicted in 3 coordinates (x;y;z) and 2 angles of direction (φ ; ϑ). Please take concrete applications from our catalogue.

VIII. Contraindications

A. Test persons with medical appliances (e.g. pace makers)

If electromagnetic fields cause signals to be induced into an implanted electronic pace maker, this may have an impact on the pace maker's functional capability. The particular types of pace makers differ very much in their sensitivities regarding the threshold for disturbances and their frequencies. The variety of possible influences stretch from a rather unimportant, once-only extension of an interval to worrisome "stumbling rhythms", when the pace maker's rhythm is added to the heart's own rhythm. However, perilous influences are extremely rare.

Little is known about the interference of other active or passive medical appliances under the influence of electromagnetic fields.



carriers of a pace maker or other medical appliances (e. g. "Insulin pump" or hearing aid) should therefore be absolutely sure to obtain information from the respective manufacturer as to what strength and frequency of magnetic field is safe for them. If they should undergo an examination with the AG500 despite the warning sign on the EMA Cube, this happens at their own risk. Carstens Medizinelektronik does not assume responsibility in this case, and is not liable for potential consequential damage.

B. Electromagnetic hypersensitivity

The AG500 should not be used on test persons with electromagnetic hypersensitivity, who are affected by being exposed to faint electric or magnetic fields in their well-being and health, even though no permanent damage in his health are to be expected.

C. Claustrophobia

Because the EMA Cube consists of transparent makrolon plates, as a rule, even with test persons disposed to claustrophobia there should be no contraindications to the use of the AG500. In especially serious cases, however, it should be renounced for safety's sake.

D. Immunocompromised and/or infectious test persons

The sensors touch the surface of the respective test person's articulators during an articulographic measurement. They are re-used afterwards for measurements on other test persons, i.e. they touch the surface of other test persons' articulators.



To keep the risk of a cross-contamination among the different test persons at a minimum, adequate resorts should be taken to keep the source contamination at a minimum.





The measures of disinfection for normal cases may not be sufficient with infectious test persons to stop a cross-contamination and thus the transfer of the respective illness on other test persons. The AG500's use with these test persons should therefore be thoroughly considered, and, if need be, refrained from.

The usually applied measures of disinfection bear a higher risk of infection via other test persons for immunocompromised test persons. Germ counts that are innocuous for healthy test persons may already lead to an infection for these test persons. In addition, even an infection with faintly pathogenic agents can cause a serious and, under certain circumstances, even perilous illness.

If the AG500 is to be applied on immunocompromised and infectious test persons nevertheless, adequate measures of sterilisation have to be applied. If need be, it should be taken into consideration, whether the respective sensors should only be re-used with the same (infectious) test person, or if still unused sensors should be used (on immunocompromised test persons).

IX. What should be considered before starting up the Articulograph AG500

A. Before unpackaging and installing the Articulograph AG500

-  Be sure not to roll the carrier DHG over uneven surfaces; if this is unavoidable, please do so only with extreme caution (so the electronic devices on the inside of the carrier are not damaged)
-  Be attentive not to subject the EMA Cube to direct solar radiation (otherwise, the macrolon cuboid would deform itself, and the transmitter coils would no longer be located in the defined layout)
-  No external devices may be connected to the non-stationary multi-outlet power strip on the carrier's exterior wall
-  Please read the manual carefully, under all circumstances

B. Prerequisites for starting up the Articulograph AG500







To start operations, a control-PC equipped with software must be connected with the Articulograph AG500 with a network cable.




software setup - [lda_update.pdf](#)

The device must be connected to the power supply 230V/50Hz and switched on. All further controlling functions take place from the control-PC.

C. Important criteria for choosing the Articulograph AG500's location

-  Please ensure that the necessary space for putting the Articulograph AG500 in use is available. The Articulograph should be assembled somewhere where an unoccupied space of not less than 1.6 x 1.6 m is available.
-  The EMA Cube can be shifted to a height of 2030mm. Once the circular has been mounted, the EMA Cube's height must be lessened by 165mm, to achieve a permitted height of 2225mm.
-  Choose a space where the device is unlikely to be subjected to strong variations of temperature during the measurements (these would cause inaccuracies in the measurements)
-  Please ensure that no extensive electric conductors are located at a distance of less than 1m from the EMA Cube
-  The EMA Cube must not be exposed to direct solar radiation
-  The AG500 may only be used in closed rooms and not in bathrooms or similarly wet areas.

-  **Pay attention to the weakened stability when the carrier has been mounted (see chapter VI.E)**

D. Transport of the Articulograph AG500

1. Rolling over uneven surfaces

- The Articulograph AG500 may be moved around within a building or over firm, even surfaces with the wheels of the carrier. Please take the following steps to roll the AG500 to its new position: Lower the EMA Cube (see Figure 10)
- Loosen the wheels' locking device
- Secure the Cables – position all cables in such a manner, that no cable is dragged on the floor or hangs out over the carrier.
- roll to the new place
- lock the wheels into position (see Figure 2)

2. Sending as cargo

- For sending, the AG500 has to be disassembled and safely packaged: Lower the EMA Cube (see Figure 10)
- Loosen all cable joints
- Disassemble EMA Cube, receiver PSR and tray, and package separately
- Package small parts like the mouse, key board, sybox and cable
- Raise the GFK tube, take it off and package
- Open the carrier's lid – fill the cavities with nobbfoil
- Close the lid
- Package the carrier
- The assembly at the destination is carried out in reverse order

X. Terms of guarantee

The Carstens Medizinelektronik GmbH warrants, that this device will not possess any material and processing defects for the period of a year.

If deficiencies should turn up in the warranty period, which are based on material or processing defects, the Carstens Medizinelektronik GmbH will substitute the device itself or its defective parts.

This guarantee does not cover any deficiencies that arise if the device is changed or adapted to comply with the effective national or local technical or safety-related regulations in countries for which the product was not originally designed and produced, without a prior written permission from the Carstens Medizinelektronik GmbH.

This guarantee does not apply, if the product's model number or serial number has been changed, deleted, removed or made illegible.

This guarantee does not cover any of the following points:

- Regular maintenance and repairs or substitution of pieces due to normal wear and tear
- Improper use under non-observance of the provided manual, especially use of the device against its purpose, as described in the handbook
- Repairs, which have not been undertaken by the Carstens Medizinelektronik GmbH itself
- Accidents, electric storms, water, fire or other circumstances beyond the control of Carstens Medizinelektronik GmbH

XI. Disposal of the Articulograph AG500

The Articulograph AG500 has to be disposed of as "Elektronikschrott"

XII. Principle function of the Articulograph AG500

The Articulograph AG500 permits digital recording, presentation and evaluation of the movements of the articulators (tip and body of tongue, lips, lower jaw and soft palate) during the production of speech. Its principle function is based on the inductive measurement of distances.

Six transmitter coils are fixed in the EMA Cube, each of them producing an alternating magnetic field at different frequencies. Several sensors, which are built up as small coils, have to be fixed onto the articulators of the subject, using a physiological glue. The head of the subject has to be positioned within the spherical measuring range of the EMA Cube. The alternating magnetic field induces alternating currents in the sensors, much like in a transformer, which can be registered as analogous signals. The strength of the induced current is a function of the distance and the angle of the sensor to the respective transmitter coil. Therefore and because of the different frequencies of the transmitters, it is possible to obtain simultaneously the amplitudes of each sensor from all of the transmitter coils.

The combination of 6 amplitudes (one from each transmitter) allows the evaluation of the position and orientation of each sensor.

The computer inside the carrier contains special software and electronics to control all Articulograph AG500 functions:

1. The transmitter's signal strength and frequencies
2. the analog sensor signals are digitised and evaluated
3. motor control and position measuring for the circular calibration unit
4. synchronously recorded acoustic signal

The signals are digitised and evaluated regarding temporal and geometric parameters, combined with the synchronously recorded acoustic signal. By means of reference sensors, head movements which are independent from speech can be subtracted after recording, so that movements of the articulators appear correct and independent of head movement. After this correction, the measured points correspond to the three coordinate planes of motion (x; y; z) and two angles (φ ; ϑ).

XIII. The parts of the Articulograph AG500

A. Carrier DHG

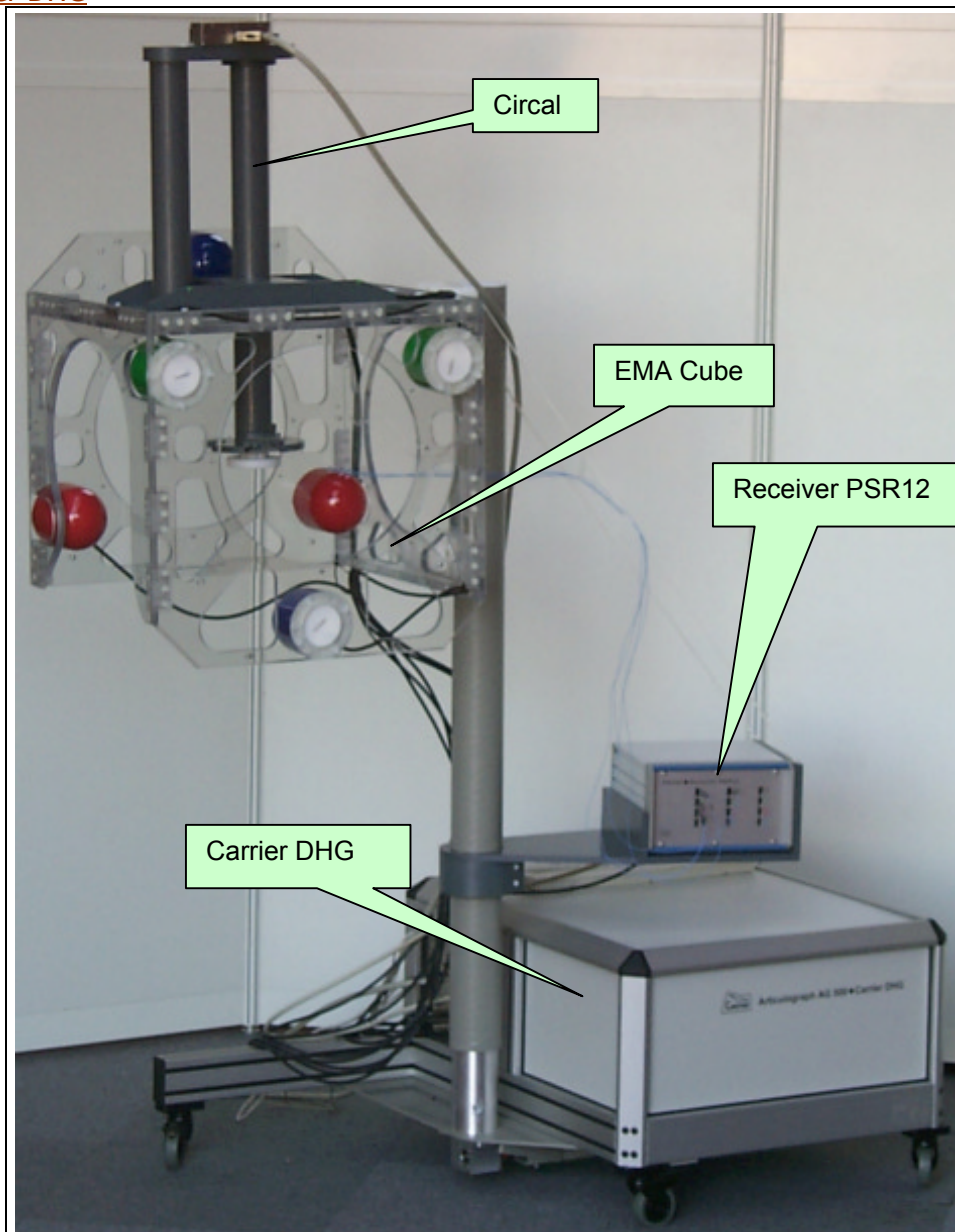


Figure 4: Parts of the Articulograph AG500

The Carrier DHG serves as the holder for the components of the AG500. The Transmitter DTC6, Power supply PSM12V, Ida-Computer as well as the respective cables are stored inside the carrier.

B. EMA Cube

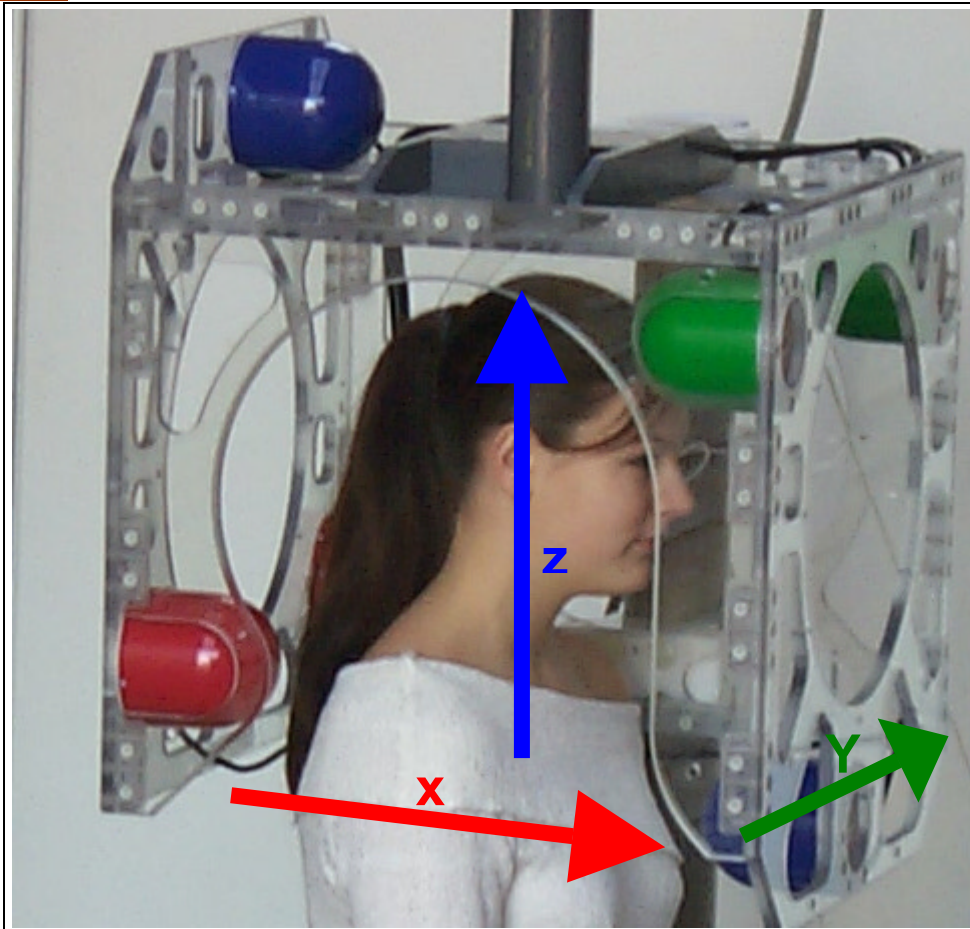


Figure 5: EMA Cube – the subject is looking in x direction

The EMA Cube is attached to the Carrier DHG. It is adjustable in height and can be tilted. It consists of a transparent square of Macrolone, surrounding the measuring range, wherein the head of the subject has to be positioned. The six transmitter coils, generating the alternating magnetic field, are fixed to the EMA Cube in defined orientations.

The origin of the coordinate system is in the centre of the EMA Cube. The arrows in Figure 5 describe the three axes.

The spherical measuring range reaches 150mm around the centre of the EMA Cube.

C. Receiver PSR12



Figure 6: Receiver PSR12

It records the signals of the induced currents. The Articulograph AG500 is designed to receive the signals from up to 12 sensors synchronously, passing them on to the Ida-Computer.

D. Sensors HS220-L165-S and HQ220-L165-S

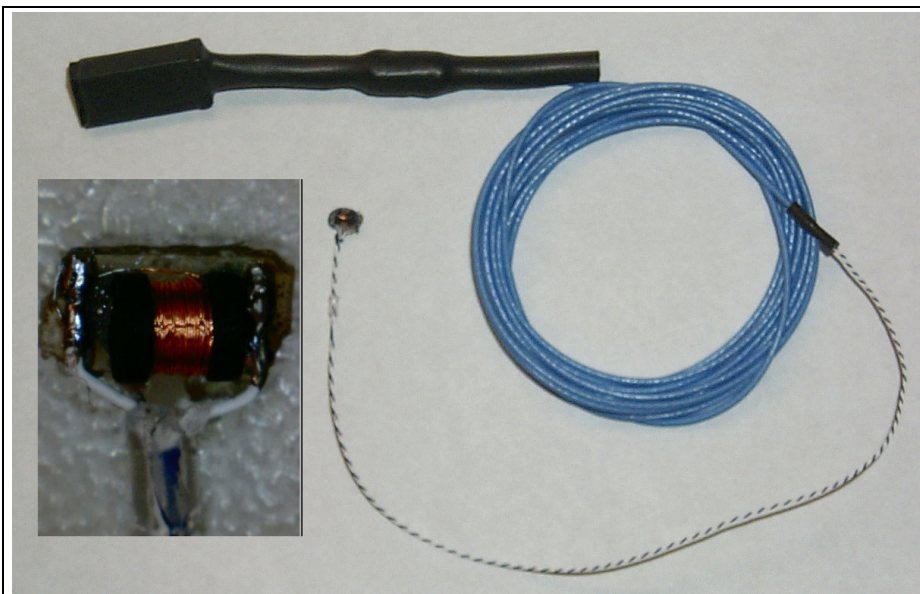


Figure 7: Sensor HS220-L165-S

The sensors HS220-L165-S contain the receiver coils, which are fixed on the articulators of the subject. The sensors HQ220-L165-S are similar but have a different receiver coil.

E. Sybox



Figure 8: Sybox-Opto4 front- and backside view

The Sybox provides synchronisation of AG500 position data with sound data and additional customer specific devices. For special purposes, the Sybox may be adapted. Comprehensive documentation is available.



[Sybox technical documentation -Sybox_man.pdf](#)



[Connecting the Sybox - AG500sound.pdf](#)

F. Circal

The Circal is used for sensor calibration. The lower part (foot) is detachable. The main part regularly stays on top of the EMA Cube. The disc is part of the foot and has 3 gaps. Each gap takes one magazine which in turn can hold 4 Sensors.



[Performing a calibration - mc5cal.pdf](#)

XIV.Commissioning

A. Setting up the AG500

➤ **The following manipulations will cause previous calibrations to be invalid! So please do all the adjustments before calibration.**

1. Adjusting the EMA-Cube

a) Pitch

In order to get the coil 1 (K-U) out of the way, the EMA Cube can be tilted. To do this, loose the two screws of the lower mounting and turn the coil around the upper mounting.

2. Adjusting the tray

Loosen the two 10mm screws and turn the tray in the desired direction. Adjust the height so that the rope is tense and keeps the tray in a horizontal position. Then fix the screws carefully.

B. Preparing a control-computer



[Ida_update.pdf](#)

C. Connecting the audio components



[Connecting the Sybox - AG500sound.pdf](#)

XV. Performing an investigation

A. Preparations

1. Warm-up

In order to reach a stable temperature, the Articulograph AG500 needs to warm up for at least one hour. Set up all cable connections and turn on the main switch. During the warm-up, the Articulograph AG500 has to run already.

Therefore open mcDiag and connect it to the Articulograph AG500. Click on the tab “Amplitudes” and then on the button “start”. Also if you now quit mcDiag, the Articulograph AG500 continues running

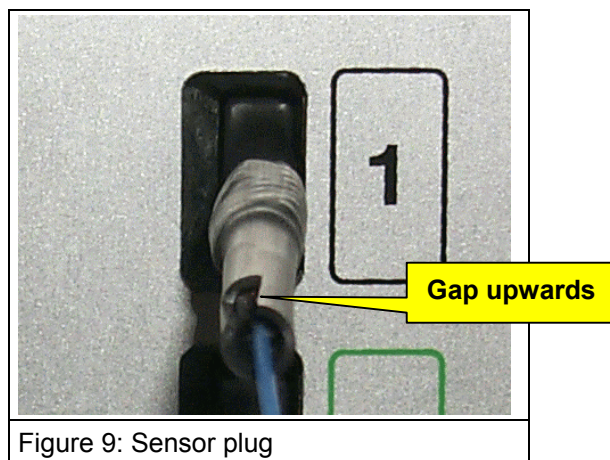
These steps are necessary to bring the AG500 in transmitting mode.

- **The Articulograph AG500 must warm up for at least one hour before the actual investigation, in order to allow the transmitter coils reaching a stable temperature!**
- **The AG500 needs to be shut down and restarted before each calibration and each new session. Otherwise failure-free operation is endangered!**

2. Calibration

- **Shut down and restart the Articulograph AG500 before proceeding!**

Prior to an investigation, the intended sensors need to be calibrated. A calibration is only valid for a dedicated sensor setup. Each sensor belongs to one defined channel. Even the rotation of the sensor plug (which can be plugged in in two ways) is fixed by the way it was plugged in during calibration.



You are recommended to mark each sensor by colour or number to be able to relate it later to the respective channel.

Cable guidance

The sensor leads are to be guided in a way that the distance to the transmitter coils is as far as possible. While calibrating the sensors, the leads shall be guided preferably like they will be guided in the actual session.

Interferences can so be reduced to a minimum and the results become better.



[mc5cal.pdf](#)

- **The pitch of the EMA Cube must not be changed after calibration!**

3. Preparing the sensors

a) Cleaning and disinfection of sensors

In order to avoid cross-contaminations which are resulting due to reuse of sensors, appropriate hygienic precautions must be taken in order to minimize the possibility of contamination. In each case, it has to be considered carefully whether disinfection of sensors will be sufficient, or if sterilization has to be performed.

Immediately after an investigation, the sensors should undergo a cautious but careful cleaning under conditions recommended for surgical instruments. Thereafter and before the reuse of sensors at another subject, appropriate methods of disinfection or sterilization must be applied. Definitely, it has carefully to be considered whether the method of choice will ensure the required security concerning the field of application as well as the operational indication of the Articulograph AG500.

It is recommended to coat the sensors before fixing them on the articulators. The sensors can be covered with latex, which can simply be removed after the examination and keeps the sensors on clean condition.

Noncommittal recommendations of experienced AG500 users regarding the preparation of the sensors can be found on our website: <http://www.articulograph.de/tips.htm>

4. Mounting the sensors

a) Function test

Since the sensor leads are very thin, broken wires on the plug and at the sensor appear as a common problem. To check whether the sensor is ok, use mcDiag. Start-up the Articulograph AG500 and plug in the sensor to be tested. Open mcDiag on the control-pc and chose the tab "Amplitudes". Click on the button "start". Now 12 lines with six values per line appear. These are the signals of the 12 channels and the six transmitter coils.

Mount the sensor in the Circal. Then move the lead at the sensor and at the plug. If the six signals in the corresponding line on the screen do not change (except for noise), the sensor lead is ok.

Another way is to record a sweep with mc5Recorder while moving the leads and then calculate the positions or look for the amplitudes. Significant position changes would indicate damaged sensor leads of the corresponding sensor.

b) Fixing the sensors

Noncommittal recommendations of experienced AG500 users regarding the fixing of the sensors can be found on our website: <http://www.articulograph.de/tips.htm>

Minimum distance between sensors: 8mm.

Avoid vertical orientation (parallel to z-axis) of the sensors.

c) fixing sensors on teeth

The physiological glue can damage artificial teeth! It is up to the user's assessment whether a method for fixing the sensors is applicable for a dedicated purpose.

d) Reference sensors

To be able to eliminate head movement in the recorded data, it is needed to place reference sensors on the head of the subject. They should be put the way that they only move when the head moves. Recommended locations for reference sensors are behind the ears and on the bridge of the nose.



[Further information on head movement normalization - NormPos.pdf](#)

e) Cable guidance

The sensor leads are to be guided in a way that the distance to the transmitter coils is as far as possible. While calibrating the sensors, the leads shall be guided preferably like they will be guided in the actual session.

Like this, interferences can be reduced to a minimum and the results become better.

5. Grounding the subject

The subject needs to be grounded to reduce interferences. Use a test lead with at least 2.5 mm² cross section and a 4mm banana plug at one end. Connect the plug to the gold-plated ground socket on the carrier.

For AG500 without ground socket, the rear panel of the receiver PSR12 can also be used to fix a ground lead.

6. Adjusting the EMA-Cube height

For recording reasonable data, all sensors need to be within the spherical measurement range of the EMA Cube. It reaches 150 mm around the origin in the middle of the measurement range. To control this at the beginning of an investigation, record a short sweep and calculate the raw-positions. The distance of each sensor from the origin must not be more than 150mm.

Use this formula to calculate the distance of a sensor from the origin:

$$l = \sqrt{x^2 + y^2 + z^2}$$

Do this for each sensor. If one sensor is not within the measuring range, control the position of the EMA-Cube and record a new sweep.

Use a 10mm socket wrench with a (cordless) drill driver to set the EMA-Cube height. Turn the axle on the backside of the carrier (see Figure 10 and Figure 11).



Figure 10: Location of the axle

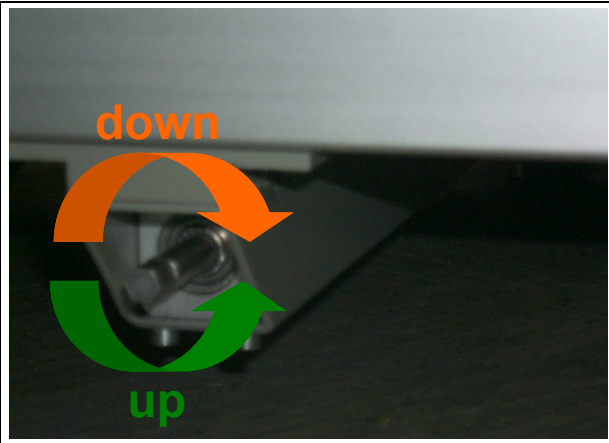


Figure 11: Directions

B. Recording data

- **Shut down and restart the Articulograph AG500 before proceeding!**

1. Using mc5recorder



[mc5recorder.pdf](#)

2. In case of power fail during recording.

In case of power fail the last recorded sweep may be lost. Shutdown the system if it is still running and switch off power. Close the mc5recorder on your Control-PC.

Power up the system and select a new folder to continue the data recording. The calibration stays valid after a power fail.

XVI. Shutting down the Articulograph AG500

Before the AG500 can be turned off, it needs to be shut down by the control computer. When quitting mc5Recorder, you will be asked for this. However, you can also use ageSysControl.exe for the remote shutdown.

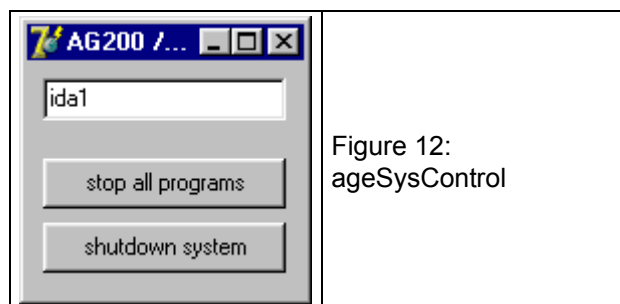


Figure 12:
ageSysControl

- Click on “shutdown system”.
- An internal countdown starts, which is indicated by a ticking sound.
- After approximately 30 seconds the ida-computer turns off.
- Now you can turn off the main switch of the AG500.

To recognize whether the internal computer is off, regard the LED in the keyboard!

XVII. Analysing data

A. Calculating the positions

1. Raw-positions

The data recorded during a session is not positions but amplitudes. This is (basically) just that what the sensors receive. In order to get usable data the actual positions need to be calculated.



[CalcPos 2.pdf](#)

2. Performing head correction

Since the test person would usually move his head while speaking, the calculated positions represent a mix of articulation and head movement. To extract just the articulation movement use NormPos.



[NormPos.pdf](#)

3. Converting data files

The internally used data format is binary and described under XVII.B (Data format). For some applications it might be useful to convert the data in a text format. For this use Bin2ASCII.



[Bin2ASCII.pdf](#)

4. EMA Cube coordinate system

This coordinate system is only valid for raw-positions! The head corrected data does not have any fixed relation to the EMA Cube (Since it is related to the head!).

B. Data format

The recorded and calculated data are saved as binary files. Their structure is documented in the following file.






[AG500_ida_format.pdf](#)

XVIII. Hints on possible sources of error

➤	Grounding of the subject	23
➤	Damaged sensor leads.	22
➤	Large metal surface area close to the AG500.	7
➤	Fluorescent lamps burning close to the EMA Cube	7
➤	High temperature differences or too short warm up.	7/21
➤	Sensor set-up has been changed after calibration.	21
➤	Sensor lead guidance too close to the transmitter coils.	23
➤	Sensors in vertical alignment.	22
➤	Sensors too close together.	22
➤	Cube tilt or tray alignment has been changed after calibration.	20

XIX. Legend

	= please note sources of danger !
	= please note further information !
	The pointing hand refers to a separate document which contains further information. For this link it is required that all the AG500 documents are in one folder!

XX. Licensing agreement

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The lawful acquisition of an Articulograph AG500 allows the use of the delivered programs for the Articulograph's handling, and the processing of the data acquired with it.

Copies of data may only be produced for the purpose of backup.

The programs may be edited and modified for personal use, yet not be passed on or sold as a whole or in pieces in a compiled form or as a source.