ENDOS AC / ACP CE 0051

(120V version)

User's Manual

Release 10 January 2006 (Rev. 5)

Revision history

Rev.	Date	Page/s	Modification description
0	02.04.03	-	Document approval.
1	25.09.03	All	Remote timer version release. ETL certification. (Ref. RDM 5641)
2	10.11.03	7, 8	Addition of "X-MIND" identification on main label. (Ref. RDM 5693)
3	26.03.04	8	Notify body change for CE mark. (Ref. RDM 5781)
4	15.03.05	8, 18, 36	Editorial correction on Enabling/Disabling the "Ready" key. Modified the DP arm label. (Ref. RDM 5938, RDM 6052)
5	10.01.06	28	Dose linearity reference measurement time update. (Ref. RDM 6164)

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Contents

This Manual in English is the original version.

1. INTRODUCTION

NOTE:
This manual is updated to the product status it is sold with, to guarantee the user an adequate reference for equipment use and any aspect connected with use safety. The manual may not reflect any product variation without impact on operating procedures and use safety.

The intraoral radiographic ENDOS AC/ACP, produces high quality intraoral X-rays, thanks to reduced exposure times and the small dimensions of the focal spot.

ENDOS AC/ACP is exclusively intended for the execution of intraoral X-rays.

The equipment has the following features:

- Very good quality X-rays pictures
- user friendly
- ergonomic design.

The equipment is controlled by a microprocessor that makes it possible to reproduce exposure times and is composed of the following parts:

- Timer: ENDOS AC or ENDOS ACP equipped with wall plate
- Extension arm (30 cm, 60 cm or 80 cm for wall version)
- Scissors arm (DP)
- Tubehead 70 kV 8 mA – X-ray tube with grid.

The purpose of this manual is to provide the user with instructions that will allow him to run the equipment safely and efficiently.

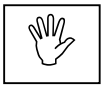
The equipment must be used according to the procedures in the manual and never for different purposes from the ones for which it has been designed.

1.1 Icons in the manual

Indicates a "NOTE"; we recommend particular attention in reading the subjects identified with this icon.

Indicates a "WARNING"; subjects identified with this icon concern safety aspects regarding the patient and/or the operator.

2. SAFETY ASPECTS



WARNING:
Read this chapter very carefully.

Villa Sistemi Medicali designs and makes their equipment according to safety requirements; moreover, they supply all necessary information for appropriate use and warnings relating to dangers connected with X-ray generators.

The manufacturer does not accept any responsibility for:

- Use of ENDOS AC/ACP equipment for purposes other than those for which it has been designed,
- damages to the equipment, the operator, the patient caused both by wrong installations and maintenance that do not follow the procedures contained in the user manuals and the installation provided with the equipment, and by wrong operating techniques,
- mechanical and / or electrical changes , made during and after installation, that differ from the ones in the Service Manual.

Only personnel authorised by the manufacturer may carry out technical work on the equipment.

Only authorised personnel can remove the tubehead from its support and/or gain access to live parts.

2.1 Warnings

The equipment must be used according to the procedures in this manual and never for different purposes from the ones for which it has been designed.

Before carrying out any maintenance disconnect the equipment from the power line using the circuit breaker provided.

ENDOS AC/ACP is an electro-medical device and for this reason can be used only under the supervision of highly qualified medical staff in possession of all the necessary knowledge about X-ray protection.

The user is responsible for fulfilling all the legal requirements connected with the possession, installation and use of the equipment itself.

ENDOS AC/ACP is built for continuous running with intermittent load; for this reason the planned duty cycle must be observed.

Appropriate accessories, such as lead aprons, must be used to protect the patient from radiation.

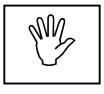
Although the equipment is designed to provide a reasonable degree of protection from electromagnetic interference, according to IEC International regulations, it must be installed at an adequate distance from electricity transformer rooms, static continuity units, from two-way amateur radios and cellular phones. The latter can be used only at a minimum distance of 1.5m from any part of the equipment.

Any instrumentation or equipment for professional use located near ENDOS AC/ACP must conform to Electromagnetic Compatibility regulations. Non conforming equipment, with known poor immunity to electromagnetic fields, must be installed at a distance of at least 3m from ENDOS AC/ACP and supplied by a dedicated electric line.

ENDOS AC/ACP must be turned off when using electro-cautery or similar equipment in the vicinity of the equipment itself.

The equipment is not designed to be used in the presence of anaesthetic mixtures inflammable with air, oxygen or nitrous oxide.

Equipment parts which may come into contact with the patient must be cleaned regularly according to the instructions given later in this document.



WARNING:
For safety reasons, it is forbidden to overload the extension arm or the scissors arm in an anomalous way, for instance by leaning on it.

2.2 Protection from X-rays

Although dosage given by modern X-ray equipment is low on average, during the execution of the exposure, the operator must take all precautions to protect the patient and himself in compliance with the regulations in force.

WARNING:
Protection from X-ray radiation is regulated by law. The equipment must be used by specialised personnel only.

a) The film (or the digital sensor) must be put into the patient's mouth manually or using the appropriate supports. If possible it must be held by the patient himself.

b) During X-ray exposure, the operator must not come into contact with the tubehead or the collimator cone.

c) During exposure, the operator must be at a certain distance from the X-ray source (at least 2 metres), in the opposite direction to X-ray beam.

d) During exposure, the operator and the patient are the only people allowed in the room.

e) The lead aprons should be used to reduce the undesirable effect of secondary radiation on the patient.

2.3 Environmental risks and disposal

Some parts of the equipment contain material and fluids which must be disposed of in special areas designated by the local health authorities at the end of the equipment's life cycle.

In particular the equipment contains the following materials and / or components:

- **Tubehead:** hard plastic materials, metal materials, glass, dielectric oil, lead, tungsten
- **Other parts of the equipment:** hard plastic materials, metal materials, printed circuits, iron-plastic materials.

NOTE:
The manufacturer and the distributor do not accept any responsibility for the disposal of equipment or parts discarded by the user and the related costs.

2.4 Symbols in use

The following symbols are used in this manual and in ENDOS AC/ACP, besides the symbols on the keyboard (see chapter 6):

Symbol	Description
	Equipment with applied parts Type B
~	Alternate current
N	Connecting point to neutral conductor
L	Connecting point to live conductor
	Protection ground
	Functional ground
	OFF ; equipment not connected to electricity line
|	ON ; equipment connected to electricity line
	Permission key to exposure; the permitted exposure status is displayed by switching on the corresponding green symbol
	Focal spot according to IEC 336
	X-ray emission

3. CLEANING AND DISINFECTION

The following procedures should be observed carefully in order to guarantee accurate hygiene and cleaning:

- **Before cleaning the equipment disconnect it from the line using the cut-out switch which must be provided when setting up. This operation is necessary as some internal parts remain live even after it has been switched off from the on board switch.**

- Be careful not to let water or other fluids enter the equipment in order not to cause a short circuit and corrosions.

- Never use solvents (alcohol, petrol, Trichloroethylene), corrosive or abrasive substances when cleaning.

External surfaces

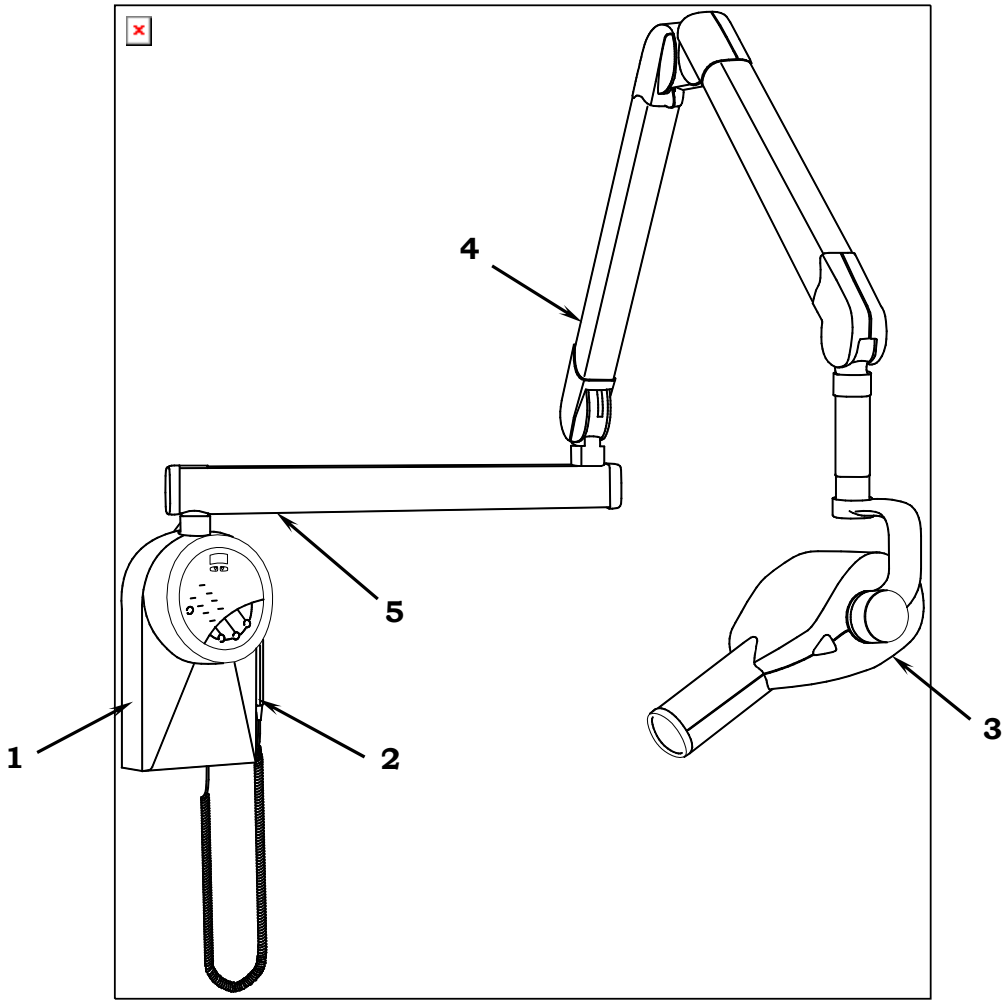
Use a soft cloth and, for a stronger action, a neutral soap to prevent damaging painted surfaces.
During cleaning operations, prevent surplus detergent and/or fluids entering the equipment or staying on painted surfaces.

Parts that come into contact with the patient's skin

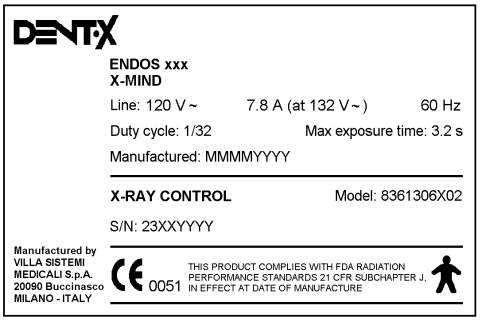
These parts should be disinfected at regular intervals with a 2% Glutaraldeide solution to guarantee hygiene.

4. DESCRIPTION

4.1 Identification labels

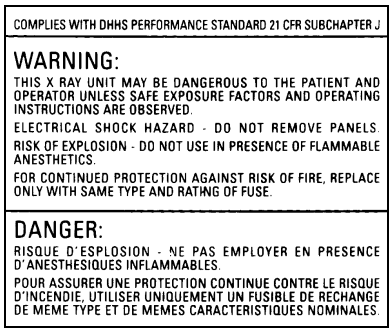


1a
ENDOS AC/ACP
label

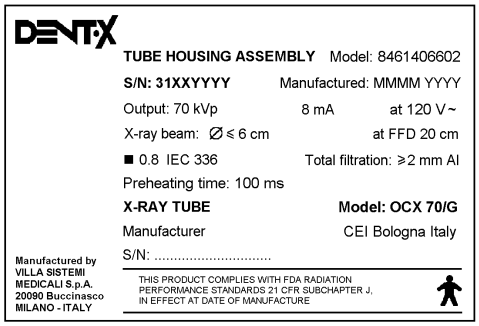


1b
ETL certification
label

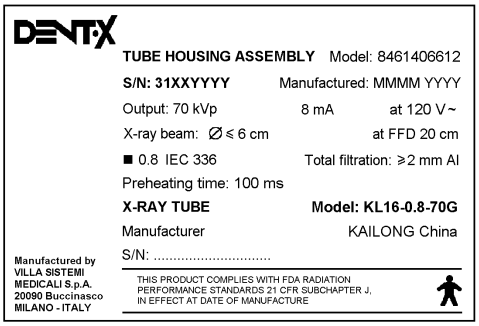
2
WARNING label



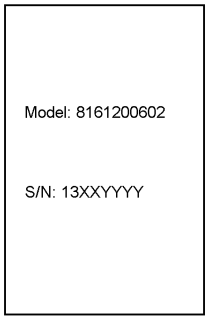
3a
Tubehead label
(X-ray tube type CEI)



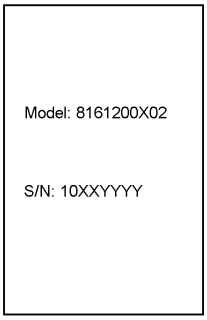
3b
Tubehead label
(X-ray tube type KAILONG)



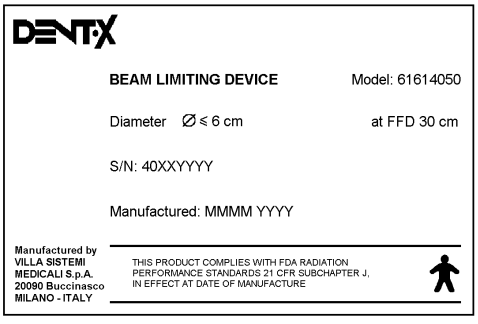
4
DP arm label



5
Extension arm label



6
Collimator 30 cm (optional) label



4.2 Functions, Models and Versions

ENDOS AC/ACP intraoral radiographic equipment is composed of the following parts:

4.2.1 Extension arm and scissors arm

It is composed of a double articulated joint arm, enabling extension horizontally and vertically. The tubehead is balanced in all positions.

NOTE:
The scissors arm is designed to work correctly at a max. angle of 160°; so its use requires a flare angle of less than 160°.

Moreover, a horizontal extension arm can be added, available in various sizes, to meet all requirements.

4.2.2 Tubehead

The 70 kVp voltage, the 8 mA current and the use of a tube with grid reduce exposure times and the quantities of X-rays absorbed by the patient. The radiogenic equipment is provided with a collimator with 20 cm focus skin distance and a 6 cm X-ray emission diameter at the exit of the cone. The tubehead is connected to the arm by a guide, which allows 360° horizontal rotation and 290° vertical rotation.

Two alternate X-ray tubes can be used: both have the same characteristics and provide the same performance.
The tubehead, assembled with different X-ray tubes, are interchangeable so long as pre-heating time is set to the proper value indicated on the tubehead label.

4.2.3 Timer

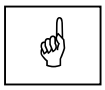
The name of ENDOS AC/ACP depends on the type of timer in use:

- ENDOS ACP

  ENDOS ACP is a digital timer with microprocessor where exposure times can be selected both manually and automatically.
  With automatic selection there is a choice of 30 pre-set times depending on the patient's size (small, medium or large) and the type of tooth and acquisition mode (film, digital).
  There are 33 fixed manual selection times that vary from a minimum of 0.02 seconds to a maximum of 3.20 seconds.
  The main feature of this timer is that it has an automatic exposure time compensation for drift of nominal voltage within ± 10%.

- ENDOS AC

  ENDOS AC has the same features as the ENDOS ACP timer, excluding automatic and digital anatomic selection.
  It has manual exposure time selection only.



NOTE:
A remote X-ray button configuration can be made, outside the exam room. This can be a pure door bell X-ray button or a device which also show status of the unit ("Ready" and "Exposure in progress").

4.3 Configurations

4.3.1 Standard configuration

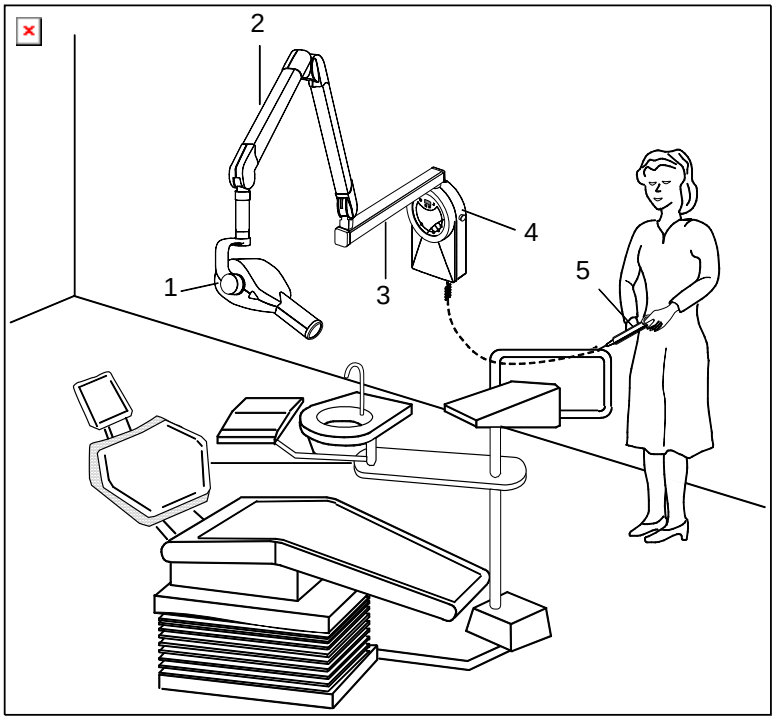


Figure 1

1 Tubehead
2 Scissors arm
3 Extension arm
4 Timer
5 X-ray button

4.3.2 Remote timer configuration

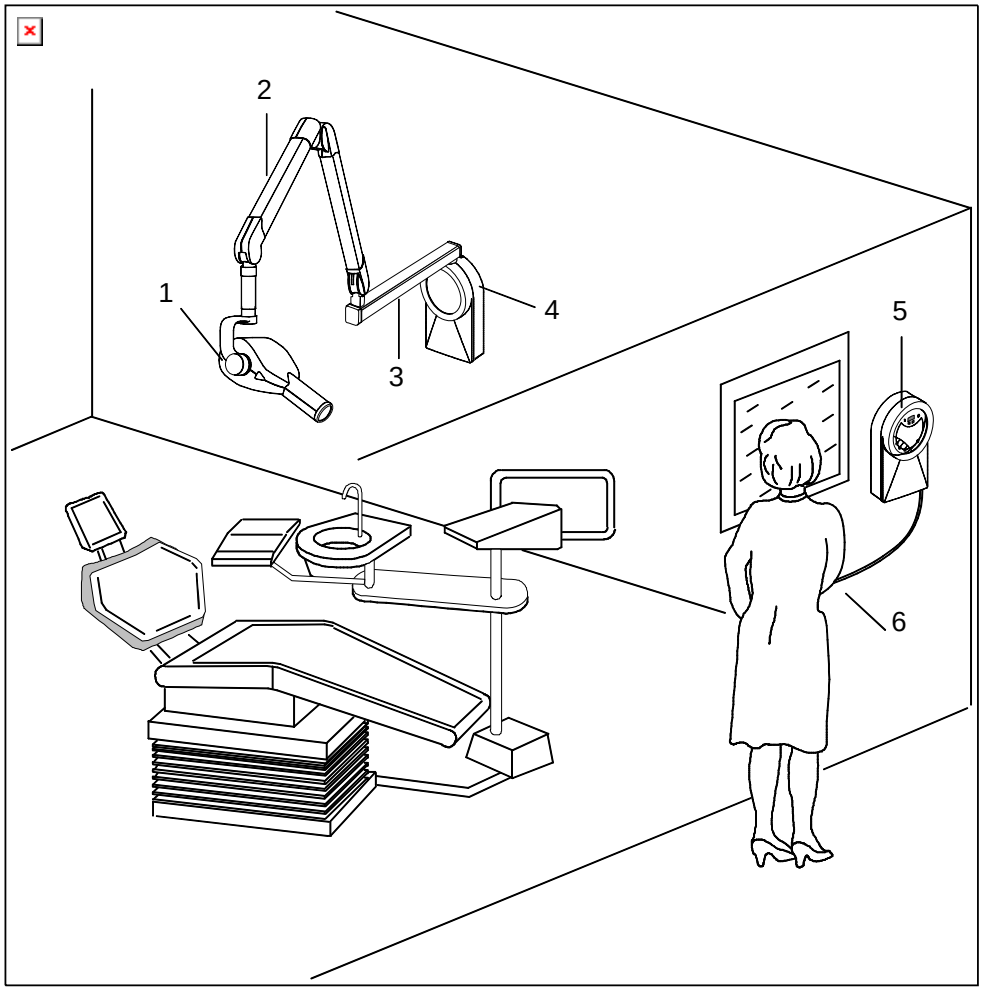


Figure 2

1 Tubehead
2 Scissors arm
3 Extension arm
4 Wall support (kit code 8161301002)
5 Remote timer
6 X-ray button

4.3.3 Mobile stand configuration

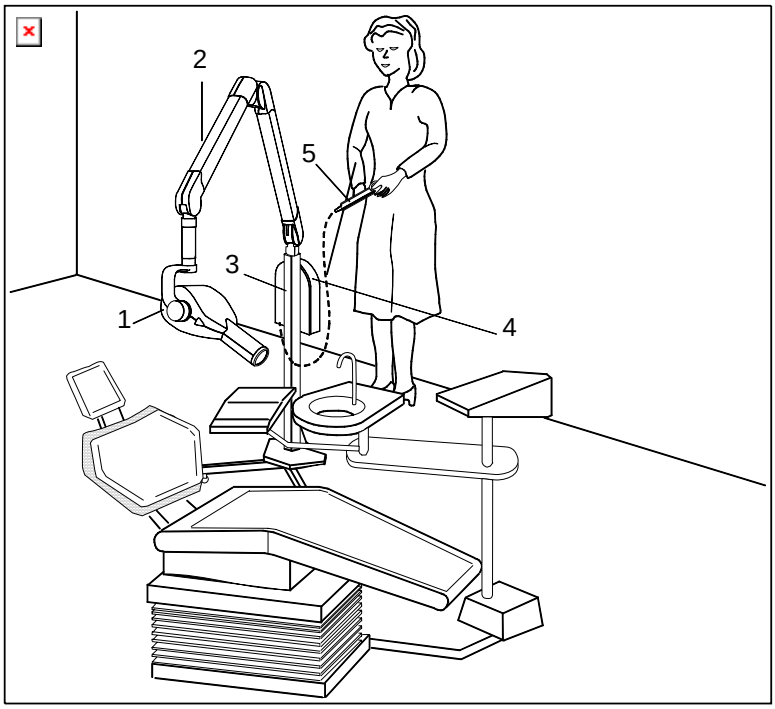


Figure 3

1 Tubehead
2 Scissors arm
3 Mobile stand
4 Timer
5 X-ray button

4.3.4 Remote X-ray button configuration

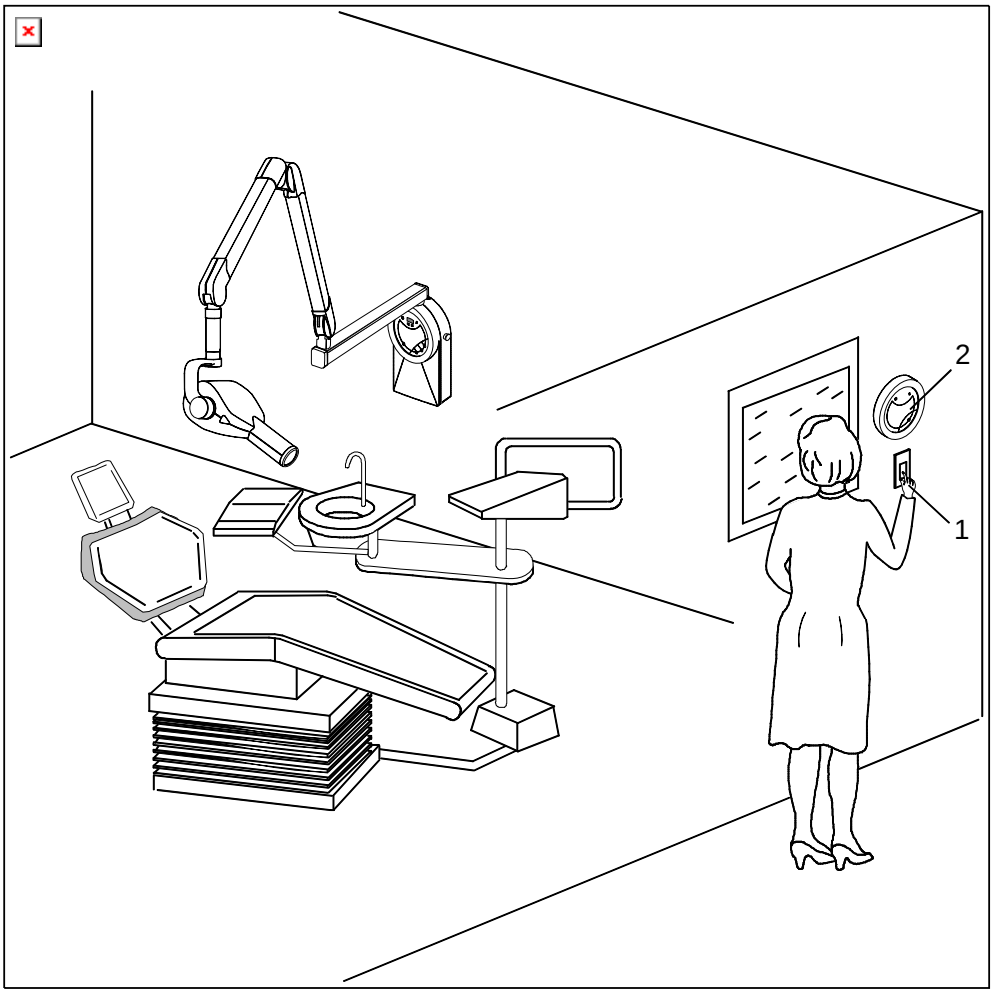


Figure 4

Alternative 1:

1 X-ray button (not supplied)

Alternative 2:

2 X-ray button + light signalling of "Ready" or "Exposure in progress" (supplied as kit P/N 6661309500)

5. TECHNICAL DATA

Technical features	
Equipment	ENDOS AC/ACP
Manufacturer	VILLA SISTEMI MEDICALI Buccinasco (MI)
Class	Class I° with type B applied parts (EN 60601-1 classification) 
Protection level	Standard Apparatus IP20
Line voltage	120 V~ ± 10%
Line frequency	60 Hz
Max absorbed current	7.8 A rms impulsive @ 132 V ~
Power consumption	920 VA impulsive @ 120 V ~
Line voltage regulation	< 3 %
Main fuse	10 AF
Pre-set exposure times	from 0.02 to 3.2 s in 33 steps
Automatic selection (only for ENDOS ACP)	30 pre-set times
Exposure time accuracy of corrected time **(*)** (see paragraph 5.1)	± 10% or ± 32 ms (whichever is greater - see note paragraph 5.5)
Pre-selected exposure time accuracy (this is the value of timer setting pre-selected by the operator)	The absolute maximum deviation can be –100% +150% when line voltage changes within rated voltage range: it includes inaccuracy and correction due to line voltage changes (see paragraph 5.1)
Circuit type	Single phase self-rectifying with grid control
kV selection (high voltage value)	70 kVp
Tubehead current	8 mA
KV accuracy	± 15 %
Tubehead (anode) current accuracy	± 2 mA
Max. exposure time	3.2 s
Timer dimension	345×195×100 mm

(*) *This is the actual exposure time, pre-indicated on the timer during the enabled status and during exposure and determined by the internal algorithm as a function of line voltage.*

Tubehead features		
Manufacturer	VILLA SISTEMI MEDICALI Buccinasco (MI)	
Rated voltage	70 kV_p	
Tubehead power	430 W	
Pre-heating time	100 ms	
Total filtration	≥ 2 mm Al eq. @ 70 kV	
HVL (Half Value Layer)	> 1.5 mm Al eq.	
Transformer insulation	Oil bath	
Interval between exposures / duty cycle	32 times X–ray time / 1 : 32	
Focal spot	0.8 (IEC 336)	
Minimum focus to skin distance	20 cm (optional 30 cm cone)	
X-ray beam diameter (@ 20cm focus)	≤ 6 cm (optional 35x45 mm)	
Cooling	Convection	
Radiation leakage at 1 m	< 0.1 mGy/h	
Technical factors for radiation leakage	70 kV, 8 mA, 1 s duty cycle 1 exposure each 32 seconds	
X-ray tube features		
Manufacturer	CEI Bologna (Italy)	KAILONG Electronic (China)
Type	**OCX/ 70-G** with grid	**KL16 - 0.8 - 70G**
Inherent filtration	0.5 mm Al equivalent to 70 kV	0.4 mm Al equivalent to 70 kV
Anode tilt	19°	19°
Anode material	Tungsten	Tungsten
Rated voltage	70 kV	70 kV
Maximum filament current	2.8 A	2.8 A
Maximum filament voltage	4 V	4.1 V
Anode thermal capacity	6 kJ	7 kJ

Environmental conditions	
Operating temperature range	+10°C ÷ +40°C
Operating relative humidity range	30% ÷ 75%
Temperature range for transport and storage	-20°C ÷ +70°C
Max. relative humidity for transport and storage	<95 % non condensing
Min. atmospheric pressure for storage and transport	630hPa
Apparatus and detachable parts weight	
Gross weight including packing	30.4 kg
Net apparatus weight in standard configuration	25.4 kg
60 cm extension arm (standard)	2.9 kg
80 cm extension arm	3.5 kg
30 cm extension arm	1.9 kg
Scissors arm	9 kg
Timer plus wall plate	5 kg
Tubehead	8.5 kg

5.1 Method for correcting exposure times

This RX intraoral equipment features a special function called Computer Controlled Density which makes it possible to correct exposure time automatically when line voltage is different from its nominal voltage. A change in the line voltage affects the peak voltage applied to the RX tube and the high voltage value affects the Rx spectrum very significantly. This, in turn, affects the optical density of the image on the film. The task of the correction is to achieve the same optical image density irrespective of the variations in line voltage, within its permitted variation range of ± 10%. In short, this feature makes it possible to obtain the same quality of image without having to be concerned about possible line variations which occur frequently in many areas and which are almost impossible to prevent without resorting to costly equipment.

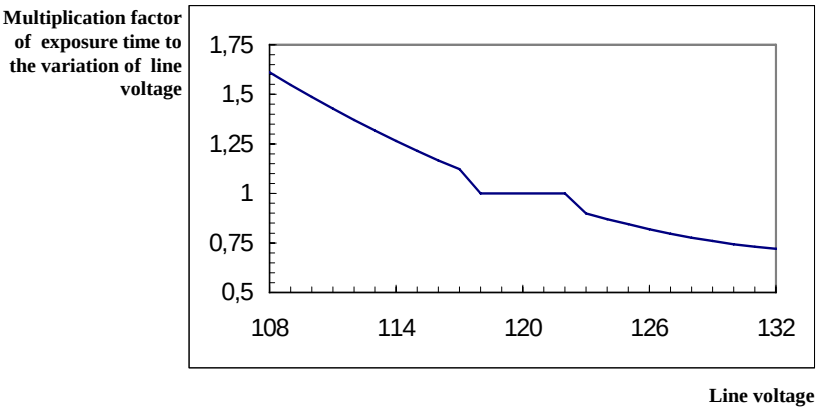
Automatic exposure time correction works with the following sequence: inside the timer there is a voltmeter which takes a constant reading of the line voltage, while the user selects the desired exposure time. After the user has chosen the exposure time he knows from experience to be the best for the type of X-ray he is going to take, the user himself presses the key enabling exposure and the timer shows on the screen the correct time that will be used for the exposure in progress, time that the timer itself has calculated according to the value of the line voltage measured an instant before pressing the key of the exposure permission.

NOTE:
ENDOS AC and ENDOS ACP timers work in step with the line frequency, so the calculated time is always rounded off to the multiple of the line frequency itself.

The correct exposure time shown once the timer has been enabled by the "Ready" key and during the execution of the X-ray is the time actually used by the equipment: it is calculated applying a correction factor to the time selected by the user, based on the empirical law relating to the optical density of the film with the high voltage peak value and consequently with the line voltage.

NOTE:
If the "Ready" key has been disabled in system configuration, the display will show the "corrected" exposure time only during exposure or holding the X-ray button pressed at the end of it.

The qualitative relation between the multiplication factor and the line voltage is shown in the following picture (for equipment configured to work at 120V):



The following table allows to establish pre-indicated times and final real exposure times as a function of pre-selected time and line voltage variation.

line voltage	108V		112V		116V		124V		128V		132V	
	corrected exposure time (on the basis of current line voltage)	max/min exposure time due to intrinsic inaccuracy	corrected exposure time (on the basis of current line voltage)	max/min exposure time due to intrinsic inaccuracy	corrected exposure time (on the basis of current line voltage)	max/min exposure time due to intrinsic inaccuracy	corrected exposure time (on the basis of current line voltage)	max/min exposure time due to intrinsic inaccuracy	corrected exposure time (on the basis of current line voltage)	max/min exposure time due to intrinsic inaccuracy	corrected exposure time (on the basis of current line voltage)	max/min exposure time due to intrinsic inaccuracy
line voltage correction factor:	1,61		1,37		1,17		0,87		0,78		0,72	
preselected time (ms)												
20	32	64	27	59	23	55	17	49	16	48	14	46
		0		0		0		0		0		0
40	64	96	55	87	47	79	35	67	31	63	29	61
		32		23		15		3		0		0
60	97	129	82	114	70	102	52	84	47	79	43	75
		65		50		38		20		15		11
100	161	193	137	169	117	149	87	119	78	110	72	104
		129		105		85		55		46		40
200	322	354	274	306	234	266	174	206	156	188	144	176
		290		242		202		142		124		112
400	644	676	548	580	468	500	348	380	312	344	288	320
		612		516		436		316		280		256
800	1288	1320	1096	1128	936	968	696	728	624	656	576	608
		1256		1064		904		664		592		544
1000	1610	1642	1370	1402	1170	1202	870	902	780	812	720	752
		1578		1338		1138		838		748		688
1200	1932	1964	1644	1676	1404	1436	1044	1076	936	968	864	896
		1900		1612		1372		1012		904		832
1500	2415	2447	2055	2087	1755	1787	1305	1337	1170	1202	1080	1112
		2383		2023		1723		1273		1138		1048
2000	3220	3252	2740	2772	2340	2372	1740	1772	1560	1592	1440	1472
		3188		2708		2308		1708		1528		1408
2500	4025	no exposure	3425	3457	2925	2957	2175	2207	1950	1982	1800	1832
		no exposure		3393		2893		2143		1918		1768
3000	4830	no exposure	4110	no exposure	3510	3542	2610	2642	2340	2372	2160	2192
		no exposure		no exposure		3478		2578		2308		2128

no exposure = the timer does not allow exposure times longer than 4 sec

5.2 Method for measuring technical factors

kV_p KVp value is defined as the stationary value of high voltage applied to the tube which settles on load after preheating time.
KV_p value is measured by a non-invasive instrument, with accuracy of over 2%, to the nominal value of line voltage.
A direct high voltage measurement can be made only by disassembling the tubehead. **This operation can be executed only in the factory**.

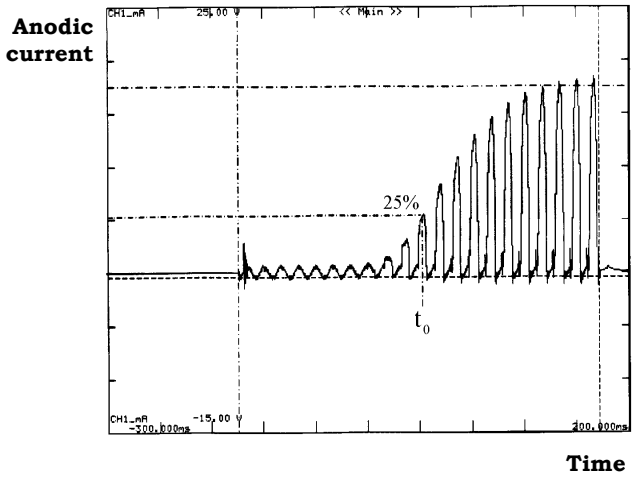
mA The anodic current value is defined as the average value of stationary current which settles on load after pre-switching time.
The anodic current value is measured using a digital voltmeter measuring the voltage drop at the ends of the resistance from 1 kΩ, 1% assembled on the tubehead. To take this measurement, remove the side plastic plug of the tube support; connect the ground voltmeter terminal on the yellow/green cable clamp screw and insert the positive terminal into the contact at the end of the grey cable. The digital voltmeter must be selected on DC, and the relation of transformation is given by 1 mA = 1V. Execute an exposure of at least 1 sec.

t The exposure time value is the time during which the value of the anodic peak current exceeds 25% of the steady state value. The time taken to reach this condition is called "pre-heating time".
The measurement must be taken at nominal line voltage, measuring the anodic current wave-form on the 1kΩ resistance and using a memory oscilloscope.
Exposure time measurements using non-invasive equipment can lead to systematic errors in exposure time measurements which cannot be quantified and which depend on the equipment used for measuring (see paragraph 5.3).

5.3 Correct use of dosimeters to measure exposure times

The spread of non-invasive equipment to measure the functional parameters of RX equipment has introduced a series of interpretation problems when measuring exposure times.

The source of the problem is in the characteristic rise curve of the RX tube's anodic current which is represented in the picture:



According to IEC60601-2-7 (1998) regulations, "in equipment where the filament is switched on and high voltage is applied simultaneously, the exposure time is calculated as the interval between the instant when the anodic current exceeds 25% of the nominal value and the instant when it goes below such value".
This method is defined as invasive because it requires that the anodic current flowing through a resistance inside the tubehead must be measured.

Non-invasive methods are definitely easier and faster compared with the invasive method, but they are prone to errors which can be considerable when determining exposure time. In fact some of these devices start counting exposure time as soon as a small quantity of radiation reaches the measuring chamber with the result that they take longer times than the ones determined by the invasive method applied by the manufacturer.

Consequently, calculations obtained by these non-invasive methods can erroneously lead to the conclusion that the equipment timer is not accurate. Actually the difference is connected to the method adopted in measuring the exposure time.

By using a tube with grid it is possible to reduce to the minimum the time required for the anodic current, and as a consequence, the dose adjustment to reach the steady state, so there is very little difference between the exposure time measurement using the invasive and the non invasive method.

Corrective actions

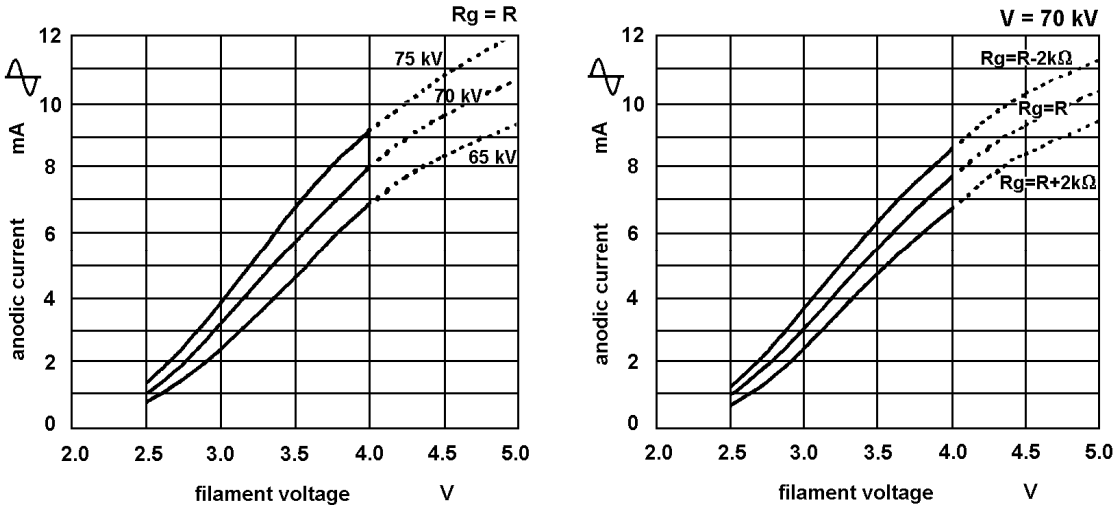
A practical method can be applied to get round the problem which can be described this way:

- In a graph you report the values of times measured using the equipment compared with the ones displayed by the timer (automatically corrected for the line variations): the dots of the graph are interpolated with a straight line (if possible by the least square method or more simply in a graphic way).
- You determine the intercept on the Y axis of this straight line: this can be assumed as the time value that the non-invasive device adds to each measurement due to the radiation which reaches the device before the anodic current is 25% of its maximum value.
- Then you subtract this "offset" time from all the device measurements and you proceed with comparing the time measurements displayed by the timer.

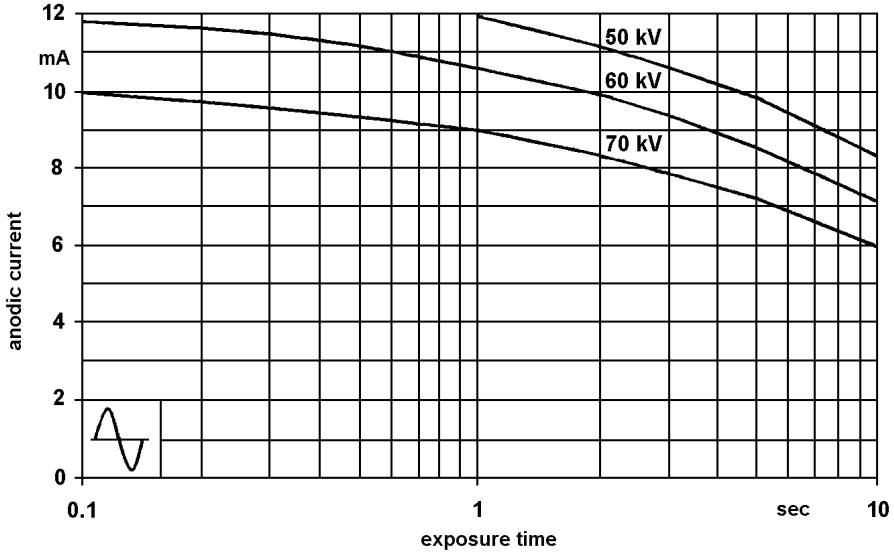
5.4 Curves tube features

OCX / 70-G

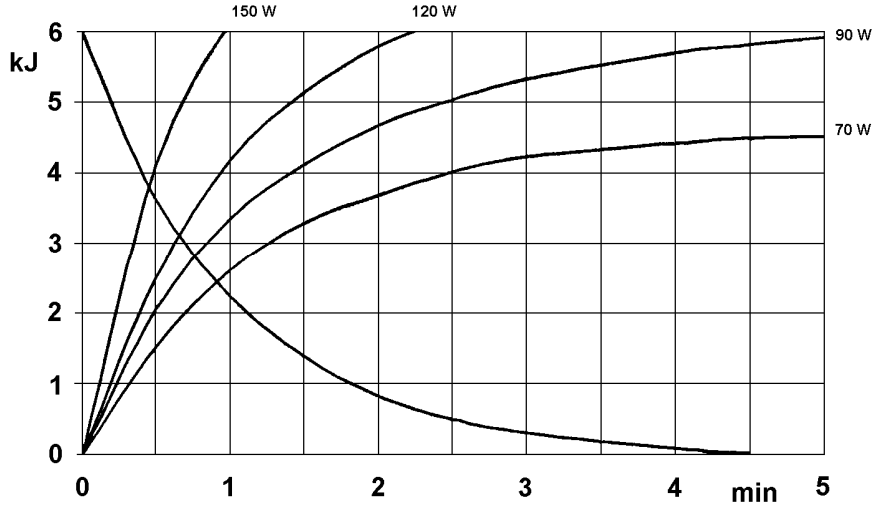
Feature of emission



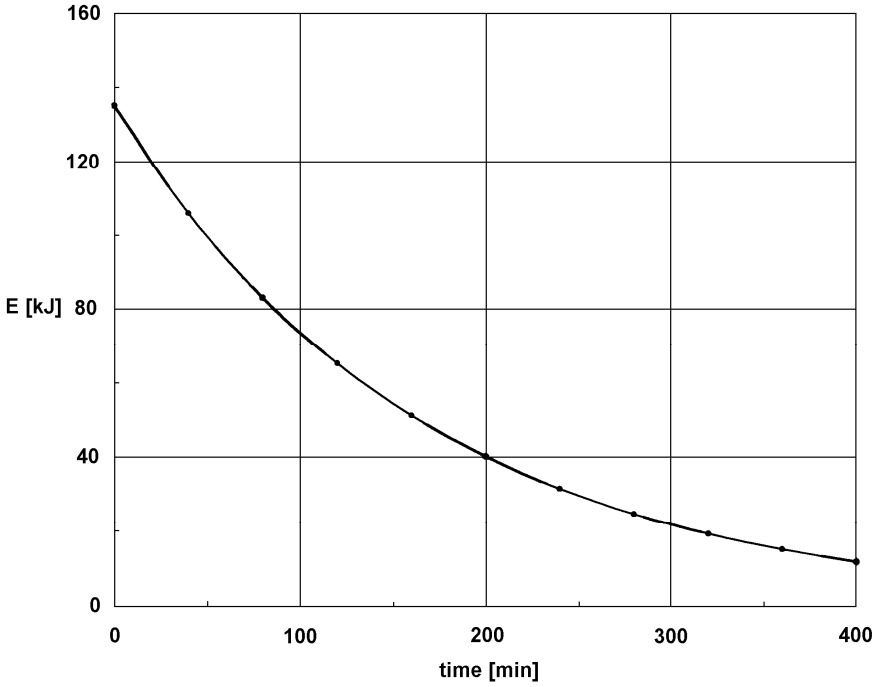
Load



Curve anode cooling

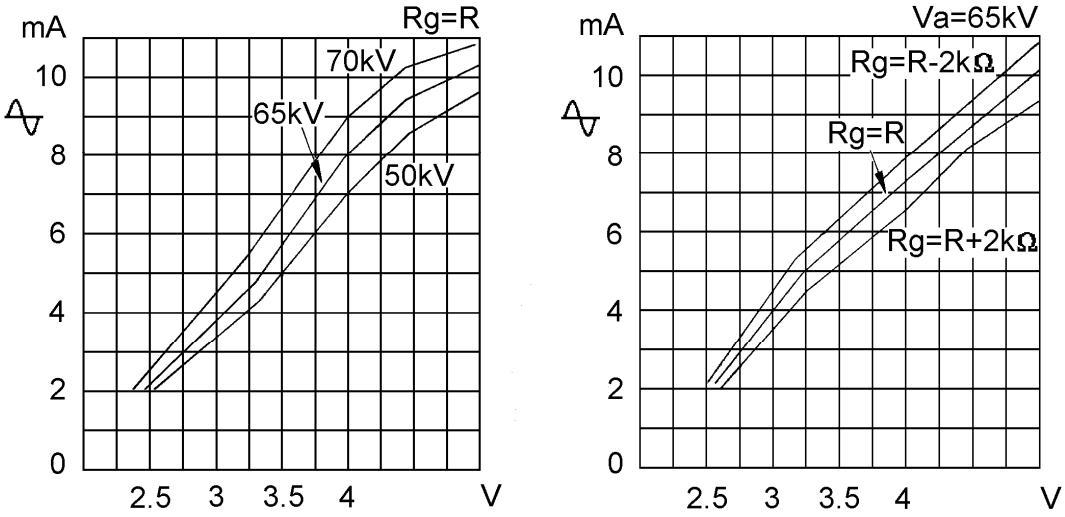


Curve tubehead cooling

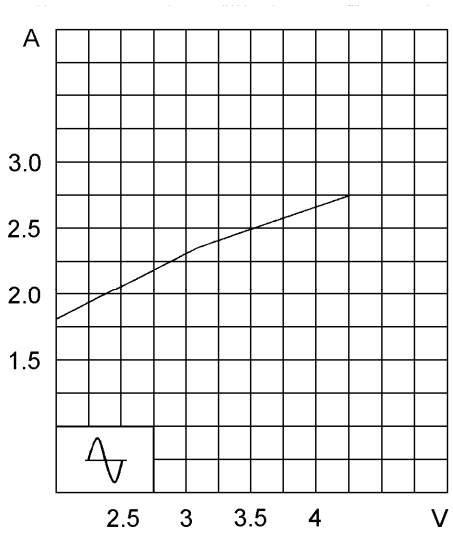


KL16 – 0.8 – 70G

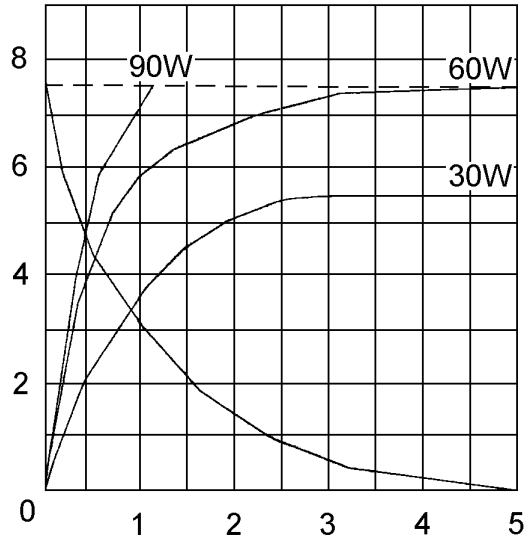
Feature of emission



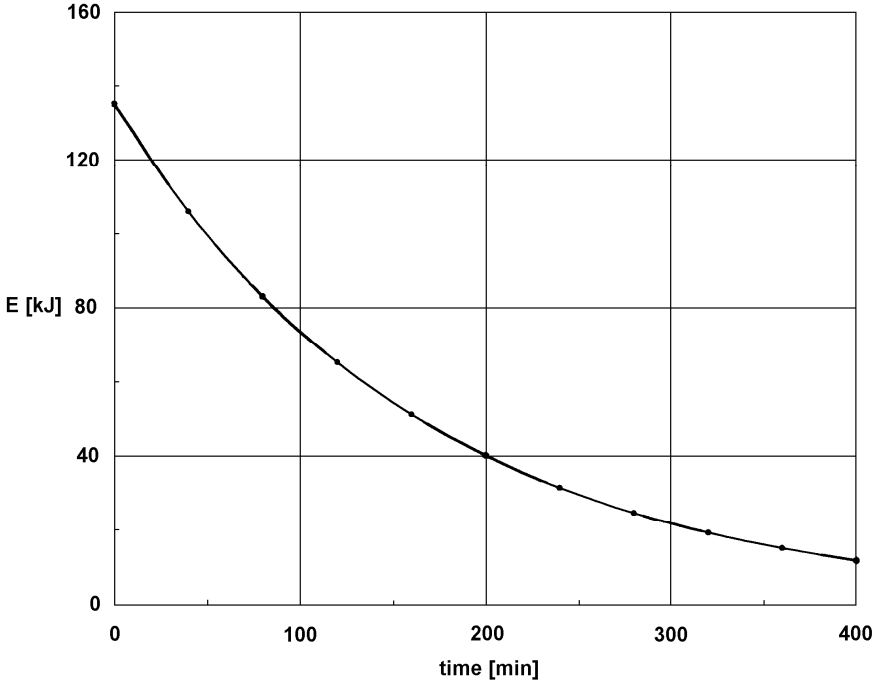
Filament characteristics



Heat storage (kJ)



Curve tubehead cooling



5.5 Reference standard

Enforceable regulations:

21 CFR

CEE 93/42: EN 60601-1
EN 60601-1-1
EN 60601-1-2
EN 60601-1-3
EN 60601-1-4
EN 60601-2-7 (see NOTE)
EN 60601-2-28

NOTE:
The technology employed in AC intraoral equipment, where the line voltage is applied simultaneously to the high voltage transformer and to the filament of the Rx tube, causes the two following deviations according to EN 60601-2-7 (ed.1998) requirements:

a) The exposure time cannot be defined with an accuracy lower than the length of a 50Hz line period (20ms) and than two 60Hz line periods (16.6ms).
In fact exposure time is defined as the interval between the instant when the anodic current exceeds 25% of the steady state value and the instant when it goes below this value. It is evident that in the anodic current rise current (see Figure paragraph 5.3) you have the uncertainty of 1 peak in determining the first peak which exceeds 25% of the steady state anodic current.
When running at 60Hz you must also consider that selectable times in the timer are not always multiples of the line period. This introduces a further approximation that the timer executes automatically to carry the selected time to the nearest multiple of the line period.

b) EN 60601-2-7 (ed. 1998) regulation defines precisely that for each pair of exposure times (in ENDOS AC/ACP equipment is the only selectable parameter), with a near relation, but lower than 2, dose linearity is calculated by the formula:

$$\left|Dose(t1)/t1 - Dose(t2)/t2\right| \le 0.2 \times \left(Dose(t1)/t1 + Dose(t2)/t2\right)/2$$

Again, due to the characteristic the anodic current rise curve in AC equipment, the linearity limit is not respected for very short exposure times.
In fact it is evident that for any exposure time a "basal dose" is emitted, produced in the period between the application of voltage to the tubehead and the time when anodic current exceeds 25% of steady state, assumed as the exposure time start.

Moreover, the interval between exceeding 25% of the steady state anodic current and reaching running point, the anodic current grows and with it the dose rate, making the emitted dose non-proportional to the exposure time.
The use of a tube with grid substantially limits the "basal" dose and also the dose emitted at the start of the exposure time , before the anodic current reaches the stationary status.
In ENDOS AC/ACP equipment, typically the basal dose and the dose emitted in the interval when the anodic current varies between 25% of the running value and stationery point is very low, thanks to the tube with grid and this makes it possible to guarantee that the linearity requirements contained in EN 60601-2-7 (ed.1998) are respected for exposure times starting from 60ms.

5.6 Overall dimensions

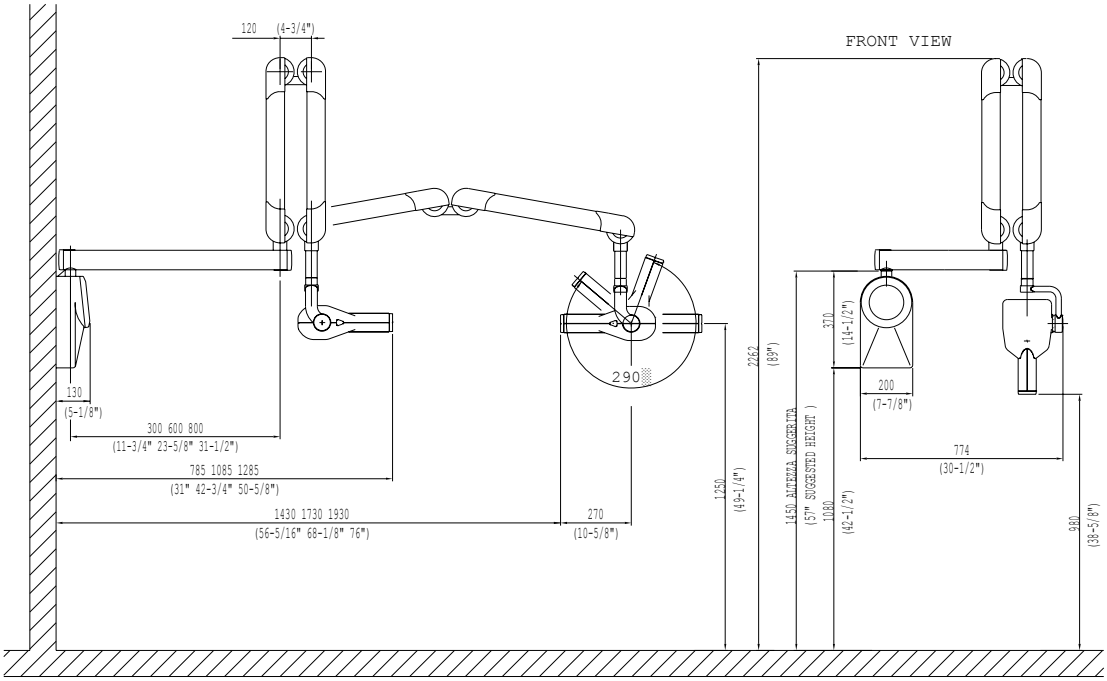


Figure 5: Overall dimensions wall version

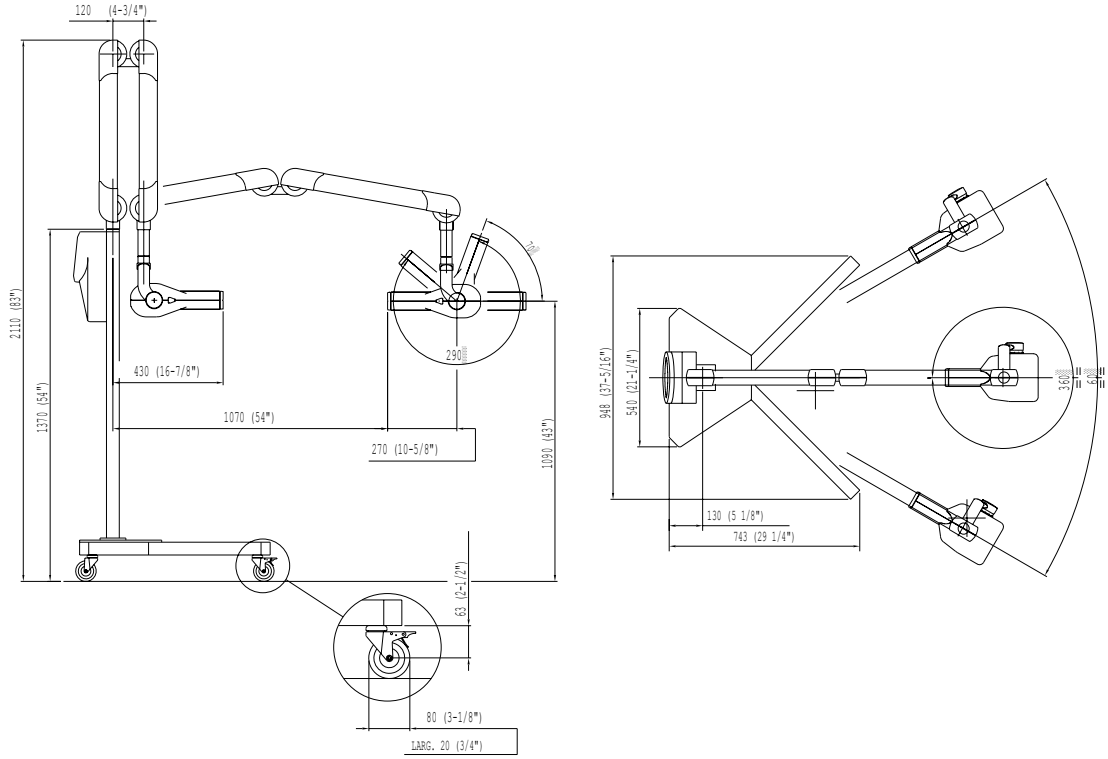


Figure 6: Overall dimensions Mobile Stand version

6. GENERAL USE INSTRUCTIONS

6.1 "ENDOS ACP" timer

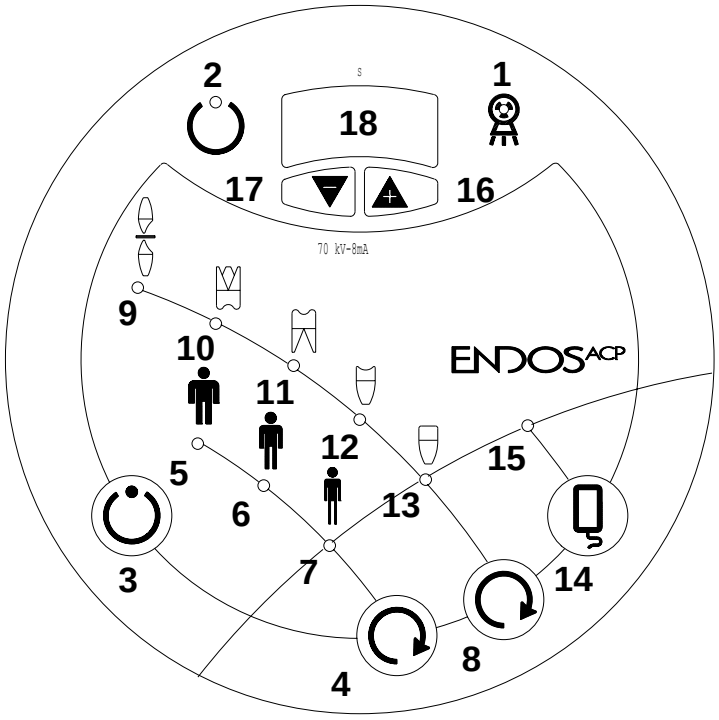


Figure 7: Control keyboard ENDOS ACP

1 X-ray emission yellow LED
2 "Ready for X-ray" green LED
3 Exposure enabling "READY"
4 "Size" selection key
5 "Large size" LED
6 "Medium size" LED
7 "Small size" LED
8 "Tooth anatomic" selection key
9 "Bite-wing" LED
10 "Upper molar" LED
11 "Lower molar" LED
12 "Premolars" LED
13 "Incisors / Canines" LED
14 Videography selection key
15 "Videography" LED
16 Increase key
17 Decrease key
18 Three figure display

NOTE:
All automatic selections are indicated by switching on the relative luminous signalling, at the bottom on the left of the symbol.

NOTE:
ENDOS ACP timer is provided with a Stand By function, so, if no key is pressed for 5 minutes, the timer goes into stand-by (low consumption), indicated on the display by the presence of only the decimal point on the right. To go back to the operative condition, press any key.

INCREASE KEY exposure time 

DECREASE KEY exposure time 

By pressing any of these keys, you go from automatic selection to manual selection. In this way, all signals related to automatic selection (Patient's size, Tooth Selection, Digital Sensor) are switched off. So time selection will work in a manual way.
You can select quickly by keeping the key pressed; in this way the variation works quickly.

To go back to the automatic time selection, press one of the Selection keys (Patient's Size, Tooth, Digital Sensor).

"SIZE" selection key

Press key (**4**)  to select from different patient sizes:  small medium  and large  .

Even in this case exposure times vary.

An acoustic signal (about ½ second) is linked to each touch of the key linked to switching on the selected function from the LED.

"TOOTH ANATOMIC" selection key

Press key (**8**)  to select from the exposure times provided for the different teeth. The meaning of symbols is explained as follows.

Bite-wing

Upper molar

Lower molar

Premolars superior or inferior

Incisors / Canines superior or inferior

Exposure enable key (Ready)

For additional safety, ENDOS ACP timer is provided with an "Enabling of exposure" function.

X-rays can be emitted only after pressing the key  . The equipment enabled signal is displayed on the keyboard by switching on the corresponding green signal. This enabled signal stays for a set time (variable during setup between 10 and 30 seconds: default 15 seconds), after which the function itself is disabled and X-rays are not emitted if the exposure button is touched.

NOTE:
When the READY key is pressed not only will exposure be enabled, but the equipment will also start displaying exposure time on the display calculated according to line voltage fluctuation compensation (see paragraph 5.1).

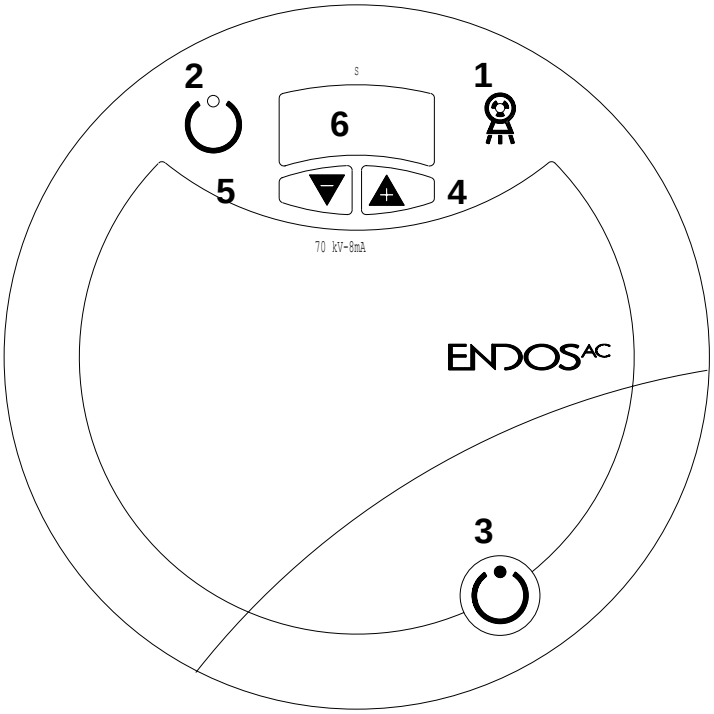
Digital selection key

Key (**14**)  enables automatic exposure for Digital X-rays, reducing exposure times to values suitable to digital sensors.

NOTE:
Value setting and the setting of the exposure time reduction factor in digital selection by the operator are described in paragraph 7.5.3.

NOTE:
This key and the connected functions, can be disabled by the Technical Service in the set-up phase.

6.2 "ENDOS AC" timer



1. X-ray emission yellow LED
2. "Ready for X-rays" green LED
3. Exposure permission "READY"
4. Increase key
5. Decrease key
6. Three figure display

Figure 8: Control keyboard ENDOS AC

NOTE:
ENDOS AC timer is provided with Stand By function, so if a key is not pressed for 5 minutes the timer goes into stand-by (low consumption), shown on display by the presence of the decimal point on the right only. Press any key to go back to the operative condition.

INCREASE KEY exposure time 

DECREASE KEY exposure time 

By pressing one of these keys, you can select exposure time by turning the key onto one of the 33 available times.
Press the increase and decrease keys to modify the pre-set time; you can select quickly by keeping the key pressed; in this way the variation happens quickly.

Equipment enabling key

For additional safety, ENDOS AC timer is provided with the "Exposure enabling" function.

X-rays can be emitted only after pressing the key  .

The equipment enabled signal is displayed on the keyboard by switching on the corresponding green signal. This enabling lasts for a pre-set time (variable during setup phase between 10 and 30 seconds: default 15 seconds), after which the function itself is disabled and no X-rays are emitted if the exposure button is touched.

NOTE:
When the READY key is pressed not only will exposure be enabled, but the equipment will also start displaying exposure time on the display calculated according to line voltage fluctuation compensation (see paragraph 5.1).

6.3 Visual signals

Equipment enabling signalling

When on, the green signal  , at the top left-hand corner of the keyboard, shows "Ready for X-rays" condition, where a touch of the X-ray button starts exposure. This exposure enabled condition stays until the exposure ends or for a pre-set time (variable during set-up between 10 and 30 seconds: default 15 seconds), after which the condition itself is disabled; in this case you must reactivate by touching the corresponding key again.

NOTE:
When the READY key is pressed not only will exposure be enabled, but the equipment will also start displaying exposure time on the display calculated according to line voltage fluctuation compensation (see paragraph 5.1).

NOTE:
If the READY key has been disabled in system configuration, the display will show the "corrected" exposure time only during exposure or holding the X-ray button pressed at the end of it.

NOTE:
If you touch the X-ray button when the enabling signal is not active, no exposure occurs; at the same time the display shows the latest actual exposure time.

Signal "X-RAY EMISSION"

The yellow luminous signal  , at the top right-hand corner of the keyboard is activated if X-rays are being emitted, signalling that emission is actually taking place. Emission is also signalled by an acoustic signal.

Display showing exposure times

The display, in the middle top part of the keyboard has a multiple function.

1. During the exposure preparation phase, it displays the automatically or manually selected exposure time.
2. Soon after enabling the equipment by pressing the "Ready" key and during the exposure phase, it displays exposure time corrected by the equipment to compensate line voltage fluctuations, while at the end of the exposure it displays the time that must elapse before the end of the tubehead cooling pause.
3. At the end, if you press the X-ray button with exposure not enabled, the display shows the latest actual exposure time.

7. EQUIPMENT USE

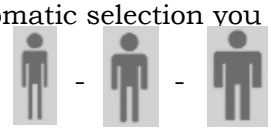
a) Press the switch-on button located at the bottom of the timer. This operation will start the equipment's automatic control function.

b) After completing the control function (possible anomalies pointed out are signalled by error messages described in chapter 8), the equipment displays the standard anatomic selection or the selection pre-set before switching off, according to the mode chosen during setting up.

NOW THE EQUIPMENT IS READY FOR USE.

7.1 Equipment preparation

7.1.1 Preparation of the timer for X-ray use with automatic selection of exposure times (only for ENDOS ACP version)

If you want to enable the automatic selection you must choose the patient's size using keys:  . You will then set the type of tooth to be examined choosing from the projections:

By pressing the keys on the control panel the selection made is highlighted by an acoustic signal and the LED relating to the pressed key turns on . The selected size/tooth combination, will produce the basic exposure time on the display (see Table 1). Exposure times shown are those suggested for Ultra Speed Kodak films (Type D).

			
	0.25	0.32	0.50
	0.36	0.63	0.80
	0.32	0.50	0.70
	0.32	0.50	0.70
	0.25	0.32	0.50

Table 1

NOTE:
When using different types of film (example type E), the multiplication factor must be modified for automatic selection. This modification can be made by the Service Technician during setting up or made directly by the user (see paragraph 7.5.2).
It is necessary to set the multiplication factor shown on the documentation provided by the film producer.

7.1.2 Preparation of the timer for radiographic use with manual selection of exposure times

Enable manual selection working on keys  and  .

By enabling manual selection, the automatically pre-set time will increase by pressing key  and decrease by pressing key 

To increase or decrease times click by click press one of the keys several times; you will hear an acoustic signal as the times vary. Holding one of the keys pressed, times increase or decrease quickly according to the respective scale bottom. Manually selectable times are 33 and go from 0.02 minimum to 3.20 seconds maximum (see Table 2).

0.02 - 0.04 - 0.06 - 0.08 - 0.10 - 0.12 - 0.14 - 0.16 - 0.18 - 0.20 - 0.23 - 0.25 - 0.30 - 0.32 - 0.36 - 0.40 - 0.45 - 0.50- 0.54 - 0.60 - 0.63 -0.70 - 0.80 - 0.90 - 1.00- 1.25 -1.30 - 1.40 - 1.60 - 2.00 - 2.50 - 3.00 - 3.20

Table 2

NOTE:
See paragraphs 5.1, 5.2, 5.3.

7.1.3 Preparation of the timer for Digital Radiography (Videoradiography) use with automatic selection of exposure times (only ENDOS ACP version)

NOTE:
This automatic program is used only if you have intraoral Video-Digital Radiography equipment.

Press key (**14**)  ; the related signal switches on and times displayed on the display will be reduced in comparison with the use of the equipment with films and anyway they will reflect the selection made (Size, Tooth).

a) Digital X-ray exposure is selected automatically by selecting one of the available times.

b) To return to radiographic automatic selection press key again. 

NOTE:
The digital exposure time reduction factor can be modified by the Service Technician during setting up or directly by the user (see paragraph 7.5.3).

7.2 Preparation of the tubehead

a) Set the tubehead with an angle suitable for the exposure and positioning requested (see Figure 9, Figure 10, Figure 11, Figure 12).

b) Put the film into the patient's mouth according to the chosen way (bisecting or parallel). For this purpose, see paragraph 7.3.

c) Move the tubehead cone towards the patient and focus it exactly towards the tooth to X-ray referring to the following Figures.

NOTE:
If you want to use the rectangular collimator 35x45, assemble it by clicking it on the end of the collimator cone, positioning it as requested.

NOTE:
If you want to use the extended 30cm cone, snap it on the 20cm cone.

WARNING:
Anatomical preset times are no more valid when 30cm cone is mounted. Typically times necessary to obtain the same optical density must be multiplied by a factor 2.25, operating in manual exposure time selection.

LOWER JAW (MANDIBLE)

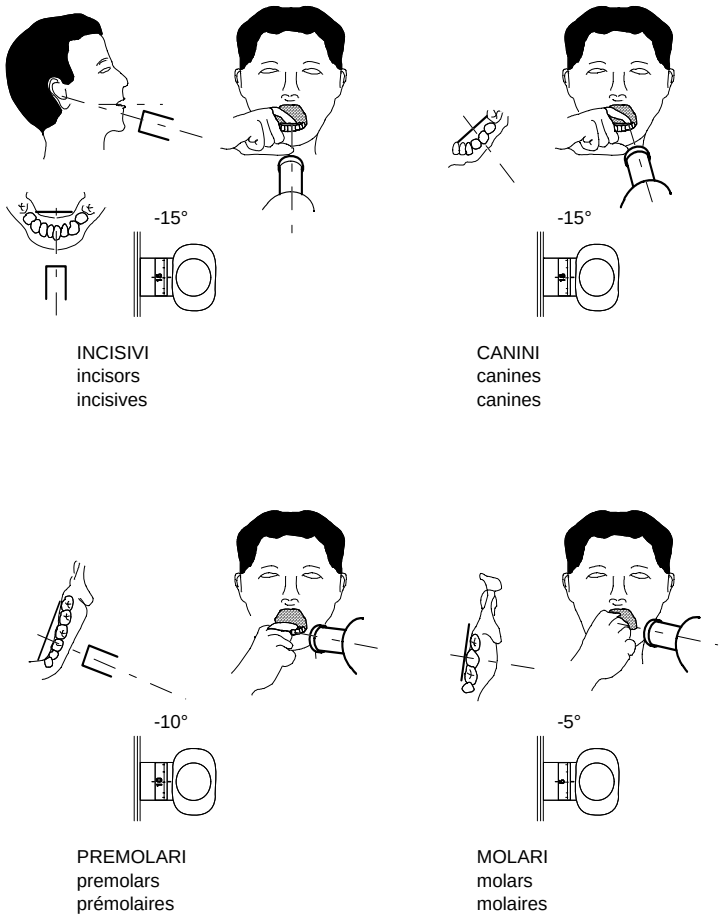


Figure 9

UPPER JAW

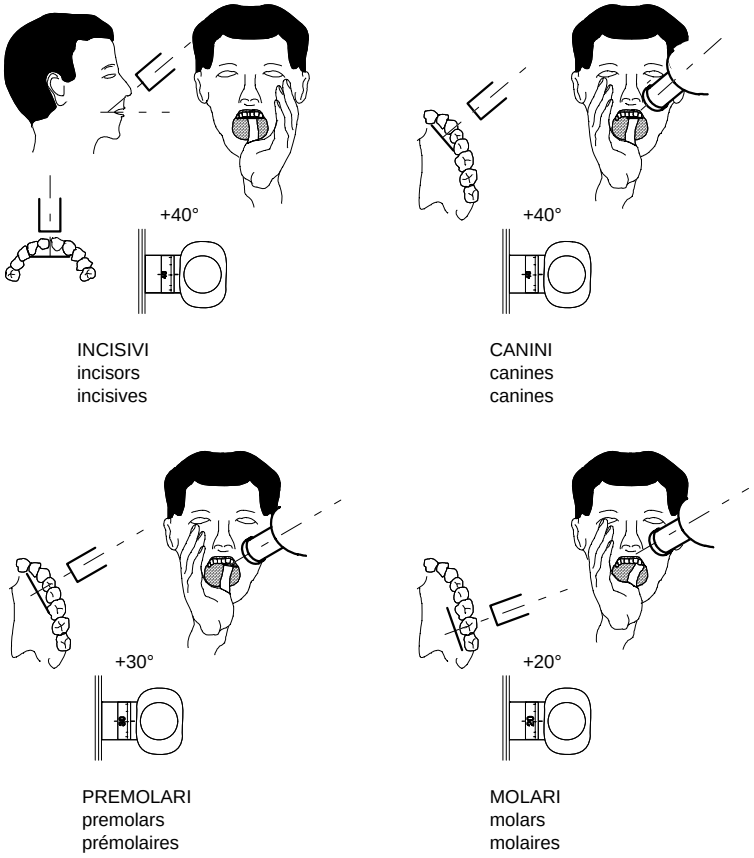


Figure 10

OCCLUSAL

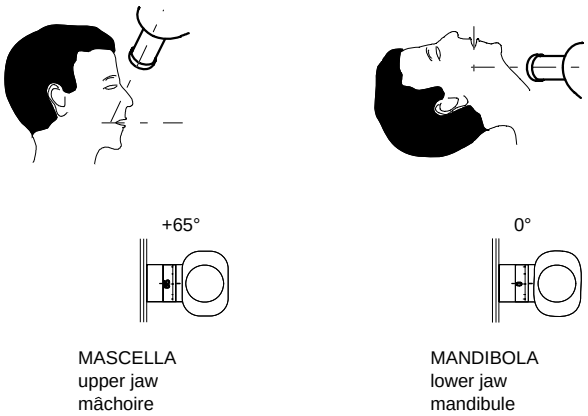


Figure 11

BITE WING

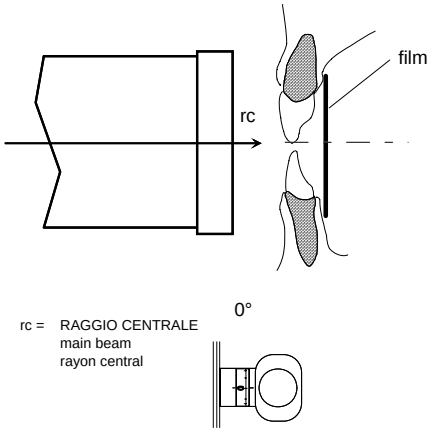


Figure 12

7.3 Exposure techniques

This paragraph describes the different techniques generally used for intraoral exposure.

7.3.1 Bisecting technique

Incidence X-ray beam – Vertical angle

To get a real image of the tooth, the X-ray must be perpendicular to the bisecting line of the angle formed by the longitudinal axis of the tooth and by the film.
After positioning the X-ray beam and the patient's head according to these criteria, it is possible to apply an average vertical incidence for each area. The incidence angle of the X-ray beam can be correctly measured by the graded scale applied to the tubehead.

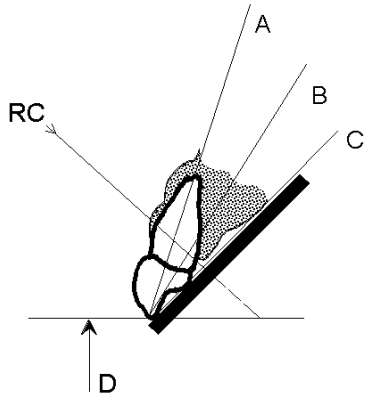


Figure 13

Legend Figure 13:
A – *Tooth longitudinal axis*
B – *Bisecting line*
C – *Film level*
D - *Occlusal level*
RC - *X-ray beam*

X-ray beam incidence – Horizontal direction

The X-ray beam must be set horizontally, in particular in the ortho-radial direction regarding inter-proximal spaces (see Figure 14), in order to avoid a superimposition of the structures (see Figure 15).

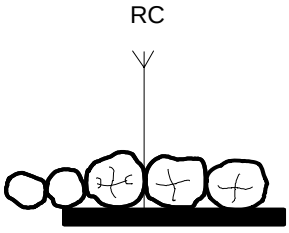


Figure 14
(Correct position)

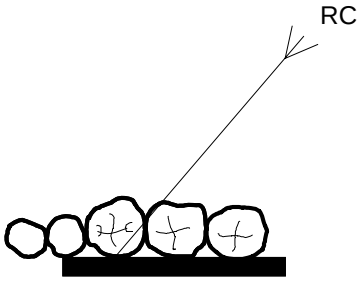


Figure 15
(Wrong position)

Legend Figure 14 and Figure 15

RC – X-r*ay beam*

7.3.2 Parallel technique

Using this technique, the film level is placed parallel to the tooth axis. Owing to anatomic factors, the film is generally kept away from the lingual surface of the tooth, except for molars.
When it is introduced into the patient's oral cavity, the film is fixed on a support to prevent distortion. The patient holds the support itself near the teeth.
Various types of supports are available on the market, to match the different types of teeth. This technique enables you to get more accurate and more easily repeatable X-rays compared with the bisecting technique (see Figure 16 and Figure 17).

HORIZONTAL SECTION

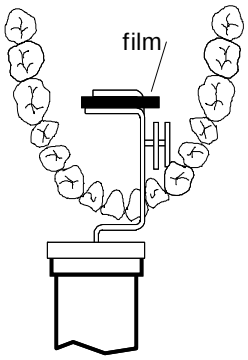


Figure 16

VERTICAL SECTION

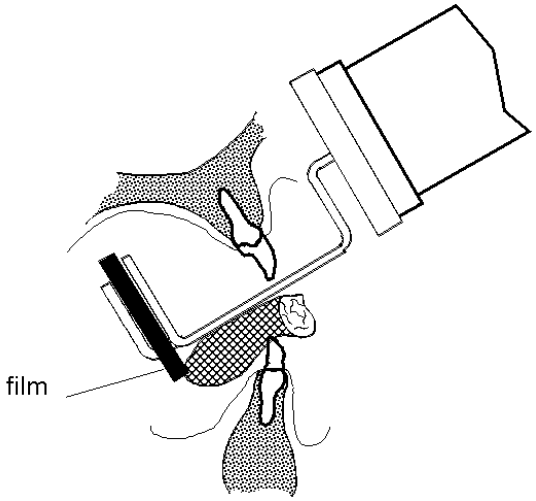


Figure 17

7.4 Exposure

a) Operating on the main keyboard, select exposure time as described in paragraph 7.2, according to the selected way.

b) Enable exposure by pressing key (**3**)  "Ready".

NOTE:
When the READY key is touched, the equipment will not only enable exposure but it will also start showing the exposure time on the display calculated according to line voltage fluctuation compensation (see paragraph 5.1).

c) Walk away as far as the X-ray button cable will allow, in the opposite direction to the X-ray beam.

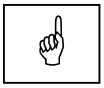
d) Press the X-ray emission button and keep it pressed during exposure.

e) Exposure starts when the yellow light and an acoustic signal come on.

WARNING:
- The X-ray emission button is a "dead man" control; so it must be held pressed during the whole exposure.
  If the button is released before the exposure ends, the emission is automatically stopped; this situation is shown on the display by the flashing message "**E P**", and the luminous signals on the keyboard will be off. This signal stays until one of the time increase keys is touched.
- If there is an excessive variation in line voltage which would require an actual exposure time of 4 or more seconds, the equipment will not execute the exposure. In this case, the display shows the correct exposure time according to the line fluctuation.
- If the voltage is outside an acceptable range, the display will show respectively 'LLL' (voltage too low) and 'HHH' (voltage too high).
- The touch of the X-ray button with non enabled exposure will display the value of the actual exposure time of the latest exposure made, or the time selected in the case of a first exposure.

f) When the exposure finishes, the equipment starts the tubehead cooling cycle (32 times the exposure time); this situation is shown by the flashing of the machine enabling light, while the time that must elapse before the pause end is shown on the display.

g) If the exposure enabled key is pressed when the X-ray button is already pressed, the exposure is stopped and the related error will be signalled.



NOTE:
The real exposure time corrected according to the line voltage variation does not include the necessary pre-ignition time so that the anodic current reaches 25% of the final value.

7.5 Special functions

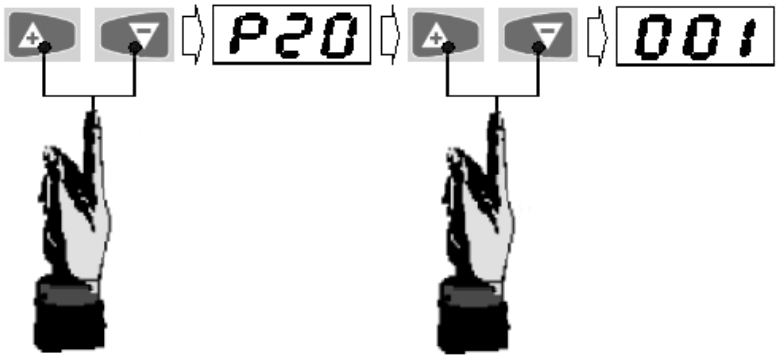
The user has the possibility of displaying 3 functional parameters:

7.5.1 Counting the number of exposures made

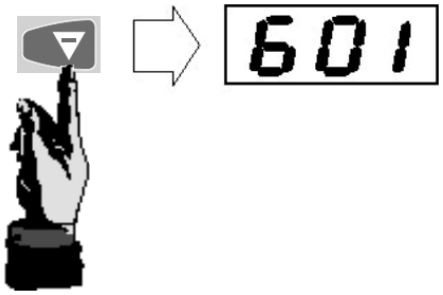
From the stand-by status it is possible to display the number of exposures made (from the last resetting) by the following procedure:

a) Press simultaneously and hold pressed the keys "increase" and "decrease" for more than 3 seconds; the display will show the message "P20" **(Release the two keys).**

b) To display the figure related to thousands (e.g. "001") press one of the keys "increase" or "decrease".



c) Press the key "decrease" to display the figures between 0 and 999.



The example shown is the same as reading 1601 exposures (001+601=1601).

To go back to stand-by status press key  .

7.5.2 Selection of multiplication factor for different types of film

NOTE:
This parameter is displayed only for the "ENDOS ACP" version, as the "ENDOS AC" version does not include the use of "automatic" selection.

This particular function enables the operator to vary the duration of exposure according to the film speed (so affecting the quality of X-ray image). The film speed is reported on the film boxes.

The value shown on display is **a X multiplication factor** correcting exposure times in **CONVENTIONAL RADIOLOGY** (non digital), **WITH AUTOMATIC ANATOMIC SELECTION.**

The different available X multiplication factors are reported in the following table:

X multiplication factor
0,2
0,4
0,5
0,6
0,8
Default value = 1,0
1,4
1,6
2,0

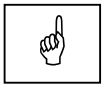
For the appropriate multiplication factor please check documentation provided by the film manufacturer.

To show this parameter on display it is necessary to switch off the equipment, switch it on again and when the wording relating to the software version (i.e. 4.xx) shows on the display, press key  for a few seconds.

P13 will appear. By pressing the "increase" or "decrease" key the value related to the set multiplication factor is displayed.

Use the "decrease" key if you want to decrease this time and the 'increase' key if you want to increase it.

Press key  to confirm the selection and to access modification of the multiplication factor for Video-X-ray-Digital (see paragraph 7.5.3).



NOTE:
If you do not want to modify the multiplication factor for Video-X-Ray-Digital, press key  again.

7.5.3 Selection of multiplication factor for Video-X-Ray-Digital

NOTE:
This parameter is displayed only for "ENDOS ACP" version, as the "ENDOS AC" version does not include the "digital function" selection use.

This particular function enables the operator to vary the length of X-ray emission according to the sensitivity of the digital acquisition system in use.

The value shown on display is **a X multiplication factor** correcting exposure times in **DIGITAL X-RAY**, **WITH AUTOMATIC ANATOMIC SELECTION.**

The different available X multiplication factors are reported in the following table:

X multiplication factor
0,10
0,15
Default value = 0,20
0,25
0,30
0,40

You must switch the equipment off to show this parameter on display, switch it on again and when the words referring to the software version appear on display press key  for a few seconds.

At first the words P13 referring to the multiplication Factor for the type of set film appear (its modification is described in paragraph 7.5.2).

Press key  to confirm the selection and display the words P14,

by pressing the "increase" or "decrease" key you display the value referring to the set multiplication Factor for Video-X-ray-Digital.

Use the "decrease" key if you want to decrease this time and the "increase" key if you want to increase it

Press key  to confirm the selection.

8. MESSAGES ON DISPLAY

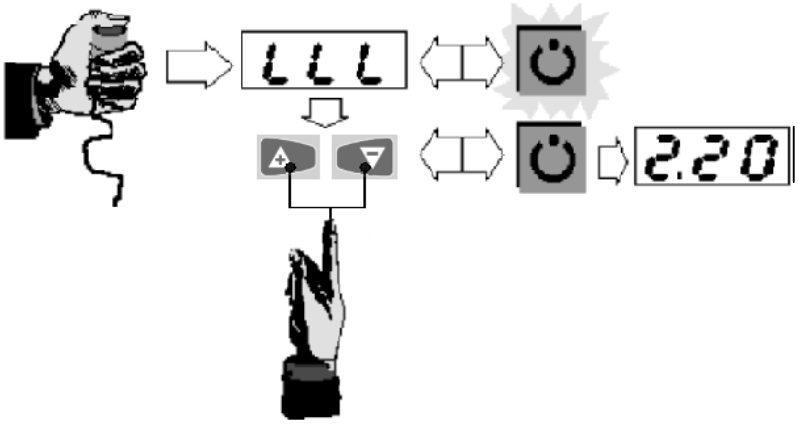
The ENDOS ACP or ENDOS AC timer display is also used to display messages identifying the equipment status.
These messages are connected to the conditions affecting X-ray emission or error conditions that occurred during normal working.

8.1 Functional messages

The X-ray cycle is not enabled or is stopped for the following reasons:

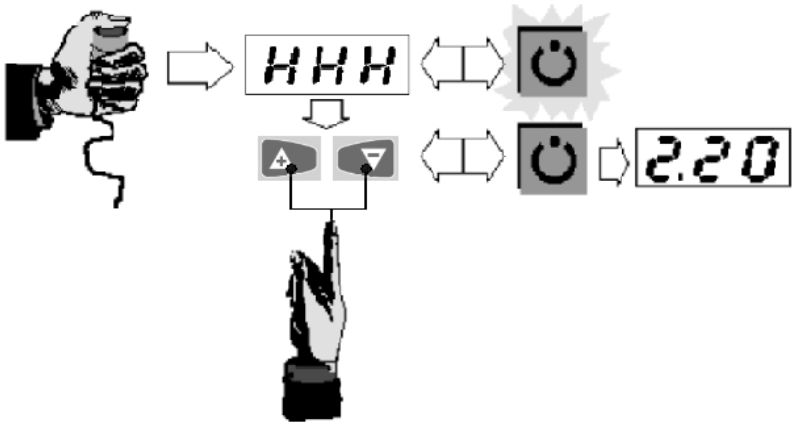
- **Line voltage less than 12.1% of rated voltage**

  Before making an exposure the device checks the line voltage. If the voltage is less than 12.1% compared with the rated voltage the display shows the letters "LLL" together with the operativity green LED which will start flashing. To reset this alert press any "increase" or "decrease" key.



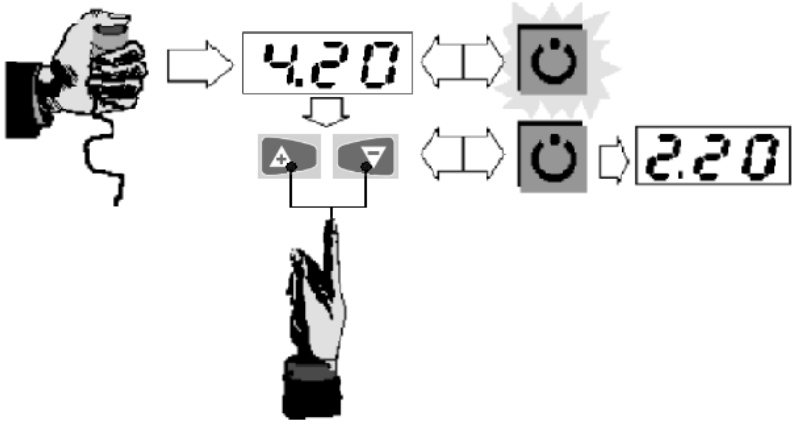
- **Line voltage more than 12.1% of rated voltage**

  Before making an exposure the device checks the line voltage. If the voltage is more than 12.1% compared with the rated voltage the display shows the letters "HHH" together with the operativity green LED which will start flashing. To reset this alert press any key "increase" or "decrease".



- **Exposure time more than 4 seconds**

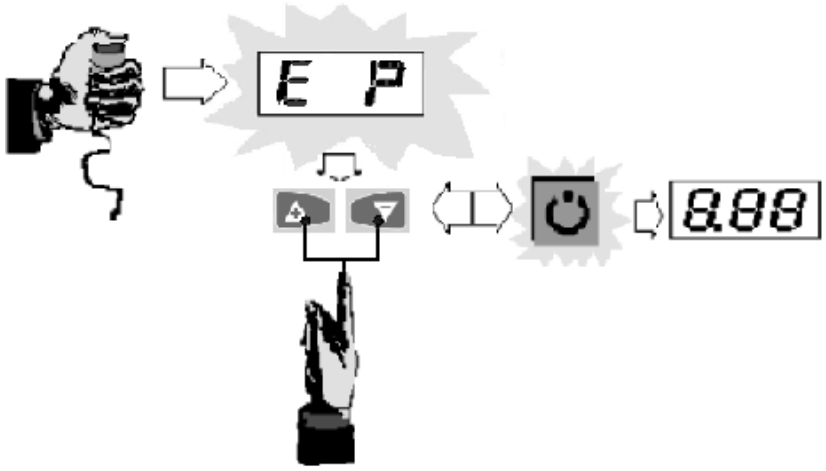
  In the start cycle phase (X-ray button pressed), the actual exposure time is calculated according to the variation of line voltage. When the time on the display is more than 4 seconds the time value will be calculated (ES. 4.20 seconds) and simultaneously the green LED of operational will flash. To reset this alert press any "increase" or "decrease" key.



NOTE:
If the equipment suffers a Software crash, there is a safety timer in the hardware that will cut off exposure after a maximum of 5.5 seconds.

- X-ray button released before exposure end

  The X-ray emission button is a "dead man" control; so it must be held pressed during the whole exposure. If the button is released before the exposure ends, the emission is automatically stopped; this situation is shown on the display by the flashing message "E P", and the luminous signals on the keyboard will be off. To reset this condition, press "increase" or "decrease": the green LED will start blinking without exposure and the tube cooling time countdown will be shown. When the cool down is over the device goes back to the IDLE state.



NOTE:
Before starting a new exposure, replace the film to avoid a double exposure with meaningless diagnostic results.

8.2 Error signalling

The ENDOS ACP and ENDOS AC timers are equipped with sophisticated diagnostics that allow you to monitor all operating phases and related safety devices.

Error messages which can be displayed are divided into three types:

- errors, in the start-up phase, which require intervention on the part of the Service Engineer;
- re-settable errors, in the start-up phase;
- errors found during the exposure phase.

The first type of error is found during the equipment start-up phase; if there is a non re-settable condition alert, the equipment stops and does not allow any operation. The condition is deleted just by switching the equipment off and starting it again or proceeding as described in the table in the following page. These anomalies have an error code of from "**E01**" to "**E09**".

Re-settable alert conditions stop some of the equipment's functions, but they allow some operations. These anomalies have an error code of "**E11**" or "**E12**".

Errors found in the exposure phase can also cause the timer to stop the following exposures. These anomalies have an error code of from "**E20**" to "**E25**".

Refer to the following descriptions for each error type.

8.2.1 Non re-settable errors

DISPLAY signal	ANOMALY type	ACOUSTIC signal	Checks and operations to execute
CHS	Checksum error of memories (EEPROM + EPROM) and RAM test (1)	Absent	Contact Technical Service
E01	X-ray relay closed at start-up	Absent	Contact Technical Service
E02	Tubehead supply active at start-up	**ACTIVE**	**Switch off system.** Contact Technical Service
E03	X-ray exposure enabling external button Primary pressed at start-up	Absent	Check if the primary X-ray button is pressed or in short circuit, in this case call Technical Service
E04	X-ray exposure enabling external button Remote pressed at start-up	Absent	Check if the remote X-ray button is pressed or in short-circuit, in this case call Technical Service
E05	Both X-ray exposure enabling external buttons pressed at start-up	Absent	Check if both X-ray buttons are pressed or in short-circuit, in this case call Technical Service
E06	Equipment enabling key pressed at start-up	Absent	Check the control keyboard and if necessary call Technical Service
E07	Digital selection key pressed at start-up (3)	Absent	Check the control keyboard and if necessary call Technical Service
E08	"Increase" key pressed at start-up	Absent	Check the control keyboard and if necessary call Technical Service
E09	"Decrease" key pressed at start-up	Absent	Check the control keyboard and if necessary call Technical Service

WARNING:

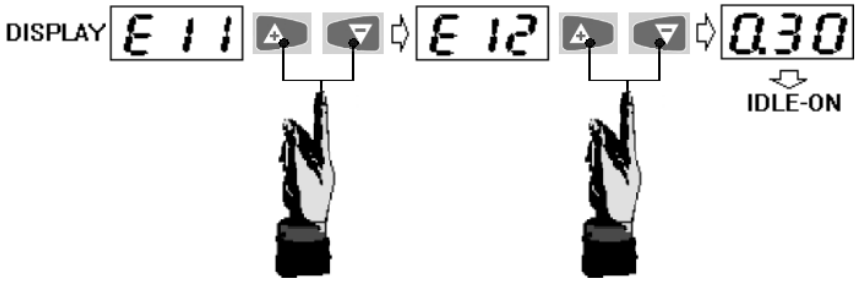
In the event of an **"E02"** error signal, switch the equipment off immediately because there is undesirable exposure.

8.2.2 Non fatal errors in start-up phase

If, during the TEST phase, one of the anomalies considered to be "**RE-SETTABLE**" occurs, the equipment enters a condition where the Anomaly signal is kept on display until you press one of the "increase" or "decrease" keys which take the equipment back to the stand-by status showing the exposure time on the display.

NOTE:
When the equipment gets more Anomalies simultaneously, touching the "increase" and "decrease" keys at the same time will show all the errors found on display in sequence. The equipment enters the stand-by status only after the last display has been "reset" and highlighted to the user.

EXAMPLE:
Selection keys SIZE and TOOTH ANATOMIC already pressed at the Power-on (TEST), we will have:



The display signals the user the type of trouble found in the following way:

DISPLAY signal	ANOMALY Type	Acoustic signal
E11	SIZE selection key pressed at start-up	Absent
E12	Tooth ANATOMIC key pressed at start-up	Absent

8.2.3 Errors in exposure phase

Non-closure of X-ray relay

DISPLAY signal	ANOMALY type	X-ray exposure	Checks and operations to execute
E20	X-ray relay does not close within pre-set time	Exposure not started	Call Technical Service

Non-aperture of X-ray relay

DISPLAY signal	ANOMALY type	X-ray exposure	Checks and operations to execute
E21	X-ray relay does not open within 50 msec	Exposure finished by the safety timer. **BUZZER signal goes on**.	Call Technical Service

Non-closure of X-ray control

DISPLAY signal	ANOMALY type	X-ray exposure	Checks and operation to execute
E22	X-ray triac does not close within 50 msec	Exposure not started	Call Technical Service

Non-aperture of X-ray triac

DISPLAY signal	ANOMALY type	X-ray exposure	Checks and operations to execute
E23	X-ray triac does not open within 50 msec	Exposure finished by the safety timer. **BUZZER signal goes on**	Call Technical Service

X-ray relay closed at cycle enabling

DISPLAY signal	ANOMALY type	X-ray exposure	Checks and operations to execute
E24	X-ray relay closed at X-ray cycle enabling	Exposure not started	Call Technical Service

Hardware timer intervention

DISPLAY signal	ANOMALY type	X-rays exposure	Checks and operations to execute
E25	Hardware timer intervention	Exposure finished by hardware timer	Switch equipment off and start again, if the trouble still exists call Technical Service

9. CHECK AND CORRECTION OF POSSIBLE ERRORS IN DENTAL X-RAYS

9.1 Typical faults in intraoral X-rays

- ### Too pale X-rays

  Possible causes:
  - Inadequate exposure to X-rays (short time)
  - Inadequate development time
  - Damaged developer
  - Developer temperature lower than the requested value
  - Wrong dilutions of developing fluids.

- ### Too dark X-rays

  Possible causes:
  - Excessive exposure to X-rays
  - Excessive development time
  - Developer temperature over the requested value
  - Wrong dilution of developing fluids

- ### Out-of-focus X-rays (impossibility to see details)

  Possible causes:
  - The patient moved
  - The tubehead moved.

- ### X-rays with fishbone marks

  Some intraoral films have a thin lead layer in the box with some fishbone marks engraved in the lower part. These films can be exposed to radiation only on one side. If the film is exposed to the wrong side, the lead layer will absorb a large amount of radiation during exposure. The result will be a lighter X-ray and the film will show fishbone marks.

- Partially exposed X-rays

  Possible causes:
  - X-rays directed far from the medial section of the film
  - Low fluid level, with subsequent partial development of the film
  - Two or more films one close to the other in the developer.

- Darkened X-rays

  Possible causes:
  - The film has been in the warehouse for too long (check expiry date)
  - Accidental exposure of the film to X-ray
  - Accidental exposure of the film to other sources of natural or artificial light.

- Dark line on X-rays

  This line appears when the film is excessively folded.

- X-rays with marks of electrostatic electricity

  When the film is excessively compressed and the air is dry, electrostatic electricity can be released so it can run down to compression points, where black marks form.

- X-rays with chemical spots

  The scattering of developing or fixing fluid on the film before development and fixing procedures causes spots on the X-rays; these spots are:
  - Dark if caused by the developing fluid
  - Light if caused by the fixing bath.

- X-rays with emulsion loss

  If the film is kept in a warm water bath too long (for instance, all night), the emulsion can soften and partially come off the base of the film. After development, the film will be scratched.

9.2 Typical faults caused by wrong positioning

- **X-rays with extended or shortened images**

  The X-ray beam is not perpendicular to the bisecting line of the angle formed by the longitudinal axis of the tooth and by the film.

- **X-rays with extended apex of the tooth**

  Probably caused by excessive folding of the film in the patient's mouth.

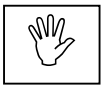
10. MAINTENANCE

Like all electrical equipment, this unit requires not only correct use, but also maintenance and checks at regular intervals. This precaution will guarantee that the equipment works safely and efficiently.

Periodic maintenance consists in checks carried out directly by the operator and/or by the Technical Service.

The operator can carry out the following checks himself:

- check the labels are intact and well attached
- check there are no oil marks on the tubehead
- check the remote control cable is not broken or scratched
- check there are no external damages to the equipment which could make it unsafe in terms of protection from radiation
- check the scissors arm balance



WARNING:
If you find irregularities or damages the operator must inform the Technical Service immediately.

MAINTENANCE OPERATIONS RECORD

Installation: Date ..... Technician.....

Maintenance: Date ..... Technician.....

Cause .....

Maintenance: Date ..... Technician.....

Cause .....

Maintenance: Date ..... Technician.....

Cause .....

Maintenance: Date ..... Technician.....

Cause .....

Maintenance: Date ..... Technician.....

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