ENDOS DC

CE 0434

Service Manual

Release 16 April 2003 (Rev. 0)

Contents

1. INTRODUCTION

NOTE:
The present manual is updated for the product it is sold with in order to grant an adequate reference in performing diagnostics and repair operations normally carried out by the service engineer.
The manual may not reflect changes to the product not impacting service operations.

The intraoral radiographic ENDOS DC, produces high quality intraoral X-rays, thanks to the exam repetitiveness combined with reduced exposure times and the small dimensions of the focal spot.

ENDOS DC is designed exclusively for performing intraoral X-rays.

The equipment has the following features:

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

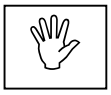
This manual is intended to give instructions for the correct installation and maintenance of the device.

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 design and make 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 DC 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's and Service Manuals 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 present 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 DC 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 DC 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, where necessary, to protect the patient from radiation.

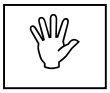
Although the equipment is designed to provide a reasonable degree of protection from electromagnetic interference, according to IEC International regulations, it must be installed at an adequate distance from electricity transformer rooms, static continuity units, two-way amateur radios and cellular 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 DC 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 DC and supplied by a dedicated electric line.

ENDOS DC 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.

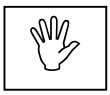
Equipment parts which may come into contact with the patient must be cleaned regularly according to the instructions given later in the User's Manual.



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

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.

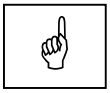
e) The lead aprons should be used to reduce the undesirable effect of secondary radiation on the patient.

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:** external packages in non-biodegradable plastic, dielectric oil, lead, copper, brass, aluminium, resin, tungsten, beryllium
- **Power supply and remote control:** external packages in non biodegradable plastic, iron, copper, plastic reinforced by fibre glass
- **Tubehead extension:** iron, aluminium, copper.



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 on ENDOS DC:

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

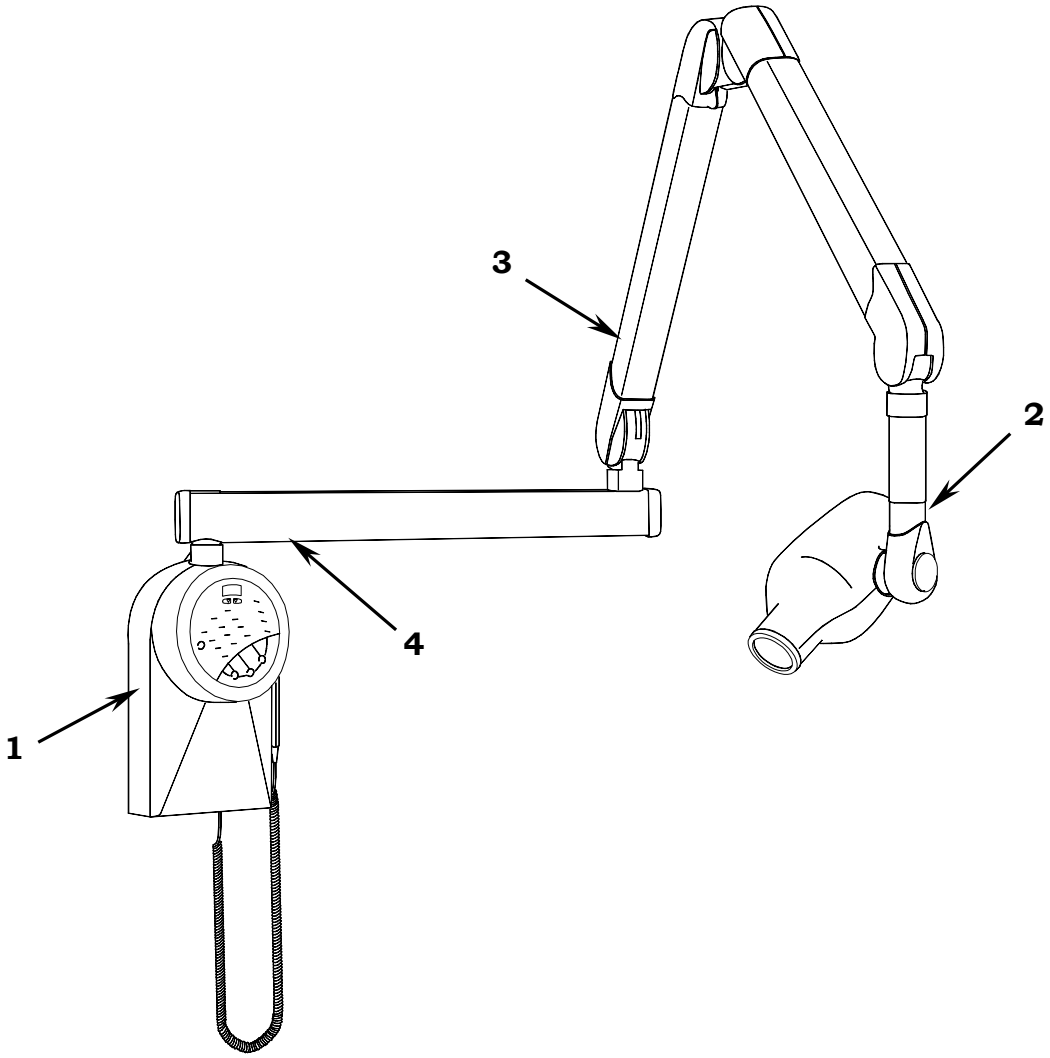
2.5 Attention points during installation

Be very careful in mounting properly the wall plate and the scissors arm. **Follow carefully instruction given in the present manual.**
Cut the safety tape against unwanted opening of the scissors arm only at the end of installation. Voltage of additional signaling lamps must not be over 24V.

Take maximum attention during the calibrating phase when the system is powered ON; **some components are at 400Vdc and not insulated**.
Presence of the power supply is made evident by the H1 LED (green) see its position on the layout of board A1 (P/N 58603901.
Interventions on the circuitry must be done only after having disconnected the line voltage and after all LEDs in the generator board are completely turned off. **It is advisable to wait at least 1 minute after having disconnected the system from mains.**

3. DESCRIPTION

3.1 Identification labels



1
ENDOS DC label

DENT-X

ENDOS DC

Line: 120 V~ 5.7 A (99 V~) 60 Hz

Duty cycle: 1/16 Max exposure time: 2 s

Manufactured: MMMMYYYY

X-RAY CONTROL Model: 8361300100

S/N: 25XXYYYY

Manufactured by
VILLA SISTEMI
MEDICALI S.p.A.
20090 Buccinasco
MILANO - ITALY

CE 0434 THIS PRODUCT COMPLIES WITH FDA RADIATION PERFORMANCE STANDARDS 21 CFR SUBCHAPTER J, IN EFFECT AT DATE OF MANUFACTURE

1a
WARNING label

COMPLIES WITH DHHS PERFORMANCE STANDARD 21 CFR SUBCHAPTER J

WARNING:

THIS X RAY UNIT MAY BE DANGEROUS TO THE PATIENT AND OPERATOR UNLESS SAFE EXPOSURE FACTORS AND OPERATING INSTRUCTIONS ARE OBSERVED.

ELECTRICAL SHOCK HAZARD - DO NOT REMOVE PANELS.

RISK OF EXPLOSION - DO NOT USE IN PRESENCE OF FLAMMABLE ANESTHETICS.

FOR CONTINUED PROTECTION AGAINST RISK OF FIRE, REPLACE ONLY WITH SAME TYPE AND RATING OF FUSE.

DANGER:

RISQUE D'ESPLOSION - NE PAS EMPLOYER EN PRESENCE D'ANESTHESIQUES INFLAMMABLES.

POUR ASSURER UNE PROTECTION CONTINUE CONTRE LE RISQUE D'INCENDIE, UTILISER UNIQUEMENT UN FUSIBLE DE RECHANGE DE MEME TYPE ET DE MEMES CARACTERISTIQUES NOMINALES.

2
Tubehead label

DIAGNOSTIC SOURCE ASSEMBLY
Model: ENDOS DC Type: 8461400002
S/N: **35XXYYYY**
Output max: 65kVp 5mA 2 sec
■ 0.7 IEC 336 Total filtration: ≥2 mm Al
X-ray beam: Ø ≤ 6 cm at FFD 20 cm
X-RAY TUBE **Model: OCX 70/G**
Manufacturer CEI Bologna Italy
S/N: .....
Manufactured: MMMM YYYY
THIS PRODUCT COMPLIES WITH FDA RADIATION PERFORMANCE STANDARDS 21 CFR SUBCHAPTER J IN EFFECT AT DATE OF MANUFACTURE
Manufactured by VILLA SISTEMI MEDICALI for DENT-X

3
DP arm label

Manufactured by
VILLA SISTEMI
MEDICALI S.p.A.
20090 Buccinasco
MILANO - ITALY

Model: 8161200702

Serial number:

13XXYYYY

Settled for:

ENDOS DC

4
Extension arm label

Manufactured by
VILLA SISTEMI
MEDICALI S.p.A.
20090 Buccinasco
MILANO - ITALY

Model: 8161200X02

Serial number:

10XXYYYY

5
Collimator 30 cm (optional) label

DENT-X

BEAM LIMITING DEVICE Model: 61614050

Diameter Ø ≤ 6 cm at FFD 30 cm

S/N: 40XXYYYY

Manufactured: MMMM YYYY

Manufactured by
VILLA SISTEMI
MEDICALI S.p.A.
20090 Buccinasco
MILANO - ITALY

THIS PRODUCT COMPLIES WITH FDA RADIATION PERFORMANCE STANDARDS 21 CFR SUBCHAPTER J, IN EFFECT AT DATE OF MANUFACTURE

3.2 Functions

3.2.1 ENDOS DC

ENDOS DC is able to produce excellent quality X-rays thanks to parameters repeatability and has very short exposure times and a very small focal spot.

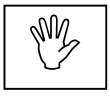
ENDOS DC X-ray equipment is compatible with VIDEORADIOGRAPHY equipment systems (Digital image acquisition equipment) and incorporates the latest digital X-ray intraoral technology.

If you do not possess VIDEORADIOGRAPHY equipment you are recommended to use high-speed films or EKTASPEED films (Kodak) in order to limit the dosage absorbed by the patient.

The working mode can be selected using the control keyboard, with the possibility of choosing between two films of a different speed (sensibility), the digital sensor or a mode that can be customised by the user, called "Custom".

ENDOS DC equipment can use the optional 30cm collimator cone (to be ordered separately with 6161405000 code); the change from standard cone (20 cm) to 30 cm cone (or vice versa) is possible using a special key; the "long cone inserted" selection is displayed by the relevant LED start-up.

The change from standard cone (20 cm) to long cone (30 cm) is made by touching keys "film speed" and "increase" at the same time and it is indicated by the relevant LED. In this selection, pre-set exposure times in anatomic selection are automatically increased by a multiplication factor equal to 2.
Vice versa, the change from long cone to standard cone is achieved by touching keys "film speed" and "decrease" at the same time.



WARNING:
ENDOS DC equipment does not automatically detect the presence of the type of cone: it is the operator's responsibility to check that the luminous sign does actually indicate the true situation.

3.2.2 High frequency generator (or HF)

ENDOS DC is composed of a generator, a tubehead including a collimator, a CPU card (or logic) which controls the equipment functions and a keyboard used to select exposure parameters. The standard configuration provides a keyboard directly connected to the CPU card, while an optional configuration allows the keyboard to be set up in remote control; in this case, instead of the X-ray button you can use the key provided directly on the keyboard itself.

The HF generator, driven by remote control, linked with the tubehead, uses microcontroller technology know-how to get very good quality X-rays and, at the same time, reducing the X-ray dose to the patient. Conventional equipment generally uses the intrinsic skill of the RX generator tube to conduct electric current in only one way. In this way you get the generation of a "train" of RX pulses. Vice versa ENDOS DC apparatus, uses the "constant tension" technology generating a continuous and steady exposure. Moreover, the emission of soft X-rays is so small that it ensures that emission parameters, kVp and mA are constant throughout exposure time. The control microprocessor ensures that exposure times remain constant and that they can be repeated; exposure voltage and exposure times depending on the patient's size and the selected tooth can be selected simply by pressing a key.

The HF tubehead is much smaller thanks to the back positioning of the X-ray tube; the length is only 27 cm, while the focus-skin distance remain at the standard 20 cm. Because the tubehead is so light (only 4.5 Kg.) the arm is remarkably easy to handle.

3.3 Configurations

3.3.1 Standard configuration

ENDOS DC is manufactured in standard configuration (9461000013 code) composed of the parts defined in the following picture:

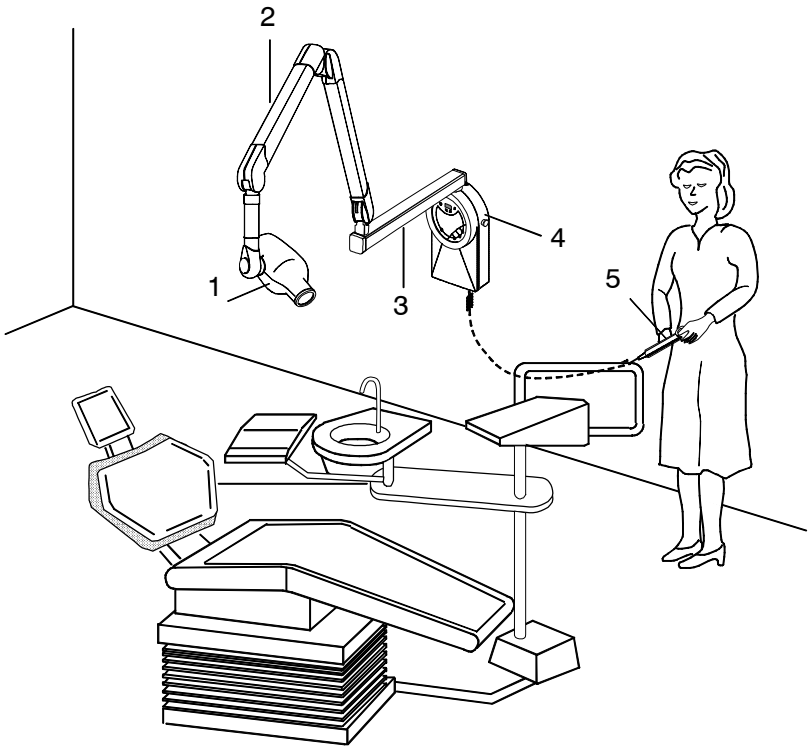


Figure 3-1

1 Tubehead
2 Scissors arm
3 Extension arm
4 Timer with high frequency generator
5 X-ray button

3.3.2 Mobile stand configuration

ENDOS DC can be assembled on a mobile stand; this configuration gives greater flexibility of use.

NOTE:
The mobile stand version must be requested when ordering. The conversion from wall version to mobile stand version is not provided.

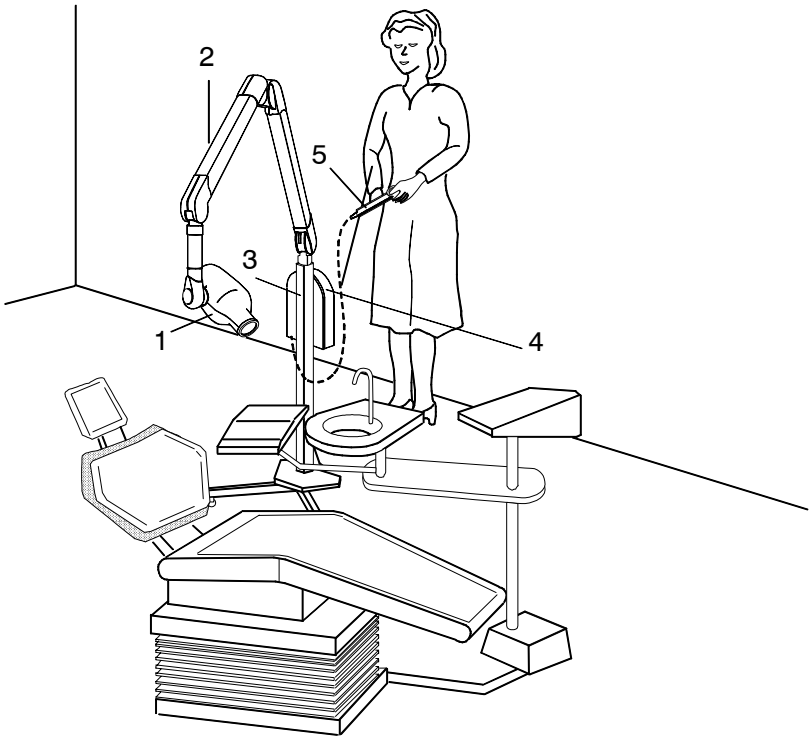


Figure 3-2

1 Tubehead
2 Scissors arm
3 Mobile stand
4 Timer with high frequency generator
5 X-ray button

3.3.3 Remote keyboard configuration

It is possible to get a remote keyboard configuration, outside the exam room.
Moreover, the apparatus provides two separate contacts for connection with external signaling devices. One contact signals the equipment is ON and ready for use while the second one signals the presence of X-rays. The connection mode and the necessary signal device requirements are reported at paragraph 6.5.1.

NOTE:
In this configuration you are recommended to install the remote keyboard in a place that is reserved for the exclusive use of specialised technical personnel and not in a place that is accessible to unauthorised persons.

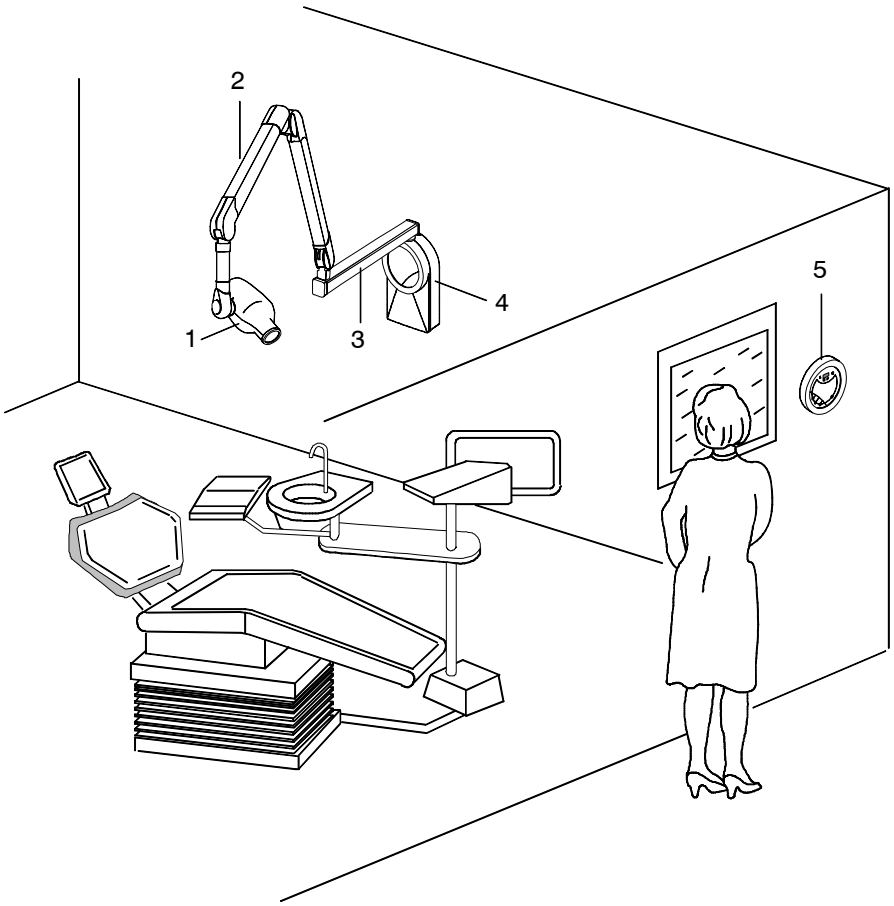


Figure 3-3

1 Tubehead
2 Scissors arm
3 Extension arm
4 High frequency generator
5 Remote timer

4. TECHNICAL FEATURES

Technical features		
Equipment	ENDOS DC	
Manufacturer	VILLA SISTEMI MEDICALI Buccinasco (MI) Italia	
Class	Class I° with type B applied (EN 60601-1 classification) 	
Protection level	Standard apparatus IP20	
Line voltage	**198 ÷ 264 V~**	**99 ÷ 132 V~ (*)**
Line frequency	50 – 60 Hz	
Rated current	0.2 Arms continuous, 2.25 Arms impulsive **@** 230 V~	0.4 Arms continuous, 5,7 Arms impulsive @ 99 V~ **(*)**
Power consumption	50 VA continuous, 0.55. kVA impulsive **@** 230 V~	50 VA continuous, 0.55. kVA impulsive **@** 120 V~
Max. apparent line resistance	0,8 Ω max	**(*)**
Line voltage regulation	-	< 3 % at 99 V
Main fuse	3 AT	6 AT
Preset exposure times	from 0.01 to 2s in 35 steps	
Automatic selection	60 pre-set times	
Time accuracy	±5 % or ± 2 ms	
Circuit type	constant potential	
High voltage value	65 kV_p	
Tubehead current	4 and 5 mA selectable	
kV accuracy	± 5 %	
Tubehead (anode) current accuracy	± 5 %	
Max. exposure time	2 s	
Electronics box dimension	345x195x100mm	

(*) *The unit can be operated with the line voltage 100 V ± 10 %, under the condition that line resistance is lower than 0.4 Ω (complies with IEC 601-1). Max line current absorption at 100 V –10 % is 6 A.*

Tubehead features	
Manufacturer	VILLA SISTEMI MEDICALI Buccinasco (MI) Italia
Rated voltage	65 kV_p
Tubehead power	325 W max.
Total filtration	≥ 2 mm Al @ 65 kV_p
HVL (Half Value Layer)	> 1.5 mm Al eq.
Transformer insulation	Oil bath
Interval between exposures / duty cycle	15 times X-ray time / 1 : 15 (adaptive)
Focal spot	0.7 (IEC 336) @ 5 mA
Minimum focus to skin distance	20 cm (optional 30 cm)
X-ray diameter (@ 20cm focus)	6 cm (optional 35 x 45 mm)
Cooling	Convection
Radiation leakage at 1 m	< 0.25 mGy / h
Technical factors for radiation leakage	65 kV - 5mA - 1s / Duty cycle 1 : 15
X-ray tube features	
Manufacturer	CEI Bologna (Italy)
Type	OCX / 70-G
Inherent filtration	0.5 mm Al eq. a 70 kV_p
Anode tilt	19°
Anode material	Tungsten
Rated voltage	70 kV
Maximum filament current	2.8 A
Maximum filament voltage	4.1 V
Anode thermal capacity	6 kJ
Anode cooling capacity (max)	90 W

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
Weight of equipment and detachable parts	
Gross weight including packing	35 kg
Net weight of equipment in standard configuration	22 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
Wall plate with generator	5 kg
Tubehead	4.5 kg

NOTE ABOUT COOLING TIME:
ENDOS DC equipment is designed to guarantee the best efficiency of use for the operator; this feature also includes a low tube cooling time, in order to limit the waiting time between one exposure and the next even when the equipment is being used intensively. In order to guarantee the useful life of the equipment, cooling time varies according to the conditions in which the equipment is used and it can assume even 1 : 30 values (30 s waiting every 1 s exposure) or 1 : 45 (45 s waiting every 1 s exposure). The calculation algorithm preset in the equipment takes into account the usage conditions and applies the correct value for the pause between two consecutive exposures.
Considering all this, you are advised not to switch the ENDOS DC off immediately after an exposure.

4.1 Method of measuring technical factors

NOTE
The best way to measure technical factors is by taking a direct measurement of radiological parameters. This is also called the invasive method. This method requires access to live parts so it can be performed by personnel authorised by the Manufacturer only.

The measurement method using non invasive tools, for instance the kV_p/t meter, is acceptable, even though it usually gives a less accurate result. In fact, measuring the high tension tube value using non invasive tools is strictly correlated to the method chosen by the manufacturer of the tool himself; generally this method is less accurate than the direct method and it may also require two consecutive exposures.
Similarly, anode current measurement using the indirect method is affected by systematic errors, as it is very often based on the current/time product measurement, dividing the measurement by the time measured by this method.

The logic card (CPU) has 3 test points (TP kV, TP mA and TP GND) to which the tool used for the measurement is connected, typically a digital multimeter with an entry resistance of more than 10 MΩ or memory oscilloscope.

- **High tension value to the tube**

  Connect the positive prod on TPkV and the negative one on TPGND; select a 1 s exposure time and read the value measured by DVM considering 1VDC = 20 kV; you must measure a 3.25 V DC ± 160 mV (3.09 ÷ 3.41) value.

- **Anode current value**

  Connect the positive prod on TPmA and the negative one on TPGND; select a 1 s exposure time and read the value measured by DVM considering 1VDC = 2 mA; you must measure a 2.5 V DC ± 125 mV [2.375 ÷ 2.625 V] value for 5 mA anode current, while for 4 mA you must have 2 V DC ± 100 mV (1.9 ÷ 2.1 V).

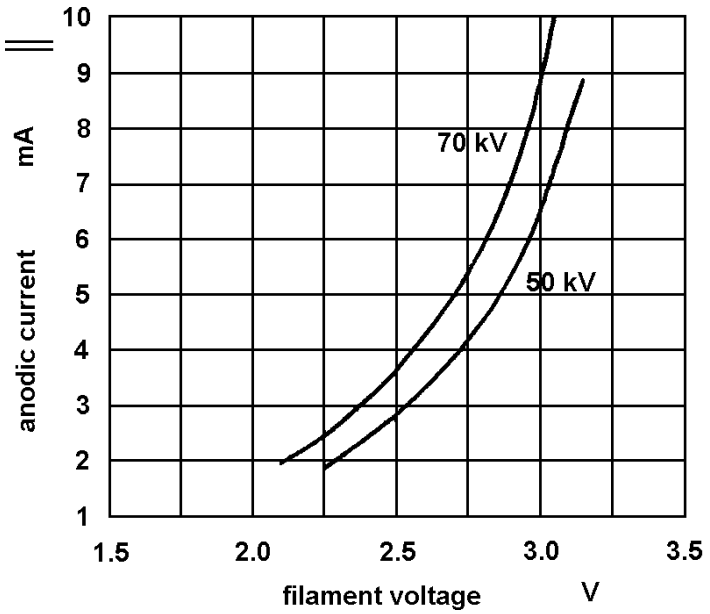
- **Exposure time measurement**

  Use a memory oscilloscope, connecting the hot point of the sound to TPkV and the mass to TPGND. Set the oscilloscope to wave form storage, with the trigger on the positive side. Select the required exposure time and make an exposure. The exposure time is **defined as the interval between the moment when Kv value goes above 75% of the stationary value and the fall under this value: exposure time accuracy must be ± 5% or ± 2 ms if bigger.**
  When using a non invasive tool, such as a kV_p/time meter, there may be a bigger error, depending on the measurement tool used.

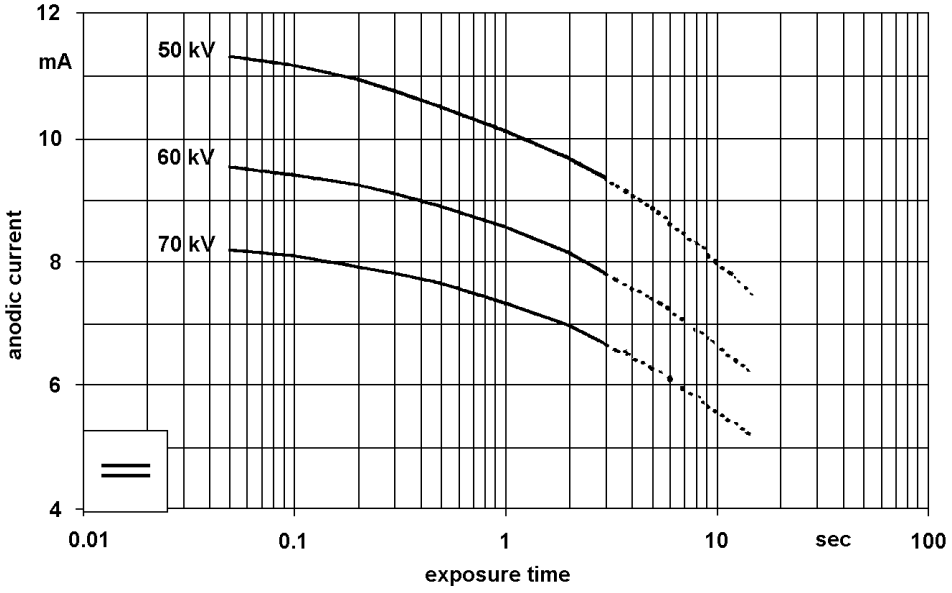
4.2 Curves tube features

OCX / 70-G

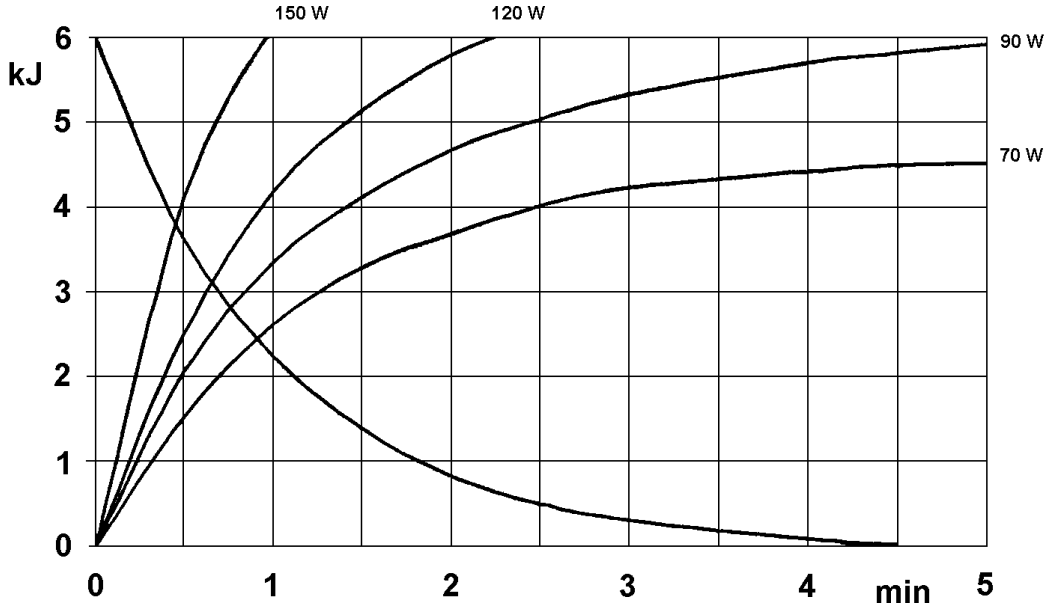
Emission feature



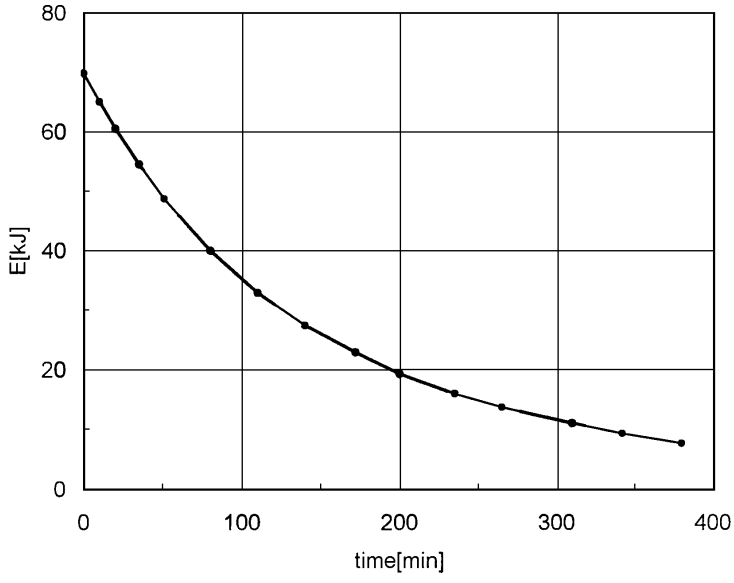
Load



Curve anode cooling



Curve tubehead cooling



4.3 Standard and regulations

ENDOS DC equipment complies with the following regulations:

- EN 60601-1 (IEC 601-1)
- EN 60601-1-1 (IEC 601-1-1)
- EN 60601-1-2 (IEC 601-1-2)
- EN 60601-1-3 (IEC 601-1-3)
- EN 60601-2-28 (IEC 601-2-7)
- EN 60601-27 (IEC 601-2-7)

- CFR 21 Subchaper J for version operating at rated line voltage 99-132 V

CE symbol certifies the compliance of ENDOS DC to 93/42/CEE legal directives.

4.4 Overall dimensions

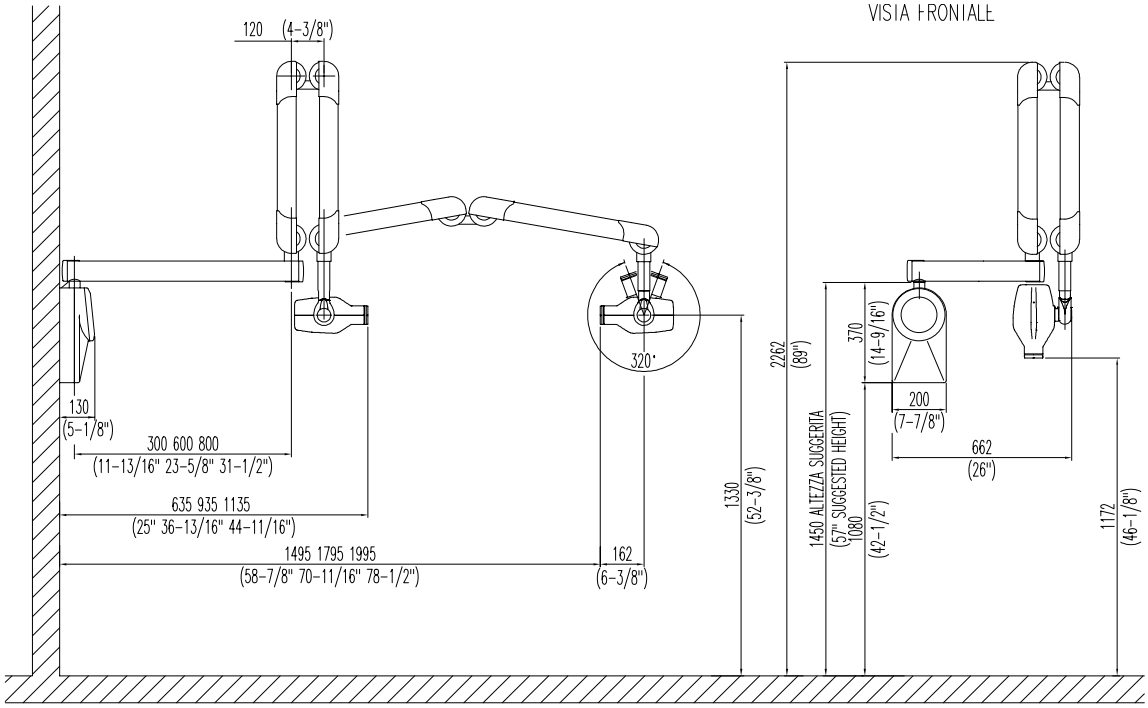


Figure 4-1: Wall version overall dimensions

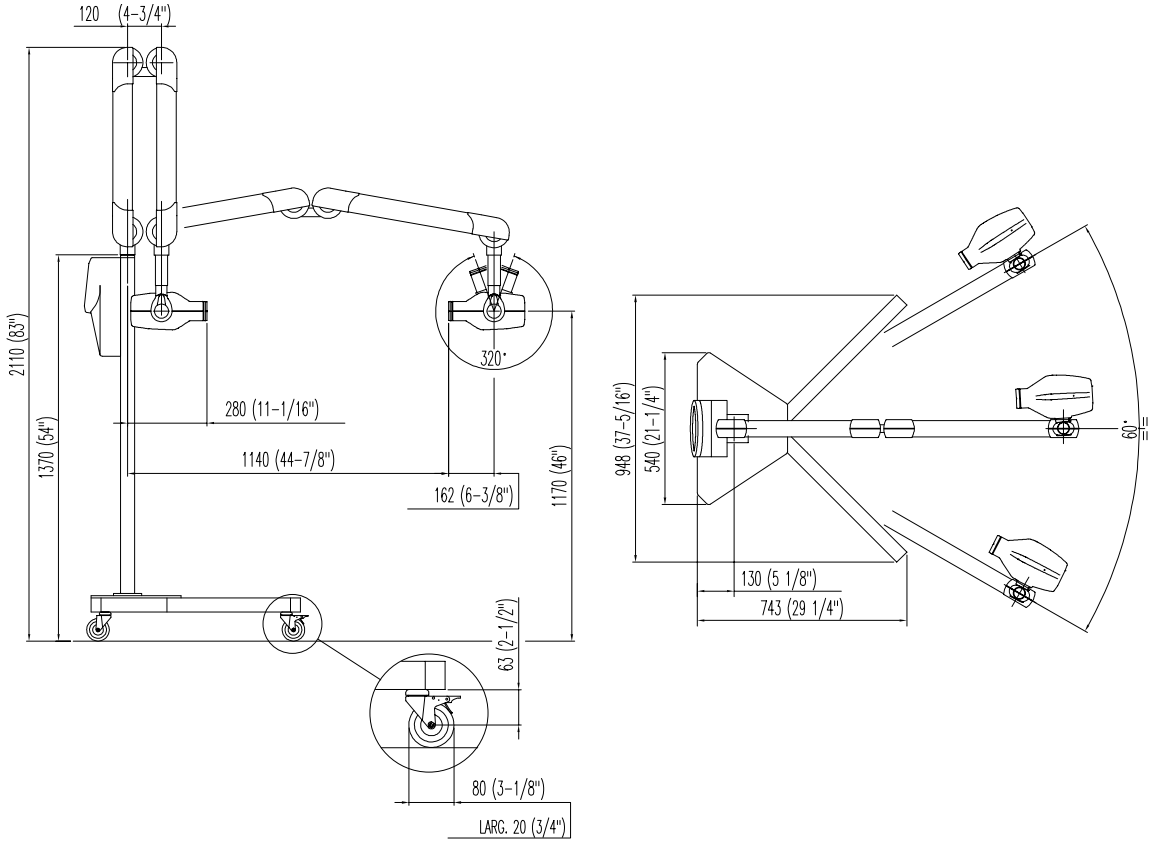


Figure 4-2: Mobile Stand version overall dimensions

5. PRE-INSTALLATION

ENDOS DC does not ask for special pre-installation works, still it is necessary to grant an adequate grounding for EMC compatibility and safety.
Section of grounding cable must be at least equal of greater than the section of line cables. It is advisable to use a grounding cable G/V with section 2.5mm².

If cables are going to be positioned inside the wall, it is better that ducts are already positioned, taking into account where the device will be installed, taking care that cables exit in correspondence of the hole on the lower right side of the wall plate.

The Manufacturer can assist technically in the pre-installation phase, but preparation works are a customer's responsibility.

5.1 Mounting methods

NOTE:
This chapter is valid for Wall version. The user does not need to assess the consistency of the wall for Stand version.

The installer is responsible for assessing the consistency of the wall. The extraction load on each screw is 570 N (58kg) for the wall version standard assembly (3 mounting screws), 1084 N (110kg) for the wall version "single stud" assembly (2 screws in line).
For each type of wall use the appropriate mounting method complying with the following specifications which guarantee a safety factor 4:

- Wooden uprights: self-threading screws 8x70 A 4.8 (provided with the installation kit)
- Full or concrete bricks: screw anchors (provided with the installation kit) in cast iron M8 or chemical screws WURTH (optional)
- Hollow bricks: chemical screws (optional).

A counter-plate must be used with walls with a lower resistance (see paragraph 6.5.3).

WARNING:
The Manufacturer is not responsible for any installations that do not comply with the specifications stated above.

5.2 Electric pre-setting

- Single-phase supply + ground 230 V~ / 120 V~
- Frequency 50 Hz – 60 Hz
- Absorbed current during emission 2.25 A / 4.5 A
- Apparent line resistance 0.8 Ω max / 0.4 Ω max.

NOTE:
The device is intended for permanent installation.
It is forbidden to connect the system by a plug in a wall socket for safety reasons.
Mobile version has to be requested on order and it is not possible to transform wall mounted version into a mobile version in field.

NOTE:
A circuit breaker with overcurrent protection must be connected to the intraoral X-ray equipment with the following features:

- Nominal current: 6A
- Differential sensitivity: 0.03A.

Section of line cables must be not lower than 1.5 mm^2.

Grounding of the system must meet requirement of the laws; a bad grounding can be dangerous for the operator and can generate malfunctioning of the device.

NOTE:
ENDOS DC can be connected to signaling devices outside the installation room; please make reference to chapter 6.5.1.

It is also possible to mount the system with remote keyboard: in this case it is necessary to use a cable with phone connector provided by the Manufacturer.

6. INSTALLATION

ENDOS DC intraoral X-ray equipment is shipped pre-assembled in sub-assys.
Mechanical assembly work consists solely in assembling these units.
All the mechanical components are therefore adjusted before delivery; not only is there no need to carry out any adjustment on these parts but it would also cause the equipment to malfunction; any adjustment must be carried out by authorised personnel only.

6.1 Timer set up (standard configuration)

1. To be sure that the equipment is in the correct position we recommend you put the provided template (4) (code 39619100) in the requested position, in this way identifying the requested wall-mounting position. Considering the overall dimensions of the equipment, put the top part of the template at 1450 mm (57") from the floor.

WARNING:
The plate must be placed so that the entry hole of the supply cables corresponds with the point from which these cables exit the wall.

The installer will assess the consistency of the wall taking into consideration the screw extraction load specified in paragraph 5.1.

2. Mark the mounting points and make the respective holes with a diameter corresponding to the chosen screws.

3. Remove the plastic timer cover (**1**) loosening the two sealing screws (**3**) placed on the lower part and lifting the cover from the bottom to the top to let the upper clamps out.
The make the operation easier, disconnect all wires between wall plate and cover.

4. Remove metallic plate (**2**) covering the power board, acting on the 4 screws.

NOTE:
The metallic plate holds the logic board (CPU) which is already connected to power board; take care to avoid damaging the flexible cable connecting the two boards.

5. Fix the timer to the wall using the relevant screws (**5**).

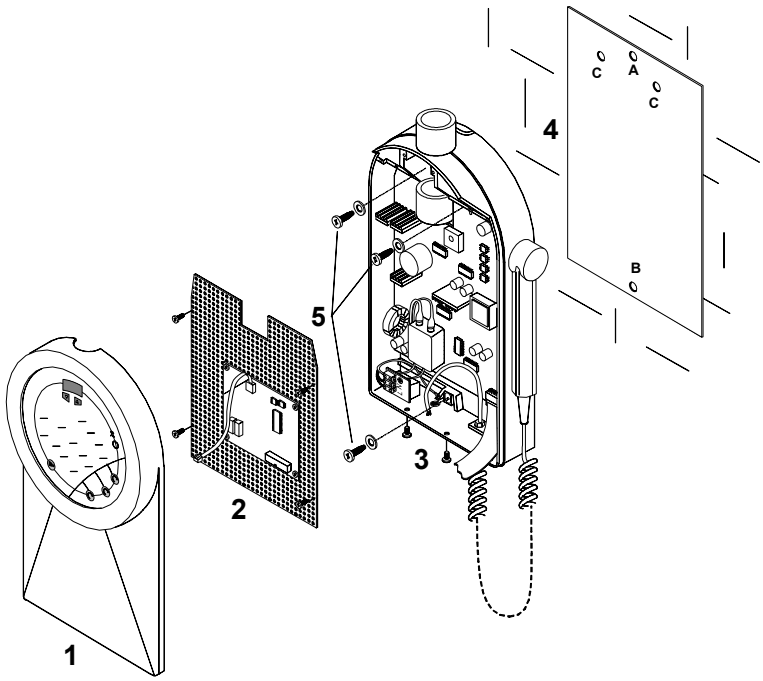


Figure 6-1

6.2 Assembling the mobile stand and timer installation

1. Cross the two base tubes (**1**) into the provided cut, fixing them together with the screw (**2**) and relevant nut (**3**). Do not tighten the screw completely.
2. Position the base plate (**4**) and fix it with the four screws (**5**). If necessary, reposition the two base tubes (**1**) slightly in order to align the relevant holes on the plate.
3. Lock the nut (**3**) in order to block the base tubes (**1**) permanently.
4. Assemble the stand column (**6**) on the base plate (**4**) with the four screws (**7**).

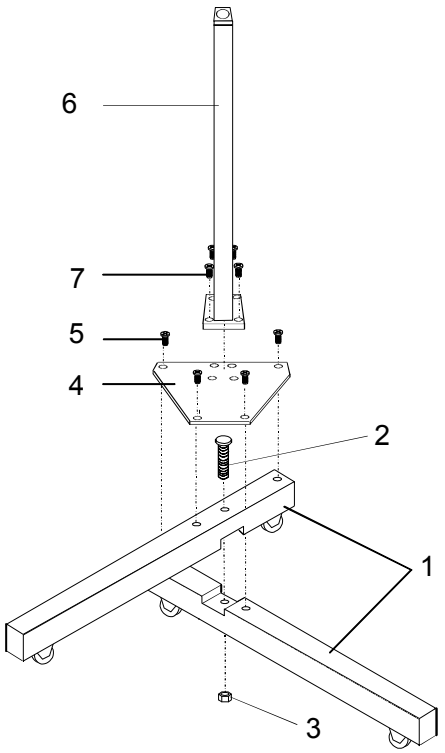


Figure 6-2

5. Assemble the timer support plate (**8**) to the stand column, fixing it with the two screws (**9**).

WARNING:
The timer must be fixed to the support plate after assembling the scissors arm (see paragraph 6.4.3).

6. Remove the plastic timer cover (**10**) by loosening the two sealing screws (**12**) placed on the lower part and lifting the cover from the bottom to the top to let the upper clamps out.
To make the operation easier, disconnect all cables connecting the timer and the plastic cover.

7. Remove the metallic plate (**11**) covering the power board, acting on the 4 screws.

NOTE:
The metallic plate holds the logic board (CPU) which is already connected to power board; take care to avoid damaging the flexible cable connecting the two boards.

8. Fix the timer (**13**) onto the support plate (**8**) with the two screws (**14**) taking care to thread the supply cable and the cables coming from the scissors arm inside the hollow one (**15**). Check that the upper level is level using a bubble level.

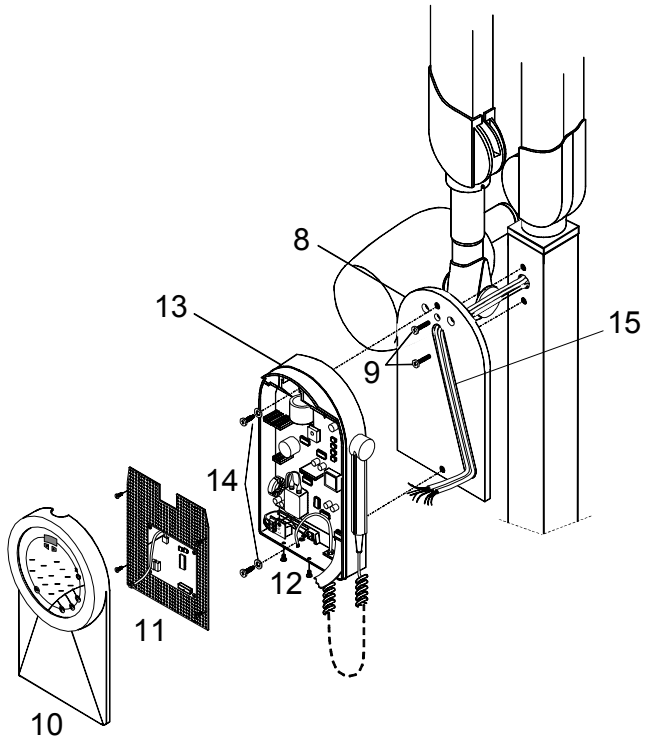


Figure 6-3

6.3 X-ray button

The X-ray button support (code 6161303800) are in the box with an installation kit that gives two options:

- mounting on the timer side; remove the small plug placed on the right hand wall of the timer box and screw the relevant support, taking care to position the flat part toward downward
- mounting on the wall; use the screw provided with the support to fix the support itself to the wall in the requested position.

6.4 Assembling the arms

6.4.1 Assembling the extension arm

1. Insert the extension arm into the arm support block which is an integral part of the wall support plate.

NOTE:
You must keep the arm orthogonal to the plate to be able to insert the shaft into the bush placed inside the support.

2. Check that the arm is level using a bubble level; if it is not level it is better to release the mounting screws on the wall plate and make the necessary adjustments.
3. The horizontal check must be performed in the three orthogonal positions (arm parallel to the wall on the right, on the left and perpendicular to the wall itself).
4. At the end of the above operations, assemble the extension arm frictioning mechanism block (**1**); this frictioning mechanism (code 6161301800) is supplied separately.
5. Assemble the arm rotation stop screw (**2**) in the hole provided on the shaft; this screw is supplied with the frictioning mechanism.

NOTE:
The purpose of the frictioning mechanism and the rotation stop pin is to prevent the extension arm from becoming detached.

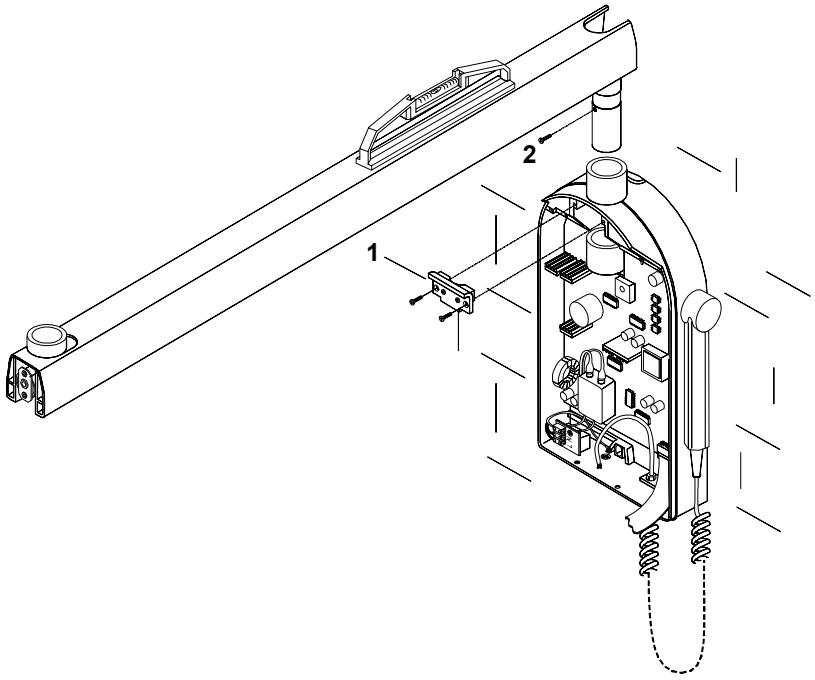


Figure 6-4

6.4.2 Assembling the scissors arm (DP arm)

NOTE:
To help assembly ENDOS DC is shipped with the tubehead already mounted on the scissors arm; it is recommended to let the tape wrapping the arm in place. In case it si removed, besides making more difficult the assembly it is possible that the installer is hurt or the arm damaged.

1. Check that the frictioning mechanism (**1**) assembled on the extension arm at the end where the DP arm is mounted has been loosened, so that the arm can be inserted correctly without damaging the frictioning mechanism.
2. Insert the scissors arm pin into the extension arm; keep the scissors arm tightened during this operation. Power cable, signal cable, and grounding cable must be let out freely from the extension arm.

NOTE:
You must keep the DP arm orthogonal to the extension arm in order to be able to insert the pin into the bush placed inside the extension arm.

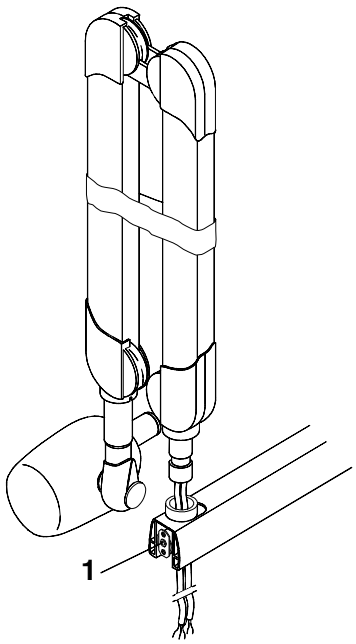


Figure 6-5

3. Insert the power cable, the signal cable and the grounding cable coming form the scissors arm inside the extension arm following the drawing here below. To make this easier, wrap together the cables with tape the grounding and signal cable.
4. Run the cable inside the extension arm until they come completely out at the opposite end; insert the cable itself inside the rotation pin as shown in the following picture.

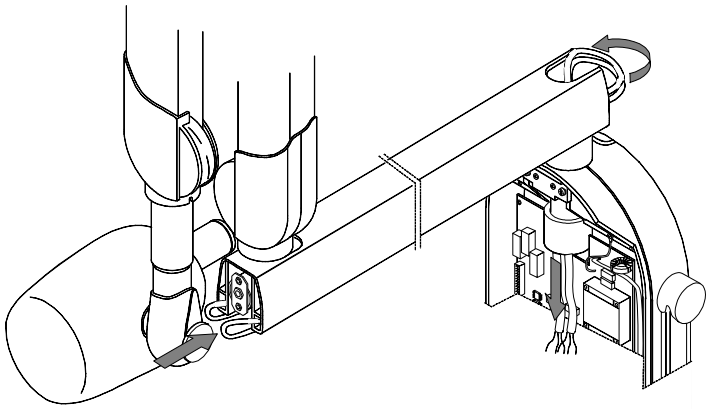


Figure 6-6

5. Check that the DP arm is perfectly inserted; check that the rotation of the scissors arm inside the extension arm is the one ergonomically requested by the operator, otherwise work on the frictioning mechanism (**1**) until you get the requested run.

NOTE:
This frictioning mechanism also serves to prevent the scissors arm from becoming detached and for this reason it must never be loosened completely.

6. Remove the scissors arm safety clamp and check the ergonomics of its movement, otherwise adjust the frictioning mechanism (**1**) and/or the tension of the arm balance springs (see paragraph 7.2.3).
7. Assemble the front covers of the extension arm, packaged separately with the small parts.

6.4.3 Assembling the stand arms set

Assemble the scissors arm (there is no extension arm in this configuration), being careful to insert the spacer (**1**) (p/n61613056) into the rotation pin.

NOTE:
Keep the arm perfectly orthogonal to the pole when inserting the extension arm rotation pin.
Do not release the arms of the scissors arm from their sealing packing.

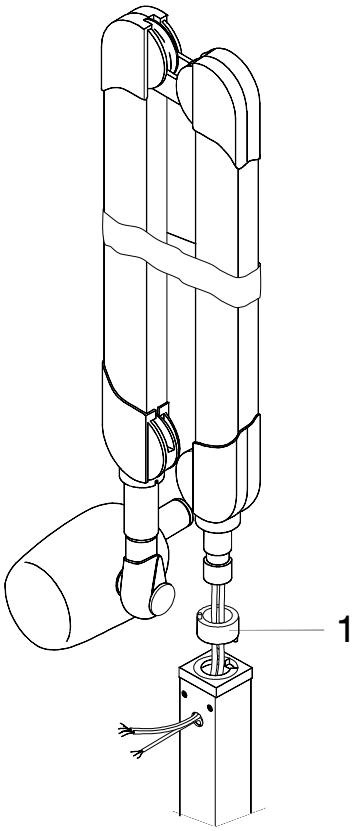
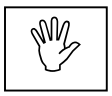


Figure 6-7

6.5 Installation of the optional parts

6.5.1 External signaling devices

ENDOS DC allows to connect additional signaling devices outside the room, as specified here below.



ATTENTION:
Specified values MUST NOT be overcome; do not connects lamps powered with line voltage.

- A signaling device indicating "device in operation" can be connected to pins 1 and 2 of connector X4 on the CPU board. **The max load for this contact is 24V 40W.**
- A signaling device indicating "X-ray exposure in progress" can be connected to pins 3 and 4 of connector X4 on the CPU board. **The max load for this contact is 24V 40W.**
- To use signaling devices it is necessary to prepare connections using 4 wires having a section of 0.5 mm^2.

6.5.2 Installation of chemical screws

You are recommend to use chemical screws when installing the equipment on hollow bricks.

Follow the instructions annexed to the installation kit when installing chemical screws.

6.5.3 Counterplate

A counterplate must be used on the opposite side of the wall when installing on walls that are too weak.

1. Put the template (**3**) (code 39619100) in the requested position to identify the requested mounting position on the wall. Considering the overall dimensions of the equipment put the top part of the template at 1450 mm (57") from the floor.
2. Mark the mounting points and make holes right through the wall at the marked points.
3. Remove the plastic timer cover (**1**) by loosening the two sealing screws (**3**) on the bottom part and lifting the cover from the bottom to the top to let the top clamps out.
   To make the operation easier, disconnect all cables connecting the timer and the plastic cover.
4. Remove the metallic plate **(2**) covering the power board, acting on the 4 screws.

NOTE:
The metallic plate holds the logic board (CPU) which is already connected to power board; take care to avoid damaging the flexible cable connecting the two boards.

5. Put some threading pins (**6**) (not provided) through the wall and fix the counterplate (**5**) (code 5661307900) onto the back of the wall after positioning the timer.

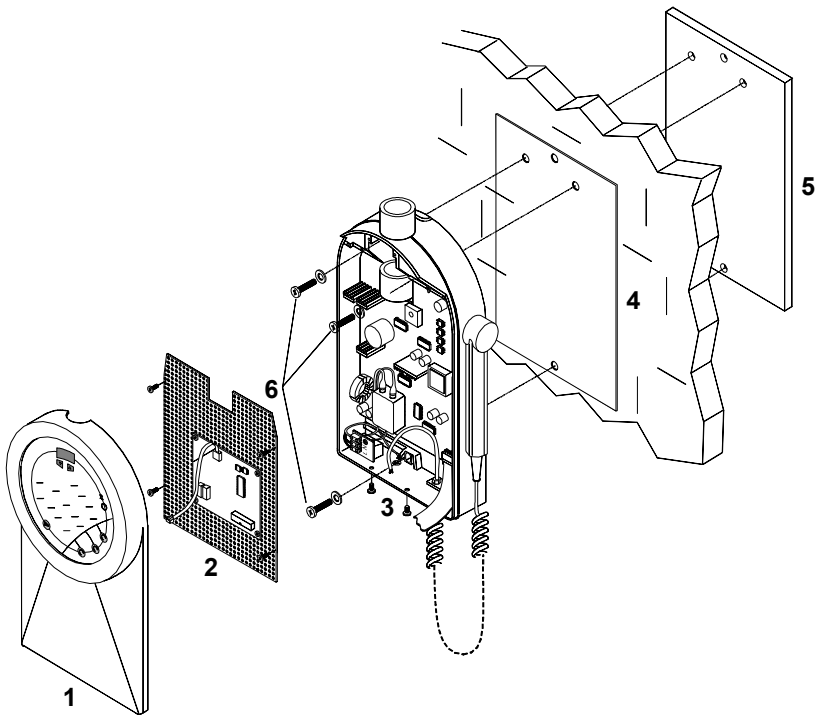
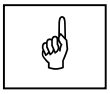


Figure 6-8

6.6 Electrical connection

After carrying out the mechanical assembly you can go ahead with the electrical connection.
The ENDOS DC system must be connected to a plant equipped with an earthing system in compliance with the regulations in force in the country of installation.



NOTE:
The electric plant must also be fitted with a residual current breaker with overcurrent protection with the following features:

- rated current: 6A
- differential sensitivity: 0.03A.

6.6.1 Electrical connection for standard versions

NOTE:
Cables coming from the tubehead are supplied for the 80 cm extension arm; do not cut off the surplus as this might cause the generator to malfunction; it must be placed between the metal plate and the plastic cover as shown in Figure 6-10.

1. Remove the two connectors X6 (with two contacts) and X7 (with five contacts) on the power card; make the connections observing the numbers of the cables and the connector itself; connect the connectors into the power card again. Remove the two fixing clamps (**1**) of the screening braidings.
2. Connect the ground cable coming from the tubehead (yellow/green cable) to the provided ground terminal of the wall support.
3. The two cables X6 and X7 coming from the tubehead must enter the groove made in the wall plate; this must be done so that the two free ends of the braiding correspond with the clamps.

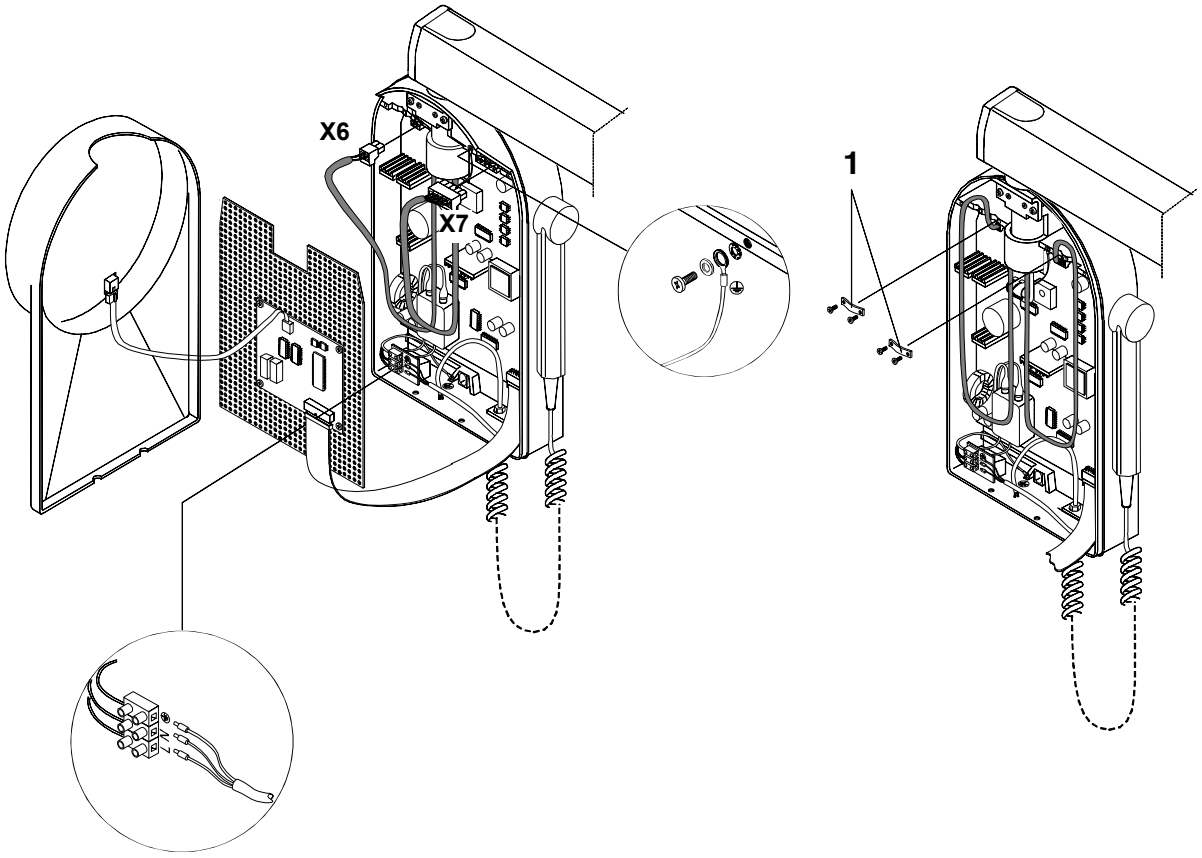


Figure 6-9

4. Screw down the braiding clamps (**1**) again, making sure that they are well secured.

NOTE:
In order to observe IEC regulations concerning electro-magnetic disturbance the metallic braidings of the two cables must be secured correctly; carry out a check to ensure this has been done correctly. Moreover, a bad ground contact may increase electric noise inside the power card, causing the system to malfunction.

5. Check that the timer is preset for the correct working tension. This test must be carried out by checking that the value and type of fuse F2 in the power card corresponds to that which is stated (3AT 250V for 230V version and 6.25AT 250V for 120V version).
6. Reassemble metal cover plate and connect the flexible cable between the generator card and the logical card.
7. Make the connection between the general switch and power line using a bipolar cable plus ground cable with the minimum suggested section of 2.5mm^2, ending the cable towards the timer with the provided prod terminals. Fix the cable to the terminal board observing the positions shown (L = line – brown cable, N = neutral – blue cable, Ground = yellow/green cable). The conductors must be secured at the timer base with the provided clamp.
8. Connect the telephone cable between the logical card and the keyboard card; connect the cable coming from the X-ray button to the corresponding connector on the keyboard card. Secure the timer again, making sure that any surplus cables coming from the tubehead do not hinder the operation.

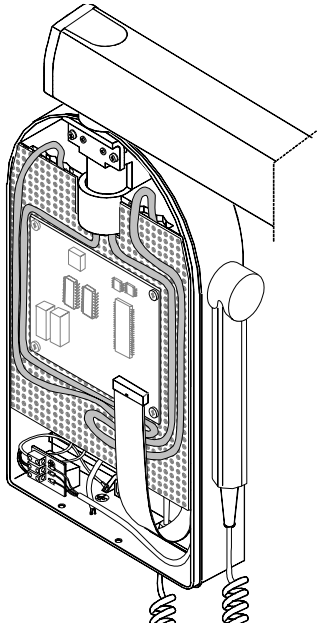


Figure 6-10

6.6.2 Wall Support - Remote keyboard connection

NOTE:
In this configuration the possibility of using the X-ray button applied to the timer is not provided.

NOTE:
The cable supplied in the kit (code 6661308000) for the remote connection is 15 meters long, ending with 6-pole telephone connectors. The single keyboard takes up a space of 200 mm in diameter on the wall.

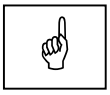
If the keyboard is positioned outside the room, you must:

1. Unscrew the relative screws to remove the keyboard disc from the plastic timer cover; remove the short connection cable between the logic card and the keyboard.
2. Remove the X-ray button applied to the timer.
3. Insert the long cable into the relevant connector on the logic card. This cable must come out of the back of the timer where a raceway has been inserted into the wall for threading this cable.
4. Apply the adhesive film supplied on the plastic timer cover from which the keyboard disc has been removed.
5. Use blocks to position and secure the keyboard bracket (suggested height about 1200 mm from the floor), in an area that is accessible to authorized personnel only, in the immediate vicinity (on the right) of the connection cable exit.
6. Set the DIP-SWITCH on the back of the keyboard disc in the following way: DS1-1 OFF / DS1-2 ON.
7. Insert the cable coming from the timer into the relevant connector on the back of the disc; hook the keyboard to the support, checking its stability.

6.7 Power-up sequence

At start-up the timer automatically checks all the internal hardware and in particular:

- Display: all segments light for 2 seconds
- LED: they all light for 2 seconds
- CHECKSUM check of the storage program and display of the words "CHS" if the check result is negative or in the event of non-initialized memory
- Buzzer check (rings)
- Check of all buttons and X-ray buttons in particular, no button must be pressed. If any buttons are pressed one of the LEDs corresponding to this key will light up and an error message will appear
- Display of software version (ex. 1.01).



NOTE:
During the first start-up, the volatile memory may not be programmed and therefore the "CHS" message will appear. In this case, press the X-ray button, switch the system OFF and ON again and restart the procedure. The "CHS" message must not be displayed any more.
If this happens again, replace the logic card (CPU) and proceed to the set-up sequence.

7. CHECKS, CALIBRATIONS AND ADJUSTMENTS

The device is calibrated in the factory during final testing carried out at the manufacturer's site.

Some adjustments (for example the friction mechanisms of the scissors arm and extension arm) may need to be done once the installation has been completed and are described in the installation chapter 6.

7.1 Radiological parameters determinations

NOTE:
The best way to measure technical factors is by taking a direct measurement of radiological parameters. This is also called the invasive method. This method requires access to live parts so it can be performed by personnel authorised by the Manufacturer only.

The measurement method using non invasive tools, for instance the kV_p/t meter, is acceptable, even though it usually gives a less accurate result. In fact, measuring the high tension tube value using non invasive tools is strictly correlated to the method chosen by the manufacturer of the tool himself; generally this method is less accurate than the direct method and it may also require two consecutive exposures.
Similarly, anode current measurement using the indirect method is affected by systematic errors, as it is very often based on the current/time product measurement, dividing the measurement by the time measured by this method.

The logic card (CPU) has 3 test points (TP kV, TP mA and TP GND) to which the tool used for the measurement is connected, typically a digital multimeter with an entry resistance of more than 10 MΩ or memory oscilloscope.

- **High tension value to the tube**

  Connect the positive prod on TPkV and the negative one on TPGND; select a 1 s exposure time and read the value measured by DVM considering 1VDC = 20 kV; you must measure a 3.25 V DC ± 160 mV (3.09 ÷ 3.41) value.
  If the measured value is outside the range proceed as follows:

  1. With the system OFF and the tubehead connected measure the resistance between Pin1 and Pin 3 of X7 connector on the generator board; the resistance value must be 14200 ± 2% ohm; if the value is correct check all connections and possibly replace the HF board or the tubehead.
  2. If the value is not correct, disconnect the tubehead, measure the resistance on the connector on the tubehead side which must be 15000 ± 2% ohm; if not correct replace the tubehead .
  3. If the value is correct replace the HF generator.

- **Anode current value**

  Connect the positive prod on TPmA and the negative one on TPGND; select a 1 s exposure time and read the value measured by DVM considering 1VDC = 2 mA; you must measure a 2.5 V DC ± 125 mV [2.375 ÷ 2.625 V] value for 5 mA anode current, while for 4 mA you must have 2 V DC ± 100 mV (1.9 ÷ 2.1 V).
  If the measured value is out of range proceed as follows:

  1. Check in set-up that the value for parameters P6 and P7 are those reported in the label of the tubehead positioned under the plastic covers.
  2. With the system OFF and the tubehead connected measure the resistance between Pin2 and Pin 3 of X7 connector on the generator board; the resistance value must be 1000 ± 2% ohm; if the value is not correct replace the tubehead.
  3. If the check of point 2 is correct, check test points TP8(RifIa) and TP9(RifIf) on CPU board: swetting anodic current at 5 mA check that voltage at TP8 and TP9 with respect to TP2 are 2.5V ± 2%; if out of range replace the CPU board, if correct replace the tubehead or the HF generator board

- **Exposure time measurement**

  Use a memory oscilloscope, connecting the hot point of the sound to TPkV and the mass to TPGND. Set the oscilloscope to wave form storage, with the trigger on the positive side. Select the required exposure time and make an exposure. The exposure time is **defined as the interval between the moment when Kv value goes above 75% of the stationary value and the fall under this value: exposure time accuracy must be ± 5% or ± 2 ms if bigger.**
  If the measured value is out of range, replace the CPU board.

When using a non invasive tool, such as a kV_p/time meter, there may be a bigger error, depending on the measurement tool used.

7.2 Arms adjustment

The arms may need adjusting in the following cases:

- the movement of the extension arm combined with the scissors arm is not considered to be ergonomic by the end user; in this case it will be necessary to adjust the extension arm frictioning mechanism.
- the scissors arm is not perfectly balanced; in this case you must adjust the springs.

7.2.1 Adjusting the extension arm support frictioning mechanism

The device to adjust the arm support frictioning mechanism is placed on the front of the wall support.
To make this adjustment you must proceed as follows:

1. Remove the plastic timer cover by loosening the two sealing screws placed on the lower part of the wall plate. Lift the plastic cover from the bottom and push it upwards to release it from the upper stops. To make the operation easier, disconnect all cables connecting the Timer and the plastic cover.
2. Using a 3 mm hexagon wrench, adjust the frictioning mechanism screws (**1**) until the movement of the arm is ergonomic.
3. Reposition the plastic cover when you have finished.

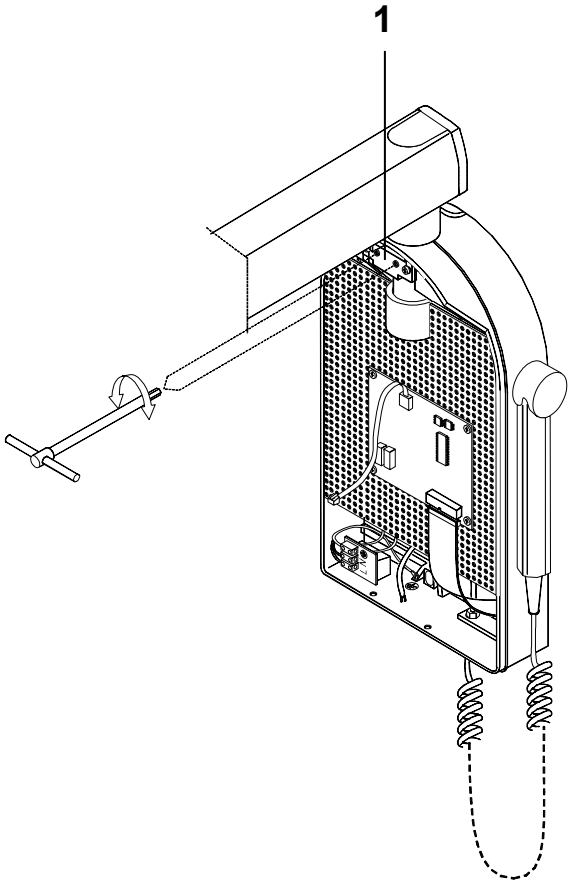


Figure 7-1

7.2.2 Adjusting the extension arm frictioning mechanism

1. Remove the small front extension arm cover, working carefully.
2. Adjust the frictioning mechanism (**1**) using a 5 mm hexagon wrench checking the rotation of the scissors arm.

NOTE:
The purpose of this frictioning mechanism is to prevent the scissors from becoming detached, so it must not be loose.

3. Assemble the cover again.

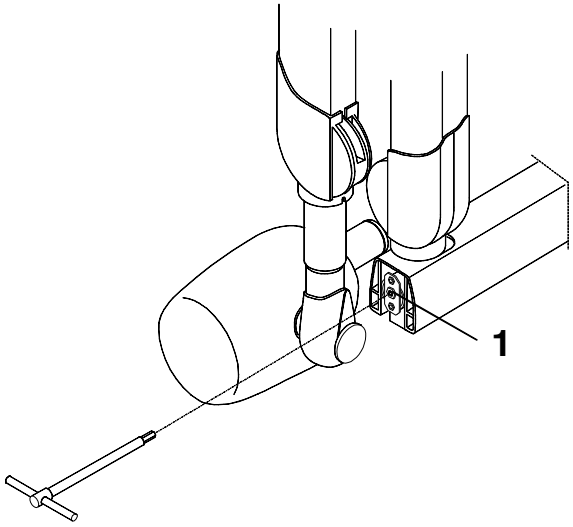


Figure 7-2

7.2.3 Adjusting the balance scissors arm

- **Adjusting the second arm**

  Proceed as follows to adjust the scissors arm:

  – **Adjusting the friction (for small corrections - picture A)**

  1. Put the arm in a horizontal position; remove the plastic coordinator covers. **This must be done carefully to avoid breaking the covers themselves.**
  2. Using a M5 hexagon wrench, loosen the dowel (**1**).
  3. Using two 13 wrenches, adjust the frictioning mechanism (**2**) by rotating one of the wrenches ¼ of a turn each time.
  4. When you have finished the adjustment, tighten the previously loosened dowel and reassemble the plastic covers.

  – **Adjusting the spring (picture B)**

  If adjustment of the friction is not enough, you can adjust the spring to optimise the balance:

  1. Put the arm in a horizontal position; remove the plastic coordinator covers. **This must be done carefully to avoid breaking the covers themselves.**
  2. Insert a 8mm hexagon wrench (about 200mm long – contained in the kit P/N 6661209900). **This wrench must rotate clockwise if the arm tends to go down compared to the release position; anticlockwise if it tends to go up.**
  3. When you have finished the adjustment, reposition the plastic covers.

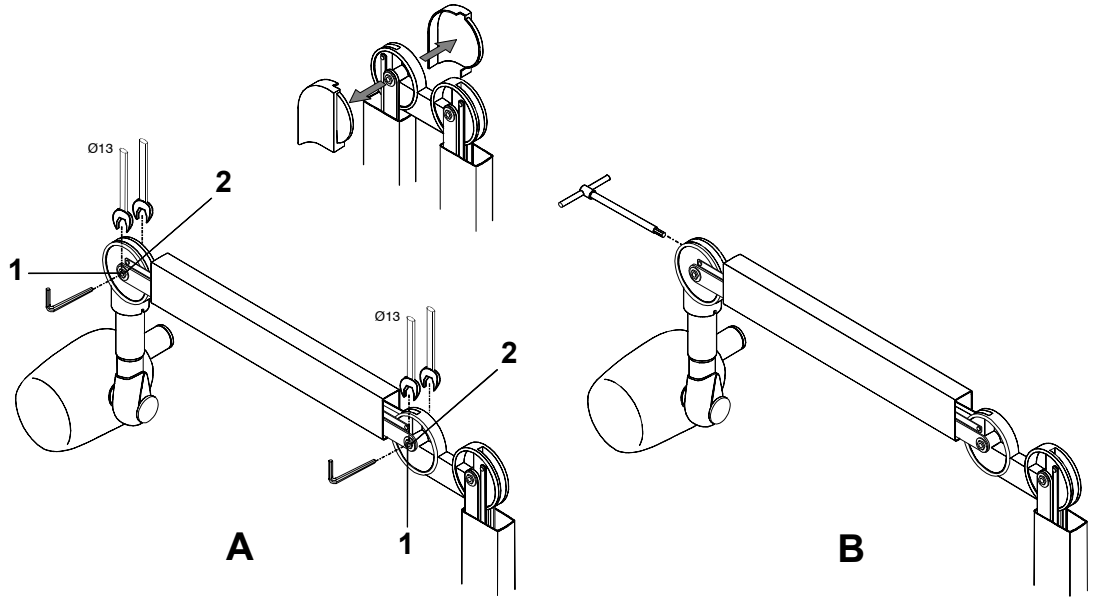


Figure 7-3

- **Adjusting the first arm**

  If the first arm also needs to be adjusted:

  – **Adjusting the friction (for small corrections - picture A)**

  1. Close the arm scissors arm; remove the plastic coordinator covers. **This must be done carefully to avoid breaking the covers themselves.**
  2. Using a M5 hexagon wrench, loosen the dowel (**1**).
  3. Using two 13 wrenches, adjust the frictioning mechanism (**2**) by rotating one of the wrenches ¼ of a turn each time.
  4. When you have finished the adjustment, tighten the previously loosened dowel and reassemble the plastic covers.

  – **Adjusting the spring (picture B)**

  If adjustment of the friction is not enough, you can adjust the spring to optimise the balance:

  1. Close the arm scissors arm; remove the plastic coordinator covers. **This must be done carefully to avoid breaking the covers themselves.**
  2. Insert a 8mm hexagon wrench (about 200mm long – contained in the kit P/N 6661209900). **This wrench must rotate clockwise if the arm tends to go down compared to the release position; anticlockwise if it tends to go up.**
  3. When you have finished the adjustment, reposition the plastic covers.

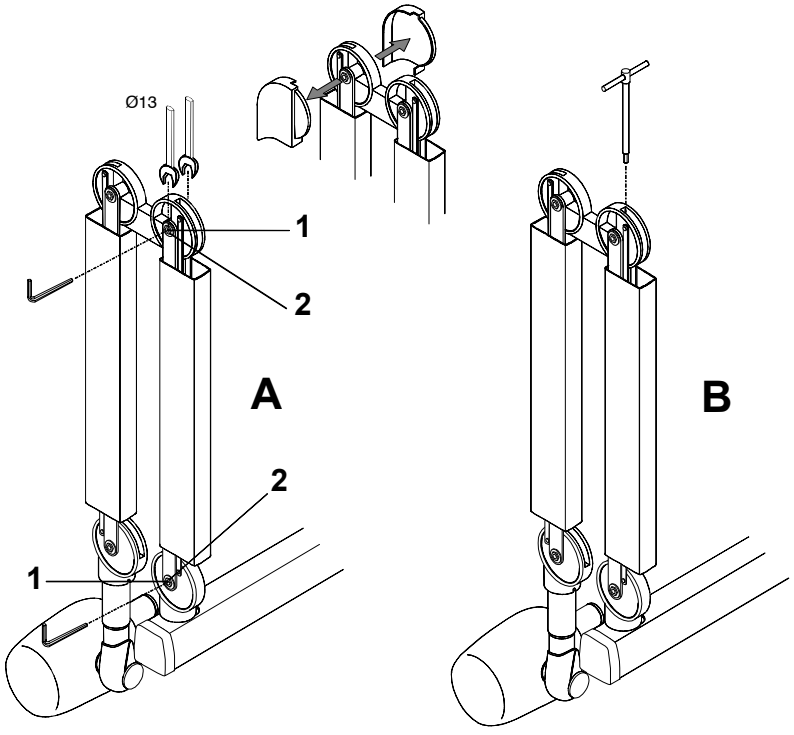
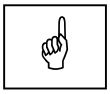


Figure 7-4

8. SET-UP

The ENDOS DC system has a modifiable configuration that can be adapted to specific usage needs; matching parameters between the power card and the tubehead are also stored in the configuration making it necessary to change these parameters during service operations involving the replacement of one of these parts.

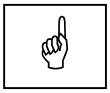
To enter the "**set-up**" function press the Increase and Decrease buttons simultaneously during the software version display phase during start-up.
The condition is signaled on the display showing the message "**Pro**" for 2 seconds from which you go to the real set up phase. The parameter under modification is displayed by the words "**Pxx**": touch the X-ray button to go to the following parameter without changing the value already stored; touch either the "Increase" or "Decrease" keys to change the displayed parameter. Press the X-ray button to get the confirmation and storage of the new set parameter.



NOTE:
You must switch the system off to exit the set-up program.

P00 System preparation:

This is the parameter that indicates if the system is constantly in the "Ready for X-rays" (P00= 0) conditions, or if it is going through the "idle" (P00 ≠ 0) condition. In this case, P00 contains the number of seconds it is in the Ready for exposure status, with the possibility of changing it between 15 and 60 (default 15).



NOTE:
When P00=0, the green "Ready for X-rays" LED is always on.

P01 Delay time between 1° and 2° time/part:

Variable between 500 and 1400 ms, default value 1000 ms, variation at 10 ms intervals with possibility of quick variation by pressing key for more than 2 seconds. The variation increases or increases depending on which key is pressed. This time represents the filament pre-heating time.

NOTE:
This parameter must not be changed from the factory configuration.

P02 Time out time change for detecting the "RX ON" signal:

Coming from the power section; time can be changed between 1 and 10 ms, with 3 ms presetting. Increases or decreases at 1-ms intervals.

NOTE:
This parameter must not be changed from the factory configuration.

P03 Drop time "RX ON" drop time change:

Variable between 5 and 40 ms with 20 ms presetting; variation at 5-ms intervals.

NOTE:
This parameter must not be changed from the factory configuration.

P04 Pause time between exposures value:

This value controls the cooling time between one exposure and the next. The factor is displayed as XX, intended as the multiplication factor of exposure time; when 0, the cooling pause is removed.
It can be selected between 0 and 80; default value 16, with variations at 1-ms intervals.

NOTE:
This value must not be changed as it can significantly reduce the expected life of the RX tube.

P05 Anode current value used for analogue receptors (film):

This parameter makes it possible to select, during setup, the value of the anodic current used for the two of analog receptors (film) selections. If P05=0, the anodic current is 5 mA (default value) while if P05=1 the anodic current is 4 mA. Variation by "Increase" and "Decrease".

P06 Display and set-up of the filament current check parameter (minimum value)

P07 Display and set-up of the filament current check parameter (maximum value)

These two parameters make it possible to display and set up specific parameters allowing to match the power card to the tubehead in use.

NOTE:
These two parameters can be changed only if the tubehead has been replaced or if the power card has been replaced so that the new one must be configured to work with the tubehead in the machine.

The values of these parameters are given on the label affixed to the internal metal part of the tubehead.

P08 Exposure counter display:

It enables the display of the exposures made, by displaying the number of thousands first and then, after pressing the "Increase" key, the number of units (1 – 999). The counter can be reset to zero by pressing the "Patient Selection" and "Tooth Selection" keys together; the operation requires confirmation, by pressing the X-ray key.

NOTE:
The exposure meter can also be displayed, without being able to modify it, during normal running conditions, outside the set-up program, by pressing the "Tooth anatomic selection" and "Increase" key simultaneously.

P09 Exposure times correction value:

It is the K parameter which makes a correction by increasing or decreasing the exposure times, so that the accuracy requirements of the system can be met more closely. Value expressed in milliseconds, with an absolute number; for example, a parameter "0" means no correction, while "02" means a two millisecond increase and "-03" means a 3 millisecond decrease.
Default value 0.

NOTE:
This parameter must not be modified from the factory configuration.

P10 Film type:

This parameter make it possible to choose the specific exposure tables between films with different sensitivities; the value can select exposure times according to the following table:

Parameter	Film selection 1 Standard	Film selection 2 Fast	Digital
1	D	E	CCD
2	E	F	CCD
3	D	E	Phosphorus
4	E	F	Phosphorus
5	D	F	CCD
6	D	F	Phosphorus

P11 Cone setting up:

When you use a 30 cm limiter cone, the exposure times in the preset tables must be multiplied by a 2 factor to get a correct dose. The default parameter is "0", which corresponds to the standard cone (DFF= Film focus distance = 20cm); a value different from 1 multiplies the values by the above mentioned coefficient.
The change from standard cone to long cone times is made by using a combination of the Film Selection + Increase (from 20 to 30) or Film Selection + Decrease (from 30 to 20) keys, also in normal working or out of set-up program modes, and it is available to the user.

P12 Display brightness variation:

This parameter makes it possible to vary the brightness of the keyboard display, in order to compensate any differences in environmental light. Values are changed by "Increase" and "Decrease" keys.

P13 Emitted dose display:

In many countries there are legal requirements prescribing that " newly set-up radio-diagnostic equipment must be provided, if possible, with a device that informs the specialist about the quantity of ionizing radiation produced by the equipment during the X-ray procedure". Since the ENDOS DC system undergoes extensive checks, both in terms of kV and mA, the dose administered to the patient can be displayed basing the calculation on experimental data.
The P13 value is 0 (default) so the dose is not displayed, or 1 and the emitted dose will be displayed for 5 s on the display; after this time the display goes back to the normal display status. The dose is shown in mGy and it is calculated at the 20 cm cone exit.
The factor according to which the dose is calculated based on selection of the anode current and exposure time is an empirical factor determined by type tests performed on some prototypes during the design phase of ENDOS DC equipment; it is clear that this calculation of the emitted dose can be affected by a serious error depending on construction differences and by the intrinsic nature of the RX tube of the individual device.

P14 Display error logbook:

Selecting parameter P14 during the set-up sequence and pressing the "increase" or "decrease" keys the words "**E01**" is displayed on the display.
Use the "increase" or "decrease" keys again to scroll through the list of possible errors.
To display the number of times a specific error has been stored, press the X-ray key while this error is selected. The display will start flashing, displaying the thousands first of all and then number of units of times the message has been recorded.
Every number is displayed for 0.5 sec. And the thousands – units sequence is repeated four times; at the end the display goes back to error selection.

Example:
If the error has been stored 2543 times, the display will display in sequence:

002 543 002 543 002 543 002 543 Exx

If no key is pressed within 10 sec. during the display of error code "**Exx**", the display will go back P14.

Switch off the system to exit the set-up program.

The following table displays the values of programmable parameters

Display	Parameters	Set Value	New setting		WARNING
P00	System preparation	15			
P01	Delay time between 1° e 2° tempo	1000 msec (display 100)			(1)
P02	Value of time-out time for measurement of "RX ON" signal	3 msec			(1)
P03	Variation of drop time "RX ON"	20 msec			(1)
P04	Value of pause time between exposures	16 sec			(1)
P05	Value of anode current used for analogue receptors (film)	0			
P06	Display and variation of filament current check parameter (minimum value)	Derived from the tubehead			
P07	Display and variation of filament current check parameter (maximum value)	Derived from the tubehead			
P08	Exposure counter display	////			
P09	Exposure times correction value	0			(1)
P10	Film type	1			
P11	Cone setting	0			
P12	Brightness display variation	////			
P13	Display emitted dose	0			
P14	Display error logbook	E01			

WARNING:
Parameters shown with (**1**) in the previous table can not be changed; the perfect running of the system and its compliance with Directive CE 93/42 cannot be guaranteed if any change is made.

9. TROUBLESHOOTING

WARNING:
The system must be switched off before performing integrity checks on fuses and components.

- **Symptom:**
  Keyboard not working with display off, light ignition switch S1 off

- **Action:**
  Replace the line fuse F4 with one with the same value (3 AT for 230V/6 AT for 120V).

NOTE:
If there is an obvious fault on one of the two electrolytic stabilization condensers, the whole HF generator group must be replaced.

9.1 Error messages on the display

As described in chapter 3, the ENDOS DC is totally controlled by a microprocessor which, not only checks the programming of exposure parameters but also signals the various machine statuses and any anomalies and errors, by messages in code on the display unit.
The following tables contain the various messages which may appear on the display, their meanings, their cause and how to behave.

NOTE:
Error messages belong to three different groups, classified according to the seriousness of the anomalies found and their possible effect on the safety of the operators' and/or the system.

NOTE:
The system provides an "Error logbook" which can be consulted by the Service Technician by entering the set-up program and selecting the P14 parameter (see chapter 8).

9.1.1 Fatal errors during start-up

These signals DO NOT allow any examination to be performed.

Displayed message	ANOMALY type	Corrective actions
CH0	Checksum error of memories/storages (EEPROM+EPROM)	If present at the first start-up of the equipment after replacing EEPROM; press a key (different from X-ray key). On the contrary if present during normal working, it shows a problem, replace EEPROM, if not enough, replace CPU card (*****)
CH1	Writing error of memory configuration (EEPROM+EPROM)	Replace EEPROM, if not enough, replace CPU card (*****)
CH2	Checksum error of program memory	Replace (D4) Micro-controller, if not enough, replace CPU card (*****)
E01	X-ray button pressed at start-up	Check button or push-button panel where a remote version is present and if necessary replace button/push-button panel
E02	A key pressed at start-up (different from X-ray button)	Check keyboard and if necessary replace keyboard ***Note:*** *the pressed button is indicated by the LED flashing nearest to the button itself*
E03	More keys pressed at start-up	Check keyboard and if necessary replace keyboard ***Note:*** *pressed buttons can be identified by pressing all keys in turn, the wrong ones do not emit any acoustic signal*

(*****) *When replacing CPU, you must recheck all set-up parameters, in particular parameters P6 and P7, taking them from the label under the tubehead covers*

9.1.2 Errors during exposure

Possible anomalies during exposure always interrupt the exposure itself. Whether there is an acoustic signal or not depends on the time the fault occurred and on the success of the X-ray interruption procedure.

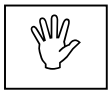
Displayed message	ANOMALY type	Corrective actions
E11	Breakage in the filament circuit	Check connection with tubehead. Replace tubehead
E12	RX ON too slow in climbing	Repeat exposure, if error is confirmed replace tubehead
E13	Emission also after end of exposure	Replace generator card
E14	Intervention back-up timer	Switch off and on again, if it is still present or repeated after an exposure, replace generator card
E15	Intervention safety overvoltage PFC (OVPFC)	Replace generator card
E16	Intervention safety undervoltage PFC (UVPFC) ***Note:*** *present also every time you switch off the equipment*	Replace generator card
E17	KV feedback beyond upper limit ***Note:*** *different thresholds if in IDLE or during exposure*	**See paragraph 7.1.** If in IDLE replace generator card, if during exposure repeat exposure and then replace generator card
E18	MA feedback under lower limit ***Note:*** *different thresholds if in IDLE or during exposure*	**See paragraph 7.1.** If in IDLE replace generator card, if during exposure repeat exposure and then replace generator card
E19	MA feedback over upper limit ***Note:*** *different thresholds if in IDLE or during exposure*	**See paragraph 7.1.** If in IDLE replace generator card, if during exposure repeat exposure and then replace generator card
E20	Filament current overload filament	Replace generator card
E21	Anode overload	Repeat exposure, if the error is repeated, replace tubehead
E22	Signal of kV overvoltage	Repeat exposure, if the error is repeated, replace tubehead
E23	Not desired emission found (RX ON present)	Replace generator card
E24	RX ON fall before exposure end	Repeat exposure, if the error is repeated, replace tubehead

WARNING:
When an error signal appears and the buzzer sounds, always switch the system off. In any case when the back-up timer is triggered it always interrupts X-ray emission.

9.1.3 Errors that do not prevent further exposures

Situations which do not directly effect the safety of the operator, patient or the system are considered as resettable anomalies. The situation which has caused the alert condition is always signaled by the green flashing LED and the display of the relevant error message, which, in these cases has the "Axx" syntax. The error condition stops subsequent exposures until it is reset by pressing one of the keys; in this case the last selection made is shown on the display and keyboard.

Displayed message	ANOMALY type	Corrective actions
A01	X-ray button already pressed when pressing one of the selection keys with the system in IDLE-ON status	Release X-ray button, reset error and repeat procedure; if the error persists replace the X-ray button.
A02	Release X-ray button during exposure	Reset and repeat exposure
A03	Release button during pre-heating phase (2° time not present yet)	Reset and repeat exposure



WARNING:
If A02 is signaled, the X-ray button has been released while emission is already underway. Therefore the film must be replaced in order to obtain diagnostic images.

In the case of an A01 signal, the X-ray button must be released; if this is not pressed, it identifies a fault, and therefore you must call the technical service.

9.1.4 Timer with display off or not working

A situation may occur that the timer is powered, but with the display off and functions absent; in this case you should access the CPU card, taking great care to ensure that the timer is kept powered and check if **the red HD1 LED on the CPU card is flashing.** If so, proceed as shown in the following table according to the flashing HD1 LED modes.

Display	ANOMALY type	Corrective actions
½ second flashing, ½ second pause	Missing communication between CPU card and Display card	Switch off and on again, check connection between CPU and keyboard, replace CPU card (or keyboard) (*)
1 short flashing followed by 1 second pause	Brown-out	Switch off and switch on again, check feed 5V to CPU card, replace CPU card (*)
2 short flashings followed by 1 second pause	Watchdog intervention	Replace CPU (*)
3 short flashings followed by 1 second pause	Stack overflow/underflow	Replace CPU (*)
4 short flashings followed by 1 second pause	Transition error between statuses	Replace CPU (*)
5 short flashings followed by 1 second pause	Reset due to RESET instruction	Replace CPU (*)

(*) *when replacing CPU, recheck all set-up parameters, in particular parameters P6 and P7, taking them from the label under the tubehead covers*

10. SERVICE ACTIONS REQUIRING PART REPLACEMENTS

10.1 Replacement of the tubehead

WARNING:
Before replacing the tubehead, close the two sections of the scissors arms and tie them together.
Failure to follow these instruction will not only make it very difficult to assemble the system but may also harm the technician and damage the arm itself.

NOTE:
Before carrying out the following operations make sure the system is off.

The spare tubehead is shipped without plastic covers. If required these must be ordered separately. The tubehead is always sent with the identification label, giving the new series number of the tubehead itself and of RX tube.
The values of the two parameters P6 and P7 connecting the tubehead itself to the generator card are given on the metal frame of the new tubehead; these parameters must be set in the system using the set-up procedure.

1. Write down the value of the two parameters P6 and P7 reported on the new tubehead.
2. Remove the identification label (**1**) on the back of the plastic covers of the tubehead to access the fixing screws (**2**) of the covers themselves. Loosen the screws, remove the front fixing ring (**3**) of the extension cone and open the two plastic covers.
3. Loosen the two fixing screws on the metallic cover (**4**), on the back of the tubehead, which holds the two connectors, to access them.
4. Disconnect the two connectors and disconnect the ground cable (**5**).
5. Holding the tubehead, loosen the two fixing screws (**6**) of the tubehead itself to the support. Remove the tubehead.

6. Take the new tubehead and assemble it on the support. Fasten it with the removed screws at point **5.** and clamp them.

7. Connect the two connectors coming from the arm with the corresponding connectors on the tubehead. Take care to observe the direction of the connectors, which are suitably polarized. Connect the ground cable.

8. Assemble fixing connectors cover, positioning the cables as before (see point **3.**).

9. Reassemble the plastic covers and secure them using the provided screws and the front fixing ring.

10. Put the new identification label on the back of the plastic covers.

11. Switch on the system and access the set-up procedures (chapter 8); proceed up to parameter P6 and insert the value reported on the tubehead and written down before. Confirm it pressing the X-ray button or key.

12. Set up the value of parameter P7 reported on the tubehead and written down before; confirm it by pressing the X-ray button or key. Go out of set-up procedure by switching off the system.

13. Report the new values in the "*New setting*" column of the table of programmable parameters at the end of chapter 8.

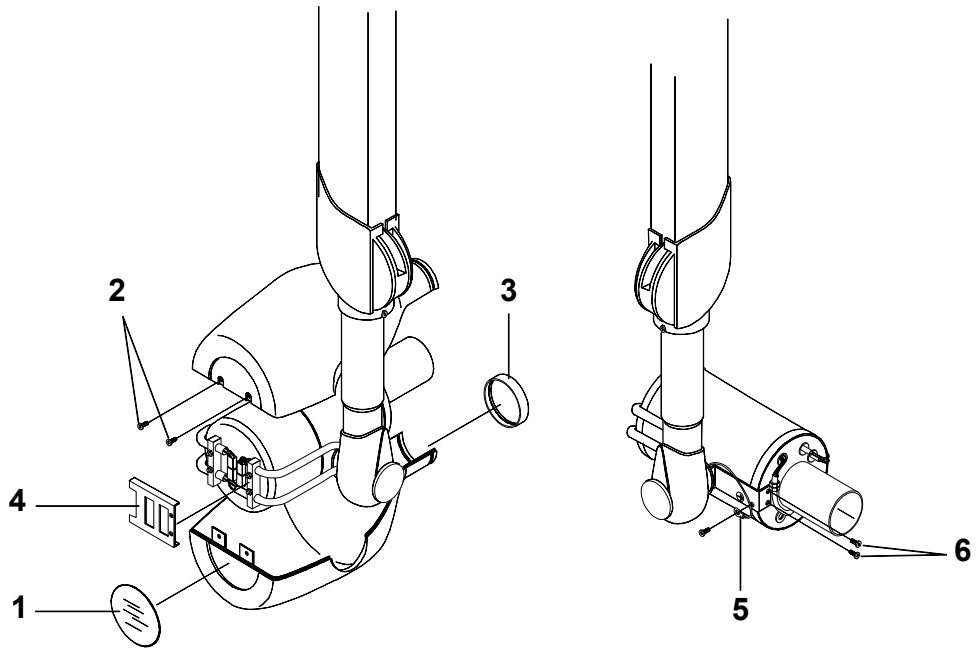


Figure 10-1

10.2 Replacing the generator card

NOTE:
Before accessing the power card, disconnect the equipment from the line.

1. Remove the plastic timer cover by loosening the two sealing screws on the bottom and, lifting the cover from the bottom to the top, let the top clamps out.
   To make the operation easy, disconnect all the connection cables between the wall support and cover.
2. Remove the flexible cable connecting the logic card and the power card, disconnecting it from the connector on the power card.
3. Remove the metal cover plate on the power card, unscrewing the four fixing screws.
4. Disconnect connectors X6 and X7 from the card, leaving the cables in the grooves.
5. Locate the fixing screws on the power card on the metal support and loosen them. Remove the card itself.
6. Insert the new card and fix it.
7. Insert connectors X6 and X7.
8. Proceed with assembling the metal plate; connect the flexible cable between logic card and power card.
9. Connect all the connection cables between the wall support and plastic cover; close the timer again.

10.3 Replacing the logic card

NOTE:
Before accessing the logic card, disconnect the equipment from the line.

NOTE:
Configuration data (parameters P6 and P7) must be recovered. These can be read directly from the machine set-up (chapter 8) if it is possible to access it, otherwise they must be read on the tubehead label under the plastic covers, or on the table at the end of chapter 8 if you are sure they have been updated during previous interventions.

1. Remove the plastic timer cover by loosening the two sealing screws on the bottom and, lifting the cover from the bottom to the top, let the clamps go out.
   To make the operation easy, disconnect all the connection cables between the wall support and cover.
2. Remove the flexible cable connecting the logic card to the power card, disconnecting it from the connector on the logic card.
3. Remove the fixing screws on the logic card and replace it with the new one.
4. Connect all the connection cables between the wall support and plastic cover; close the timer again.
5. Switch the system on and enter the set-up procedure (chapter 8). Check all configuration parameters. **The values of parameters P6 and P7 must be re-entered.**

10.4 Replacing the keyboard

No particular operation is required after replacing the keyboard.

10.5 Replacing the scissors arm

10.5.1 Replacing the scissors arm with wall Timer (standard configuration)

WARNING:
Before proceeding with these operations, close the two sections of the scissors arm and tie them together.
Failure to follow these instruction will not only make it very difficult to assemble the system but may also harm the technician and damage the arm itself.

1. Remove the tubehead as described in paragraph 10.1, from points 2 to 5.
2. Remove the plastic timer cover by loosening the two sealing screws on the lower side, and lifting the cover from the bottom to the top, let the top clamps out.
   To make the operation easy, disconnect all connection cables between the wall support and cover.
3. Remove the flexible cable connecting the logic card to the power card, disconnecting it from the connector on the logic card.
4. Remove the metal cover plate on the power card, loosening the 4 fixing screws.
5. Remove the two fixing clamps on the screening braidings.
6. Remove the front covers of the extension arm.
7. Disconnect cables X6 and X7 coming from the tubehead from the correspondent connectors. Disconnect the ground cable (yellow/green cable) coming from the tubehead from the ground terminal of the wall support. Remove the cables from the extension arm completely.
8. Loosen the gear assembled on the extension arm at the end where the scissors arm is inserted; remove the arm.
9. Assemble the new arm as described in paragraph 6.4.2.
10. Connect the cables as described in paragraph 6.6.1.
11. Reassemble the tubehead as described in paragraph 10.1, from points 6 to 10.

10.5.2 Replacing the scissors arm with Timer with mobile stand

WARNING:
Before proceeding with these operations, close the two sections of the scissors arm and tie them together.
Failure to follow these instruction will not only make it very difficult to assemble the system but may also harm the technician and damage the arm itself.

1. Remove the tubehead as described in paragraph 10.1, from points 2 to 5.
2. Remove the plastic timer cover by loosening the two sealing screws on the lower side, and lifting the cover from the bottom to the top, let the top clamps out.
   To make the operation easy, disconnect all connection cables between wall support and cover.
3. Remove the flexible cable connecting the logic card to the power card, disconnecting it from the connector on the logic card.
4. Remove the metal cover plate on the power card, loosening the 4 fixing screws.
5. Remove the two fixing clamps on the screening braidings.
6. Disconnect cables X6 and X7 coming from the tubehead from the correspondent connectors. Disconnect the ground cable (yellow/green cable) coming from the tubehead from the ground terminal of the wall support.
7. Remove the timer from the support plate.
8. Remove the support plate from the stand column.
9. Remove the scissors arm.
10. Assemble the new arm as described in paragraph 6.4.3.
11. Fix the support plate and the timer as described in paragraph 6.2, point 5 and following.
12. Connect the cables as described in paragraph 6.6.1.
13. Assemble the tubehead again as described in paragraph 10.1, from points 6 to 10.

11. 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
- check that the X-ray beam is centred
- check proper functioning of X-ray exposure LED and exposure buzzer.

The Service Engineer, during preventive maintence, besides the checks listed above, will verify also:

- correct adjustment of the rotation friction mechanism of the extension arm and of the scissors arm
- correct balancing of scissors arm, making proper adjustment when necessary.

NOTA:
Interventions carried out by the Service Engineer must be noted in the Maintenance Record page at the end of the User Manual, with a short description of the actions done

12. SCHEMATICS AND DRAWINGS

1. ENDOS DC - General connection diagram

2. Generator HF board (A1) layout

3. Logic board (A2) layout

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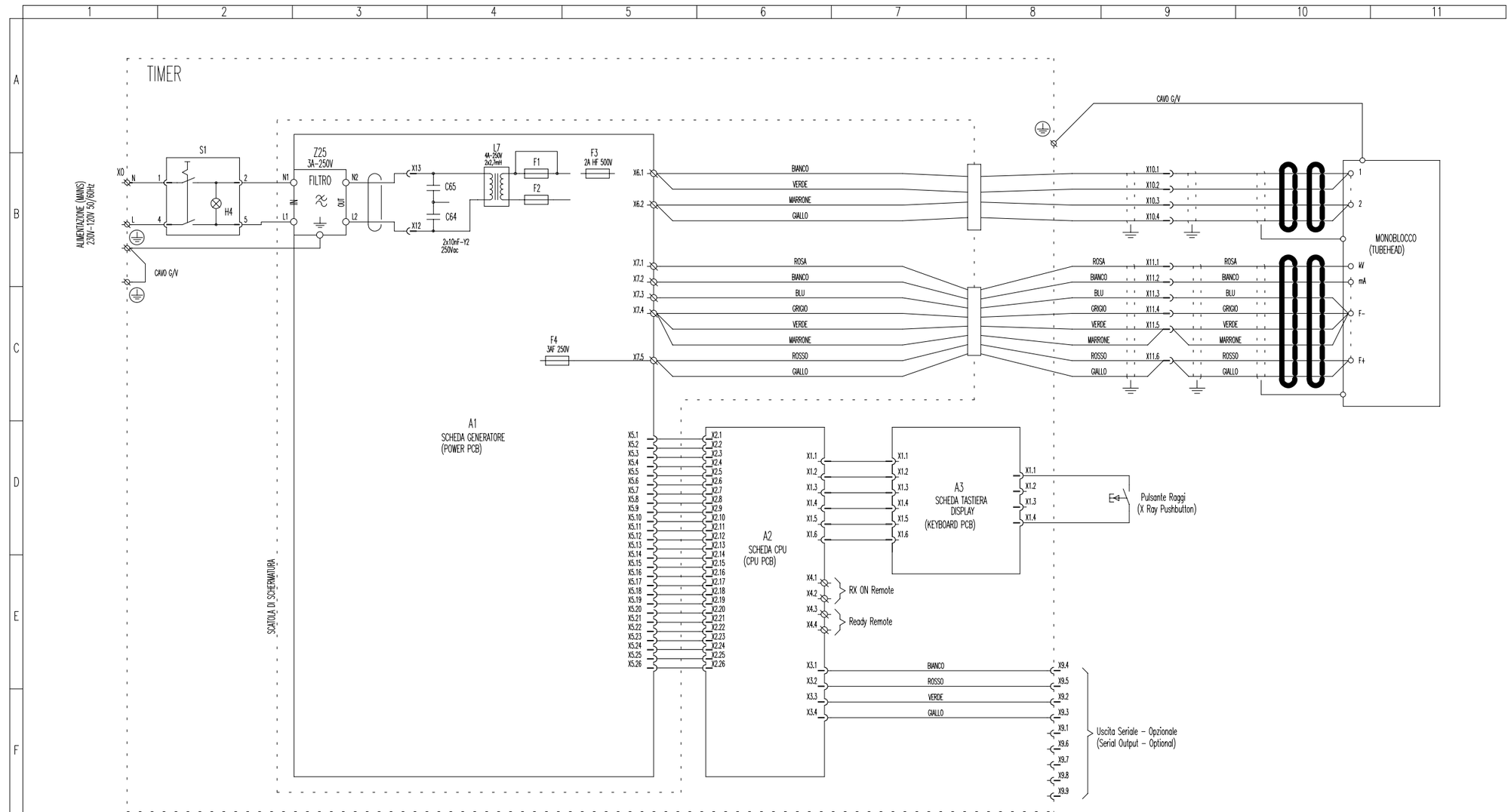


TABELLA FUSIBILI (FUSES TABLE)		
F1	F2	
cavallotto (short circuit)	3AT 250V	Versione 230V murale (230V wall version)
cavallotto (short circuit)	6.25AT 250V	Versione 120V murale (120V wall version)
3AT 250V	3AT 250V	Versione 230V stativo (230V stand version)
6.25AT 250V	6.25AT 250V	Versione 120V stativo (120V stand version)

ENDOS DC **General connection diagram**	**1**
Code 39619001 - Rev. 0	**Page 1 of 1**

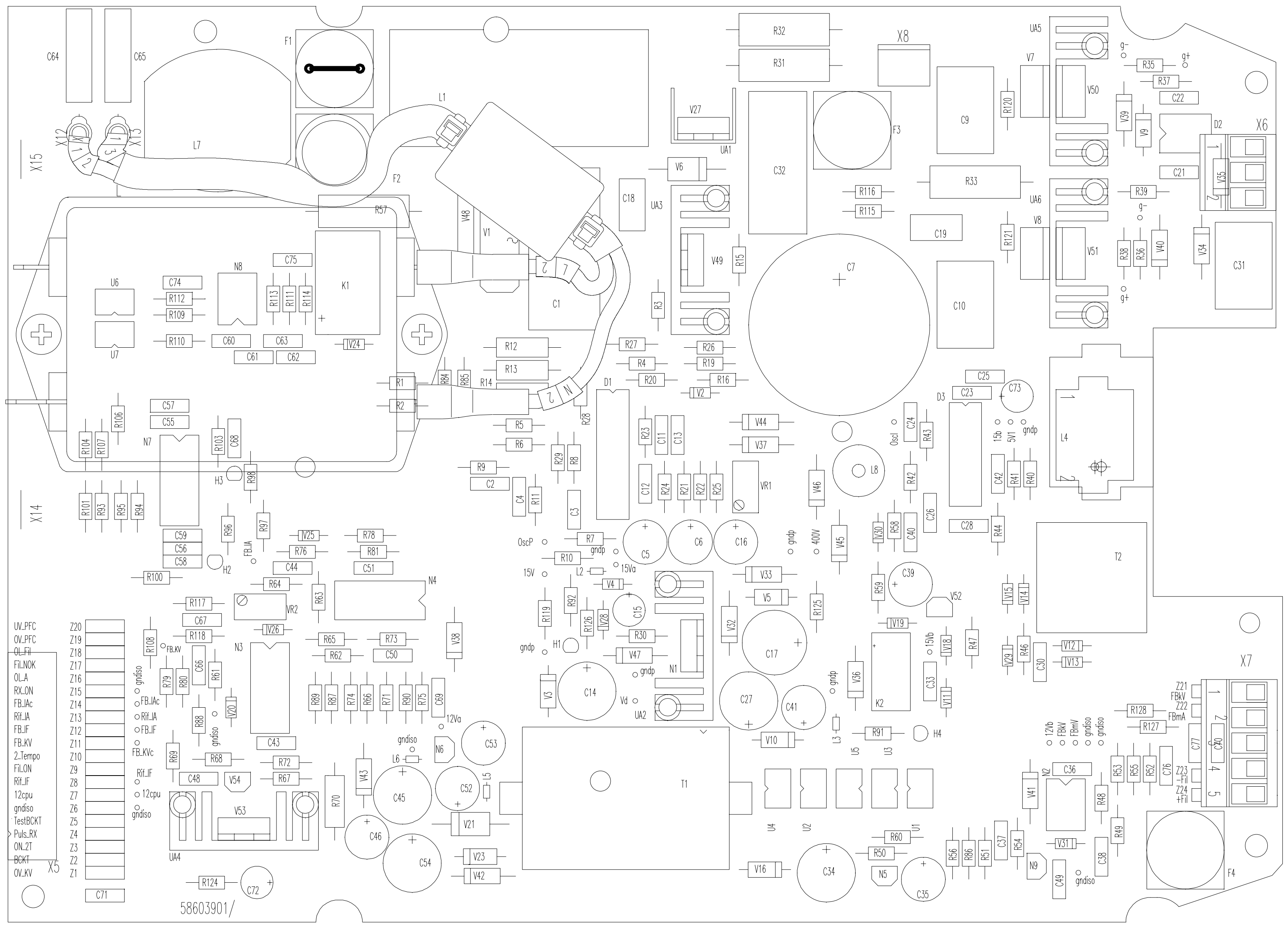
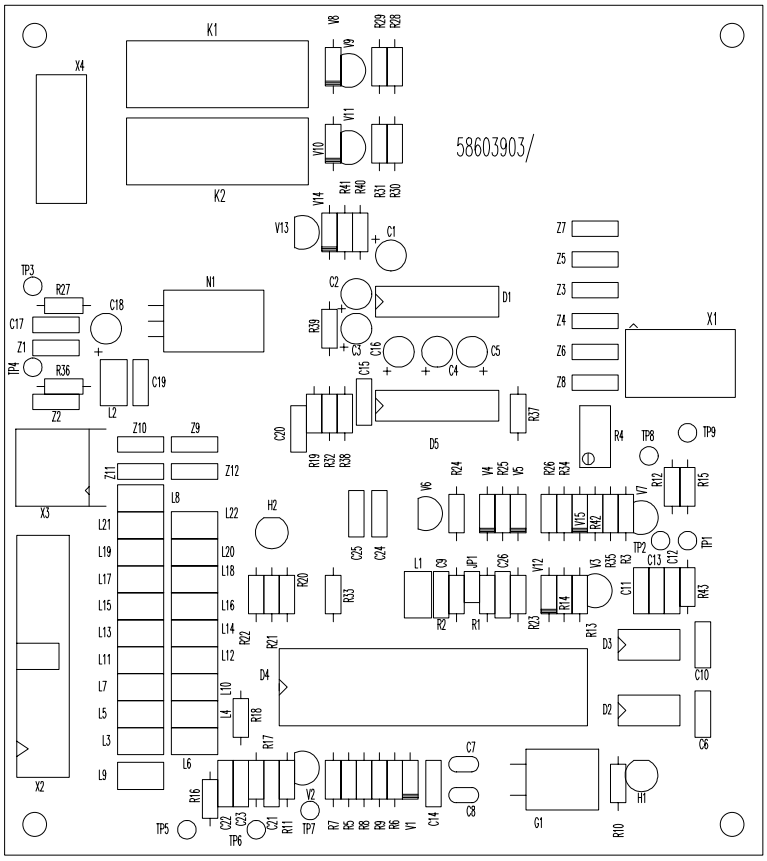


TABELLA FUSIBILI (FUSES TABLE)			Codice (Code)
F1	F2		
cavallotto (short circuit)	3AT 250V	Versione 230V murale (230V wall version)	5860390101
cavallotto (short circuit)	6.25AT 250V	Versione 120V murale (120V wall version)	5860390102
3AT 250V	3AT 250V	Versione 230V stativo (230V stand version)	5860390103
6.25AT 250V	6.25AT 250V	Versione 120V stativo (120V stand version)	5860390104

ENDOS DC Generator HF board (A1) layout	2
Code 58603901 - Rev. 2	Page 1 of 1



ENDOS DC Logic board (A2) layout	3
Code 58603903 - Rev. 3	Page 1 of 1

13. SPARE PARTS

1 – TIMER: ENDOS DC

2 - EXTENSION ARM / SCISSOR ARM

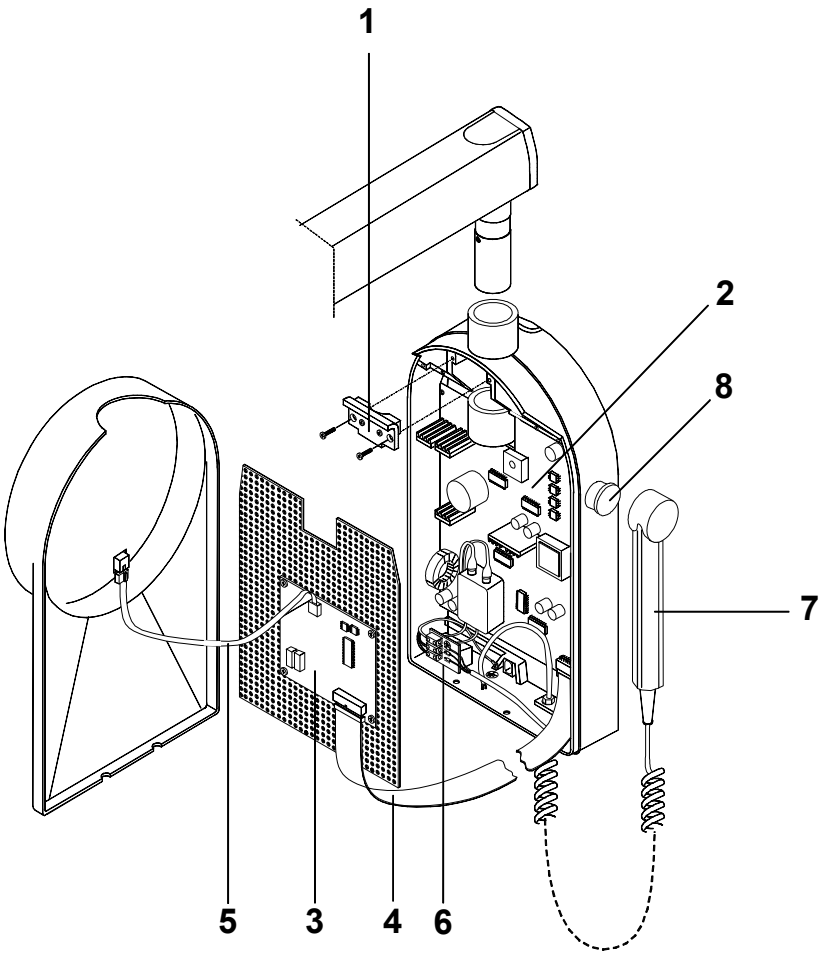
3 – MOBILE STAND

4 – TUBEHEAD

5 – OPTION

1 – TIMER: ENDOS DC

Ref.	VSM code	Description	Note
1	6661301800	Frictioning mechanism assy	
2	5861308600	Generator board 230V wall version	
	5861308700	Generator board 120V wall version	
	5861308800	Generator board 230V mobile version	
	5861308900	Generator board 120V mobile version	
3	5860390300	CPU board	
4	6261302400	Flat cable	
5	6261302200	Keyboard connection cable	
	6261308100	15mt cable for remote connection of keyboard	
6	4291415900	ON/OFF switch	
7	6261303000	X-ray push button	
8	6661303800	X-ray button holder	
9	5461302800	Timer keypad	
10	6661302900	Keyboard cpl.	
11	5461302000	Front cover	
12	5461305800	Timer front cover	
F2	2300974100	Fuse 3A T 6.3x32 for 230V wall version	Mounted on Power PCB
	2300975800	Fuse 6.25A T 6.3x32 for 120V wall version	
F1	2300974100	Fuse 3A T 6.3x32 for 230V mobile version	Mounted on Power PCB
	2300975800	Fuse 6.25A T 6.3x32 for 120V mobile version	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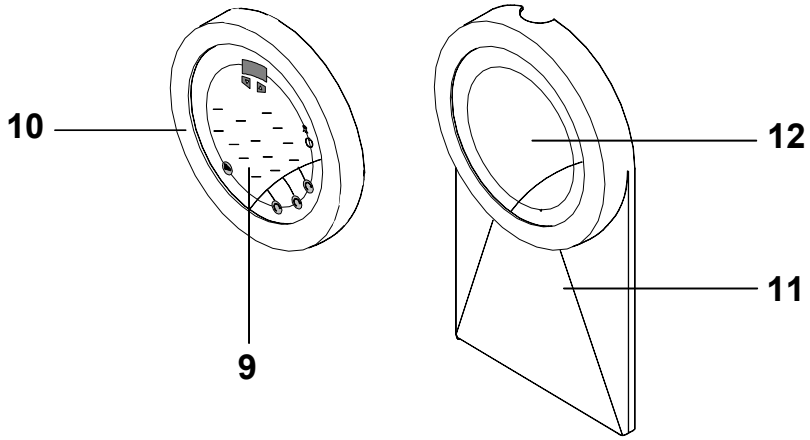
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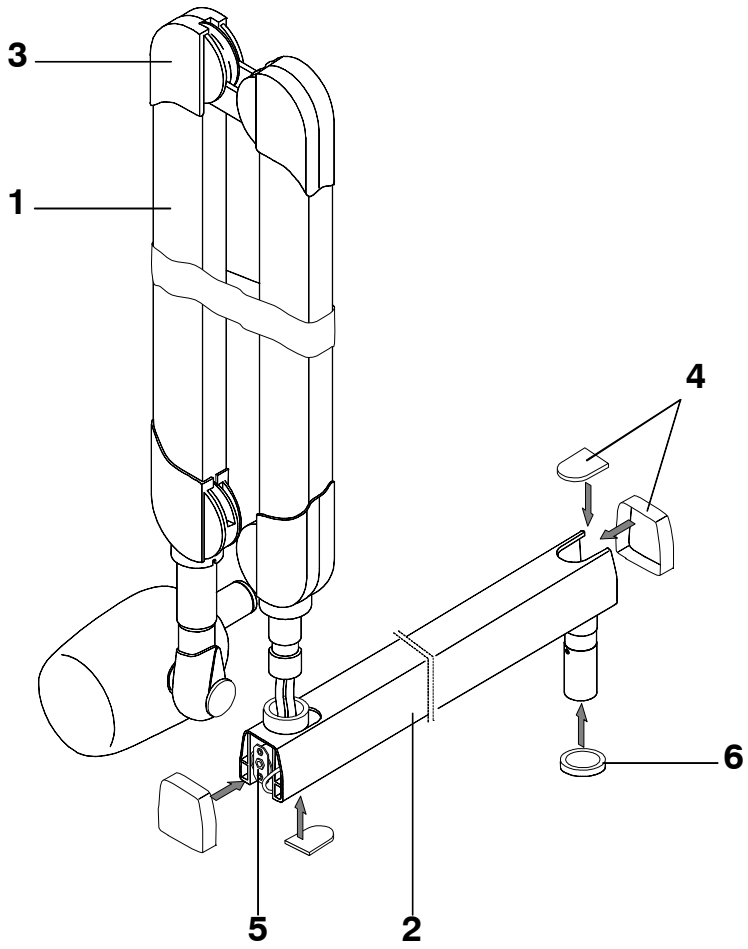
2 – EXTENSION ARM / SCISSORS ARM

Ref.	VSM code	Description	Note
1	8161200702	Scissors arm complete of tubehead support	
2	8161200302	Extension arm 30 cm	
	8161200502	Extension arm 60 cm	
	8161200402	Extension arm 80 cm	
3	6661210000	Scissor arm joint covers kit (DX + SX)	
4	6661210300	Extension arm end-covers kit	
5	6661210200	Extension arm frictioning mechanism	
6	5160249500	Busher ∅ 28mm	


3
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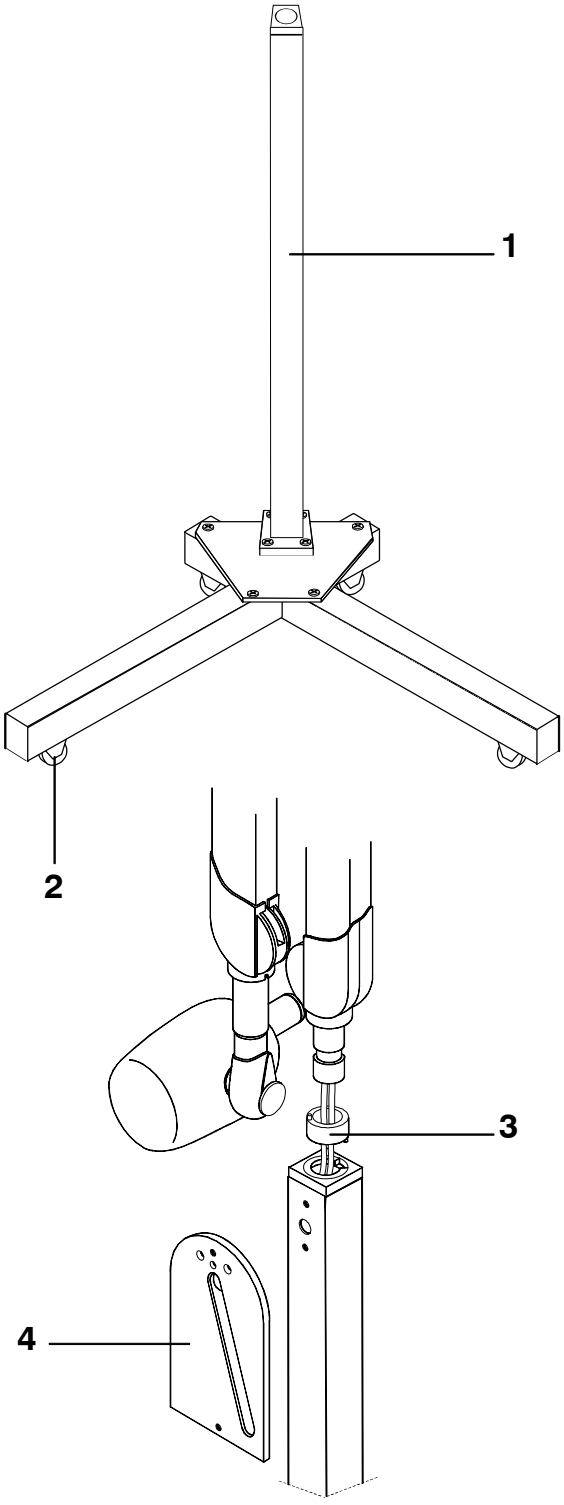
2

3 – MOBILE STAND

Ref.	VSM code	Description	Note
1	8160120000	Mobile stand complete	
2	4890310400	Wheel with brake 80x24	
	4890307000	Wheel 80x24	
3	6661305600	Mobile stand spacer	
4	5261304700	Timer fixing plate	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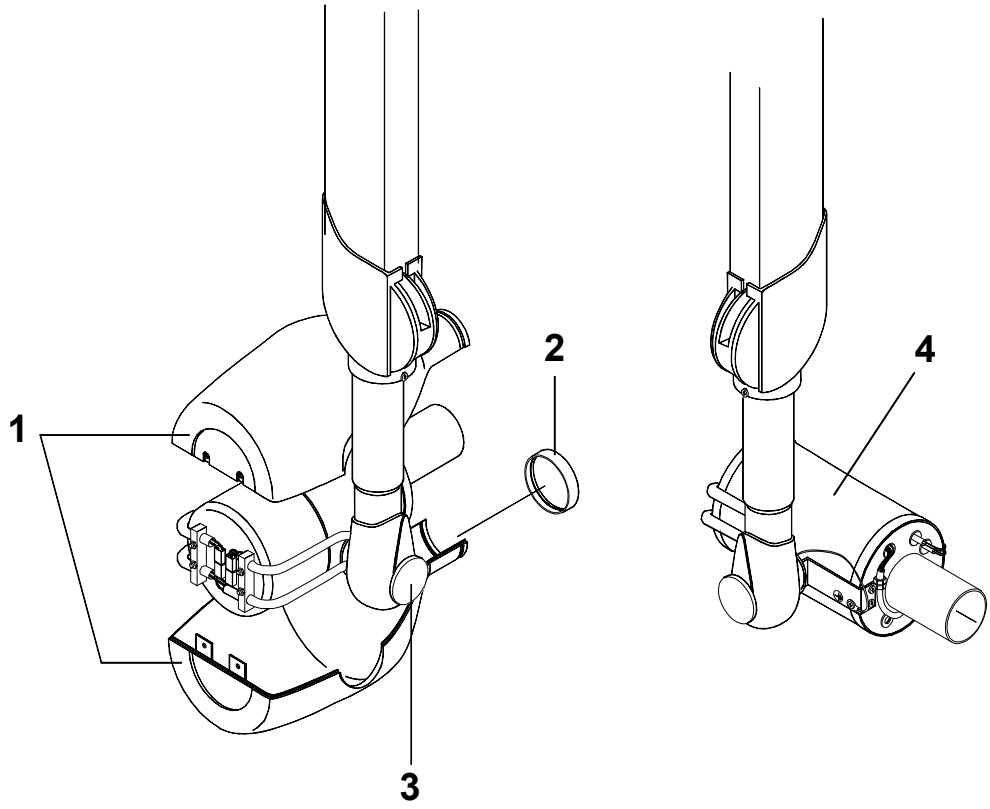
2 – TUBEHEAD

Ref.	VSM code	Description	Note
1	6661408400	Tubehead cover kit (without label)	
2	5460461800	Front fixing ring	
3	5160469903	Tubehead lateral cover	
4	6661408300	Tubehead	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6 – OPTION

Ref.	VSM code	Description	Note
1	6160462003	Rectangular beam limiting device 45x35mm	
2	6161405000	Extension cone for SFD 300mm	
3	6661308000	Remote Timer kit	
4	6660132000	Chemical screws kit	
5	5661307900	Counterplate	
6	6661209900	Allen wrenches kit	

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14. FIXING TEMPLATES

The system is equipped with a set of templates, composed of the following elements:

Code	Description
39619100	Fixing template

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Cod. 6961900903_Rev.0 CE 0434

Dent-X Corporation USA
250 Clearbrook Road
Elmsford, New York 10523
Phone: (914) 592-6100
Fax: (914) 592-6769