AN ISO 9001:2008 & 13485:2003 COMPANY

Mars 40

(High Frequency X-Ray Machine)

INSTALLATION/SERVICE MANUAL

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Catalogue No. 23

We Aim For Your Delight

Table of Contents

This machine is type approved for Mechanical, Electrical & Radiation safety standards by following regulatory boards:

PRODUCT APPROVALS

- Bureau of Indian Standards (BIS) – CM/L-9129174: Approved for meeting Mechanical & Electrical Safety Standards.
- Atomic Energy Regulatory Board (AERB) – 12/1401: Approved for meeting Radiation Safety Standards.
- CE Certified – 09 0439 QS/NB: Approved for meeting International Safety Standards.

SYSTEM APPROVALS

- ISO 9001:2008 & 13485:2003 Approved for meeting Quality Management System Requirements

1. For Your Safety

Read these simple guidelines. Not following them may be dangerous or illegal. Read the complete **User/Installation Manual** for further information.

SWITCH ON SAFELY

Switch **ON** the machine only with dry hands. Please check the earthing before switching **ON** the machine.

ATTENTION SYMBOL

Please refer to **User/Installation Manual** when seen this symbol on your machine.

USE SENSIBLY

Operate your machine as explained in the **User/Installation Manual .**

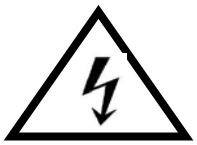
QUALIFIED SERVICE

Only qualified personnel may **Install** or **Repair** this Equipment.

WATER RESISTANCE

Your device is not **Water Resistant**. Keep it dry.

DANGEROUS VOLTAGE



If seen on your equipment don't touch that part because some **High Voltage** or **Dangerous Voltage** must be there.

INTERFERENCE

Wireless or **Mobile Devices** may be susceptible to interference, which could affect performance.

CONNECTING TO OTHER DEVICES

When connecting to any other device, read its **User/Installation Manual** for detailed **Safety Instructions**. Do not connect incompatible products.

WARNING MESSAGE

Please refer **User/Installation Manual** when seen this symbol on your machine.

PROTECTIVE EARTH

This symbol is for protective earth. If seen on your equipment, it indicates the protective earth terminal.

OFF

Indicate that equipment can be switched OFF when pressed this switch.

ON

Indicate that equipment can be switched ON when pressed this switch.

Attention

Please read this Manual thoroughly. Although Allengers devices comply with the related **Safety Requirements**. This manual provides all information necessary for a correct use and the warnings related to danger associated with **X-Rays Generating Units.**

Allengers, is not to be held responsible for,

- Use of the equipment different from the intended one as described in this Manual;
- Damages to the unit, to the operator, to the patient, caused either by wrong installation or maintenance procedures, different from those described in this Manual supplied with the unit, and by wrong operations;
- Mechanical and/or electrical modifications performed during and after the installation, different from those described in the Manual.

Allengers Qualified Engineers must only perform any technical intervention. If so required, only the authorized personnel can remove the covers and has access to the internal circuitry of the equipment.

Warnings:

- This device has not been designed to be used in environments where vapours, anesthetic mixes flammable with air, or oxygen and nitrous oxide can be detected.
- **Before cleaning the device, please disconnect it from the AC Mains supply**.
- Wherever necessary, use the suitable accessories, such as the Leaded Aprons, Lead Goggles, and Thyroid Guards to protect the Patient, User & Support Staff of OT from radiation exposure.
- While performing the radiography, no one, apart from the Operator and the Patient, must remain in the room.
- Though this unit has been designed with a quite acceptable protection level from electromagnetic interference, it is advisable to install it at a certain distance from electrical energy transformation rooms, from static continuity units, from portable receiving-transmitting units and for Cellular use. Cellular Telephones are only admitted at a distance of more than 1.5m from any component of the device. Other medical instruments and devices that must be used in the same installation area of the unit must comply with the Electromagnetic Compatibility rules in force. Non-complying instruments, of which the poor immunity from electromagnetic fields is well known, must be installed at least 3 m away from the equipment and supplied by a different electrical line.
- The equipment must be **OFF** while using devices such as electrical scalpels or similar instruments. The equipment automatically performs some self-test functions and therefore is able to detect some anomalous conditions. However, whenever there are doubts on the performance of the equipment (e.g. images too clear, too dark or with artifacts), the activity must be suspended and an **Allengers Qualified** and **Authorized Engineer** must be contacted.

- During the use of the equipment, the operator must comply with the local work **Safety Regulation,** in particular with the ones referring to the use of **X-Ray Equipments**.
- Avoid to use the **CFL Lamps in O.T.** as some of the CFL Lamps generate **UV Spectrum (>700 mm)** which some times hamper the performance of electronic circuits.

Environmental risks and displacement

The equipment contains in some of its parts, materials that at the end of the unit's life, must be recycled at an approved location. Particularly the device contains the following materials and/or components:

- **Central Unit and Control Console:** Iron, Copper, Aluminum, Non-biodegradable Plastic Material, Glass-Resin for Printed Circuit Boards (PCB).

- **Tube Head Assembly**: Tube Head Assembly of this X-Ray Equipment contains High Voltage Tank, X-Ray Tube and Oil filled alongside, Printed Circuit Board (PCB) and Lead used for controlling Stray Radiations.

Allengers is not responsible for the disposal of the equipment performed by the user and for the costs related to this intervention.

It is assumed by the manufacturer and distributors of this equipment that all persons responsible for the operation of this equipment are aware of danger and excessive exposure to X-Radiation and this equipment is sold with the understanding that **Allengers Medical Systems Limited, their agents and representatives have no responsibility for injury or damage which may result from exposure to X-Radiations.**

Recommendations to reduce Radiation Exposure

The main objective of radiation protection procedures in an X-Ray Diagnostic Installation is to limit the Radiation Exposure arising from the use of the Diagnostic Equipment as low as possible so that the radiation doses received by the radiological personnel and general public never exceeds the maximum permissible dose limits recommended by **ICRP** (International Commission on Radiation Protection).

a) The radiation exposure to the patient should be the minimum exposure required to produce images of good diagnostic quality. Use radiation with care, caution and at a rate which is **ALARA** - 'As Low As Reasonably Achievable'

b) The speed of the film, or screen and film combinations should be of fastest speed consistent with the diagnostic objective of the radiographic examination.

c) When a patient or film must be provided with auxiliary support during radiation exposure:

    (i) Mechanical holding devices shall be used when the technique permits.

(ii) Individuals may be permitted to hold the patient when absolutely necessary and no individual shall be used routinely for this purpose to the exclusion of others who might share the task.

(iii) If a human holder is required, the holder shall be positioned such that no part of body shall be struck by primary X-Ray beam unless protected by at least 0.5 mm lead equivalent and shall be protected from direct scatter radiation by protective lead apron of not less then 0.25 mm lead equivalent.

d) Gonadal shielding of not less then 0.25 mm lead equivalent shall be used for patients who have not passed their reproductive age during radiographic procedures in which gonads are under primary beam, except, in cases where shielding would interfere with diagnostic procedures.

e) Doors of the Room/OT where X-ray equipment is installed should be closed before making exposures.

f) The X-ray beam should not be directed towards doors or windows of the room, or towards control panel or darkroom walls unless no other geometry is possible.

g) Obey radiation protection rules pertaining to time, distance and shielding.

h) Prefer low exposure settings to high.

i) Use Collimator to set minimal useful field size; keep Image Intensifier in close proximity to the patient.

THE EQUIPMENT MUST BE USED WITH GENUINE ALLENGERS ACCESSORIES

First Aid In Case of Electrical Shock

1. Switch **OFF** the **Power Supply**: If this is not possible, protect yourself with dry insulating material and pull the victim clear off the conductor. Do not touch the victim with your bare hands until he/she is clear off the conductor.

2. Place the victim in supine position.

3. Keep the air passage clear by turning the head to one side, opening the patient's mouth and cleaning it of water, saline, mucus or blood, a lot of which might have accumulated in the back of the throat.

4. If the jaw is rigid, try to force the mouth open by pressure on the gum behind the last molar tooth of the lower jaw. When the upper air passage is cleared, tilt the head backward and force the jaw forward from the angles of the jaw in front of the ears. This would prevent mechanical obstructions to the upper air passages.

5. Hold the chin up and forward with one hand and pinch the nostril of the victim with other.

6. Take a very deep breath and apply your mouth to that of victim and blow into his mouth until the chest of the victim moves up indicating filling of the lungs (Never allow the chin to sag).

7. When the chest has moved up, withdraw your mouth and allow the chest to sink back.

Have someone else sent for a Doctor.

Keep patient warm and loosen his/her clothing.

Do not give liquids until the patient is conscious.

2. About Your Device

Mars 40 is an X-Ray Machine with high frequency generator and have features for operator's ease like APR.

The Radiography **Parameters** defined in this machine are based on Human **Anatomy**. This is reason why this machine is known as **APR** (Anatomical Programmed Radiography Machine).

There are different keys to define the Body Part to be exposed and depending on the defined Part by operator, machine it-self set the parameters depending on the built of patient and Screen Speed combination available for Exposure.

Operator can choose manual mode and can select their own parameters fro exposures.

A Variety of tube stands & tables can be chosen depending upon the customer's requirements. This machine is best suited for Chest, Extremities, Skulls, Abdomen & Pelvic for all routine & special Radiographic & Fluoroscopy examines.

Machine is supplied with different combinations and tables depending on the type of operation needed.

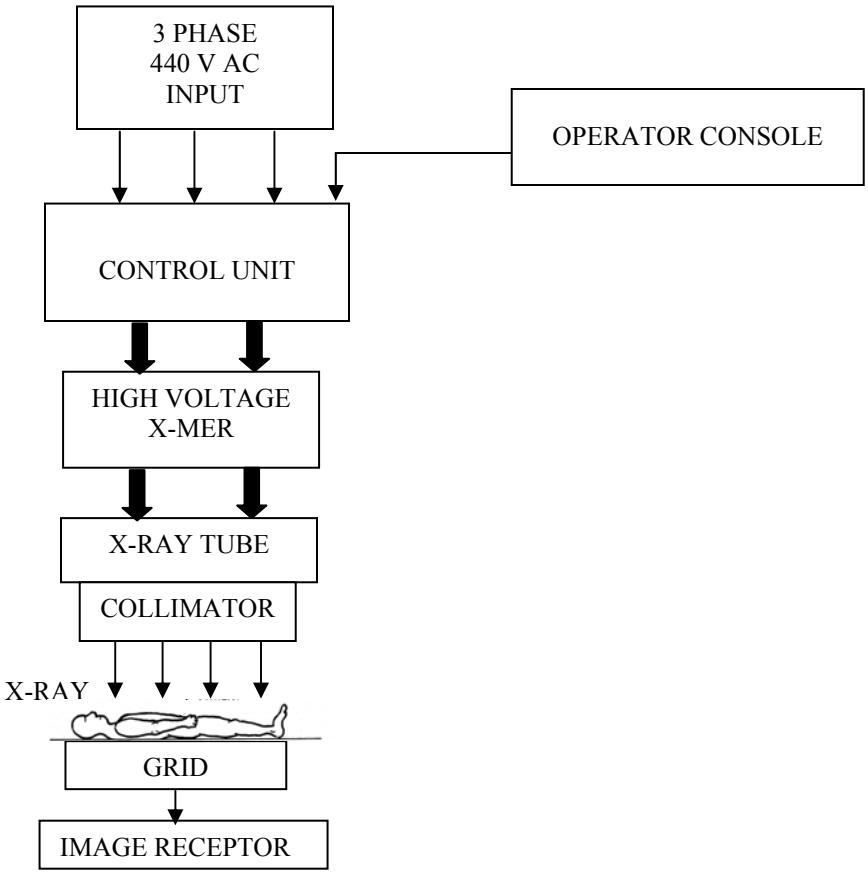
Whole of the equipment offers innumerable benefits like compact size, consistent output and negligible dose rate.

Mars 40 with Ceiling Free Stand and Floatex Table makes and ideal combination for all possible radiographic applications offering ease of patient positioning specially in Trauma cases.

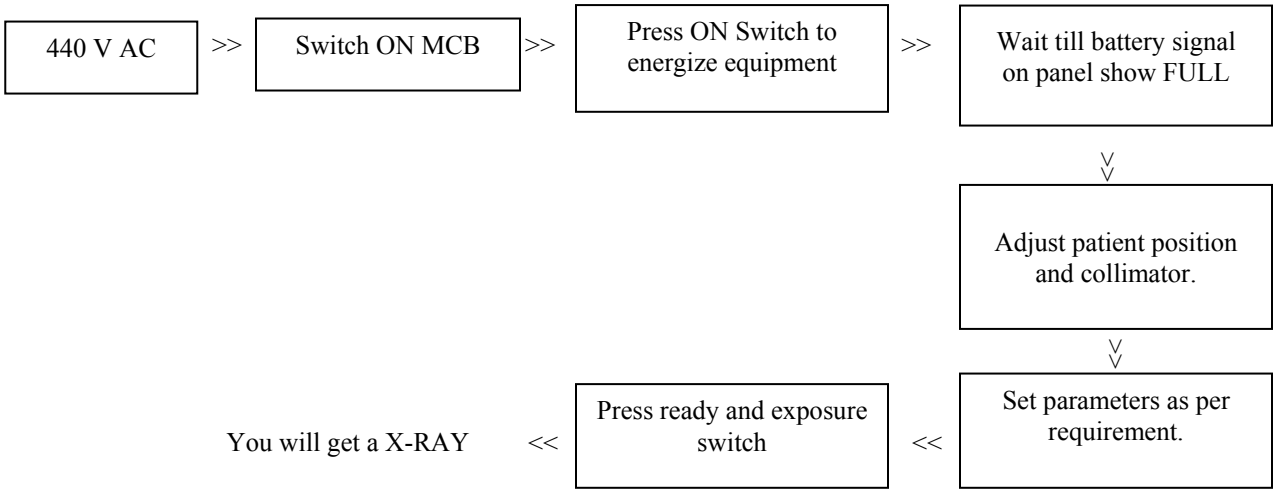
Mars 40 with Floor to Ceiling Stand & Allpose is used for Special Investigation purposes e.g. HSG, Barium Investigation etc.

3. Product Description

a) Block Diagram:



b) Sequence of Operation: -



4. Technical Specifications:

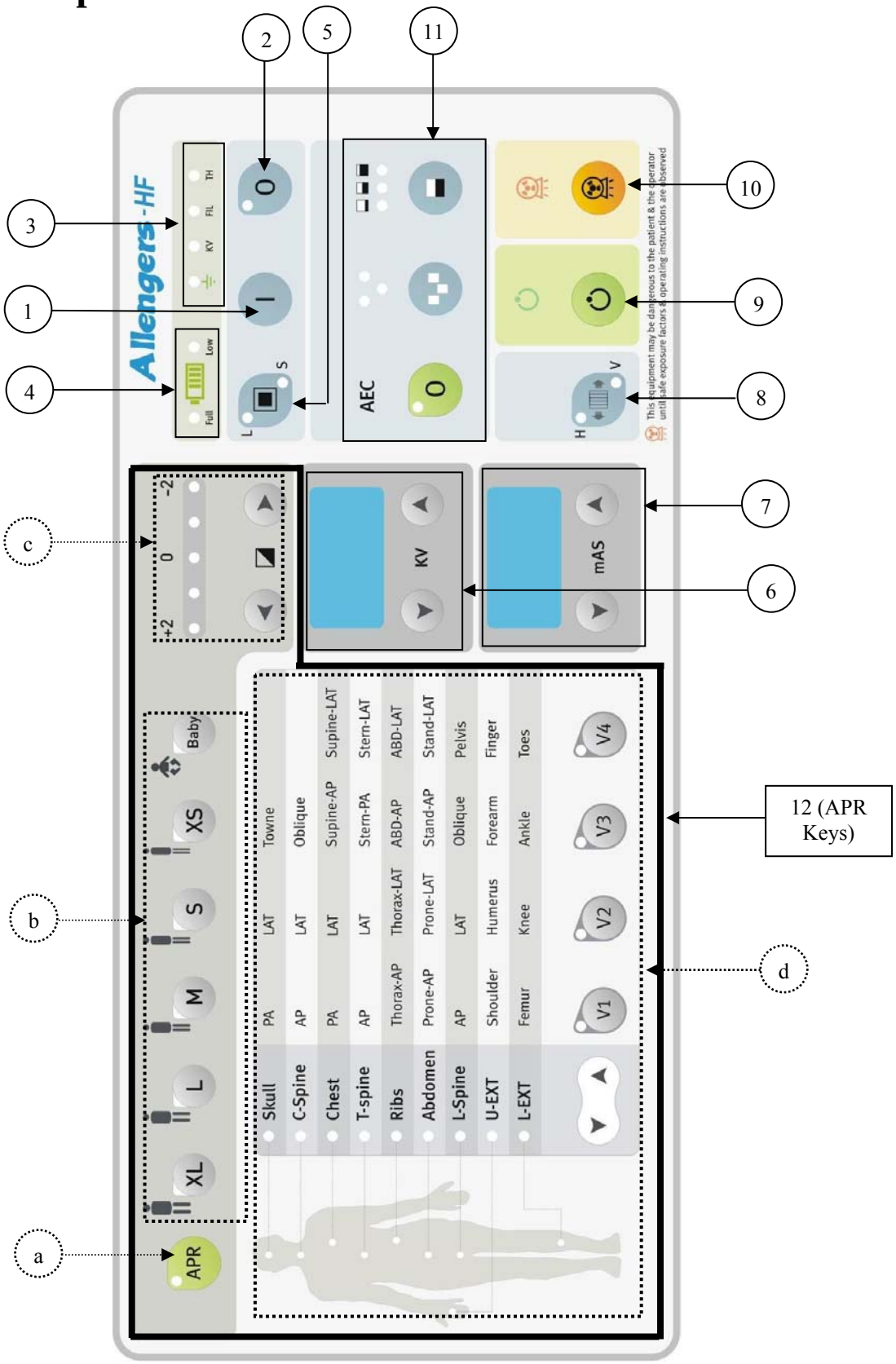
PARAMETERS	SPECIFICATIONS
KV	- 40 to 125 KV in steps of 1 KV
mAs	- Variable mAs from 1 to 200 mAs (500mA max.)
X-Ray Generator	- High Frequency 40 KHz., 40 KW X-Ray Generator
X-Ray Tube	- Dual Focus, Rotating Anode Tube, of focal spot 1.0 mm^2 (Small) & 2.0 mm^2 (Large) - Collimator with Auto Shut OFF
Control	- Digital Display of kV/mAs - X-Ray Tube Head Temperature Sensor for Thermal Cut-OFF - Indicators of Ready & X-Ray ON, - Machine ON/OFF Switch, X-Ray Exposure Switch, kV Increase/Decrease switch & mAs Increase/Decrease Switch - Bucky ON/OFF - Self Diagnostic on Panel - APR Mode - Keys for selecting Area - Keys for selecting View - Keys for selecting Patient size - Patient Selection Switch
Additional Features	- Hand Switch with retractable cord for initiation of exposure
Power Supply	- 440V(AC-Supply) 50/60 Hz, ± 10%
Environmental & Operating Conditions	Storage Temperature 0 to 40° C Humidity Maximum 90% at 30° C Operating Conditions: Temperature 10 to 40° C Humidity Up to 75%

Fuse Details:

FUSE NO.	FUNCTION	RATING
F1	Phase-1	63 amp
F2	Phase-2	63 amp
F3	Phase-2	63 amp
F4	Bucky	04 amp
F5	LBD	04 amp
F6	Rotor	08 amp

MCB: 63 Amp (For Over Current Protection)

5. Description of Control



a) Description of Control Functions:

1. MACHINE ON SWITCH

This **switch** is used to **turn ON** the machine.

2. MACHINE OFF SWITCH

This **switch** is used to **turn OFF** the machine. Indicator along this switch glows when power is available to the machine but machine is in OFF condition.

3. FAULT INDICATORS

-  Indicator glows to indicate the **Phase Failure**. When this Indicator is glowing then either of phases is not available to the machine or Voltage Level is not in range of 180V – 250V (Phase to Neutral).
- 

Indicator glows to indicate **High Voltage Fault**. When this Indicator is glowing, either there is problem in **Inverter** or **H.V. tank.**
- 

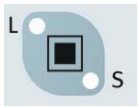
Indicator glows to indicate the **Filament Fault**. This **fault** is due to some fault in **Filament Section.**
- 

Indicator glows to indicate **Thermal Fault**. This **fault** is due to **overheating** of Tube. When this fault occurs then waits for some time to ensure cooling of the Tube.

4. CAPACITOR CHARGING INDICATION

When we switch **ON** the machine **Low Capacitor Indicator** will glow about approx. **50 sec.** When this indicator is glowing the machine does not exposes. When full indicator glows then machine is **ready for exposure.**

5. LARGE/SMALL FILAMENT MODE SELECTION SWITCH



Used to select either **Large or Small Filament of the Tube.**

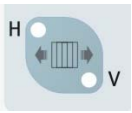
6. KV INCREASE & DECREASE SWITCH

This switch is used to Increase and Decrease the KV. KV can be increased or decrease from 40 to 125 KV in steps of 1 KV each and the display of KV is shown on the display above these switches.

7. mAs INCREASE & DECREASE SWITCH

This switch is used to Increase and Decrease the mAs. mAs can be Increased or Decrease from 1 to 200 mAs. The display of mAs is shown on the display above these switches.

8. BUCKY SWITCH

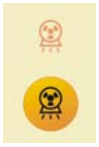


This **switch** is used to **energize the Bucky.** When no Indicator is glowing then none of the Bucky is selected. When we **press it one time** then **H** Indicator glows and **Horizontal Bucky** is selected. If we again press the switch then **V** Indicator starts glowing and **Vertical Bucky** is selected

9. READY SWITCH WITH INDICATOR

This **switch** is used to **Boost the Filament**. When this switch is pressed, Indicator above this switch glows.

10. EXPOSURE SWITCH WITH INDICATOR



This **switch** is used to **make an Exposure**. For exposure, first press the Ready Switch and then Exposure Switch. **Exposure Indicator** above this switch glows to indicate that **exposure takes place.**

11. AEC Mode (Optional)

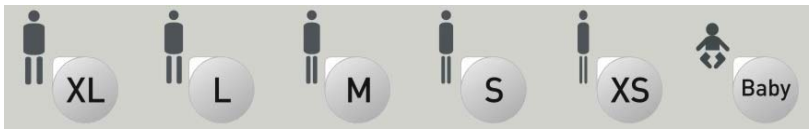
In **AEC Mode** user can select the KV according the patient size and also select the chambers as per area of exposure. The machine will automatically select the dose rate to be given to patient.

12. APR KEYS:-

a) APR Key

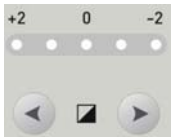
When we switch ON the machine then by default machine is in the APR Mode, and the corresponding indicator will glow. By pressing this switch the machine will come out of APR Mode and vice versa.

b) Patient Selection Switch



These switches are used to select the body size of the patient.
When XL switch is pressed then the factors selected is for extra large patient and similarly for L, M, S, XS and baby the factors selected are for LARGE, MEDIUM, SMALL, EXTRA SMALL and BABY.

c) Film Density Selection Switch



These **switches** are used to **Increase** or **Decrease** the **mAs** as per density of film used by the Operator.

d) Body Part Selection Switches

Skull	PA	LAT	Towne	
C-Spine	AP	LAT	Oblique	
Chest	PA	LAT	Supine-AP	Supine-LAT
T-spine	AP	LAT	Stern-PA	Stern-LAT
Ribs	Thorax-AP	Thorax-LAT	ABD-AP	ABD-LAT
Abdomen	Prone-AP	Prone-LAT	Stand-AP	Stand-LAT
L-Spine	AP	LAT	Oblique	Pelvis
U-EXT	Shoulder	Humerus	Forearm	Finger
L-EXT	Femur	Knee	Ankle	Toes

These switches are used to select the Area and the View in which X-Ray is to be taken.

This  Switch is used to define the Area to be Exposed. By pressing these two switches the operator can select the area for exposure and the corresponding LED for selected area will glow on the panel e.g. if the operator scroll down by pressing down key to Chest then corresponding LED will glow on the Panel.

By pressing the **V1, V2, V3 & V4** key one can select the view for the X-Ray e.g. if operator wants to take PA view for the chest then he/she has to press 

key and if he/she wants to take LAT view then he/she has to press 

similarly if one has to take the SUPINE AP or SUPINE LAT, he/she has to press **V3 & V4**.

Similar procedure will follow for the rest of selection.

13. HAND SWITCH

This is used to press Ready switch and Exposure switch using retractable type cord.

LBD ON/OFF SWITCH (ON LBD) 

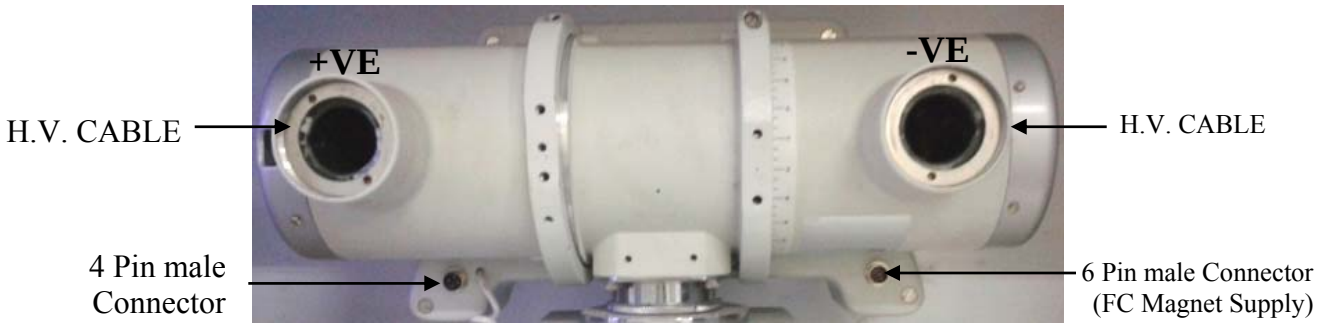
This is Push to ON type switch. When it is pressed bulb gets ON and remains ON for 1 minute. After 1 minute bulb gets OFF automatically.

AUDIBLE ALARM

Beep tone is heard during the emission of X-Rays.

6. Assembly Procedure

1. Plan the location of various parts of machine i.e. Control, Table, Tube Stand etc. in an X-Ray room.
2. A proper Earth connection must be available & all parts of X-Ray machine must be earthed.
3. Take measurements for lengths of different types of wires required as per their size.
4. Fix thimbles on different wires required for inter-connection of different parts as per Inter connection details. Ensure that thimbles on all wires are not loose.
5. Connect Main Supply Lead in Main Switch (3 Phase supply - Phase1, Phase2, Phase3, Neutral & Ground).
6. Connect H.V. Cables from H.T. Tank to Tube Head as follows:



+ve of H.V. Tank to +ve of Tube Head

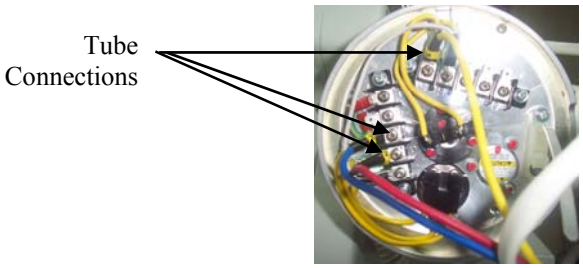
-ve of H.V. Tank to –ve of Tube Head

7. Connect Rotor connections from control as follows (Recommended for Toshiba Tube Only):

TS3-1 to 5 on Tube Head

TS3-2 to 3 on Tube Head

TS3-3 to 2 on Tube Head



Control Side:- Connect LBD supply (24V AC) wires to TS3-8 & TS3-9.

Tube Head Side Connections:- Connect 4 Pin Connector in Electromagnet Panel & Connect 5 Pin Connector of Electromagnet Panel to In LBD. Connect 6 Pin connector of Stand Supply in Electromagnet Panel.

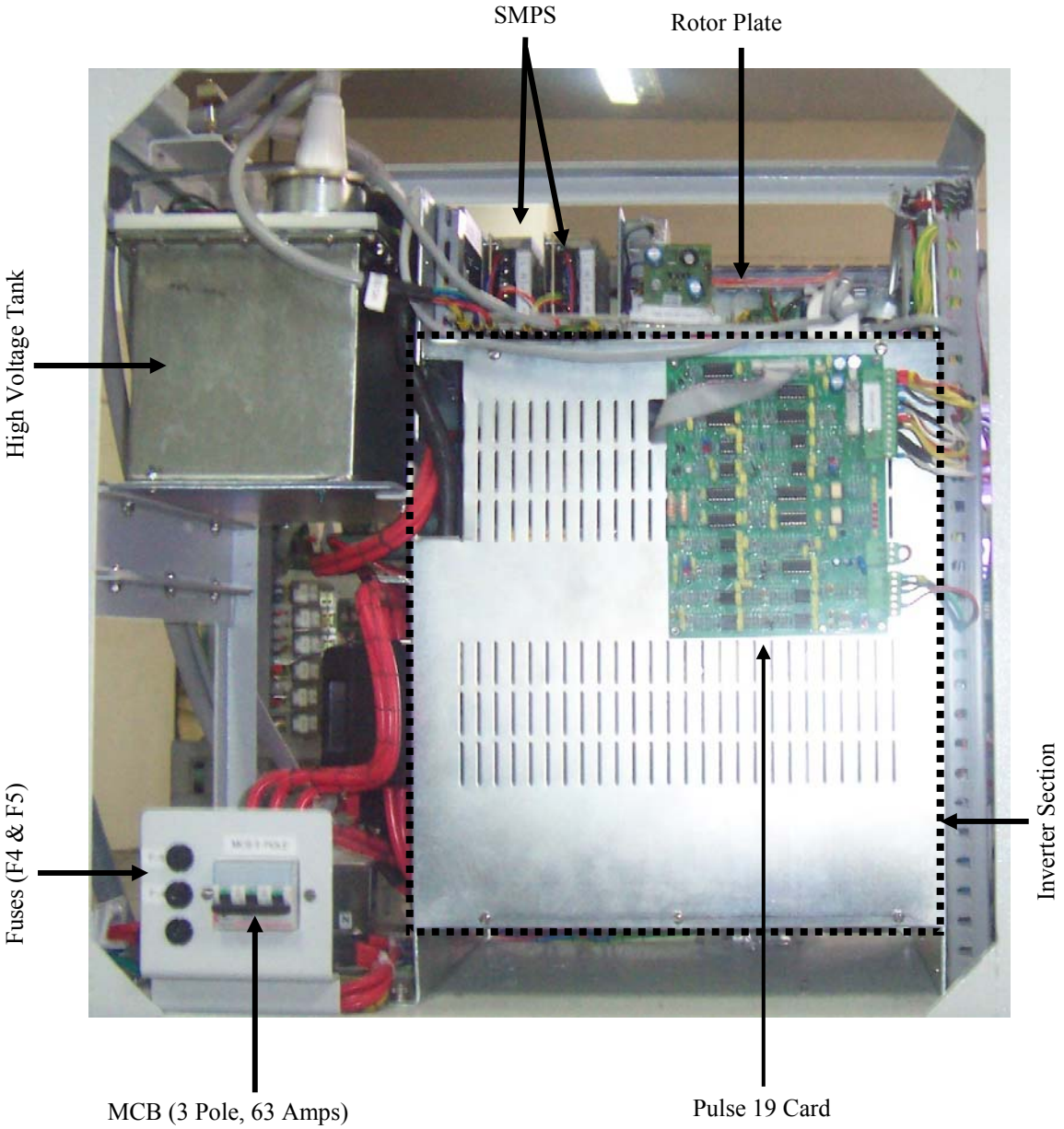
8. **Pedestal Connections:**
    - Connect FRC cables to Motherboard Card J1 & JP3 after giving 4 turns through Ferrite Core as shown at Page No.18.
    - Connect Hand Switch connections at JP6-1 (Ready) JP6-2 (X-Ray) & JP6-8 (Common) connector in Mother Board Card.
    - Connect Buzzer Connections (3-pin Connector) at JP7-1 (Positive) & JP7-2 (Negative) in Motherboard Card.
9. Connect Table Supply Connections in Control at terminal strip TS3-6 (Magnet Supply-230V AC), TS3-11 (Common-0V AC) & TS3-10 (Horizontal Bucky Supply-230V AC).
10. Connect Vertical Bucky Stand Supply Connections in Control at terminal strip TS3-6 (Magnet Supply-230V AC), TS3-11 (Common-0V AC) & TS3-12 (Vertical Bucky Supply-230V AC, If Applicable).

PRECAUTION TO BE TAKEN WHILE ASSEMBLING H.V. CABLES AND H.V. TANK

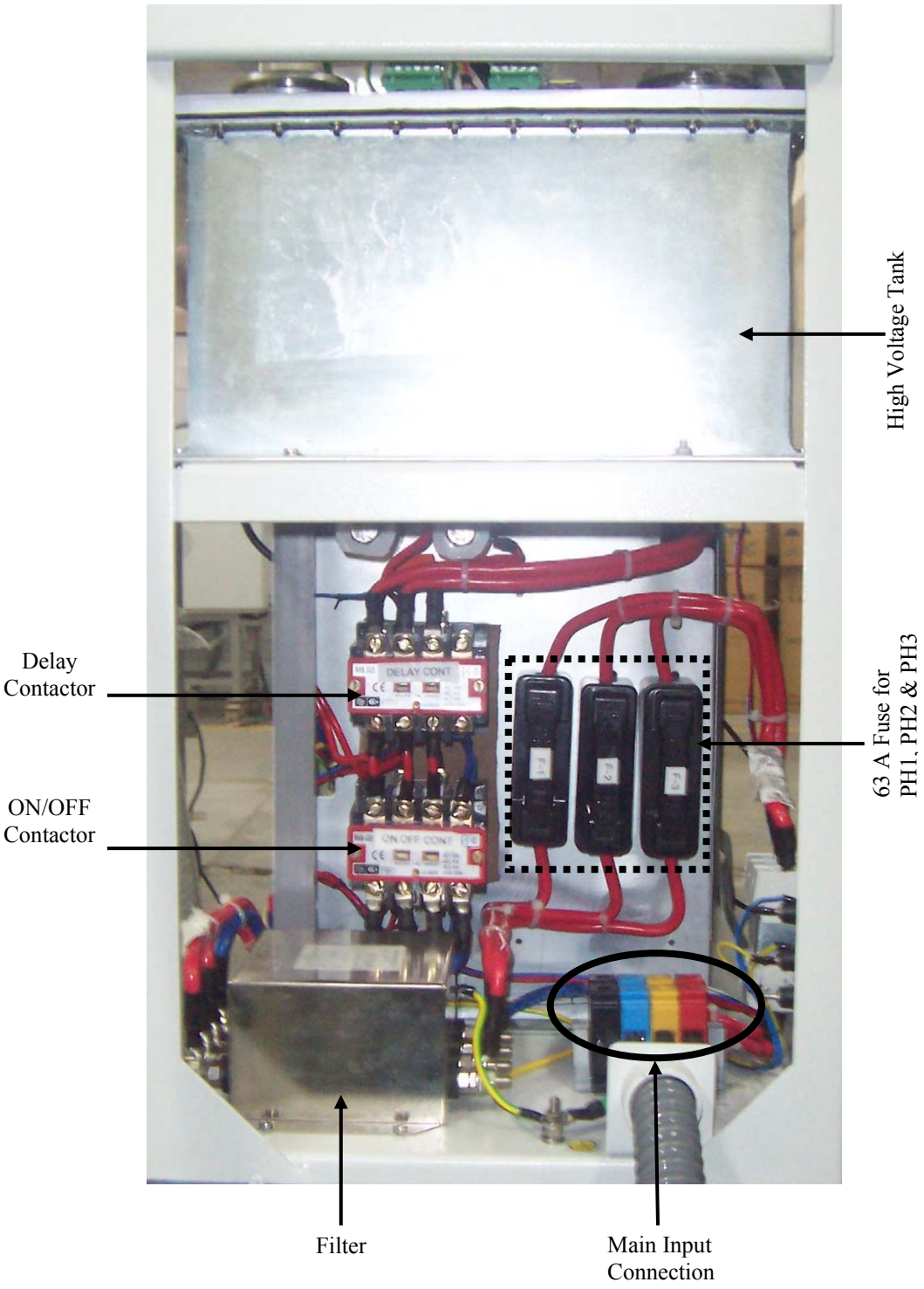
- The Entire surface of the Bushing & Receptacle should be thoroughly cleaned for any dirt or dust.
- Jelly should be applied on the High Voltage Bushings of the HV Cables so as not to leave any air between receptacles & bushings. (**It is strictly advices that apply the jelly, which is supplied with the tube. Other jelly should not be used).**
- The Earth wire on the HV Transformer should be properly tightened.
- All connections on the H.T. Tank & Tube Head should be firmly tightened.
- All connections on the H.T. Tank & Tube Head should be firmly tightened.

7. Component Layout:

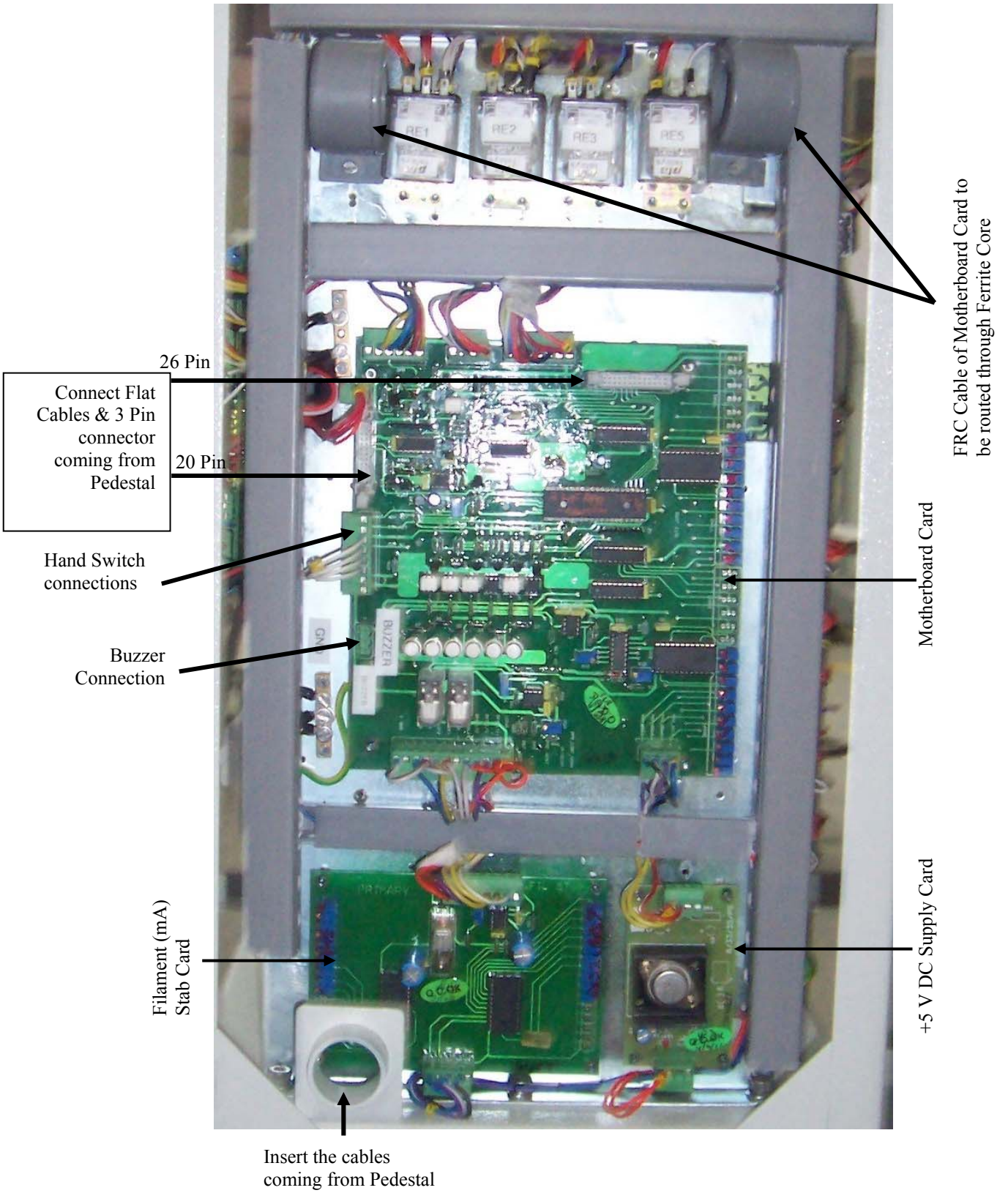
Left side View:



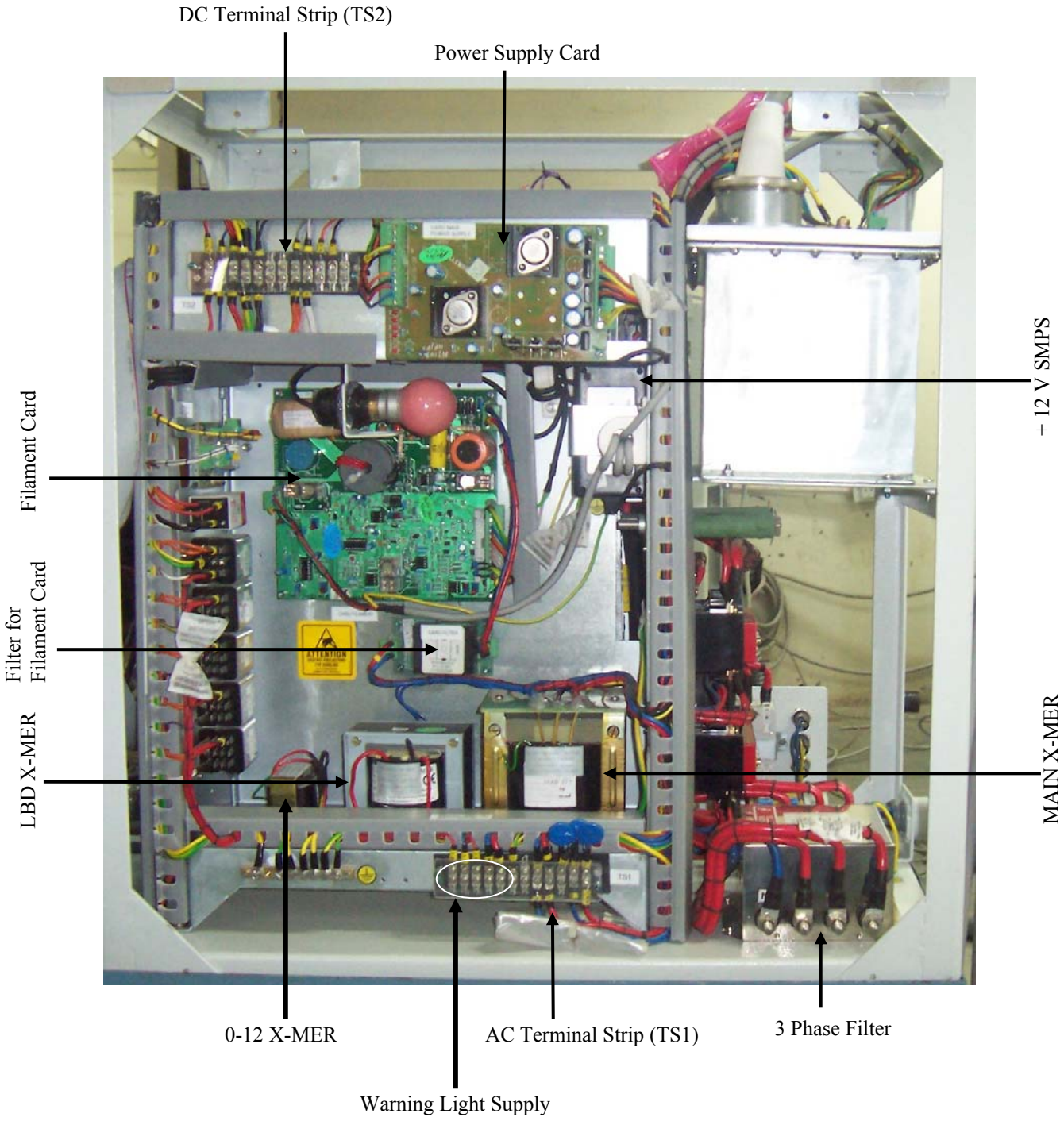
Back View:


High Voltage Tank
Delay Contactor
ON/OFF Contactor
63 A Fuse for PH1. PH2 & PH3
Filter
Main Input Connection

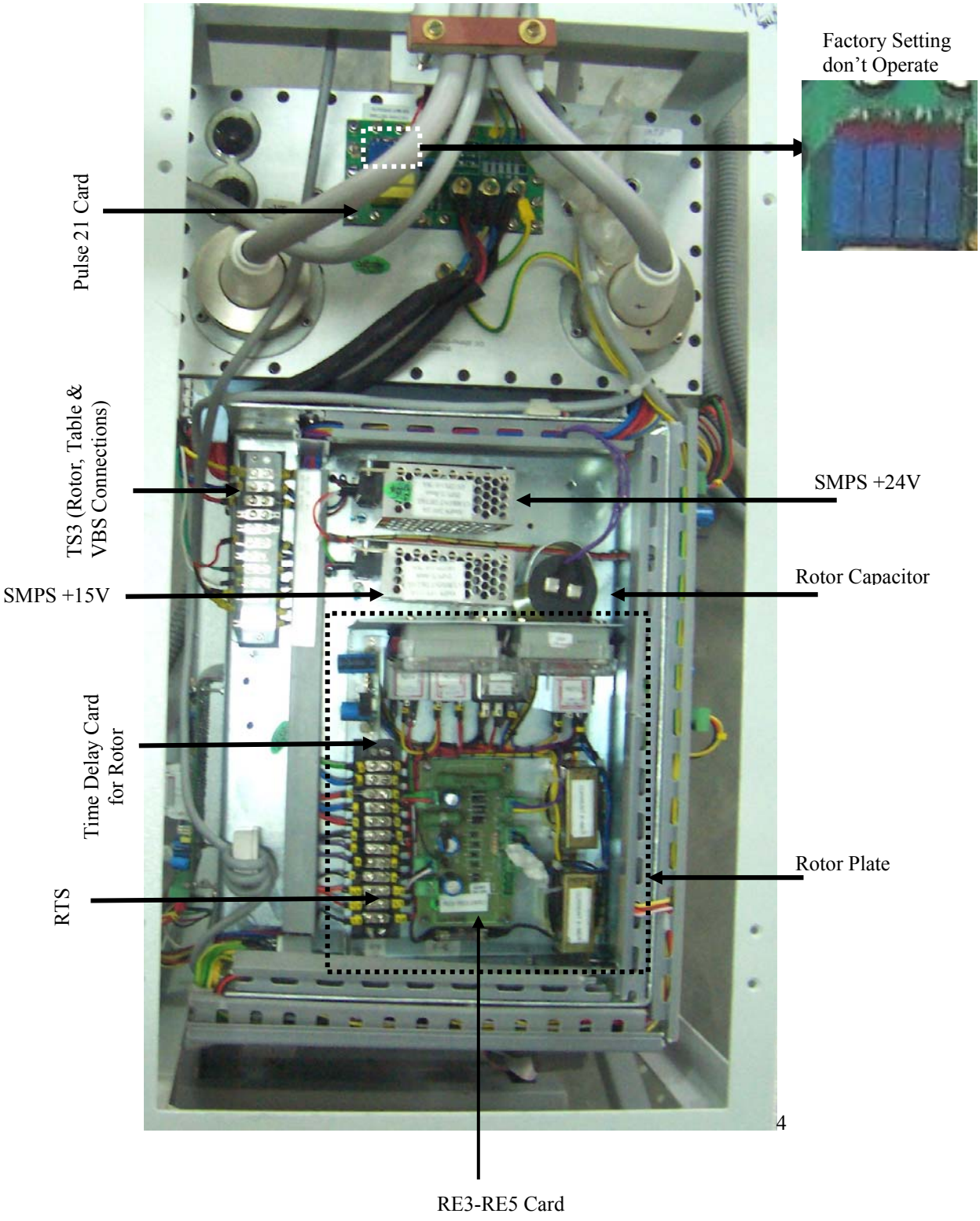
Front View:


FRC Cable of Motherboard Card to be routed through Ferrite Core
26 Pin
Connect Flat Cables & 3 Pin connector coming from Pedestal
20 Pin
Hand Switch connections
Buzzer Connection
Motherboard Card
Filament (mA) Stab Card
+5 V DC Supply Card
Insert the cables coming from Pedestal

Right Side View:



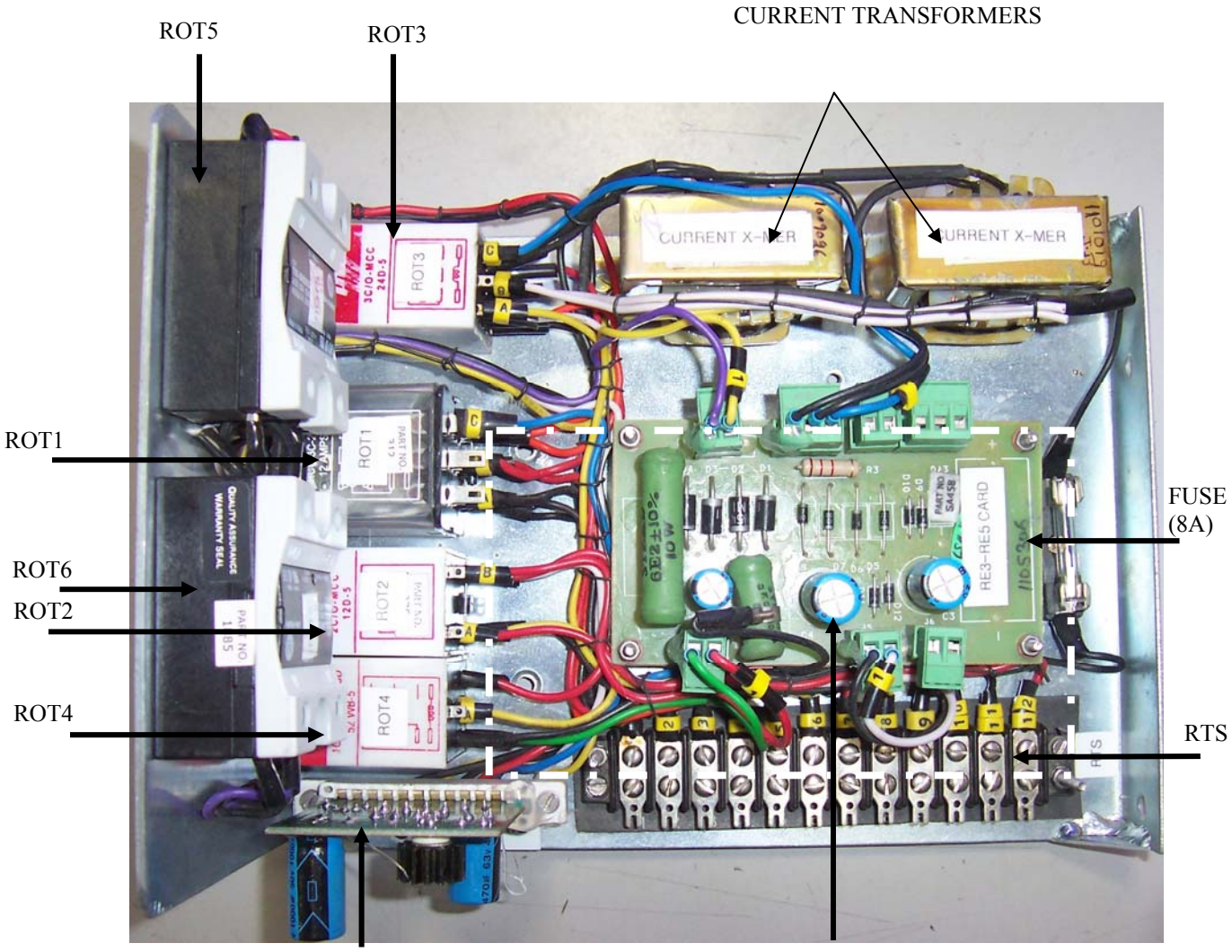
Top View:


Factory Setting
don't Operate
Pulse 21 Card
TS3 (Rotor, Table &
VBS Connections)
SMPS +24V
SMPS +15V
Rotor Capacitor
Time Delay Card
for Rotor
Rotor Plate
RTS
RE3-RE5 Card

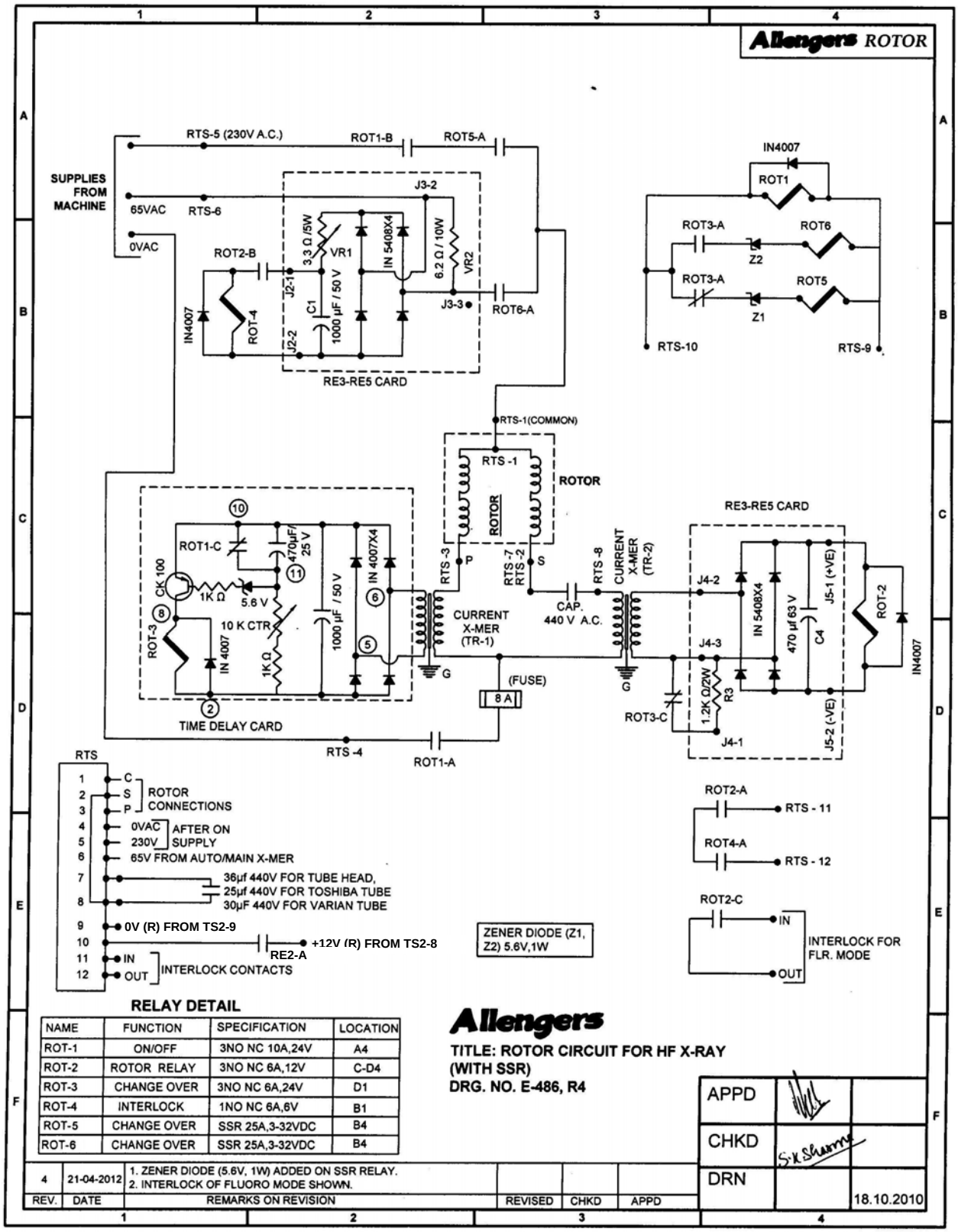
8. Cards/Assemblies Details

SR. NO.	NAME OF CARD/ASSEMBLY	LOCATION IN WIRING DIAGRAM	QUANTITY
1	Initial Time Delay Card	C6	01
2	Power Supply Card	C2	01
3	Filament Card	B4	01
4	Pulse-19 Card	B2-3	01
5	Motherboard Card	C-D4	01
6	Filament Stab Card	C5	01
7	Rotor Card Assembly	B5	01
8	Filter Card	B4	01
9	Display Card	--	01
10	Pulse-20	A3 (IN INVERTER)	01
11	Pulse-21	A4	01
12	Pulse-18	A3 (IN INVERTER)	01
13	+ 5 V DC Power Supply Card	C3	01

ROTOR ASSEMBLY



TIME DELAY CARD **RE3-RE5 CARD**


Allengers ROTOR
SUPPLIES FROM MACHINE
65VAC
0VAC
RTS-5 (230V A.C.)
RTS-6
ROT1-B
ROT5-A
ROT2-B
ROT4
IN4007
3.3 Ω /5W
VR1
IN 5408X4
6.2 Ω / 10W
VR2
J3-2
J3-3
ROT6-A
J2-1
J2-2
C1
1000 µF / 50 V
RE3-RE5 CARD
IN4007
ROT1
ROT3-A
ROT6
Z2
ROT3-A
ROT5
Z1
RTS-10
RTS-9
RTS-1(COMMON)
RTS -1
ROTOR
ROTOR
RTS -3
RTS -7
RTS -2
P
S
RTS -8
CURRENT X-MER (TR-2)
CAP. 440 V A.C.
CURRENT X-MER (TR-1)
G
(FUSE)
8 A
RE3-RE5 CARD
J4-2
J4-3
J4-1
IN 5408X4
470 µf 63 V
C4
J5-1 (+VE)
J5-2 (-VE)
ROT-2
IN4007
ROT3-C
1.2K Ω/2W
R3
ROT1-C
CK 100
1K Ω
5.6 V
10 K CTR
1K Ω
ROT-3
IN 4007
470µF/ 25 V
1000 µF / 50 V
IN 4007X4
TIME DELAY CARD
RTS -4
ROT1-A
RTS
1 C
2 S
3 P
ROTOR CONNECTIONS
4 0VAC
5 230V
AFTER ON SUPPLY
6 65V FROM AUTO/MAIN X-MER
7
8
36µf 440V FOR TUBE HEAD,
25µf 440V FOR TOSHIBA TUBE
30µF 440V FOR VARIAN TUBE
9 0V (R) FROM TS2-9
10 +12V (R) FROM TS2-8
RE2-A
11 IN
12 OUT
INTERLOCK CONTACTS
ZENER DIODE (Z1, Z2) 5.6V,1W
ROT2-A
RTS - 11
ROT4-A
RTS - 12
ROT2-C
IN
OUT
INTERLOCK FOR FLR. MODE
RELAY DETAIL
NAME | FUNCTION | SPECIFICATION | LOCATION
ROT-1 | ON/OFF | 3NO NC 10A,24V | A4
ROT-2 | ROTOR RELAY | 3NO NC 6A,12V | C-D4
ROT-3 | CHANGE OVER | 3NO NC 6A,24V | D1
ROT-4 | INTERLOCK | 1NO NC 6A,6V | B1
ROT-5 | CHANGE OVER | SSR 25A,3-32VDC | B4
ROT-6 | CHANGE OVER | SSR 25A,3-32VDC | B4
Allengers
TITLE: ROTOR CIRCUIT FOR HF X-RAY (WITH SSR)
DRG. NO. E-486, R4
APPD
CHKD
DRN
18.10.2010
4 | 21-04-2012 | 1. ZENER DIODE (5.6V, 1W) ADDED ON SSR RELAY. 2. INTERLOCK OF FLUORO MODE SHOWN.
REV. | DATE | REMARKS ON REVISION | REVISED | CHKD | APPD

Brief description of Operation Rotor Assembly

Drawing No. E-486, R4

Note:

1. **The letters written in curly brackets {} denotes the location of part/ Component/ contact terminal in wiring diagram.**
2. **Abbreviation**

    - **NO** stands for Normally Open Contact of Relay / Contactor.
    - **NC** Stands for Normally Close Contact of Relay / Contactor.
    - **ROT**-Relay of Rotor Plate
    - **TS** stand for Terminal Strip
    - **TR** stands for Transformer
    - **Ckt**. Stands for Circuit
    - **J** stands for Connector Number of Cards
    - **RTS** stands for Rotor Terminal Strip
    - **C** stands for Common Terminal of Rotor
    - **S** stands for Shift Terminal of Rotor
    - **P** stands for Principle Terminal of Rotor

1. 0VAC from Machine is fed at ROT1-A NO **{D2}** Contact through RTS4.
2. 230VAC from machine is fed to ROT1-B NO **{A2}** Contact through RTS5
3. 65VAC from Machine to given to RE3-RE5 Card **{B2}** connector J3-2 through RTS6 **{A2}**. From RE3-RE5 Card connector J3-3 fed to ROT6-A NO Contact **{B3}**.
4. Capacitor of 25µFD is connected at RTS-7 & RTS-8 **{C3}** for Phase shift.
5. 0VDC is directly fed to ROT1 Coil **{A4}**, ROT5 & ROT6 **{B2}** Relays from RTS-9 **{B4}**.
6. 12VDC is given at RTS-10 {B3} through Ready Relay of Machine. When Ready Relay gives 12VDC, ROT1 **{A4}** & Through ROT3-A NC Contact & Z1 (Zener Diode 5.6V 1W) ROT5 Relay **{B4}** gets energized.

7. Now 0VAC from ROT1-A **{D2}** is fed to Current Transformers (TR-1 & TR-2) through 8A glass fuse. Current Transformer-1 **{C2, D2}** gives the 0V at Output Terminal RTS-3 **{C2}** (Principle Point of Rotor Winding). Current Transformer-2 {C3, D3) gives output at Output Terminal RTS-2 **{C3}** (Shift Point of Rotor Winding) through Phase Shift Capacitor.
8. From ROT1-B NO Contact **{A2}** 230VAC supply given to ROT5-A NO Contact **{A3}** and then 230V is fed to Output Terminal at RTS-1 **{C3}** (Common Point of Rotor Winding). ROT1-C NC Contact **{C1}** (10& 11 of Time Delay Card) gets open & Cap. 470µFD {C2} inside the Time Delay Card is now can be charged.
9. Now 0V & 230V voltage reaches to the Rotor Winding Terminals **{C3}** & then current will starts flowing through Current Transformers & both the Transformer gives voltage output according to current flow level.
10. Current Transformer-2 **{C3, D3}** output is given at RE3-RE5 Card at J4-2, 3 directly & at J4-1 {D3, D4} through ROT3-C NC Contact **{D3}** for voltage drop. This voltage is converted into the DC through diodes and fed to ROT2 Relay **{D4}** from J5-1 (+VE) & J5-2 (-VE) of RE3 & RE5 Card which energize the Relay.
11. FLR Interlock IN Signal now available from ROT2-C Common Contact to ROT2-C NO Contact **{E4}** (FLR Interlock Signal without Time Delay).
12. Current Transformer-1 **{C2, D2}** gives output to Time Delay Card at Terminal 5 & 6 which further converted into DC inside the Card through Bridge Rectifier Diodes. -VE voltage is directly given to ROT3 Relay {**D3**} from 2No. Terminal of Time Delay Card. +VE voltage is given to the Capacitor 470µFD & Transistor **{C1}** CK100 emitter terminal. Now Capacitor 470µFD starts charging through 10K variable resistance, when the level of Voltage reaches above 5.6V Zener Diode conducts & gives the voltage to Transistor. CK100 Transistor get biased & gives the +VE output at Terminal No.-8 & further to ROT3 Relay. So there is a delay in the output voltage which is produced by the charging time of Capacitor. This delay is used for attain the full speed of Rotor.
13. Now ROT3 Relay gets ON & OFF the Relay ROT5 **{B4}** through ROT3-A NC Contact & ON the Relay ROT6 through ROT3-A NO Contact & Zener Diode (Z2, 5.6V / 1W). ROT3-C NC Contact {B3} bypass the Resistance mounted inside the RE3-RE5 Card for ROT2 Relay coil voltage drop. ROT3-B Contact is not used.

14. As ROT5 Relay is gets OFF then 230VAC is blocked & 65VAC given at output terminal RTS-1 (Principle Point of Rotor Winding) through ROT6 NO Contact **{B3}** from RE3-RE5 Card (J3-3). Now Rotor works on 65VAC supply.
15. The voltage Drop across the 6.2Ω / 10W Resistance **{B2**} is converted into the DC in RE3-RE5 Card. & given to ROT4 Coil **{B1}**. Positive Voltage through 3.3Ω Variable Resistance **{B2}** (For Voltage Level Adjustment) & ROT2-B NO Contact **{B2}** (Which is already closed). Negative Voltage directly given to ROT4 Coil.
16. When ROT4 Relay gets ON then IN voltage for Interlock will be available at RTS-12 from RTS-11 through ROT4-A NO & ROT2-A NO Contacts **{E4}**.Which completes the Rotor Interlock & which further fed to controlling ckt. of Machine.

Relay sequence:- ROT1 – R OT5 – ROT2 – ROT3- ROT5 OFF, ROT6 ON- ROT

9. Wiring Diagram

10. Brief Description of Operation: -

DRG. NO.-397, R11, Number of Sheet-6

Note:

1. **The letters written in curly brackets {} denotes the location of part/ Component/ contact terminal in wiring diagram.**
2. **Abbreviation**

- **NO** stands for Normally Open Contact of Relay / Contactor.
- **NC** Stands for Normally Close Contact of Relay/Contactor
- **CON** stands for Contactor
- **F** stands for Fuse
- **TS** stand for Terminal Strip
- **RE** stands for Relay
- **SMPS** stands for Switching Mode Power Supply
- **TR** stands for Transformer
- **Ckt**. Stands for Circuit
- **CP, JP, CN, J** stands for Connector number of Cards
- **RTS** stands for Rotor Terminal strip

Step 1: - Switching on Main MCB.

When we Switch ON the MCB (3 Pole 63Amp) **{A1},** 3-Phase supply is fed from Terminal block **{A1}** to HRC Fuses (F1, F2 & F3) and from Fuses to Filter and from Filter to Contactor terminals as below:

- ❖ Phase 1 is given to the **CON.1-A {A2} & Programmable Relay Terminal-R {B1}**
- ❖ Phase 2 is given to **CON.1-B {A2} & Programmable Relay Terminal-Y {B1}**
- ❖ Phase 3 is given on Terminal Strip TS1-1 and then **CON.1-C {A2} & Programmable Relay Terminal-B {B1}**

- Neutral is directly given to Filter from Terminal Block and from Filter to TS1-2, Programmable Relay Terminal-N {B1} and Contactor Terminal **CON.1-D {B2}**
- Ground of the Machine should be properly earthed such that voltage between GND and Neutral must be minimum as possible (Maximum allowable voltage is 3 volts).
- Phase-1 is directly given to ON/OFF Contactor CON.1 Coil {B1} and Phase-2 is given to it through the NO Contact of **RE1A-C {B1}**.
- 3 Metal Oxide Variastor (MOV) are used to protect circuit against excessive transient voltages at TS1-1 (Line) & TS1-2 (Neutral), TS1-1 & TS1-3 (Ground) and TS1-2 & TS1-3.
- Now 230V from TS1-1 and 0VAC from TS1-2 is fed to 15W Bulb mounted near Filament Card {B1}, SMPS-1 (12V/1A) {C2-B2}, Cooling Fan Supply {B1} and 0-12V Transformer (TR-1) {C1-C2}. Now Before ON (0-12V DC) Relay Supply is generated by SMPS-1 given at TS2-8 (12V DC) & TS2-9 (0V DC). Output of 0-12V Transformer (TR-1) {C1:C2} is given to Power Supply Card at J1-10 & 11 and Output of Power Supply Card from J2-10 (+12V DC) and J2-11 (0VDC) is given at TS2-1 & 2 respectively.
- Before ON **Relay Supply +12V DC** from TS2-8 is fed to RE1, RE1A & RE6 Coils, and Motherboard Card at JP9-1, JP2-4 and at JP1-1, 2 & 4 & to NO Contact of RE1A-A. **Relay Supply 0V DC** from TS2-9 is fed to Motherboard Card {C4} at JP9-3, JP2-7 & JP1-7, 9 & 12, to the Initial Time Delay Card {C6} at J2-2 & Programmable Relay Terminal C {B1}

- **Before ON Supply +12VDC** from TS2-1 is fed to Motherboard Card at JP2-5 (+12V DC), NC Contact of RE6-B & 0V DC from TS2-2 on JP2-6 of Motherboard Card.
- OFF Indicator on Panel glows before Switching on Machine.

NOTE:

Relays Contacts used for only DC supply is mentioned as DC Relay and Contacts used for AC supply is mentioned as AC Relay

RE1, RE2, RE3, RE5 & RE6 → DC Relays
RE1A, RE2A, RE4, RE4A & RE5A → AC Relays

Step 2: - Switch ON the Machine from Panel by pressing ON Switch.

- OFF Indicator on Panel gets OFF when ON Switch is pressed.
- As the ON Switch from the Panel is pressed, Transistor Q20 on the Motherboard Card gets biased and pulls down the Relay Coil RE1 from JP9-2 making it to energize through NO Contact of RE6-A and then from NO Contact of **RE1-C {C4}**, 0V Relay Supply is given to RE1A Coil from JP9-3. Hence RE1A operates which further gives + 12V Relay Supply to all Relays through NO Contact of **RE1A-A {D5}**. ON/OFF Contactor of CON.1 gets Phase-2 from NO Contact of **RE1A-C {B1}** and gets ON.
- CON.1 Contactor's Contacts give the 3-Phase supply to Delay Contactor CON.2 Terminals **CON.2-A {A2}**, **CON.2-B {A2}** and **CON.2-C {A2}**. Initially 2-Phase Supply is fed to Inverter via two Wire Wound Resistances (50Ω, 50W) to limit the charging current of capacitors inside the Inverter until CON.1 (Delay Contactor) operates.
- After ON supply now comes at TS1-4 & 5 from Contactor Terminal **CON.1-C {A2}** and **CON.1-D {B2}**. From TS1-4 & 5 Supply is fed to SMPS-3 (24V/2A) **{A2}**, to Filter Card {B4}, to Rotor Plate {B5} at RTS-5 & 4 respectively, SMPS-2 (15V/3.4A) {B2}, to Cooling Fan, to LBD Transformer (TR-3) {C1}, to Main Transformer (TR-2) {C2}. TS1-4 is then fed to NO Contact of **RE5A-A {B2}** (Time Delay Contactor Supply) to the NO Contact of **RE2A-A {D1}** (For Bucky Supply).

- 230VAC supply from TS1-4 is given at TS3-6, and 0VAC from TS1-5 is given at TS3-11 through Fuse F4 (4Amps) for Table & VBS Magnet Supply,
- From TS1-4 230VAC Supply given at TS1-10 & from TS1-5 0VAC given to TS1-11 for Machine ON Indicator Supply.
- Then SMPS-2 (15V/3.4A) generates 15V DC Supply at TS2-3 through NO Contact of **RE1-B {B3}** and 0V DC at TS2-4, which is given to all the Cards described as follows:

+5VDC Power Supply Card {C2} -	CN1-2 (+15VDC) CN1-1 (0V DC),
Motherboard Card {C4} -	JP2-2 (+15VDC) JP2-6 (0VDC)
Pulse-19 Card {B2} -	CP1-1 (+15VDC) CP1-2 (0VDC)
Filament Card {B4} -	J7-1 (+15VDC) J7-2 (0VDC)
Pulse-21 Card {A4} -	CP-2-1 (+15VDC) FOR Thermal interlock
mA Stab Card {C5} -	J6-2 (+15VDC) J6-5 (0VDC)
Initial Time Delay Card {C6} -	J1-1 (+15VDC) J1-2 (0VDC)

  - 15V DC supply is given at the Connector JP5-2 of Motherboard Card for Low Indication at Panel through NC Contact of **RE5-A {C4}**.
  - To NO Contact of RE3-A {B4} for Small Filament Selection Signal to Filament Card at J7-7.

- +5V Power Supply Card from CN2-1 gives +5V DC supply to Motherboard Card at JP2-1 & to Filament (mA) Stab Card at J6-1.

- SMPS-3 (24V/2A) **{A2}** gives 24V DC supply to Pulse 18 COM Card at CP1-1 mounted in Inverter through NO Contact of **RE1-A {A3}**.
- Main Transformer (TR2) **{C2-B2}** gives 15V-0-15V, 0-24V, 0-24V output which are further given to Power Supply Card {C2-B2}. 15-0-15 to J1-3, 4 & 5 and 24-0V at J1-6 & 7 & J1-8 & 9. Power Supply Card converts these AC supplies to DC supplies.
  - -15VDC output of Power Supply Card from J2-5 is given at TS2-5.

    TS2-5 **{C2}** is further Connected to: Motherboard Card: JP2-3

    Pulse-19 Card: CP1-3

    Filament Card: J7-3

    mA Stab Card: J6-3
  - 12VDC (Relay) output from TS2-8 is given for Rotor Relay Supply at RTS-10 through NO Contact of **RE2-A {B5}**.
- LBD Transformer (TR3) **{C1}** gives 24V AC Supply to LBD & Magnets through Fuse F5 at TS3-8 & 9.
- After 30-40s, 0V (Relay) supply comes from Connector J2-3 of Initial Time Delay Card and Relays RE5 & RE5A gets energized which further gives 230V AC Supply to Delay Contactor CON.2 Coil and then CON.2 operates through NO Contact of **RE5A-A {B2}**. As CON.2 Contactor operates, it starts giving 3-Phase Supply to Inverter directly and by pass the Wire Wound Resistances. NO Contact of **RE5-A {C4}** gives 15V DC to Motherboard Card for Full indication at Panel to Motherboard Card at JP5-1 and Initial Time Delay OK Signal at JP8-5 of Motherboard Card to close the safety Interlock Signal.

Step 3:- Selection of Small Filament (By default Machine is Switched on In Large Filament).

- When L/S Switch is pressed, Relay K2 operates mounted on the Motherboard Card, which changes Set Filament Voltage for Actual mA & gives 0V (Relay) Supply at JP1-10 of Motherboard Card to energize the RE3 (Large/Small Relay) & following functions are performed:

    a. It sends 15V DC Signal through NO Contact of **RE3-A {B4}** to Filament Card at J7-7 for Small Selection & Yellow Led Glows on the Filament Card, which indicates Small Filament is selected.

    b. A 0V Body GND Signal is sent through NO Contact of **RE3-B {B5}** to Filament (mA) Stab Card at J6-4, which operates Relay K3 mounted on this Card. This Relay selects the mA Stab Signal for Small Filament.

Step 4:- Selection of Bucky {No Bucky is selected when Machine is Switched ON}

1. When Horizontal Bucky is selected by pressing H-Bucky Switch, LED along with this Switch glows on the Panel & 0V Signal comes from JP1-3 of Motherboard Card, which energizes the RE4 (Horizontal Bucky Relay) and 230V AC Supply, is routed through NO Contact of **RE4-A {D1}** at TS3-10 for Horizontal Bucky.
2. When Vertical Bucky is selected by pressing V-Bucky Switch, LED along with this Switch glows on the Panel & 0V Signal comes from Motherboard Card at JP1-5 that energizes the RE4A Relay & 230V AC Supply is routed through NO Contact of **RE4A-A {D1}** at TS3-12 for Vertical Bucky.
3. 0V (Common) is directly given at TS3-11 through Fuse F4 (4Amps).

    NOTE: -230V AC Supply is routed through NO Contact of RE2A-A to RE4 and RE4A Relays so Supply will be available at the time of Ready.

Step 5: - Stand By mode. (Machine Ready for Exposure)

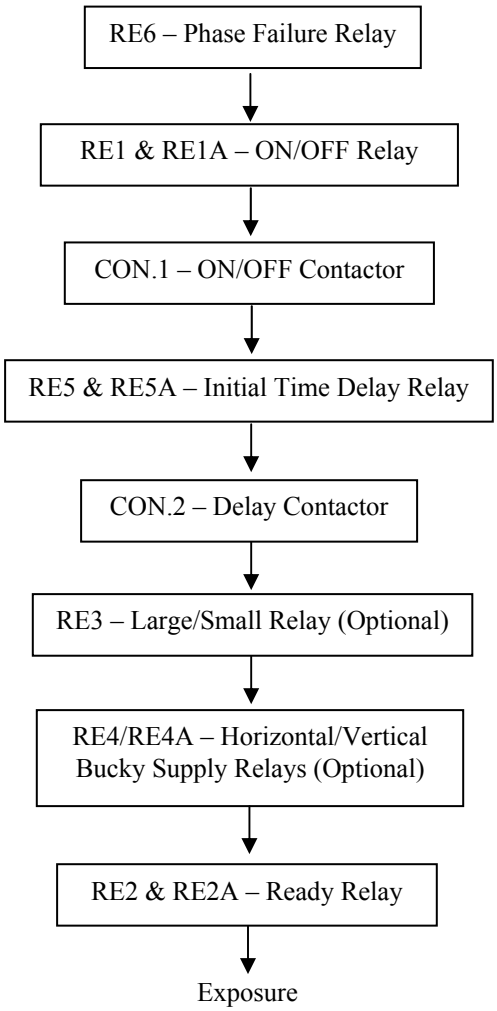
Machine comes in stand by mode (Ready) by pressing Ready Switch from Panel or by pressing Ready from Hand Switch & Ready Indicator along with Switch on Panel glows.

1. When Ready Switch is pressed Following Functions works:
    a. K1 Relay operates on Motherboard Card, which gives 0V (Relay) supply from JP1-7 to JP1-8, which further pulls down the RE2, RE2A Relays Coils and makes them to energize.
    b. Pre-Rx Signal is generated from Motherboard Card at JP6-3 & goes to Pulse 19 Card at CP1-5 through NO Contact of **RE2-B {C4}**.
    c. Tube Filament Boost during Ready for Exposure. Filament is boosted through set Filament Signal. Pre-Heat Voltage comes from JP6-6 of Motherboard Card at J7-6 of Filament Card until Ready Switch is pressed but when Ready is pressed Pre Heat Voltage converts to Set Filament at Filament Card J7-6 (Set Filament Voltage for actual mA) which is more than Pre-Heat Voltage.
2. NO Contact of **RE2-A {B5}** sends 12V DC supply to Rotor Plate (RTS-10), which energizes the ROT1 Relay. Now Tube Rotor works on 230V AC supply. After 0.8 Second Delay ROT3 Relay energizes & then Rotor starts working on 65V AC through ROT6. If Rotor Circuit is working OK, a Rotor OK Signal of 15V DC goes from RTS-12 to Motherboard Card at JP8-4 as a Feedback Signal and completes the Rotor Interlock Signal.
3. 230V AC supply goes to NO Contact of **RE4-A {D1}** & **RE4A-A {D1}** for Bucky Supply. (RE4 for Horizontal Bucky & RE4A Vertical Bucky Relay) through NO Contact of **RE2A-A {D1}.**

Step 6: - Exposure

1. When Exposure Switch from Panel (while keeping Ready Switch already pressed) or from Hand Switch is pressed Exposure Indicator on Panel glows & Com-Rx Signal is generated from Motherboard Card at JP6-4 and goes to Pulse-19 Card at CP1-9 through NO Contact of **RE2-C {C4}** (Already energized when Ready is pressed).
2. Com-Rx Signal then generates COM1 & COM2 Signals in Pulse-19 Card, which are further given to Pulse 18 COM Card for IGBT firing through FRC Cable (CF1). The output of Inverter goes to Pulse-21 Card on HT Tank.
3. HV Tank Step Up this Voltage, and converts into DC according to the KV Selection. Output of HV Tank is given to Tube through HV Cables. Then calibrated current flows in Tube, the current flows & KV Feedback is given to Pulse 19 Card at CP2 by HV Tank through CP1 of Pulse 21 Card for correction of current & KV.
4. A Buzzer **{C4}** beeps during Exposure. (Buzzer Supply comes from JP7-1 and JP7-2 of Motherboard Card).

Relay Sequence:-



INTERLOCK SIGNALS: -

- **INVERTER FAULT:** -This Signal is used to indicate the proper working of Inverter and HT Tank. If there is any problem in Inverter or HT Tank then this Signal becomes High (+15VDC) RED LED in Pulse 19 Card glows. Signal is generated from Pulse 19 Card (CP1-6) and given to Motherboard Card at JP8-2. This Signal is normally 0V DC.
- **THERMAL FAULT: -** This Signal is used for protection of HT Tank from Over Heating. This Signal is normally 15V DC generated from HT Tank at CP2-2 and given to Motherboard Card at JP8-6. If This Signal becomes 0V DC then TH-Fault Indicator on Panel glows.
- **FILAMENT FAULT: -** This Signal indicates the Filament glow status of Tube, if there is any problem in Filament Card Ckt / Tank / Tube. Then this Signal becomes 0V DC and FIL-Fault glows at Panel. This Signal is normally 10-13V DC generated in Filament Card at J7-9 and given to Motherboard Card at JP8-3.
- **ROTOR OK: -** This Signal is generated from Rotor Plate to indicate the proper working of Rotor Ckt. This Signal is normally 0V DC and during Ready 15V DC if Rotor Ckt. is working OK. This Signal is fed from RTS-12 to Motherboard Card at JP8-4.
- **INITIAL TIME DELAY OK:** -This Signal is used to indicate the Full Charging of Capacitors inside the Inverter. Normally this Signal is 0V DC and when Time Delay Relay gets ON (RE5 & RE5A) this Signal becomes 15V DC. This Signal fed from RE5-A to Motherboard Card at JP8-5.
- **EARTH FAULT:**- This Signal is used to indicate the following parameters:
    - Voltage Level of All Phases to Neutral)
    - Frequency of Supply
    - Presence of Supply in All Phases

  This signal is normally or and when RE6 do not get ON due to Programmable Relay Trip. +12V Signal comes at JP6-7 of Motherboard Card. In case of Earth Fault occur Machine will not get ON.

IMPORTANT SIGNALS: -

- **SET KV SIGNAL: -** This Signal decides the generation of KVP. This Signal varies according to display KVP with a relation of 1V=20KVP. If 40 kVp is selected then Signal Voltage will be 2.0V DC. This Signal is generated in Motherboard Card by ICU7 -LF412 & can be checked at **Set KV Test Point** or at JP6-5 in Motherboard Card. This Signal can be adjusted from POT R10 & R15 on the Motherboard Card.
- **PRE -HEAT SIGNAL: -**This Signal is used for Filament glow of Tube to warm up the Tube Filament before Exposure. This Signal controls the Filament Glow & can be checked in Motherboard Card at **Pre-Heat Test Poin**t & adjustments can be done from R39 Pot of Motherboard Card. This Signal is normally 2.0V DC and fed to Filament Card at J7-6.
- **SET. FILAMENT SIGNAL: -** This Signal is used to achieve actual mA. The level of voltage depends upon the machine rating, KV station, & according to tube. Max. Voltage can be set is 5.0V DC for Large Filament & 3.5VDC for Small Filament. Overall Pot is R86 & Individual Pot for Large Filament is VR1 to VR11 & for Small Filament VR17 to VR26 at Motherboard Card.
- **mA STAB. SIGNAL: -** This Signal is used to stabilize the mA output according to the Selected KV station. mA Stab Signal is generated in Filament (mA) Stabilization Card and can be checked at J6-7 at Filament (mA) Stab Card or at J7-4 of Filament Card. The level of voltage depends upon the KV station & mA equation of Pulse 19 Card. If mA are 250 & mA equation is 1V=50mA then Stab. Voltage will be 5.0V DC.
- **ANODIC mA:-**This Signal is generated in Pulse 19 Card during Exposure and Test Points are TP6 & TP11 or can be checked at CP1-12. It is a reference voltage, which indicates the Actual mA, flows through Tube. This Signal is given to Filament Card (J7-5) for comparison of Stab Signal & Actual mA.

  mA Equation:-

  1V=50mA

- **KV OK: -** This Signal is used for activating mA stabilization function. This signal is generated during Exposure from Pulse 19 Card at CP1-4 and given to Filament Card at J7-8. This Signal is 10V on load. This Signal indicates the kV Generation in from HT Tank is OK.
- **PRE-RX: -** This Signal is used to complete an Interlock in Pulse 19 Card for Exposure. This Signal is generated in Motherboard Card at JP6-3. Pre-Rx Signal is normally 15V DC & on load 11VDC. This Signal is given to Pulse 19 Card at CP1-5.
- **COM-RX**: -This Signal is used for generating COM1 & COM2 Signal in Pulse 19 Card which is used for firing of Inverter's IGBT. This Signal is generated in Motherboard Card at JP6-4. Com-Rx Signal is normally 15V DC & on load 10V DC. This Signal is given to Pulse 19 Card at CP1-9.

11. Calibration Procedure

Do the following steps:-

STEP-1:- Applicable in case of Motherboard Card is changed.

STEP-2:- Applicable in case of Filament Card is changed.

STEP-3:- Applicable in case of HT tank is changed.

STEP-4:- Applicable in case of Inverter is changed.

- **Step 1:-** Remove JP6 connector & connect all other connectors of Motherboard Card and Ensure all connectors should be tight. Calibrate the Following signals:-

    1. **Set KV:-**Check Set KV between JP6-5 & GND or at Set KV test point of Motherboard Card. Voltage should be 2.0 V DC at 40 KVP & 6.0 V DC at 120 KVP. If required, adjustment can be done from the Pot R-10 or R-15 at Motherboard Card.

    2. Check Pre-Heat voltage between JP6-6 Motherboard Card & Main GND or at Pre-Heat Test Point, voltage at this point is 2.0 V DC (approx). If required, adjustment can be done from the R39 in Motherboard Card.

    3. Check Set Filament between main GND and SET FIL Test Point, voltage at this point is 2.5V DC (Approx.) at starting calibration stage (Can be increased to achieve mA). If required, adjustment can be done from the R86 (Overall POT) or Individual pot (For 40KVP 10mAS VR1-Individual POT) at Motherboard Card.

    4. Connect JP6 connector in Motherboard Card.

    5. Check SET FIL. Signal at J7-6 during ready should be same as set on Motherboard Card SET Filament Test Point.

- **Step 2:-** Tight All the connectors of Filament Card after Ensuring All supplies**:**

    1. J4-2 & J4-4, Voltage should be 230 V AC
    2. J7-1, +15 V DC
    3. J7-2, GND
    4. J7-3, -15 V DC
    5. J7-6, Set Filament should be same as set in JP6-6 Motherboard Card (After Pressing Ready), normally Pre-Heat Voltage.

- **Step 3:-** check tightening of Connecters, P1A, P2B, GND wires connections & fixing of HV Cables.

    1. Check Filament glow- Large Filament should glow during Large selection on Panel & Small Filament should glow during Small Filament selection.

- **Step 4:-** Tight the mounting screws of Inverter check proper fixing of P1A and P1B wires, 3-phase supply connections. Connect all connectors properly of Pulse 19 Card after checking supply at CP1 Connector.

    1. CP1 Connector Detail:

        Pin 1 & GND: +15V DC

        Pin 2 & GND: 0V DC

        Pin 3 & GND: -15V DC

        Pin 4 & GND: Stab. Relay coil voltage O/P to Filament Card during exposure

        Pin 5 & GND: 0V (Pre-Rx)

        Pin 6 & GND: 0V (Inverter Fault)

        Pin 7 & GND: +15V DC

        Pin 8 & GND: 0V

        Pin 9 & GND: 0V (Com-Rx)

        Pin 10 & GND: Set KV

        Pin 11 & GND: Not Used

        Pin 12 & GND: Anodic mA O/P to Filament Card during exposure

NOTE: Com-Rx & Pre-Rx will be high during exposure.

2. Ensure proper fixing of CP1 connector of Pulse 18 COM Card.

3. Ensure LD1 should glow after Removing CF1 FRC Cable from Pulse-19 Card.

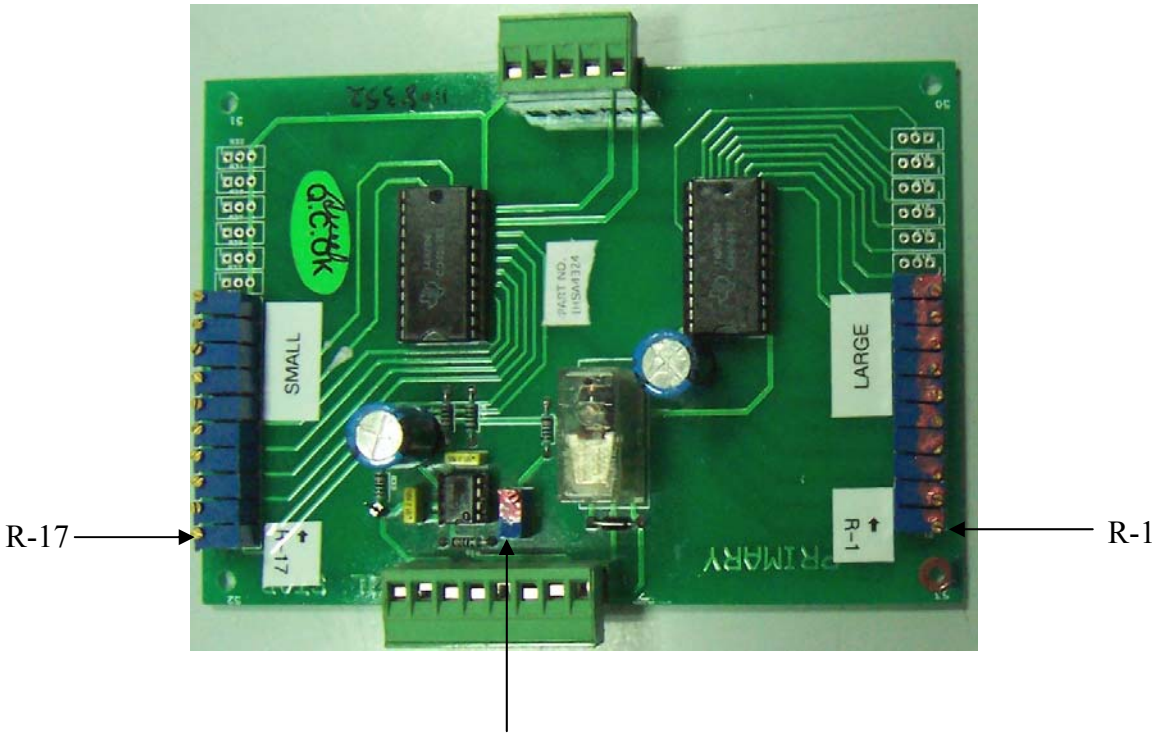
4. Connect CF1 FRC Cable in Pulse 19 Card ensure FRC Cable should be locked in Male FRC connector of Pulse 18 COM and Pulse-19 Card properly.

5. Press APR Key on Panel to activate the NON-APR (Manual) Mode. All the Calibration is to be done in NON-APR (Manual) Mode.

a) Calibrating the Equipment

1. Calibrate the Filament (mA) Stab Card by adjusting the Stab. Signal with the Pots mentioned according to the KV mA Chart. Check the Stab. Signal at J6-7 with respect to body GND or Test Point on R35 in Filament (mA) Stab. Card or at J7-4 at Filament Card.

FILAMENT STAB CARD



For Large filament:-

KVP	REQUIRED DC VOLTAGE (in Volts)	mAs	ADJUSTMENT OF POT.
40-42	5.0	1-200	R1
43-53	10.0	1-25	R2
54-64	5.0	1-25	R3
65-74	5.0	1-25	R4
75-85	4.0	1-25	R5
86-96	4.0	1-200	R6
97-106	4.0	1-200	R7
107-125	3.5	1-200	R8
43-85	3.5	32-200	R8 (MULTI STATION)
40-125	3.5	1-200	R8 (APR MODE)

2. Select the Small filament from Panel & adjust the small station pots in Stab Card.

KVP	REQUIRED DC VOLTAGE (in Volts)	mAs	ADJUSTMENT OF POT.
40-42	3.2	1-200	R17
43-53	2.6	1-25	R18
54-64	2.2	1-25	R19
65-74	2.0	1-25	R20
75-85	2.0	1-25	R21
86-96	2.0	1-200	R22
97-106	2.0	1-200	R23
107-125	2.0	1-200	R24
43-85	2.0	32-200	R24 (MULTI STATION)
40-125	2.0	1-200	R24 (APR MODE)

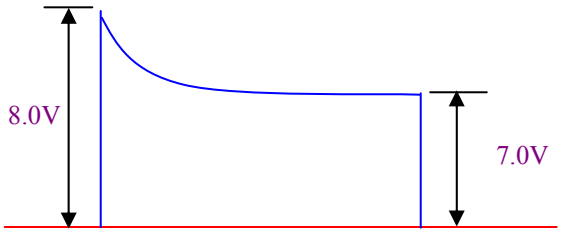
If required adjustment can be done from overall POT R-37 on all stations.

- **Ensure these voltages once again**

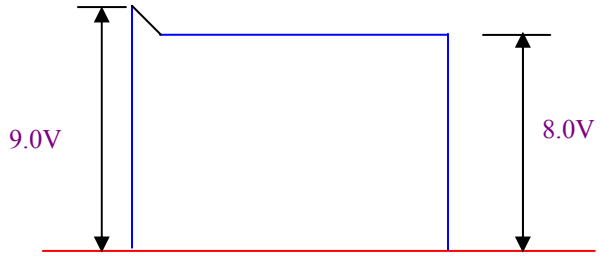
3. First cover the Tube Head with Lead Apron.
4. Connect the CRO probe at TP6-(Actual mA) & TP11 (GND).
5. Make CRO adjustments for measuring voltage according to KV mA Chart.
6. Make an exposure at 40KVP 4mAS and hold the Image, check the voltage in CRO.

The mA equation:- 1V=50mA.

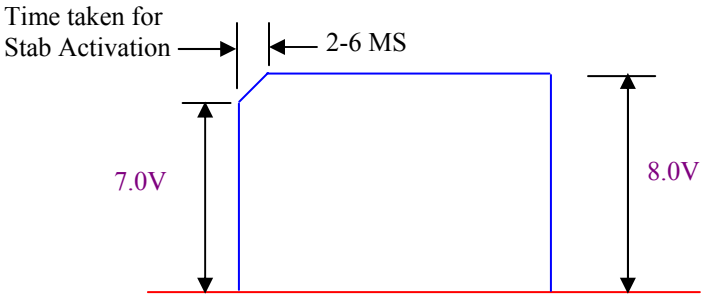
Increase the set Fil. Voltage from Motherboard Card (Pot No. & mA are mentioned in KV mA chart) till mA are not achieved according to chart. See the images



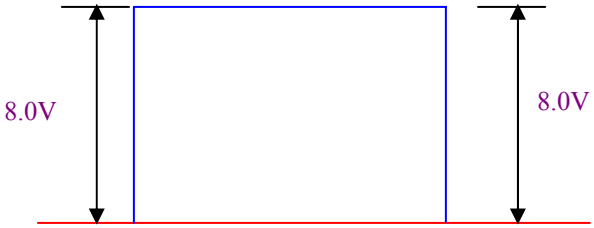
mA Wave shape Without mA Stab. Function



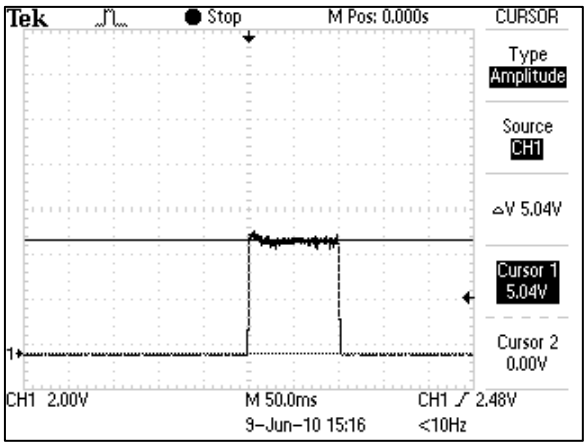
High Set Fil. mA Wave shape With mA Stab. Function



Low Set Fil. mA Wave shape With mA Stab. Function



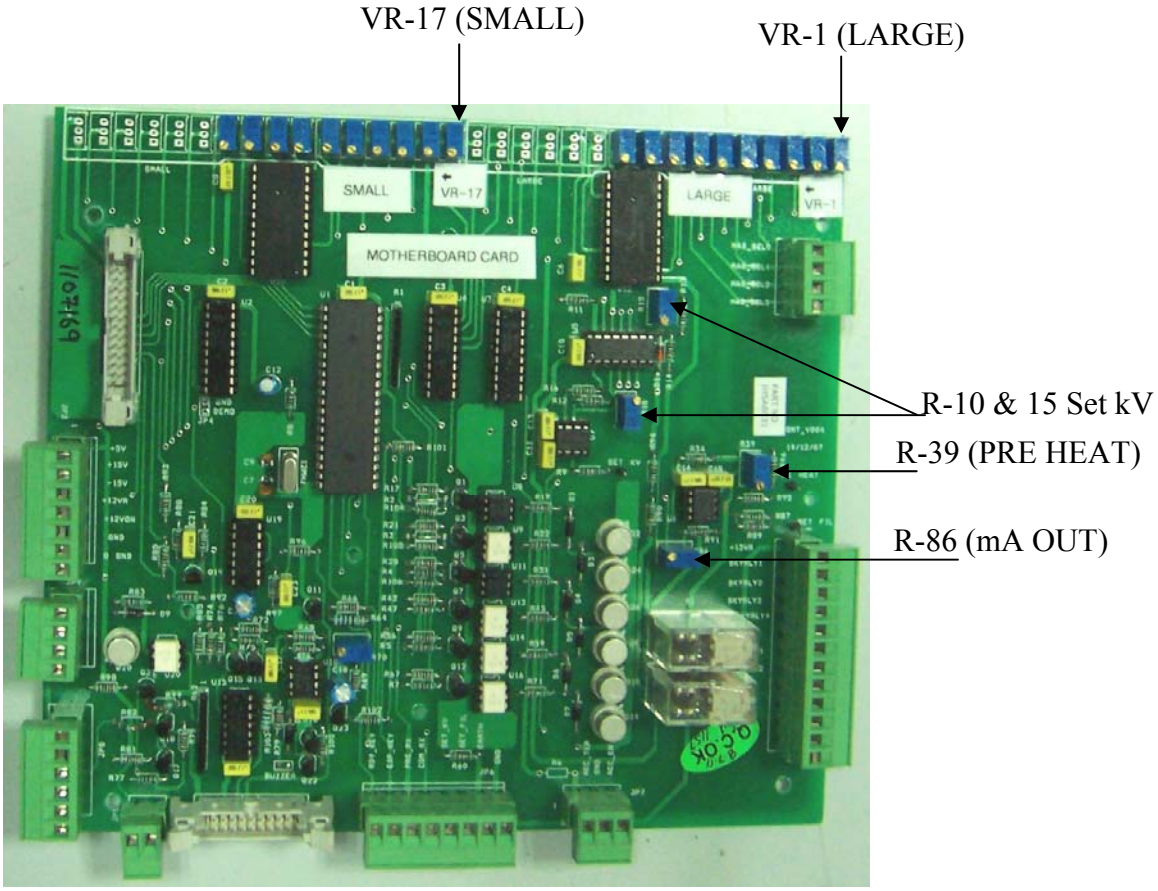
Proper mA Wave shape With mA Stab. Function



mA wave shape in CRO

Limit of Set Fil.:- For large filament 5.0VDC & For Small Filament 3.7VDC

MOTHERBOARD CARD



mA Calibration on Large Filament

KVP	mA	mAs	ADJUSTMENT OF POT.
40-42	250	1-200	VR 1
43-53	500	1-25	VR 2
54-64	250	1-25	VR 3
65-74	250	1-25	VR 4
75-85	200	1-25	VR 5
86-96	200	1-200	VR 6
97-106	200	1-200	VR 7
107-125	175	1-200	VR 8
43-85	175	32-200	VR8 (MULTI STATION)
40-125	175	1-200	VR8 (APR MODE)

- Select the Small Filament from Control Panel. Check the actual glowing of Small Filament. If it is OK then calibrate the mA as per following chart at different KVP stations by adjusting SET Filament Signal in motherboard card with the pots mentioned in KV mA chart.

mA Calibration on Small Filament:

KVP	mA	mAs	ADJUSTMENT OF POT.
40-42	160	1-200	VR17
43-53	130	1-25	VR18
54-64	110	1-25	VR19
65-74	100	1-25	VR20
75-85	100	1-25	VR21
86-96	100	1-200	VR22
97-106	100	1-200	VR23
107-125	100	1-200	VR24
43-85	100	32-200	VR24 (MULTI STATION)
40-125	100	1-200	VR24 (APR MODE)

If required adjustment can be done from overall POT VR-86 on all stations

12. Trouble Shooting

SR. NO	FAULT SYMPOTOMS	CHECK POINTS	SOLUTION
1.	1. Machine is not getting ON. OFF Indicator not glowing & Machine is not getting ON.	Check connections of FRC cables	Should not be loose
		Check Supply At TS2-1 & 2, JP2-5 & 6 of Motherboard Card, SMPS-4 output	Should be 12V DC, If available replace 4093 (U-19), Transistor Q19, BC 547.
		If Supply is not available check Input supply of SMPS-4. should be 230VAC	If not available, check for any fuse F1, F2 is blown or any loose connection.
	2. OFF Indicator glows but becomes OFF when ON Switch is pressed & Machine is not getting ON.	Check Supply At TS2-8 & 9 And JP2-4 & 7, JP9-1 & 3 of Motherboard Card. Should be 12VDC.	If supplies are available then check supply at JP9-1 & 2 of Motherboard Card should be 12VDC
		If available then check the functioning of RE6 Relay (Phase Failure Relay), RE1 (ON/OFF Relay) & CON.1 (ON/OFF Contactor)	Coil should not be open; contact should not be miss function.
		If 12VDC is not available on JP9-1 & 2	Replace 4093 (U-19), IC MCT2E (U-20), Transistor Q20 CL 100 or Transistor Q19 BC547. If still problem exist replace Motherboard Card.
		If 12V DC is not available at TS2-8 & 9 then check functioning of SMPS-1 (12V/1A).	Check Input of SMPS-1 230V AC, in available replace SMPS. If not available check for any fuses F1, F2, F3 is blown or any loose connections.
		If still Machine is not getting ON, Check continuity of 26 Pin FRC cables from Motherboard Card to Panel	ON Switch at Pin 19 & 21 OFF Switch at Pin 20-22 should not be open also continuity will be available when ON / OFF Switch is pressed
	3. Earth Fault & OFF Indicator glowing but Machine is not getting ON.	Check 3 Phase Supply.	All Phases should be available. And in range of 360-440VAC.
		Check Indication on Programmable Relay, in case of RED indication check display in Programmable Relay and correct the Input Supply as per Table.	If GREEN indicator is glowing check loose connection at Programmable Relay. Check continuity of Programmable Relay Terminal NO & C. If not available replace Programmable Relay.
		If Programmable Relay is working ok then check functioning of RE6 (Phase Failure) Relay	Coil open, loose connections or any wire open

		If RE6 Relay is working ok then check functioning of RE1 Relay	Coil open, loose connections or any wire open
		If RE1 & RE6 both are working ok then check the functioning of CON1 contactor	Check the Coil Voltage, If not available then check the Input supply of machine. If voltage is ok then check contactor coil resistance. After removing the coil supply wires. Or check the contact functioning.
2.	Display not coming at Panel & machine is gets ON	Check fixing of Connectors JP2 of Motherboard Card, CN1 & CN2 of Power Supply Card & FRC Cables.	Should not be loose
		Check 5V supply at Motherboard Card JP1 with respect to Body Ground	If not available check input of +5V Power Supply Card. {CN1-1 0VDC & CN1-2 +15VDC}
		If Input Supply is available	Replace Regulator 7805 or 5V Supply Card.
		If +5VDC is available at Motherboard Card	Check frequency of crystal at IC U1-18 w.r.t Body Ground If not available replace crystal 12Mhz
		If frequency is available then replace the controller (U1-89V51)	If still display is not coming then replace the Motherboard Card.
3.	Initial Battery signal on Panel remains Low (not shifts to Full)	Check loose connection on Motherboard Card JP5, Initial Time Delay Card J1 & J2 connectors.	Should not be loose.
		Check RE5 & RE5A is getting on?	If getting ON check working of RE5-A Relay Contact / replace the Relay.
		If RE5 & RE5A not getting on check the functioning of Initial Time Delay Card.	Check input supply of Card- J1-1 (+15VDC) J1-2 (0VDC) If not available then check the working of 15V SMPS.
		If Input supply of Initial Time Delay Card is OK then check the functioning of K1 Relay (inside the Card)	K1 is not getting ON-Replace the IC U1 (LM555) or TRS. Q1 (CK100)
		If K1 Relay is getting on	Then check the working of Relay (K1) contacts or replace Card
4.	Thermal fault is glowing at panel	Check connectors of Motherboard Card JP8, Pulse-21 Card CP2, FRC Cable on Panel & Motherboard Card.	Should not be loose

		Remove the connector from Pulse-21 Card & check the continuity between terminal CP2-1&2	If not available then replace the HV Tank
		If Continuity is available then check voltage at CP2-1 should be +15VDC w.r.t Body GND.	If not available then trace the wire & check for any loose connection or wire open
		If Voltage is available then check the Voltage at CP2-2 Pulse-21 Card w.r.t to Body GND.	If not available then repeat the check point step 2.
		If available then check the voltage at JP8-6 w.r.t. Body GND. Should be +15VDC	If not available then trace the wire & check for any loose connection or wire open
		If Voltage is available then	Replace the Transistor Q21 (BC547) Replace the IC4082 (back voltage from IC to Transistor Base)
5.	Ready is not working (from Panel & Hand Switch) 1. Pre-Rx is not coming	Check loose connection on Motherboard Card JP6 & JP1, & CP1 of Pulse-19 Card, FRC Cables	Should not be loose.
		Check Pre-Rx at CP1-5 of Pulse-19 Card & JP6-3 should be >11VDC w.r.t to Body Ground.	If available at JP6-3 Motherboard Card & not on CP1-5 of Pulse-19 Card then check the functioning of Ready Relay (RE2) of Machine.
		If not available at Motherboard Card JP6-3 then check the Ready Key Signal at JP6-1 w.r.t to Body Ground.	Should be 0VDC w.r.t to Body Ground during Ready. If not then check the 26 Pin FRC Cable Pin 23 may be open or Hand Switch is not working
		If 0VDC is available during ready then.	Replace the transistor CL100 (Q11) or check the connector (JP6) for any loose contact
	Ready relays are not working of machine	Check Relay K1 is not getting on inside the Motherboard Card.	If Getting ON then remove the JP1 Connector from Card & check continuity on JP1-7 & 8 in the Card—If continuity is not available then replace the Relay.
		If continuity is available then connect the JP1 connector & Check the Functioning of Ready Relay (RE2 & RE2A)	+12V (R) is feed directly to the Relays & 0V (R) from JP1-8. So check the voltage at Coil, Coil may be open or contacts not working or replace the Relay

		If K1 Relay of Motherboard Card is not getting ON then check the 0VDC during Ready JP6-1 w.r.t. Body Ground.	If not available then check the 26 Pin FRC Cable Pin 23 may be open or Hand Switch is not working
		If 0VDC is available then check the voltage at IC U13-1 w.r.t to Body Ground.	Should be 1.0VDC during Ready-If not available then replace the Transistor Q7 (BC547)
		If available then check voltage at U13-4 w.r.t Relay Ground.	Should be 0.7VDC (w.r.t. Relay Ground.) during Ready if not available then replace the U13 (MCT2E)
		If 0.7VDC is available then check the voltage across D6 should be 12VDC	If Not available then replace the Q10 (CL100). & If available then check the Relay K1—Coil may be open or contact not working
6.	Filament Fault is glowing at Panel	Check connectors of Motherboard Card JP8, Pulse-21 Card CP2, Filament Card J1, J4, J7, Filter Card connectors & HV Cables	Should not be loose
	Filament Fault while Switching ON Machine Red LED glowing	Check Pre-Heat voltage at J7-6 of Filament Card w.r.t. to Body Ground.	Should be less 2.0VDC If not then adjust from Motherboard Card Pre-Heat Pot.
		If 2.0VDC is available then check the supplies at J7 connector w.r.t. Body Ground.	J7-1 +15VDC, J7-2 0VDC, J7-3 -15VDC If not available then check the Power Supply Card & SMPS. If available then Replace the Filament Card
	Filament Fault while Switching ON Machine Green LED not glowing	Check Pre-Heat Voltage at J7-6 of Filament Card w.r.t. to Body Ground.	Should not be less 2.0VDC If not then adjust from Motherboard Card Pre-Heat Pot.
		Check Supplies at J7 & J4 connector	J7-1 +15VDC, J7-2 0VDC, J7-3 -15VDC w.r.t. Body Ground. (If not available then check the SMPS & Power Supply Card) J4-2 & 4=230VAC (If Not available then check the Filter Card or loose connections.
		If supplies & Pre-Heat Voltage is OK then Remove the J1 connector from Card & connect the 100W bulb on J1-3 & 2 (large) Filament Card or at J1-1 & 2 (Small)	If Bulb is not glowing then Replace the Filament Card.

		If bulb is glowing then check the continuity at CP2-3 & 5 and CP3 & 4 of Pulse-21 Card	If continuity is not available then replace the HV Tank
		If continuity is available then Remove the HV Cable –VE from X-Ray Tube & Connect the 24V Bulb (LBD rating Bulb) at C & L Terminal of HV Cable.	If Bulb is not glowing then replace the HV Tank
		If Bulb is glowing then check the continuity of C & L and C & S Filament Terminals of X-Ray Tube	If Continuity is not available then replace the X-Ray Tube
		If continuity is available then check the HV Cable	Check continuity of Terminal of HV Cables from HT Tank to X-Ray Tube. If continuity is OK then check the loose connection mounting in receptacles of HV Tank & X-Ray Tube
	Filament is glowing but green LED is not glowing & Filament Fault at Panel	Remove the JP8 connector from Motherboard Card & Check voltage at J7-9 in Filament Card connector w.r.t. Body Ground. Should be 11-13VDC	If not available then replace the Filament Card. If available then replace the IC4082 or Transistor Q18 (BC547) of Motherboard Card
	Filament Fault during Ready & Red Led glows	Check Set Filament Voltage at J7-6 during Ready w.r.t. Body Ground. Should not be more then 5.0VDC	Adjust the Set Filament from Motherboard Card from adjusting POT (According to Calibration Procedure)
	Filament Fault during Ready & Green Led gets OFF	Check Set Filament Voltage at J7-6 during Ready w.r.t. Body Ground. Should not be less then 1.6 DC.	Adjust the Set Filament from Motherboard Card from adjusting Pot (According to Calibration procedure)
7.	Rotor is not working	Check AC Input supply at RTS-4 & 5 & 4 & 6 Should be 230VAC & 65VAC respectively.	Should be available If not then check supplies of Machine.
		If voltage is available then check the DC voltage at RTS-9 & 10 should be 12VDC during Ready.	If not available then check the functioning of Ready Relay (RE2) of Machine
		If voltage is available then check the functioning of ROT1 & ROT5 Relay.	Coil may be open or supplies wires are not properly connected (Dry solder/ wire open)

		If ROT1 & ROT5 are getting ON then check the voltage at RTS-1 & 3 or at Tube Terminal-1 & 2 should be 230VAC before Time Delay.	If voltage is not available then check the glass Fuse (8A) & functioning of ROT1 & ROT5 Relays contacts.
		If voltage is available then remove the wires from Tube Terminals & check the resistance at Tube Terminal 1 & 2 and 1 & 3 should be approx. 30Ω & 60Ω.	If resistance is not available then check the Thermal Switch (Continuity between Terminal 5&6) If resistance is not available then replace the Tube Head
	Time delay not working	Check connections at Tube Terminals 5, 2. & 3. Also check jumper between Terminal 1 & 6	Should be properly connected. & tightened.
		Check interconnections of X-Ray Tube & Control	Should be Control side Tube Side TS3-1 5 TS3-2 3 TS3-3 2
		Check voltage at RTS-1 & 3 should be 230VAC.	If not available then check according to step 4.
		If voltage is available then check the voltage at Time Delay Card connector Pin 5 & 6 should be 30-40VAC	If not available then replace the Current Transformer-1
		If available then check the output voltage at Pin 2 & 8 should be 30-40VDC	If not available then replace the Transistor CK100 or Time Delay Card.
		If output is available then check the functioning of ROT3 Relay.	For Coil open & contact miss functioning
	Rotor Interlock not coming	Check Rotor Interlock at RTS-12 should be +15VDC w.r.t. Body Ground.	If available then check the loose connections at JP8 Motherboard Card.
		If not available then Check the ROT4 Relay Coil voltage at RE3-RE5 Card connector J2-1&2. Should be 6-8VDC.	If not available then check the Time Delay function & Wire Wound Resistance of RE3-RE5 Card.
		If voltage is available then check the functioning of ROT2 Relay	Contact miss functioning or Coil may be open & Coil voltage (8.0VDC after Time Delay) from RE3-RE5 Card J5-1 & 2.

		If Coil voltage is not available then check the input of RE3-RE5 Card at J4-2&3 should be 6-8VAC after Time Delay	If not available then replace the Current Transformer-2 If available then replace the RE3-RE5 Card.
		If Coil voltage of ROT2 & ROT4 Relays available then check the functioning of ROT4 Relay.	Coil open or contact functioning
8.	KV Fault is Glowing at Panel Check which Fault LED glows at Pulse-19 Card In case of LD2 / LD3	Check Set KV Signal at CP1-10 of Pulse-19 Card w.r.t. to Body Ground. Should be 2.0VDC at 40KVP	If not then set the voltage with R10/R15 Pot in Motherboard Card.
		If Set KV is OK then remove the connector at Pulse-21 Card & check the Feedback Resistance at CP1-1&2 should be 19.5-20.5K Ω and at CP1-2 &3 should be 19.5-20.5K Ω.	If not available then adjust the Resistance with CP1-1&2 (Adjustment Pot P2) CP1-2&3 (Adjustment Pot P4)
		If Resistance is OK then check the Pulse-19 Card with testing JIG	There should be no fault during exposure. If fault is coming then replace the Pulse-19 Card If Pulse-19 Card is OK then Replace the HV Tank.
	In case of LD5 glows	Check the mA & Stab. Calibration	Adjust the Pots according to KV mA Chart in Calibration Procedure of Motherboard Card & Filament (mA) Stab. Card.
		Check the X-Ray Tube	Rotor should rotates & tube surface should not be golden
		If X-Ray tube & calibration is ok then adjust the LD5 calibration from Pulse-19 Card.	Increase the resistance at IC U16-1&6 with POT-R120 in Pulse-19 Card.
	In case of LD4 glows	Check Set KV Signal at CP1-10 of Pulse-19 Card w.r.t to Body Ground. Should be 2.0VDC at 40KVP.	If not then set the voltage with R10/R15 Pot in Motherboard Card.
		Check the Pulse-19 Card with testing JIG.	If fault observed during exposure then replace the Pulse-19 Card.
		If Pulse-19 Card is OK then check the Feedback Resistance at CP1-1&2 should be 19.5-20.5K Ω and at CP1-2 &3 should be 19.5-20.5K Ω	If not available then adjust the resistance with CP1-1&2 (Adjustment Pot P2) CP1-2&3 (Adjustment Pot P4)

		If feedback resistance is OK then check the supply of Pulse-18 Com Card supply.	Should be 24VDC (CP1-1 +24VDC, CP1-2 0VDC) If not available then check functioning of RE1 relay & SMPS 24V 2A.
		If supply is available then check D10 LED in Pulse-18 Com Card is glowing during fault	If glowing then remove the shield wires of P1 P2 Cable (Connected at Output) or replace the Cable.
		If LD10 is not glowing then check Input supply of Inverter.	Should be 230VAC. If not available then check the functioning of Delay contactor (CON.2).
		If voltage available then check voltage at Capacitor Terminal of Inverter.	Should be 280-320VDC. If not available then check the HRC Fuses of Inverter.
		If Voltage is available on Capacitor's Terminals & HRC Fuses are OK then remove the P1, P2 Cable from HV Tank side & IC4049 U13 from Pulse-19 Card & connect the 100W 2 nos Bulb in series at P1 P2 cable. And check the glow during Exposure	Bulb should glow during Exposure. If not glowing then check the IGBT or replace the Inverter If Bulb is glowing during Exposure then replace the HV Tank.
9.	Exposure not working (Com-Rx not generated)	Check connectors of Motherboard Card, FRC Cables	Should be tight
		Check fault display at Panel	For FIL / TH / EF / KV Fault check according to above trouble shooting Or check the Interlocks at JP8 Motherboard Card.
		If Fault LED are not glowing then check the interlocks at JP8 of Motherboard Card.	JP8-2 - Inverter Fault (Normally 0VDC) JP8-3 - FIL Fault (Normally 10-13VDC) JP8-4 - Rotor Interlock (during Ready 15VDC) JP8-5 - (Full) Initial Time Delay OK JP8-6 - Thermal Fault (Normally 15VDC) If any voltage is not available then check follow the trouble shooting according to Signal

		If all Interlocks are available then check the voltage at IC U18 (555) Pin 3 during Exposure w.r.t. to Body Ground. Should be +13 - +15V DC	If not available then replace the IC555. If still not available then replace the Transistor Q15 & Q13
		If voltage is available then check voltage at IC (U15-4082) w.r.t to Body Ground during Exposure.	Pin-2, 3, 4 & 5 if available then check voltage at Pin 1 if not available then replace the IC4082 (U15).
		If voltage is available at PIN1 (U15-4082) then check at Pin NO.10, 11 should be high during Exposure w.r.t. Body Ground.	If not available then check voltage at JP8 w.r.t. to Body Ground of Motherboard Card.
		If available then check at Pin 12 (U15-4082) w.r.t to Body Ground should be high without Exposure.	If not available then check at JP8-2 should be 0V. If 0V available then replace the Transistor Q17 (BC547)
		If Pin No. 10, 11 & 12 of U15-4082 are high then check the output at Pin No. 13 should be High (+15VDC) during Exposure.	If not available then replace the U15-4082
		If Voltage is available then check the voltage at U1-25 (89V51) w.r.t. to Body Ground during Exposure.	Should be 0V during Exposure. If not available then replace the Transistor Q22 BC 547.
		If 0VDC available then check the Output of IC U1-10 during Exposure w.r.t. Body Ground. Should be 0VDC during Exposure (Normally 0.7V DC)	If not available then replace the IC 89V51.
		If available check Com-Rx Signal at JP6-4 of Motherboard Card during Exposure.	If not available then replace the Transistor Q23 (BC547) If available then check Com-Rx at CP1-9 of Pulse-19 Card.
		If not available then check the functioning of Ready Relay (RE2)	For contact functioning or Coil open.

Programmable Relay Setting

Sr. no:-	Parameters	Setting	Mode Display	Parameter Limit display
1	Under Voltage	Min. 360VAC		
2	Over Voltage	Max. 440VAC		
3	Delay time for Trip for Voltage	1Sec		
4	Phase voltage difference limit	30VAC		
5	Phase difference voltage trip time delay	1Sec. [		
6	Phase sequence Function	Normally mode off		
7	Over Frequency limit	53Hz		
8	Under Frequency limit	47Hz		
9	Delay time for Trip for Frequency	1 Sec.		

SEQUENCE OF LED'S AT PULSE-19 CARD OF INVERTER.

LED NO.	SIGNIFICANCES
LD1	COM-RX
LD2	KV>110%
LD3	ΔKV MAX. (FEED BACK FAULT)
LD4	MINIMUM KV FAULT
LD5	I>MAX.
LD6	COM1
LD7	COM2
LD8	PRE-RX
LD9	+ 15V
LD10	- 15V

1. DURING MACHINE ON LD9 (+15V) AND LD10 (-15V) WILL GLOW INDICATES THAT SUPPLY TO CARD IS O.K.

2. DURING EXPOSURE. THE SEQUENCE IS
   LD8 ⟶ LD1 ⟶ LD6 ⟶ LD7
   WHEN EXPOSURE IS RELEASED, THEN THE OFF SEQUENCE IS
   LD7 AND LD6 ⟶ LD1⟶LD8

13. Post Installation Instructions

1. The Party Code stickers and our Contact Numbers should be pasted on the equipment as per the place specified.

2. Technic chart should be fixed near the machine and operator/customer should be explained the Technic chart.

3. The Service Engineer should demonstrate the equipment to the operator. The operator should be given training on essential Do's and Don'ts like ---

    a. Use as much of Shielding material as possible, use lead screens, lead aprons, lead goggles and shields etc.

    b. Radiation Dose should be as low as reasonably achievable.

    c. Use collimators/cones and collimate radiation field to the smallest possible area.

    d. Before giving an exposure for the first time in the day, try to warm up the equipment for 10-15 minutes. For this purpose simply switch ON the machine and leave it as it is.

4. The Equipment should be handed over to the customer. The Installation Report should be properly filled along with the Warranty Card and required Serial Nos.

14. Dark Room Procedures & X-Ray Film Processing

Dark Room Procedure:

To obtain the best results from the X-Ray Machine, following procedure should be observed in Dark Room: -

2. A qualified and trained Radiographer should only be allowed to operate the X-Ray Equipment.
3. Dark Room should be totally dark and no light should enter in the room.
4. Loading and unloading of films in the cassette should be done only in Dark Room under standard safe light.
5. Films should be stored in Dry and Dark place.
6. The Intensifying screens should be handled with care and wet finger marks of any chemicals should not touch the screens.
7. The Developer and the Fixer solutions should always be covered and preferably new solutions to be prepared after every 2 Months or after 250 films.
8. The Temperature of Developer and Fixer to be maintained between 25 to 30 Degrees.
9. Solutions should be stirred with wooden stick each time films are dipped. Separate wooden sticks, each for developer and fixer should be used.

X-Ray Film Processing:

1. Open the exposed cassette in the Dark Room.
2. Take out the exposed film and fix it in the hanger of suitable size.
3. Dip the film in the Developer. After about 15 seconds take out the film from the Developer to visually observe the Developing status. Dip it again and take out to monitor the development as frequently as possible.
4. Take out the film from the Developer tank after it is fully developed.
5. Dip the film in water to rinse all traces of developer on the film.
6. After proper rinsing, dip the film in the fixer. Let it be dipped in fixer for 5 Minutes.
7. Dip the film in running water to rinse and remove all the fixer from the film.
8. Dry the film either in open place or in film drier.

15. Radiation Monitoring & Protection

15.1 Personnel Monitoring

Personnel monitoring is the evaluation of radiation doses received by the personnel working with radiation.

The most commonly used personnel monitoring device is the film badge which consists of a personnel monitoring film (PM Film) kept in cassette containing a set of filters. With film badge, a wide range of doses from 10 mRem to 1000 Rem of different types of radiation can be evaluated. The film serves as a permanent record and if worn on chest, gives the most representative value of whole body dose under normal working conditions.

The radiation dose received by radiation worker can also be determined by the use of Thermoluminescent dosimeter (TLD) badge. This consists of three CaSO4:Dy TLD discs embedded in a metallic frame work and enclosed in a multi filter cassette. The TLD badge can be used to monitor Beta, Gamma and X-Ray radiations. The TLD badge can cover a wide range of doses from 10 mRem to 1000 Rem.

In addition to PM Film & TLD Badge, radiation dose to personnel can also be assessed by pocket dosimeters. Pocket dosimeters are very useful in certain operations, where the radiation levels vary considerable and may be quite hazardous. They give on the spot check of radiation doses.

It is always advisable that personnel handling the X-Ray machine should use TLD badges, PM Films or other devices like Pocket Dosimeters to monitor the absorbed dose within the safe limits.

15.2 Radiation Protection Accessories

It is advisable to all personnel handling X-Ray machines to use following radiation protection accessories:

- Lead Goggles
- Protective Barrier
- Lead Apron
- Lead Gloves
- Thyroid Shield
- Gonad Shield

16. Preventive Maintenance Procedure

Preventive Maintenance of any equipment is very important to keep it in proper working condition through out its life span. Timely and proper Preventive Maintenance not only increases the life of the equipment, but it reduces the down time, hence savings on otherwise expensive repairs. We must therefore try to be disciplined as far as the time schedule and the procedure for carrying out the P.M. is concerned. The details given below would give guidelines of P.M. procedure. P.M on all the equipments must be performed every 4 months i.e.: thrice a year.

For optimum output of the equipment we should start writing the voltage drop during exposure at Average working KVP Time and mA settings. This record at the time of installation itself can be mentioned on the Machine History Card. The date and month of Installation would help us actually know the extent of voltage drop as our experience suggests that during the summer season; the voltage drop is on the higher side. During P.M the Voltage drop can be checked with the reference value and is noted. Any increase in Voltage Drop would thus be noticed and line checked for any loose connections etc. in the mains switch/pole etc.

Inform customer in advance about your visit preferably through a letter/ telephone and agree for a convenient time and date.

17. Preventive Maintenance Checkpoints

The following preventive maintenance procedure may be adopted for carrying out all P.M. on the X-Ray Equipments.

A). GENERAL:

Whenever visiting for any Preventive Maintenance, please ensure to carry all the Tools, Meters, Grease, Lubricants, Machine History Card and consumables like the dusters, polish etc. Please make sure that your Multimeter is calibrated with a Standard Meter lying in your Branch Office.

1. On reaching the Customer's site enquire from Operator/Doctor for any specific problems they are facing with the equipment.

2. Rectify first the problems as indicated by the customer and then proceed as under for carrying out the Preventive Maintenance

B). PREVENTIVE MAINTENANCE PROCEDURE (ELECTRICAL)

1. Before attempting to carry out the P.M. switch ON the equipment and check the working of the Machine electrically and mechanically. Observe for any flaws, which should be rectified during the course of P.M.

2. Observe all the Electrical/Mechanical/Radiation precautions while performing the P.M.

3. Switch OFF the Main Switch, open the cover and tighten any loose contacts/screws. Also check the fuse wire Rating and it must comply with the Rating of the equipment in operation.

4. Open the control panel cover. Keeping the Machine in "OFF" condition tighten all the screws on the Terminal Blocks/Resistance Taps etc.

5. Check the rating of all the Glass Fuses and replace if necessary.

6. Open cover of ON/OFF & Delay Contactors and check that contacts are not worn out or burnt & should be clean. Check the operation of the X-Ray contactor. It should not be sticky.
7. Check Calibration as per calibration procedure.

C) MECHANICAL

1. Check all the movements of Tube Head, Tube Stand and Tables. Check for functioning of all locks and ensure that all movements are smooth and noiseless. Specially check for Vertical Carriage Up/Down Movement. Rectify wherever required. Remove old grease with cloth and apply fresh grease on all movement areas (wherever applicable).

2. Open the Table Top and brush out all the dust settled on the Grid and on the Bucky Motor Area. Clean, apply lubricant and check the Bucky play, it's lock and tighten all nuts/bolts/screws in the Table.

3. You must ensure that the alignment of the Center Ray of Light Beam diaphragm matches with the Table center and Bucky center (Adjust if required).

4. In case of the Motorized Table check the working of following:
    a. SFD Movements
    b. Table Movements
    c. Functioning of the limit switches at the Horizontal and the Vertical positions
    d. Check the functioning of the Safety micro switches
    e. Check the functioning of the Electromagnetic Locks, prep switch, Hand Switch and the change over switch.
    f. The movement of the Table
    g. Functioning of the Motorized collimator shutters from SFD. Adjust if required.
5. Now check for Air Bubbles in Tube Head and ensure that all wires/cables on Tube Head are tight. Check for bellow condition and any oil leakage. Ensure that the gap between mA & G Plate is maintained at 2mm.

D) X-RAY / LIGHT BEAM/ ALIGNMENT

1. Check and perform X-Ray/ Light Beam Alignment.
2. Check the LBD Bulb's mounting and orientation. Incase LBD Bulb's are fusing quite often check the voltage if the voltage supply is on the higher side, reduce input voltage to LBD Bulb.
3. Check the smooth movement of the LBD Shutters.

E) CLEANING POUSHING

1. Clean the machine with dry cloth and for the stubborn stains, use cleaning agent and polish. Do not allow any liquids to step in the control and other Electrical Areas.

F) DARK ROOM

Check the Dark Room and its accessories for the following:

1. No light leakage in the Dark Room.
2. Safe light is of proper intensity.
3. Films used should not be beyond the expired dates.
4. Cassette locks are not loose.
5. Screen Quality should be OK and no staining of the screens.
6. Developer and the fixer are fresh and their temperature is maintained properly.
7. Wooden sticks are available for stirring of the Developer and fixer.
8. Radiographer/Operator is trained to handle Dark Room Accessories.

G) GENERAL

1. Enquire if radiographer/Operator needs any training for use of equipment & impart if necessary.
2. Handover Equipment to customer.
3. Explain/show equipment to customer, apprise him of jobs undertaken.
4. Fill Machine History Cards and get the card/report signed from customer.
5. Inform tentative date of next Preventive Maintenance.