

MINXRAY^{INC.®}

MINXRAY **TR90B**

PORTABLE VETERINARY X-RAY UNIT

SERVICE MANUAL

Version 2.0

This manual is established for repair and adjustment of MinXray TR90B portable veterinary x-ray unit. It prohibits the other company from transferring and/or perusing without consent of mikasa x-ray co., ltd.

EDITOR

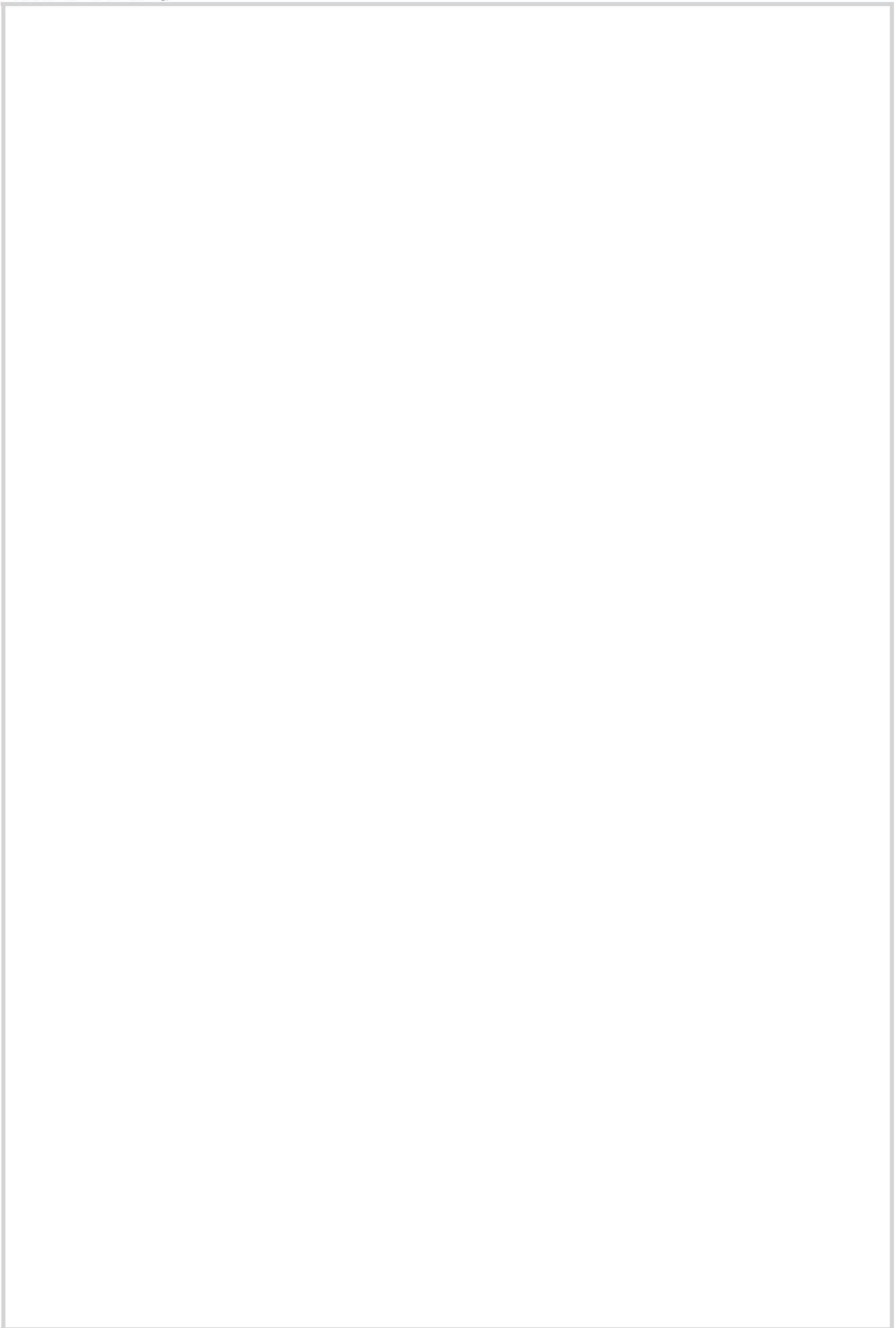
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1.0 NOTICE FOR SAFE OPERATION

1. The following safety symbols will be used in this manual.

	WARNING:	Warns of the possibility of injury to patient or operator.
	CAUTION:	Cautions about possible damage to the product.
	NOTE:	Notes for operating this product correctly.
	WARNING: RADIATION HAZARD:	Warns of possible radiation hazards.
	DANGEROUS VOLTAGE:	Caution for the possibility of electric shock.

2. The **MinXray TR90B** is not certified for human use. It has been developed specially for veterinary x-ray applications. It should not be used for other applications.
3. During operation, the operator should be fully protected from exposure to radiation and use a dosimeter badge.
4. Operators must follow all guidelines of applicable regulations and in-house radiation protection programs for patients and operators, especially those who are pregnant or expect to become pregnant.
5. Operators must fully understand safety precautions and established maximum permissible doses.
6. Do not use **MinXray TR90B** until the patient and operator are positioned correctly and ready for the radiographic exam. This reduces the possibility of interruption, and prevents inadvertent X-ray exposure to others.
7. Only a licensed or authorized radiographer (e.g. doctor, X-ray technician, etc.) should operate the **MinXray TR90B**.

	WARNING: This x-ray unit may be dangerous to patient and operator unless safe exposure factors, operating instructions and maintenance schedules are observed.
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8. Please take the following precautions during installation:

- A) Keep equipment dry.
- B) Do not subject equipment to excessive atmospheric pressure, temperature, humidity, direct sunlight, dust, or air containing salt and sulphur.
- C) Do not subject equipment to excessive vibration and/or shock during transportation, etc.
- D) Do not store equipment under any adverse gaseous conditions.
- E) Insure that the input electrical voltage, amperage and hertz are correct.

9. During operation, consult and/or develop a technique chart for appropriate anatomy, distance, and screen/film or digital imaging system speed.

10. After using the equipment:

- A) Remove cords carefully, if necessary.
- B) Keep equipment clean and dry.
- C) Store inside carrying case in cool, dry environment.

11. Maintenance

For proper maintenance, this schedule must be followed:

- A) Every 6 months
 - 1) Check the alignment of the collimator light field with the x-ray beam.
 - 2) Check the audible and visible exposure functions.
 - 3) Check to see that all bolts, screws and lock nuts are tight.
 - 4) Re-adjust the position of laser beams to be aligned with the central ray of the x-ray unit at the source-to image-distance (SID) you typically use.
- B) Every 2 years
 - 1) Replace the collimator bulb.



WARNING: TO INSTALLERS, SERVICE PERSONNEL, AND USERS OF X-RAY SYSTEMS.

When performing periodic maintenance, calibration, or changing of the components of an x-ray system, the person in charge should confirm whether all components and screws are properly connected and securely tightened. Continued use of loose components is dangerous and could cause further loosening, damage of screws and bolts, or mount failure which could result in **HEAVY COMPONENTS FALLING DURING USE**. The operator should report all loose system components to x-ray service personnel for immediate repair.

Routinely check the collimator to confirm that it is securely mounted to the tubehead. The system should also be inspected for loose joints, not only between the collimator and tubehead/control, but other mounting areas as well.

The four (4) collimator mounting screws must engage the collimator mounting ring. If inspection reveals loose collimator mounting screws at an installation, or as a precautionary measure at any installation, it is suggested that a medium strength thread locking glue such as LOCTITE #242 or PERMA-LOK MM-115 be used after first cleaning the screw with alcohol.



WARNING: MODIFICATIONS, SERVICE AND REPAIR MAY ONLY BE CARRIED OUT BY THE MANUFACTURER OR OTHER PERSONNEL EXPLICITLY AUTHORIZED BY MINXRAY AND OUR AUTHORIZED SERVICE PARTNERS.

Only original replacement parts may be used for repair. Opening of the unit body and dismantling are not permitted and may result in:

- A) Loss of warranty.
- B) Forfeiture of the operating safety for user and patient, otherwise guaranteed by the international legal regulations.
- C) Danger of bodily injuries due to high voltage!

All correspondence concerning this system must state the unit type and the serial number

2. INTRODUCTION

This service manual is for **MinXray TR90B** portable veterinary x-ray unit.

If you have any questions or need further assistance, please contact us. We have available Monday – Friday, 8:30 – 17:00 central time

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The **MinXray TR90B** is a battery powered x-ray device utilizing the latest high frequency resonant inverter system. This x-ray unit has the following features:

1. This x-ray unit is very easy to carry by hand because of its small size and low weight.
2. This unit is battery powered.
3. Dual Laser Pointers in the light beam collimator are easy to adjust to indicate the central ray at your typical source-to-image distance (SID).
4. A high frequency resonant inverter with output greater than conventional models and constant x-ray tube voltage.
5. Output of kV and mA are corrected and stabilized by automatic feedback circuits.
6. Focal spot size is 0.8 mm only. Therefore, the quality of X-ray images is almost the same or better than X-ray images taken by bigger stationary X-ray units.
7. The kV can be adjusted in 2kV steps from 40 kV to 90 kV. mA output adjusts automatically. kV, mAs and sec. are digitally indicated on the Control Panel.
8. It is easy to select either exposure time or mAs display on the Control Panel.

9. X-ray exposures are confirmed by buzzer and X-ray Indicator.
10. The last kV and timer settings before the unit is turned off are stored for the next operation.
11. Five different technique setting can be stored in memory for quick recall on this x-ray unit.
12. The **MinXray TR90B** has an interface connector for DR digital imaging system.
13. Various stands are available from MinXray for use with the **MinXray TR90B**



WARNING: As the **MinXray TR90B** uses high voltage, please read this manual carefully prior to operation.

3. SPECIFICATIONS

Rating

Power Requirement:	DC, 59.2V, Li+ battery (Check rating label on x-ray unit.)
Maximum input current:	45A @90kVDC
Protection against electrical shock:	Type B Internally Powered Equipment
Mode of operation:	Continuous operation with intermittent loading
Duty cycle:	1:60 (one 0.2 second exposure every 12 seconds)
Fuse:	20 A @ 63VDC (Characteristic: Slow-Blow)

Beam Limiting Device

Model number:	R-300V type: B01
Manufacturer:	Mikasa X-ray Co., Ltd.
Inherent filtration:	0.5 mm Al
Maximum X-ray Field Size:	35 × 35 cm @ SID 100 cm

Laser Pointers

Model number:	LP4
Laser type:	Class IIIa Laser Diode
Maximum output:	< 3.0 mW
Wavelength:	635 nm
Beam length:	16.5 mm at 60 cm
Power:	12 VDC

Dimensions And Accessories

Equipment size (X-ray Generator):	W: 218mm x H: 189mm x L: 250mm (8.58" x 7.44" x 9.84")
Weight:	7.0kgs (15.4 lbs.)
Exposure switch cord:	HS-M1 (Two-stage, Deadman with RJ11 connector)
Size:	2.44m (8 feet)

Environmental Conditions For Use

Temperature:	+10 °C ~ +40 °C (50 °F ~ 104 °F)
Humidity:	30 % ~ 75 %, excluding condensation
Atmospheric Pressure:	700 hPa ~ 1060 hPa
Other:	Avoid using where explosive or corrosive gases are present.

Environmental Conditions For Transport And Storage

Temperature:	-20 °C ~ +60 °C (-4°F ~ 140°F)
Humidity:	10 % ~ 90 %
Atmospheric Pressure:	500 hPa ~ 1060 hPa
Other:	During transport by air, we recommend to reduce the battery charge level to 2 bars on battery level indicator in order to preserve lithium ion cells.

X-ray Generator

Generator system:	Max 200 kHz resonate high frequency inverter system
Electric power:	1.35 kW @ 90 kVDC, 15 mA
Tube voltage:	Tolerance ±10 % Range: 40 kVDC – 90 kVDC kV switch : 2 kV step
Tube current:	Tolerance ±10 % Range: 20 mA @ 40 kVDC – 60 kVDC 15 mA @ 62 kVDC – 80 kVDC 10 mA @ 82 kVDC – 90 kVDC High Power Mode 15 mA @ 82 kVDC – 90 kVDC
Exposure timer:	Tolerance ±10 % +1 msec Range: 0.01 sec – 1.00sec: 0.01 sec step High Power Mode 0.01 sec – 0.30 sec: 0.01 sec step
Leakage technique factors:	0.05 mA @ 90 kV 0.05 mA is maximum rated continuous current for 10mA with duty cycle 1:60
Filtration:	Inherent Filtration : 2.0 mmAl Total Filtration : 2.5 mmAl (with beam limiting device)

X-ray Tube

Model number:	D-0814
Manufacturer:	TOSHIBA CORPORATION
Focal spot:	0.8 mm
Target material:	Tungsten
X-ray tube target angle:	16 degrees
X-ray tube inherent filtration:	Minimum 0.8 mm Al
Anode heat storage capacity:	9.86 kWh (7kJ)

Battery

Model Number:	M900BL
Battery type:	Lithium ion battery
Typical Voltage:	59.2V (14.8V x 4 pack built-in)
Capacity:	1,450mAh
Electric Discharge Final Voltage:	59.5V
Max Continuous Discharge Current:	45A
Environmental Condition For Use:	Charge +10 ~ +40°C (50°F ~ 140°F) Discharge +10 ~ +60°C (50°F ~ 140°F) Storage -20 ~ +40°C (-4°F ~ 104°F) Long storage -20 ~ +35°C (-4°F ~ 104°F)
Size:	Length 160mm (6.30") Wide 80mm (3.15") Height 62mm (2.44")
Mass	1.0kg (2.2lbs.)

Battery Charger

Model Number:	M110BC
Input:	DC 19V 2A
Charge method:	CC – CV
Constant current	2000mA±200mA
Constant voltage	16.8V±200mV
Charge time:	About 4 hours
Environmental Condition For Use:	Charge Temperature +10 ~ +45°C (50°F ~ 113°F) Humidity 0 ~ 85% RH Storage Temperature -20 ~ +45°C (-4°F ~ 113°F) Humidity 0 ~ 85% RH
Size:	Length 113mm (4.45") Wide 86mm (3.39") Height 36mm (1.42")

AC Adapter

Model Number:	RC45-19
Nominal Line Voltage:	Single – Phase, 90VAC – 240VAC, 50/60Hz

4. MAINTENANCE

GENERAL INFORMATION

The unit is adjusted in the factory, therefore adjustment should be unnecessary. However, if you replace the circuit boards or check the unit for maintenance, please adjust by the following procedures. If these checks and adjustment are not performed, the compliance with regulations cannot be assured.

1. Remove outer case.



SHOCK HAZARD: Dangerous voltages are present on the circuit boards inside the unit. Turn off the main power switch of the unit and remove the battery from the unit. Allow 3 minutes for large capacitors to safety discharge.

2. Replacement and adjustment



CAUTION: All parts for replacement should be used the specified parts.



WARNING: Be sure all connectors are properly connected, before adjustment of the circuit boards.



CAUTION: Maintenance and adjustments should be adjusted according to each procedures.

5. RE-ADJUSTMENT OF PC BOARD

5.1 MT1002A PC Board adjustment



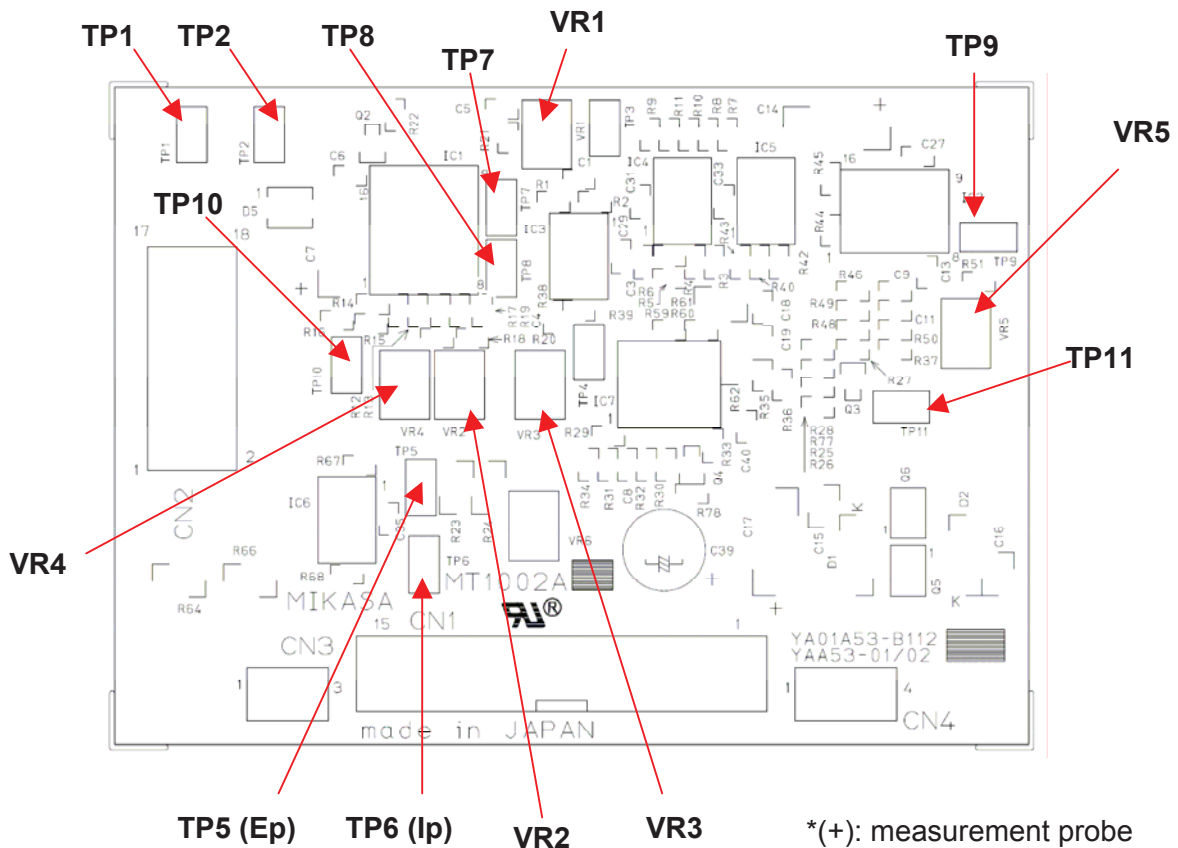
CAUTION: This adjustment has to be done after connecting all the connectors except the insert box and the collimator. Actual x-ray exposure is not necessary.

1. Adjustment of frequency for mA and pre-heat
 - a.) Adjust frequency between TP9 (+) and GND (-)* to be **90kHz** turning **VR5**.

Turning clockwise decreases frequency.
2. Adjustment of VR4 for pre-heat [Read the contents 9 (RE-ADJUSTMENT OF PRE-HEAT VALUE).]
 - a.) The value which select the kV output is 40kV
 - b.) Exposure switch is connected the unit and press and hold the first button.
 - c.) Adjust voltage between TP10 (+) and GND (-)* to be **0.41V** by turning **VR4**.


Turning clockwise increases voltage.
3. Adjustment of inverter frequency for kV [Read the contents 6 (RE-ADJUSTMENT OF INVERTER FREQUENCY).]
 - a.) Adjust frequency between TP7 (+), TP8 (+) and GND (-) to be **71kHz** turning **VR3**. (MINIMUM)
 - b.) Adjust frequency between TP7 (+), TP8 (+) and GND (-) to be **200kHz** turning **VR2**. (MAXIMUM)

Turning clockwise increases frequency.
4. Adjustment of inverter frequency of dead time for kV [Read the contents 6 (RE-ADJUSTMENT OF INVERTER FREQUENCY).]
 - a.) Adjust dead time between TP7 (+), TP8 (+) and GND (-) to be **600nsec** turning **VR1**.



*(+): measurement probe
 (-): ground probe (TP1,TP2)

5.2 MT2005C PC Board adjustment

	<p>CAUTION: This adjustment has to be done after connecting all the connectors except the insert box and the collimator. Actual x-ray exposure is not necessary.</p>
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1. Adjustment of OVP voltage of x-ray tube

a.) Adjust voltage between TP3 (+) and GND (-)* to be **10V** by turning **VR1**.

Turning clockwise increases voltage.

2. Adjustment of OCP voltage of x-ray tube

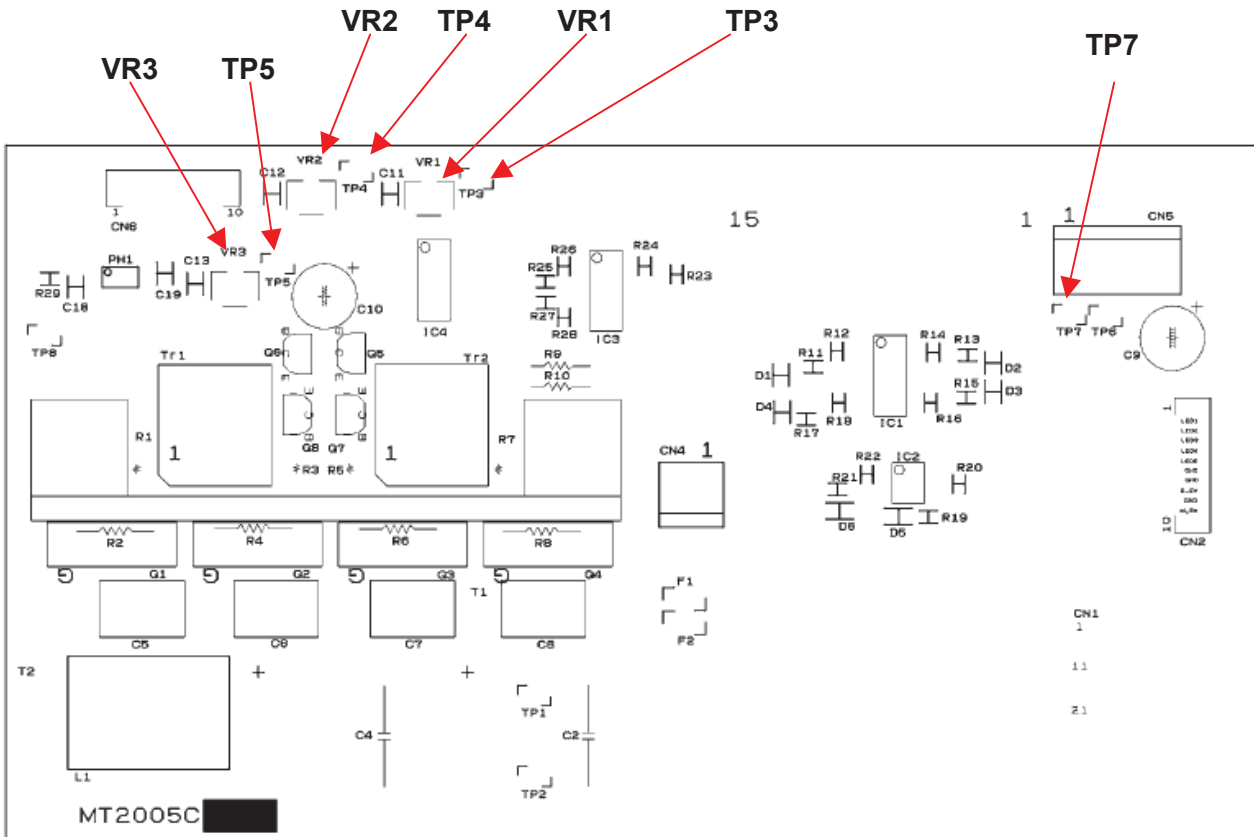
a.) Adjust voltage between TP4 (+) and GND (-)* to be **6V** by turning **VR2**.

Turning clockwise increases voltage.

3. Adjustment of OCP of voltage of filament

a.) Adjust voltage between TP5 (+) and GND (-)* to be **4V** by turning **VR3**.

Turning clockwise increases voltage.



*(+): measurement probe
 (-): ground probe (TP7)

5.3 MT5002A PC Board adjustment

1. VR2 is a volume for EP adjustment from 40kV to 60kV.

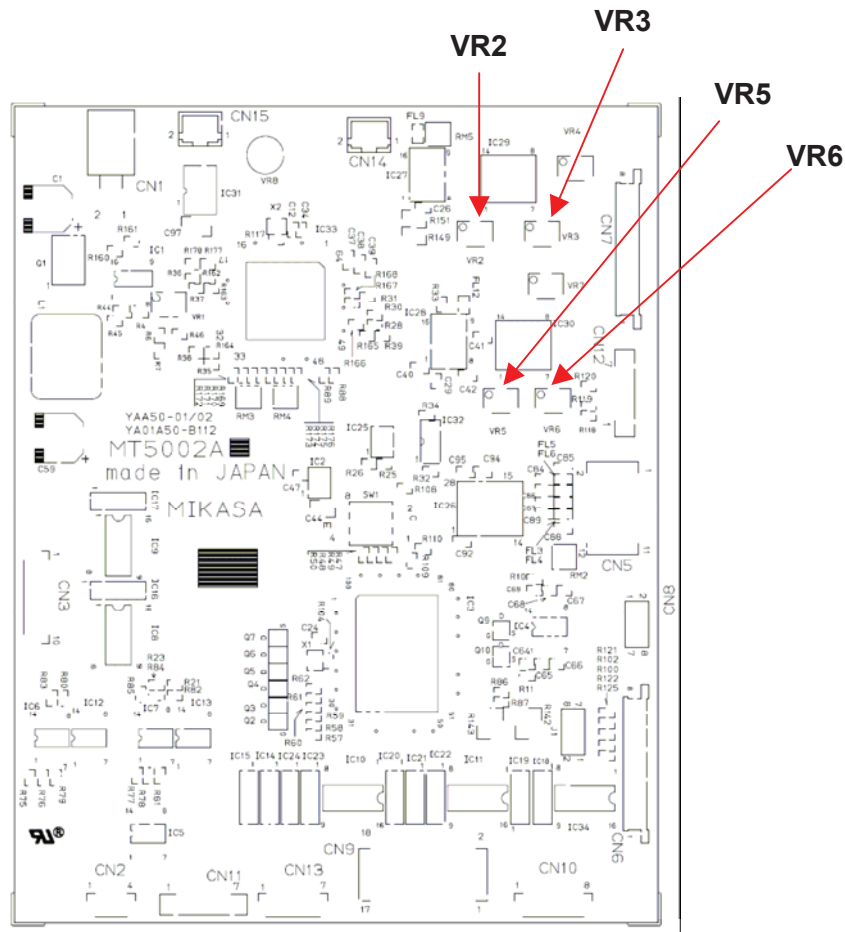
2. VR3 is a volume for EP adjustment from 62kV to 90kV.

[Read the contents 7 (RE-ADJUSTMENT OF kV).]

3. VR5 is a volume for IP adjustment from 10mA to 15mA.


4. VR6 is a volume for IP adjustment from 16mA to 20mA.


[Read the contents 8 (RE-ADJUSTMENT OF mA).]



NOTE: The above PC boards are already adjusted at MIKASA. Therefore, it will not be necessary to adjust greatly at your side.

6. RE-ADJUSTMENT OF FREQUENCY OF INVERTER

 **CAUTION:** This adjustment has to be done after connecting all the connectors except the insert box and the collimator. Actual x-ray exposure is not necessary.

 **CAUTION:** The following of PC board is already adjusted at MIKASA. Therefore, it will not be necessary at your side.

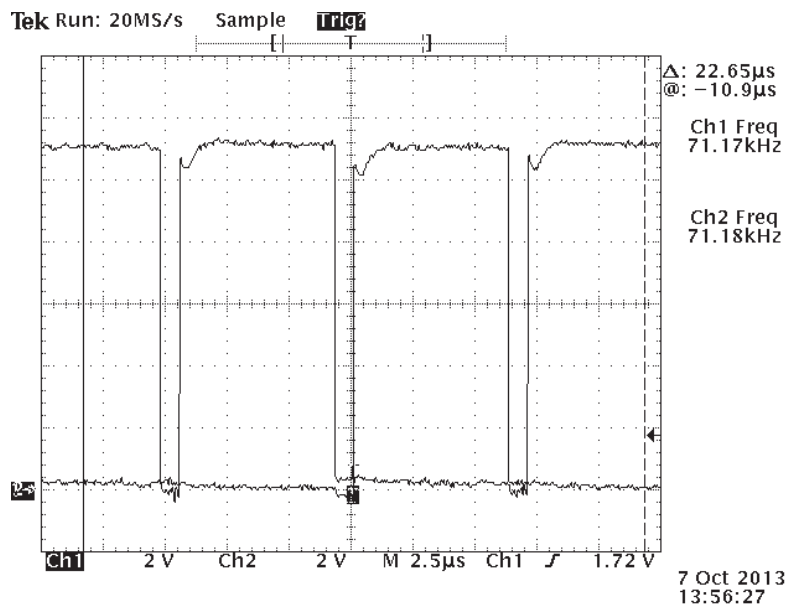
Measurement tools: Oscilloscope (Connect CH1 probe to TP7, CH2 probe to TP8 and GND (TP1 or TP2) terminal on MT1002A PC-board.)

Setting 1

- Place of adjustment : **VR3** on MT1002A PC board
- Oscilloscope mode : storage mode
- Range : CH1: 2V / div, CH2: 2V / div, SEC: 2.5 micro sec / div
- X-ray output : 0.5sec, 40kV
- Method of adjustment : Measure frequency of inverter by oscilloscope and adjust pulse waveform.
- Precision : **71kHz ± 1kHz**

Turning clockwise increases frequency.

The actual pulse waveform

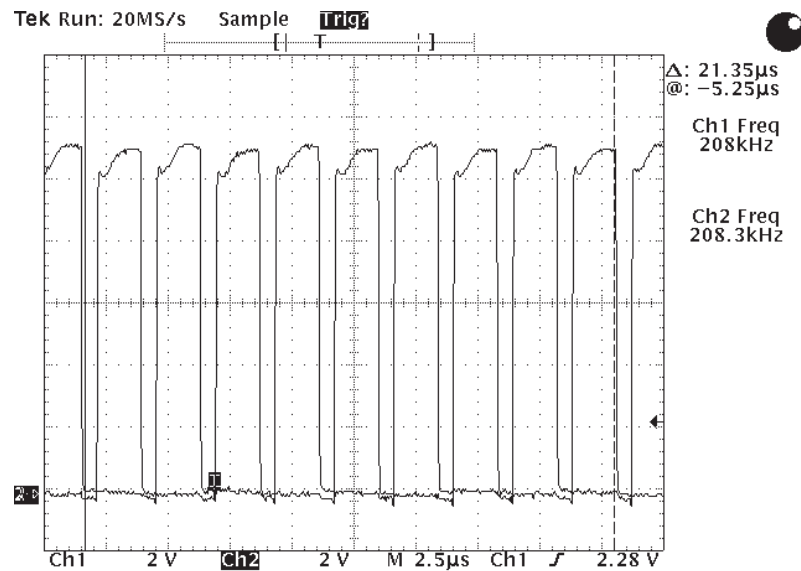


Setting 2

Place of adjustment : **VR2** on MT1002A PC board
Oscilloscope mode : storage mode
Range : CH1: 2V / div, CH2: 2V / div, SEC: 2.5 micro sec / div
X-ray output : 0.5sec, 40kV
Method of adjustment : Measure frequency of inverter by oscilloscope and adjust pulse waveform.
Precision : **200kHz +10kHz**

Turning clockwise increases frequency.

The actual pulse waveform

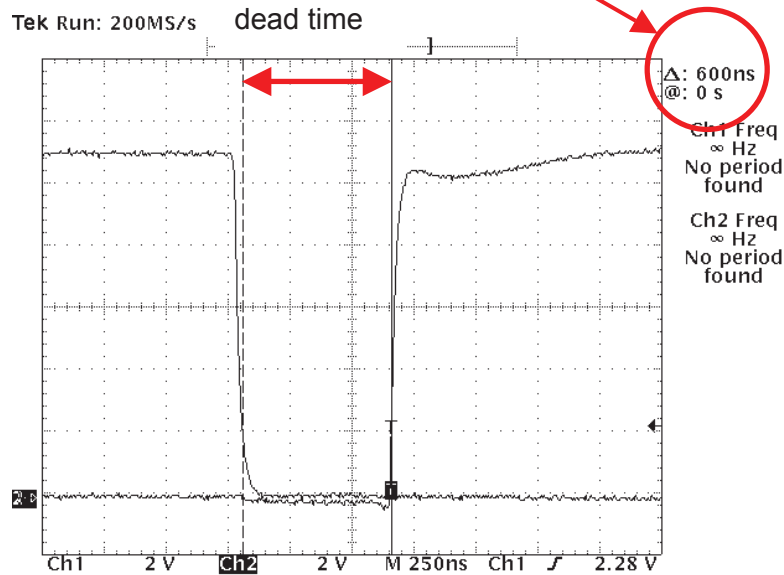


Setting 3


Place of adjustment : **VR1** on MT1002A PC board
Oscilloscope mode : storage mode
Range : CH1: 2V / div, CH2: 2V / div, SEC: 250nsec / div
X-ray output : 0.5sec, 40kV
Method of adjustment : Measure dead time of inverter by oscilloscope and adjust pulse waveform.
Precision : **600nsec ± 50nsec**


Turning clockwise increases value (dead time).


The actual pulse waveform



7. RE-ADJUSTMENT OF kV

 **CAUTION:** This adjustment has to done after connecting all connectors completely. Actual x-ray exposure is necessary. This adjustment requires that an exposure be made. Please observe all radiation related safety precautions.

 **CAUTION:** Confirmation is surely necessary after the re-adjustment of kV. Direct kV test is necessary using kV test instrument such as the VICTOREEN NERO.

 **NOTE:** Charge the battery before adjusting PC board.

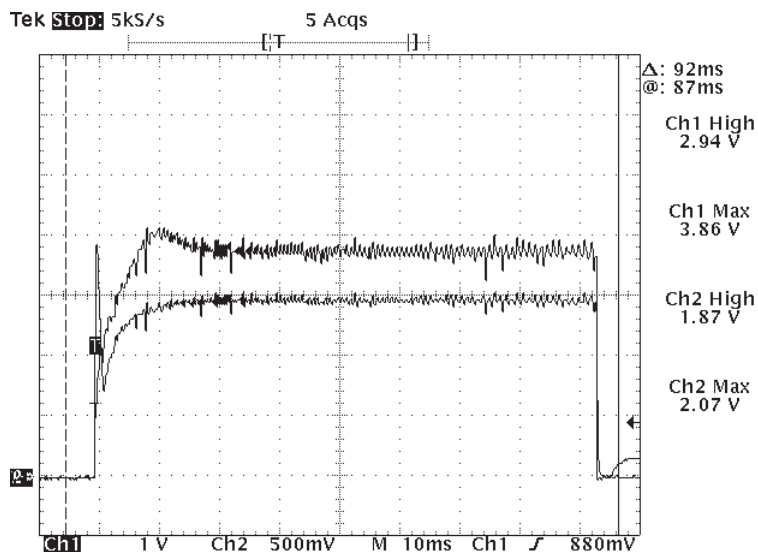
Measurement tools: Oscilloscope (Connect CH1 probe to TP5, CH2 probe to TP6 and GND (TP1 or TP2) terminal on MT1002A PC-board.)

Setting 1

- Place of adjustment : **VR2** on MT5002A PC board
- Oscilloscope mode : storage mode
- Range : CH1: 1V / div, CH2: 500mA / div, SEC: 10msec / div
- X-ray output : 0.07sec, 60kV
- Method of adjustment : Measure voltage of x-ray tube by oscilloscope and adjust average of peak values of Ep waveform.
- Precision : **2.9V ± 0.06V**

Turning clockwise increases voltage.

The actual Ep waveform

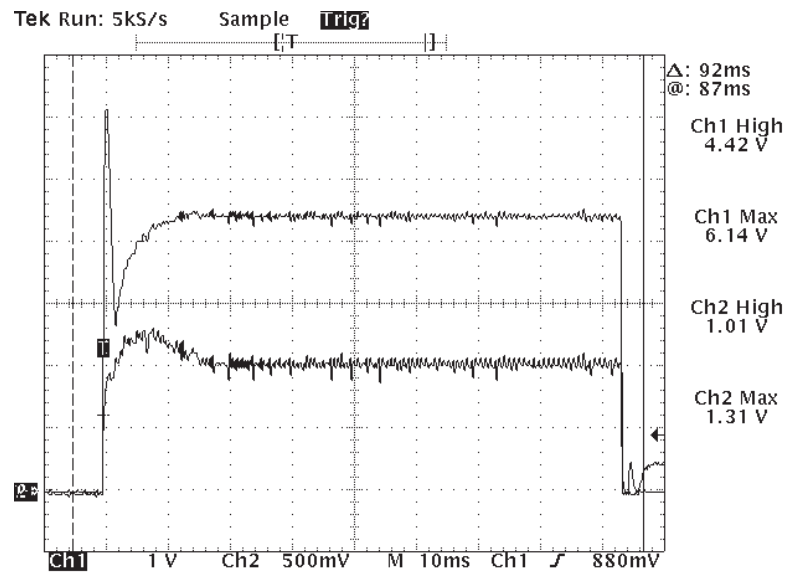


Setting 2


Place of adjustment : **VR3** on MT5002A PC board
Oscilloscope mode : storage mode
Range : CH1: 1V / div, CH2: 500mA / div, SEC: 10msec / div
X-ray output : 0.07sec, 90kV
Method of adjustment : Measure voltage of x-ray tube by oscilloscope and adjust average of peak values of Ep waveform.
precision : **4.4V ± 0.05V**


Turning clockwise increases voltage.

The actual Ep waveform



8. RE-ADJUSTMENT OF mA

	<p>CAUTION: This adjustment has to done after connecting all connectors completely. Actual x-ray exposure is necessary. This adjustment requires that an exposure be made. Please observe all radiation related safety precautions.</p>
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	<p>NOTE: Charge the battery before adjusting PC board.</p>
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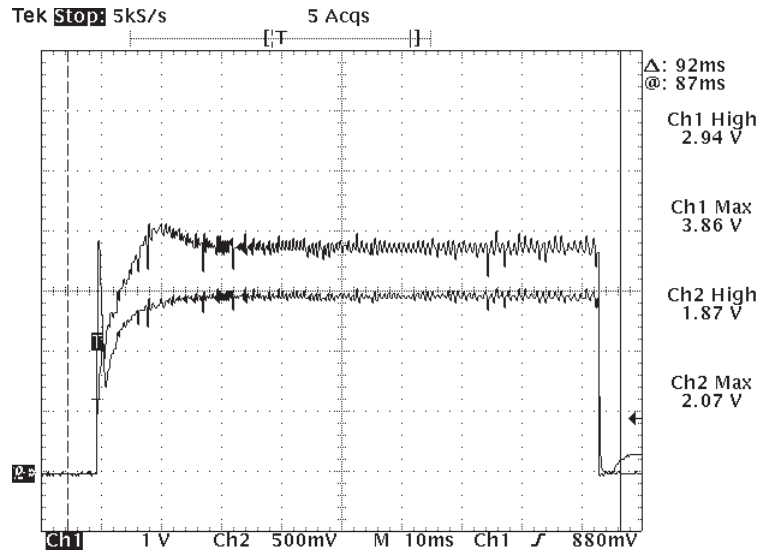
Measurement tools: Oscilloscope (Connect CH1 probe to TP5, CH2 probe to TP6 and GND (TP1 or TP2) terminal on MT1002A PC-board.)

Setting 1

- Place of adjustment : **VR6** on MT5002A PC board
- Oscilloscope mode : storage mode
- Range : CH1: 1V / div, CH2: 500mA / div, SEC: 10msec / div
- X-ray output : 0.07sec, 60kV
- Method of adjustment : Measure current of x-ray tube by oscilloscope and adjust average of peak values of Ip waveform.
- Precision : **1.9V ± 0.06V**

Turning clockwise increases voltage.

The actual Ip waveform

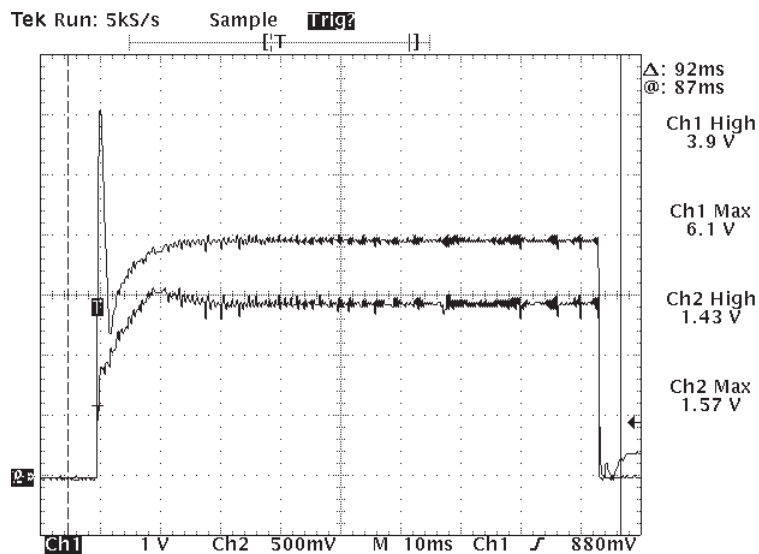


Setting 2

Place of adjustment : **VR5** on MT5002A PC board
Oscilloscope mode : storage mode
Range : CH1: 1V / div, CH2: 500mA / div, SEC: 10msec / div
X-ray output : 0.07sec, 80kV
Method of adjustment : Measure current of x-ray tube by oscilloscope and adjust average of peak values of Ip waveform.
Precision : **1.45V ± 0.06V**

Turning clockwise increases voltage.

The actual Ip waveform



9. RE-ADJUSTMENT OF PRE-HEAT VALUE



CAUTION: This adjustment has to done after connecting all connectors completely. Actual x-ray exposure is necessary. This adjustment requires that an exposure be made. Please observe all radiation related safety precautions.

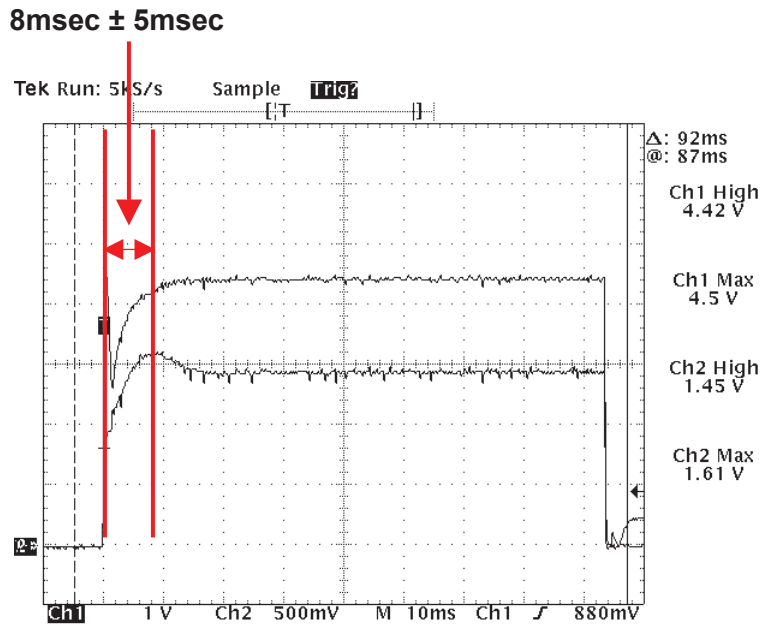
Measurement tools: Oscilloscope (Connect CH1 probe to TP5, CH2 probe to TP6 and GND (TP1 or TP2) terminal on MT1002A PC-board.)

Setting

- Place of adjustment : **VR4** on MT1002A PC board
- Oscilloscope mode : storage mode
- Range : CH1: 1V / div, CH2: 500mA / div, SEC: 10msec / div
- X-ray output : 0.07sec, 90kV (HP mode)
- Method of adjustment : Measure current of x-ray tube by oscilloscope and adjust pre-heat values of Ip waveform.
- Precision : **8msec ± 5msec**

Turning clockwise increases value (sec).

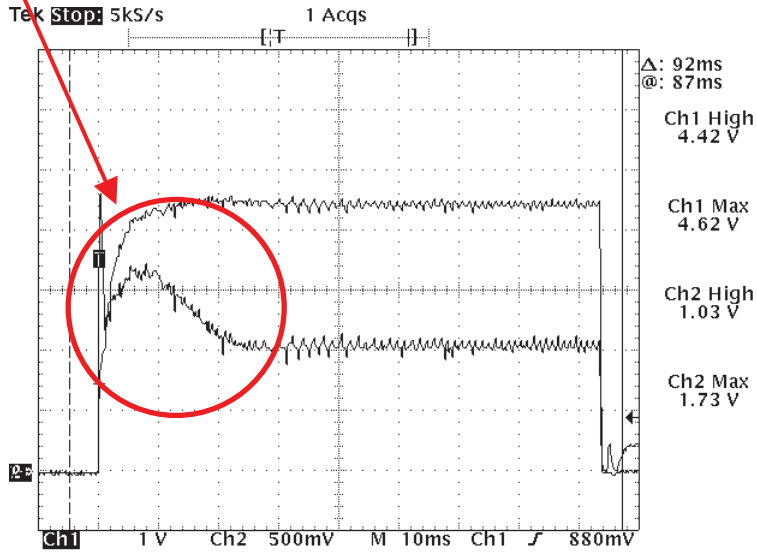
The actual Ip waveform






NOTE: If rise time of voltage is fast, it would overshoot with 90kV, 10mA. Then, slow rise time of voltage.

Voltage overshoot



10. RE-ADJUSTMENT OF EXPOSURE TIME AND THE BUZZER VOLUME

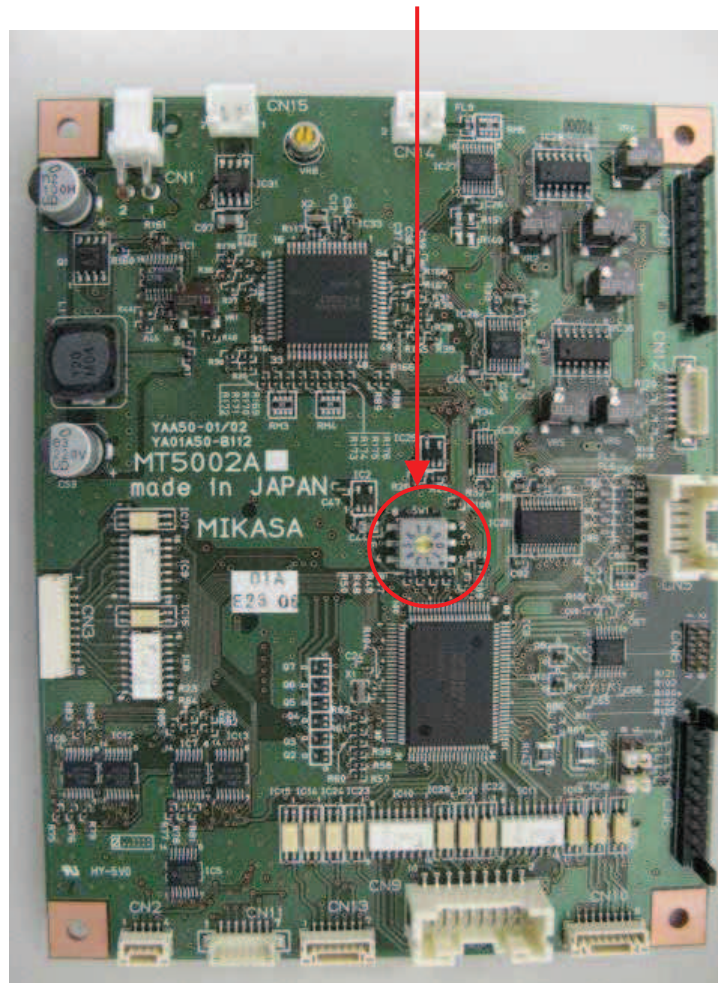
10.1 Exposure time adjustment

	<p>CAUTION: This adjustment has to done after connecting all connectors completely. Actual x-ray exposure is necessary. This adjustment requires that an exposure be made. Please observe all radiation related safety precautions.</p>
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Check the exposure time by using an external exposure time meter such as the VICTOREEN NERO.

The adjustment of the exposure timer is done with the Rotary Switch (SW1) on the MT5002A board. When SW1 is No.1, an exposure time gets long 0.005 sec for all settings.

※Turn off a power of unit when you change **SW1**.

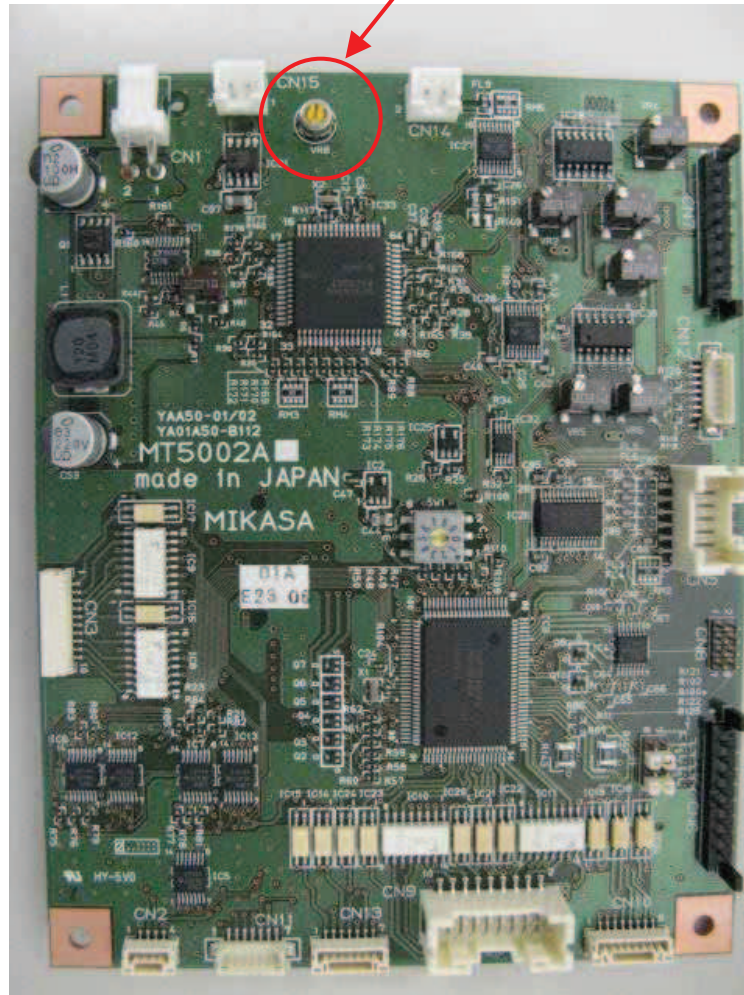


No.	1	2	3	4	5	6	7	8	9	10
Additional time (msec)	5	6	7	8	9	10	11	12	13	14

10.2 The buzzer volume adjustment

Turning clockwise increase the volume.

※Turn off a power of unit when you change **VR8**.



11. ERROR CODE

11.1. The following Error Code is displayed on kV indicator in approximate 10 seconds. This meaning is described in the following cause. If the following is displayed, read the contents 11 (TROUBLESHOOTING).

kV indicator	Error	Cause
P00	X-ray Exposure Error	If the exposure switch is released before the set exposure time, this code is displayed.
P01	X-ray tube Over Voltage	If EP voltage exceeds OVP voltage (MT2005A: VR1) of x-ray tube, this code is displayed.
P02	X-ray tube Over Current	If IP voltage exceeds OCP voltage (MT2005A: VR2) of x-ray tube, this code is displayed.
P03	Filament Over Current	If filament voltage exceeds OCP voltage (MT2005A: VR3) of filament, this code is displayed.
P11	Flat Battery	If the battery is empty, this code is displayed.

11.2. The following Error Code is displayed on kV indicator in approximate 10 seconds. This meaning is described in the following cause. If the following is displayed, read the contents 11 (TROUBLESHOOTING).

kV indicator	Cause
E01	No reply to be detected RX_COM assert for some time after detecting RX_REQ assert.
E02	Detect RX_COM assert before RX_REQ assert.
E03	Detect RX_COM negate during X-ray exposure.
E04	The connection is canceled during X-RAY exposure.
E05	No reply to be detected RX_COM negate for some time after X-ray exposure.

11.3. The following Error Code is displayed on kV indicator or sec / mAs indicator in approximate 10 seconds. This meaning is described in the following cause. If the following is displayed, read the contents 11 (TROUBLESHOOTING).

kV indicator	sec / mAs indicator	Error	Cause
ESB	1	Secondary CPU Error	Detect over time of X-ray.
ESB	2		Detect kV ref voltage error.
ESB	3		Detect mA ref voltage error.
ESB	4		Detect time out of INIT command during starting up.
ESB	5		Detect non-regulated of INIT command during starting up.
ESB	10		Detect monitoring unfair time of X-ray monitoring timer setting command.
ESB	20		Detect a reading error of kV ref voltage in A/D converter.
ESB	21		Detect a reading error of mA ref voltage in A/D converter.
ESB	999		Detect undefined command.

11.4. The following Error Code is displayed on sec LED and mAs LED. If the following is displayed, read the contents 11 (TROUBLESHOOTING).

- a) If Secondary CPU is broken, both of mAs LED and sec LED are lit.
- b) If incorrect signal goes from Secondary CPU, mAs LED and sec LED are lit alternately.

12. TROUBLESHOOTING

12.1. Symptoms including Error code

This x-ray unit has self-diagnostic indications of failure or malfunction. If the following **Error Code** is display or any other unusual conditions on control panel occur, release EXPOSURE SWITCH and stop exposing. Follow the Inspection work described below. The unit has malfunctioned and x-ray cannot be generated.



CAUTION: If any of the following symptoms occur, please take the following precautions.

1. Allow 10 seconds after turning off the unit before removing battery.
2. After removal, allow at least 30 seconds before reinserting and performing **Countermeasure (s)**.
3. If the Error Code remains on and the following symptoms happened again, contact Mikasa.

SYMPTOM : Error Code is displayed P01 – P03

Inspection work

- 1) “Spontaneous shutdown” or Error Code P01 may occur due to unusual discharge from the X-ray tube.
- 2) The adjusted values of OVP and OCP are out of range.

Countermeasure (s):

- a) Refer to the contents 12.2 “SYMPTOM: Occasionally, “spontaneous shutdown”, “Error Code P01”, or “popping” sounds occur.”” and “SYMPTOM: The unit cannot be turned off”.
- b) Check all connectors whether they are connected completely.
- c) Check the OVP and OCP value (VR1-VR3) on MT2005C.
- d) Check some components on the PC boards (MT1002A, MT2005C and MT5002A) whether they are defective. If the symptom still occurs, contact Mikasa.

SYMPTOM : Error Code is displayed P00

Inspection work :

- 1) Check whether the exposure switch was pressed until the end of exposure time.
- 2) Check exposure switch whether it is defective.
- 3) Check code of exposure switch whether it is connected properly.

Countermeasure (s):

- a) If exposure switch is broken, exchange it. If the symptom still occurs, contact Mikasa.

SYMPTOM : Error Code is displayed P11

Inspection work :

- 1) Check the battery to see if it is defective.
- 2) Check some components on the PC boards (MT2005C and MT5002A) whether they are defective.

Countermeasure (s):

- a) Recharge the battery.
- b) If some PC boards are broken, exchange them. If the symptom still occurs, contact Mikasa.

SYMPTOM : Error Code is displayed E01 – E05

Inspection work :

- 1) If DR system is used, check DR connectors whether they are connected properly.
- 2) Check components on the PC board (MT5002A) whether they are defective.

Countermeasure (s):

- a) Make sure DR system is working properly again.
- b) This symptom may indicate a failure of the primary CPU. So, exchange the PC board (MT5002A). If the symptom still occurs, contact Mikasa.

SYMPTOM : Error Code is displayed ESB 1 – ESB 5, ESB 10, ESB 20 ESB 21, ESB 999

Inspection work :

- 1) Check all connectors whether they are connected properly.
- 2) Check component on the PC board (MT5002A) whether they are defective.

Countermeasure (s):

- a) This symptom may indicate a failure of the secondary CPU. So, exchange the PC board (MT5002A).). If the symptom still occurs, contact Mikasa.

SYMPTOM : Both of mAs LED and sec LED are lit./ mAs LED and sec LED is lit alternately.

Inspection work :

- 1) Check components on the PC board (MT5002A) whether they are defective.

Countermeasure (s):

- a) This symptom may indicate a failure of the secondary CPU. So, exchange the PC board (MT5002A). If the symptom still occurs, contact Mikasa.

SYMPTOM : Control panel display does not illuminate.

Inspection work :


- 1) Refer to the contents 12.2 “SYMPTOM: The unit cannot be turned on”.
- 2) Check all connectors whether they are connected properly.
- 3) Check some components on PC board (MT1002A, MT2005C, MT4003B, MT5002A and MT6001A or B) whether they are defective.
- 4) Check components on DC power supply (HBQ12R180) whether they are defective.
- 5) Check the battery whether they are defective.

Countermeasure (s):

- a) If some PC boards are broken, exchange them.
- b) If fuse of MT2005C is broken, remove defective fuses, and replace to new one.
- c) Exchange the DC power supply (HBQ12R180).
- d) Exchange the new battery. If the symptom still occurs, contact Mikasa.

12.2. Symptoms not including Error code

If unit performance is compromised please refer to the checkpoints described below.

	<p>CAUTION: If any of the following symptoms occur, please take the following precautions.</p> <ol style="list-style-type: none">1. Allow 10 seconds after turning off the unit before removing battery.2. After removal, allow at least 30 seconds before reinserting and performing Countermeasure (s).3. Do not touch the connecting pins on the “pin block” of the battery.
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SYMPTOM : The battery cannot be inserted into the unit.

Checkpoints :

- 1) Was equal pressure applied on the left and right sides in the marked places?
- 2) Check for any dust, foreign substances or damaged connection pins on the “pin block”?

Countermeasure (s):

- a) Refer to the contents 7.1 “Operation – 1” in the instruction manual.
- b) Ensure connection pins are clean (refer to the contents 11.1 “Battery Best Practice - e. CAUTION”). If connection pins appear to be damaged, do not attempt to repair yourself for safety reasons, and contact Mikasa.

SYMPTOM : The battery cannot be inserted into the battery charger.

Checkpoints :

- 1) Was the battery charger vertically inserted into the battery?
- 2) Check for any dust, foreign substances or damaged connection pins on the “pin block”?

Countermeasure (s):

- a) Regarding how to insert battery charger (refer to the contents 11.3 “Charging the Battery –3” in the instruction manual).
- b) Ensure connection pins are clean (refer to the contents 11.1 “Battery Best Practice e. CAUTION”). If connection pins appear to be damaged, replace the battery.

SYMPTOM : Battery flap cannot be closed or opened.

Checkpoints :

- 1) Were the connector pins properly aligned and was the battery fully inserted?
- 2) Has the Clip pinhead worn down?
- 3) Has hinge rod fallen out? Has hinge rod shifted from the center?

Countermeasure (s):

- a) Refer to the contents 7.1 “Operation – 1” and 11.3 “Charging the Battery – 1” in the instruction manual.
- b) Replace it.
- c) It is necessary to disassemble the unit. Refer to the “Disassembling for TRB9020V – 7” in the Disassembling/Assembling Procedures.

SYMPTOM : When inserting the battery, the indicators were displayed or the buzzer sounded without turning on.

Checkpoints :

- 1) Did you wait for at least 30 seconds after removing and before re inserting the battery?
- 2) The battery was equally pressed on the left and right sides in the marked places?

Countermeasure (s):

- a) After removal, allow at least 30 seconds before reinserting the battery.
- b) Refer to the contents 7.1 “Operation –1” in the instruction manual.

SYMPTOM : When removing the battery, the indicators was displayed or the buzzer sounded.

Checkpoints :

- 1) After all of the indicators turns off with turning off, was the battery removed after at least 10 seconds?
- 2) The battery was removed with placing thumb in correct position marked?

Countermeasure (s):

- a) Refer to the contents 11.3 “Charging the Battery-1” in the instruction manual.
- b) Refer to the contents 11.3 “Charging the Battery-1” in the instruction manual.

SYMPTOM : Occasionally, “spontaneous shutdown”, “Error Code P01”, or “popping” sounds occur.

Checkpoints :

- 1) Were the warm-up procedures followed at the beginning of each day before using?
- 2) Was the duty cycle of (For example, 1 sec exposure needs 60 sec break.) exceeded?
- 3) Was the unit used under the environmental conditions for use?

Countermeasure (s):

- a) Refer to the contents 6.4 “Warming Up” in the instruction manual.
- b) Refer to the contents 7.1 “Operation –12” in the instruction manual.
- c) Refer to the contents 6.2 “Environmental Conditions For Use” in the instruction manual.

Note: Occasionally “spontaneous shutdown” or Error Code P01 may occur. This is an automatic safety function to protect the unit. To continue using the X-ray unit, turn on the main power switch again. If the unit can not be turned on, remove the battery and wait at least 30 seconds, then turn on the main power switch again.

SYMPTOM : The unit cannot be turned on.

Checkpoints :

- 1) Has the battery been inserted and removed correctly?
- 2) Was the battery power level low?
- 3) Prior to this symptom, did “spontaneous shutdown” or “Error Code P01” occur?
- 4) Has the battery overheated? (There is an automatic safety shutdown function to protect the unit)

Countermeasure (s):

- a) Refer to the contents 7.1 “Operation –1” and 11.3 “Charging the Battery –1” in the instruction manual, remove battery then reinsert. (If unit has just been turned off, allow 10 seconds before removing battery then wait for a further 30 seconds before reinserting.)
- b) If the Error Code P11 was displayed, recharge battery.
- c) Refer to the contents 7.1 “Operation – 1” in the instruction manual, remove battery then reinsert. (If unit has just been turned off, allow 10 seconds before removing battery then wait for a further 30 seconds before reinserting.)
- d) If the battery overheats, remove battery and let it cool. Then recharge the battery.

Note: If the symptom still occurs after the above 4 countermeasures, the battery and/or the unit may be faulty. First, check the battery using a battery checker. If the battery condition is normal and you have a spare unit, insert the normal battery into the spare unit to check the condition of the unit. If the symptom still occurs, please also check the following 3 items:

- 1) Check all connections are properly connected.
- 2) If some PC boards (MT1002A, MT2005C, MT5002A, MT6001A or B and the DC power supply HBQ12R180 on the MT4003B) are broken they must be replaced.
- 3) If the fuse of MT2005A is broken, it must be replaced with a new one.

SYMPTOM : The unit cannot be turned off.

Checkpoints :

- 1) Was the main power switch depressed for one second?

Countermeasure (s):

- a) Refer to the contents 7.1 “Operation – 13” in the instruction manual.

SYMPTOM : No/Weak X-ray image.

Checkpoints :

- 1) Was the unit used under the correct Environmental Conditions For Use?
- 2) Were there any problems with related devices?

Countermeasure (s):

- a) Refer to the contents 6.2 “Environmental Conditions For Use” in the instruction manual.
- b) Check the conditions of the related devices.

SYMPTOM : The battery level dropped quickly.

Checkpoints :

- 1) Was the battery fully charged?
- 2) Was the unit used under the correct Environmental Conditions For Use?
- 3) Have you experienced this before? Did you interrupt charging before battery was fully charged? (The battery cells may be damaged due to “inrush” current has entered the empty battery cells).

Countermeasure (s):

- a) Remove battery, charge fully, then reinsert.
- b) Refer to the contents 6.2 “Environmental Conditions For Use” in the instruction manual.
- c) Replacing with a new battery is recommended.

SYMPTOM : Unit could not generate X-ray even when battery level indicator showed “1 STEP”

Checkpoints :

- 1) Has the unit been used at “1 STEP” on the battery level indicator for a while?
- 2) Was the unit used under the correct Environmental Conditions For Use?

Countermeasure (s):

- a) Refer to the contents 5.2 “Functions ①” in the instruction manual.
- b) Refer to the contents 6.2 “Environmental Conditions For Use” in the instruction manual.

SYMPTOM : The battery cannot be charged.

Checkpoints :

- 1) Was the AC adaptor plugged to a wall outlet correctly? Were all connections correctly plugged in?
- 2) Was there any damage to the AC&DC power cables?
- 3) Were any other battery chargers or AC Adaptors used?
- 4) Was the battery charger inserted into the battery correctly?
- 5) Was the charging performed under the correct environmental conditions for use?

Countermeasure (s):

- a) Disconnect in the following order. Unplug AC cord from a wall outlet, remove battery from charger, unplug AC cord from AC adapter and unplug DC cord from battery charger. Then try to charge the battery again.
- b) Replace the cables.
- c) Refer to the contents 11.1 “Battery Best Practice: WARNING” in the instruction manual.
- d) Refer to the contents 11.3 “Charging the Battery –3” in the instruction manual.
- e) Refer to the contents 6.2 “Environmental Conditions For Use” in the instruction manual.

SYMPTOM : The Battery charging cannot be completed.

Checkpoints :

- 1) Has the battery been inserted into the battery charger correctly?
- 2) Was charging performed under the environmental conditions for charging?

Countermeasure (s):

- a) Check if the AC and DC cables have any damage.
- b) Confirm the correct environmental conditions (between 50°F/10°C and 104°F/40°C). Refer to the contents 11.3 “Charging the Battery –3” and 12.2 “Battery” in the instruction manual.

SYMPTOM : Exposure switch does not work properly.

Checkpoints :

- 1) Has the Exposure switch cable plug been inserted into the DR connector by mistake? (This could cause damage to each pin of the DR connector.)

Countermeasure (s):

- a) Try to insert the DR cable into the DR connector to re-align the pins.