

SERVICE MANUAL

(Version 03)

High-end Video Processor
PENTAX EPK-i



PENTAX

Medical Instrument Division / Service Technical Group

MNL-045-03 / May 16, 2008

< CONTENTS >

1. Specifications	Page 1
2. General explanations Feature	Page 2
3. Functions	Page 3
4. Configuration (Main parts)	Page 6
5. Precaution	Page 7
6. Service	Page 8
6.1 Lamp block	
6.2 Pump	Page 10
6.3 Iris	Page 13
6.4 Peripheral Board (G700)	Page 14
6.5 Process Board (H700)	Page 15
7. Electrical safety test	Page 18
7.1 Dielectric strength test	
7.2 Protective GNDing wire resistance	
7.3 Leakage current test	Page 19
8. Trouble shooting	Page 20
9. Wiring Diagram	Page 21
Appendix – Exploded view Parts list	

Notes for using this Service Manual

- 1) Up-date of Service Manual will be notified by such information as Notice of Modification, Service Note and so on.*
- 2) When you start repair servicing, be sure to leave service records.*
- 3) This Service Manual voids preceding "New Product Repair Guide" for the same model, if any.*
- 4) Upon request, PENTAX will provide qualified service personnel with further information to service this product provided that the requested information needed within the range of servicing described in this Service manual.*

1. Specifications

Item	Description	Specification		
		120V model	230V model	
Video system		NTSC	PAL	
Power requirement	Voltage	120VAC	230VAC	
	Frequency	50 - 60Hz		
	Power consumption	Less than 5.4A	Less than 2.8A	
	Voltage fluctuation	+/-10%		
Operation environment	Temperature	10 – 40		
	Relative humidity	30 – 85 %		
	Atmospheric pressure	700 –1060 hPa		
Storage environment	Temperature	-20 – 60		
	Relative humidity	0 – 95 %		
	Atmospheric pressure	700 – 1060 hPa		
Illumination	Lamp	300W Xenon lamp		
	Lamp average life span	Continuous use, Average 500 hours		
	Color temperature	6,000K		
	Iris control	Automatic / Manual		
	Brightness control	Adjustable by +/- 5 steps each		
	Auxiliary lamp	3W White LED (IEC60825-1)		
Scope compatibility		PENTAX Color Video Endoscope i-series and K-series (K-series with Y/C output)		
Color correction		Red and Blue each adjustable by +/- 5 steps each		
White balance		Adjustable automatically with “White Bal” button		
Video signal	DVI-D, DVI-A	DVI x 1 terminal (either DVI-D or DVI-A is assigned)		
	RGBS output	9pin D-sub x 2		
	Y/C output	S terminal x 2		
	Composite video output	BNC connector x 1		
	DV output	DV terminal x 1		
	Printer output	N. A.	9pin D-subx1, S terminal x1	
	Analog input	BNC connector x1	S terminal x1, BNC connector x1	
Digital output	Serial output	USB A terminal (Female) x 2 (for memory, printer)		
	LAN	RJ45 terminal x 1		
Audio input	Analog input	Stereo mini plug x 1		
Control signal	RS-232c	9pin D-sub x 1		
	Remote	Stereo mini plug x 3		
	Keyboard	6-pin Mini-DIN x1 (exclusive or ordinary PC keyboard)		
	Footswitch	4pin Bayonet lock type(Female) x 1		
	Water feeder (SA-P2)	4pin Bayonet lock type(Female) x 1		
	Sync signal (Y signal)	BNC connector x 1		
Air feeding	Control	On / Off, Air flow volumes are selectable in 5 steps Level 1: 2.0 – 2.8 L/min. Level 2: 2.9 – 3.4 L/min. Level 3: 3.5. – 4.0 L/min. Level 4: 4.1 – 4.5 L/min. Level 5: 4.6 – 7.2 L/min.		
	Air pressure	45 – 70 KPa		
LCD touch screen	Display	6.4 inch TFT		
	Touch screen	Pressure-sensitive type		
Classification electro medical equipment	Electric shock protection	Class – I		
	Degree of protection	BF type		
	Degree of explosion proofing	Do not use in potentially flammable surroundings.		
Electromagnetic Interference	Electromagnetic compatibility	Complied with IEC60601-1-2 Class B		
	Harmonic current emissions	Complied with IEC60601-3-2 Class A		
Medical electrical equipment general requirement for safety		UL60601-1	IEC60601-1	
Size	Dimensions	430mm (W) x 485mm (D) x 205mm (H)		
Weight	Main body	26.5Kg		

Table-1 Specifications

2. General explanations

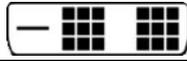
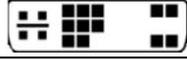
The PENTAX *EPK-i* is a high-end Video Processor, which produces High Definition images with a specially developed scope "Mega Scope 90i". Several image processing methods (advanced enhancement, etc.) that help the user observe precisely and easily have been introduced. At the same time, the *EPK-i* keeps compatibilities with the former K-series scopes (Y/C signal type). To obtain stiller frozen images, a mechanical structure (rotary shutter etc.) has been built in. A user-friendly manner has been established with several new devices.

Features

- 1) **High Definition image**> High Definition images can be created with "Mega Scope 90i" which has a mega pixel CCD. The 90i scope provides the image data in digital signal to the EPK-i. The EPK-i can process the image signal without converting the analog signal. The EPK-i has a DVI (Digital Visual Interface) output port. Therefore non deteriorated image can be seen on the PENTAX LCD monitor (when "DVI-D" port of the monitor is used. / For analog signal, "VGA" port is also available on the monitor). The DVI port can provide either DVI (digital signal) or VGA (analog signal) depending on "DVI Output" setting of the system (refer to the Owner's Manual). The default setting is "VGA". When the full digital environment is used, "DVI Output" must be set to "DVI". Otherwise the image will not appear on the monitor.

Note: PENTAX LCD monitor will be launched soon.

A summary for the monitor connector, exclusive cable and "DVI Output" setting are shown in the table below:

Connector on LCD monitor	Connector of cable	DVI Output setting
DVI-D		DVI
VGA		VGA

Note: The connectors shown in the table are male.

Because DVI signal is very fast, the DVI cable is limited to 3m. With a longer cable, the image becomes noisy as opposed to the image on the analog CRT monitor becoming darker with an analog longer cable.

- 2) **Advanced Enhancement**> In addition to the ordinary image enhancement (Edge enhancement), Surface Enhancement and Contrast Enhancement are available. Both enhancement modes cannot be used simultaneously. The other one will be disabled.
- 3) **Still and Fine Freeze**> Thanks for the progressive scan method on the mega pixel CCD and the rotary shutter of the EPK-i, stiller and finer images can be captured. Because of the progressive scanning the captured image is real as opposed to the compensated or interpolated image from the field scanning. The finer image is attributed to the progressive scanning. Meanwhile the rotary shutter controls the exposure time. The shorter the exposure time is, the stiller the frozen image becomes. However as the side effect the image becomes darker. Together with the ordinary iris, the rotary shutter controls the exposure time as short as possible and so that the luminance becomes enough for the acceptably brighter and stiller image. During the progressive scan, the next light comes through the hole of the rotary shutter. Thus another mechanical shutter interrupts the light. This shutter is driven by a solenoid motor and momentarily closes. As a result of the stiller freeze, mechanical parts are increased. However no adjustment or it is easy if any.
- 4) **LCD Touch panel**>As an operational panel, an LCD touch screen panel has been introduced. The EPK-i has a single board computer inside. Thus it takes about one and half minutes by the LCD touch panel is ready for the operation. The LCD touch panel reacts by pressure, which is a sensitive device. Do not operate it with a sharp edge. The lamp, pump and white balance switches are independent from the single board computer. It means the lamp can be turned on and the pump works with level-1 before the system has been up and running. The LCD touch screen has a function that an image put from "VIDEO IN" port is displayed.
- 5) **SA-P2 port**>The exclusive port for the water jet supplier SA-P2 is available on the back panel of the EPK-i. When the scope button or the foot switch assigned with function "WJ" is pressed, an open-collector, active-low signal is sent to the SA-P2 to turn on and off.
- 6) **Lamp**>The lamp (300W xenon lamp) can be replaced by a lamp cartridge (OL-X25) by the user (refer to the Owner's Manual). The door of the lamp house can be opened without any special tool. This door activates the interlock switch for AC power of the unit when it is completely closed. The lamp cartridge consists of the lamp, two heat sinks and IR cut filter. Trained service engineers are allowed to replace the lamp itself (The Service manual for the EPK-i will be issued soon. Please refer to it in detail).

- 7) **Pump**>Air feed volume can be changed in five levels with the touch screen panel. The air feed volumes of each level are set with the special Set up menu (It is a hidden menu to customers). When the peripheral board (G700) is replaced for the pump function repair, the former setting value can be reused without measuring the air feed volume with an air flow meter. When the pump is replaced, the air feed volumes of each level will be adjusted with the menu by measuring the air feed volume with the air flow meter. The peripheral board is attached with a small tube from the pump. It has been prepared for the precise air feed control, however it is not currently working. But if it is detached, the air must leak at this point. As a result, the air won't be fed from the air outlet.
- 8) **Auxiliary lamp**>3W white light LED has been introduced as an auxiliary lamp. When the main lamp ignition failure continues for about 8 seconds, the auxiliary lamp automatically comes into the light axis by the solenoid motor.
- 9) **DC Power supply for patient circuit**>The DC power supply unit for the patient circuit exists independently from the DC power supply unit for the secondary circuits. However the input of the DC power supply unit for the patient circuit is connected to the DC output of the DC power supply unit for the secondary circuits. The reason why the DC power supply units individually exist is just due to limited spaces of the EPK-i unit inside.
- 10) **Lamp power supply unit**>The main unit and the igniter exist individually. Of course they are connected each other. However they can be treated as a spare part independently.
- 11) **Scope detector**>A limit switch has been attached just beside the scope connector assembly. When the scope handle is turned clockwise to lock the scope connector, the switch is activated and the system recognizes that the scope has been connected completely.
- 12) **Processor ID**>The processor model name "EPK-i" and its serial number have been stored as ID. These information must be necessary for the LAN environment.
- 13) **Serial and LAN port**>Using an USB memory device or LAN, system modification can be done easily.
- 14) **XLUM and Manual mode**>Both modes act as an iris manual mode. On the basis of the concepts that "XLUM" is for confirming the location of the scope distal tip and "Manual" is for observing the specific parts in vivo in iris manual mode, these modes are available independently.

3. Functions

1) Preprocess Board (J700)

- 1)-1 Image signal processing> Because the EPK-i can accept all types of the K-series scopes, Preprocess board has a function that can process the three kinds of the image signals such as R-Y/B-Y color differential signal (old 30/40 series), Y/C signal (30/40 or 70/80 series) and LVDS signals (90K and 90i series).
 - R-Y/B-Y and Y/C signals (analog) are converted into 10 bit YUV signal with the video decoder/ADC (U16).
 - The 20 bit YUV signal is sent to the FPGA (U23) and converted into 12 bit YCbCr signal.
 - Finally the 12 bit YCbCr signal is sent to Process board (H700) through the connector CN13 on Mother board(E700).
 - As for LVDS signal, DO+/DO- (LVDS: Low Voltage Differential Signal) is sent to the serializer/deserializer (U42) to be serialized into 12 bit (90i scope) or 8 bit (90K scope) LVDS signal.
 - The LVDS signal is sent to the also the FPGA (U23) to be converted into 12 bit YCbCr signal.
 - Finally the 12 bit YCbCr signal is sent to Process board (H700) through the connector (CN13) on Mother board(E700) as well.
 - With 90i scope, the white balance is adjusted with the FPGA (U23). With the other scopes, the white balance is adjusted with the control board in the scope.
- 1)-2 Iris signal> Depending on a scope, there are three kinds of signals from the scope that is used for the iris control – "YIRIS" (90K scope), "Yout" (30/40, 70/80K scope) and "DO+/DO-" (90i scope). And there are two types of processing the iris control signals.
 - "YIRIS" or "Yout" signal is converted into 12 bit iris control signal with the AD converter (U56).
 - "DO+/DO-" is converter into 12 bit iris control signal with the FPGA (U23).
 - Both converted signals are sent to Peripheral board (G700) through the connector (CN13) on Mother board (E700).
- 1)-3 Patient circuit> Because Preprocess board that is directly connected to the scope exchanges signals with the scope, it has digital isolators that divides Preprocess board into the patient circuit and the ordinary circuit.

2) Process Board (H700)

- 2)-1 Image signal processing>This board receives 12 bit YCbCr signal from Preprocess board (J700) through Mother board (E700).

- The 12 bit YCbCr signal is processed by enhancing or changing color with the front panel operation with the FPGA (U2).
 - The processed YCbCr image signal is converted in to 10 bit RGB signal with the DSP (U2), and sent to the FPGA (U39).
 - The 10 bit RGB signal is sent to Video process board (I700) through the connector (CN8) on Mother board (E700) after gamma compensation with the FPGA (U39).
 - Meanwhile the same 10 bit RGB signal is converted into 8 bit RGB signal with the FPGA (U39).
 - The 8 bit RGB signal is sent to the digital display processor (U51) to be superimposed with characters.
 - The 8 bit RGB signal with characters is sent to the two ways. One is to the panel link transmitter (U56) to be converted into the image signal for DVI. And the image signal for DVI is sent to I/O-1 board (L700) with the internal cable (B521).
 - The other one is sent to D/A converter (U59) to be converted into RGB analog signal for VGA. And the RGB analog signal is sent to I/O-1 board (L700) with the internal cable (B522).
 - The digital display processor (U51) has function to zoom up the image or to make a sub screen.
- 2)-2 Character generation>The FPGA (U2) handles the keyboard operation.
- The FPGA (U2) detects the character inputs and sends the instructions to the digital display processor (U51) to create the characters.
 - The digital display processor (U51) generates the characters and merges them to the image signal.
 - The fixedly displayed texts like "Age" are stored in the memories connected to the FPGA (U2). These texts are also merged to the image signal with the digital display processor (U51).
 - The FPGA (U2) also sends the instruction to the digital image processor on Video Board (I700) in order to create appropriate characters to meet the different display resolution.

3) Video Board (I700)

- 3)-1 Image signal processing-1>This board receives 10 bit RGB signal from Process board (H700) through Mother board (E700).
- The 10 bit RGB signal is converted into the 8 bit RGB signal and sent to the digital display processor (U100, 102) to be merged with characters.
 - The 8 bit RGB with characters is sent to the digital video encoder (U303) through the FPGA (U301) and encoded into RGB analog signal. Finally the signal is sent to the RGB port x2 on the back panel through I/O-1 board (L700).
 - Also the 8 bit RGB with characters is sent to the digital video encoder (U310) through the FPGA (U301) and encoded into Y/C analog signal. Finally the signal is sent to the Y/C port x2 on the back panel through I/O-1 board (L700).
 - The same 8 bit RGB signal with characters is corrected with the FPGA (U301) in order to meet the required printer color. The look-up-table in the FPGA (301) is used for the color compensation. The corrected RGB signal is converted into RGB and Y/C analog signal with the digital video encoder (U317 and U324) and sent to the RGB or Y/C printer port on the back panel through I/O-2 board (M700). *Note: This port is not available with 120V model.*
- 3)-2 Image signal processing-2>This board creates DV format image signal.
- The 10 bit RGB signal is converted into the 8 bit RGB signal and sent to the digital display processor (U100) to be merged with characters.
 - The 8 bit RGB with characters is sent to the DV encoder (U411) through the FPGA (U301) and encoded into DV signal. Finally the signal is sent to the DV port on the back panel through I/O-2 board (M700). Audio picked up by the microphone attached to "Audio IN" port on the back panel is converted into 4 bit digital signal and sent to the DV encoder (U411) to merge to the DV signal.
- 3)-3 Image signal processing-3>This board receives the outer video signal to superimpose it on the main image.
- Outer video image is accepted from "COMPOSITE-IN" port through I/O-2 board (M700).
 - The outer video signal is converted into 8 bit rec656 format signal with the video decoder (U208) and sent to the digital display processor (U100).
 - The outer video signal is processed as picture-in-picture data with the digital display processor (U100) and merged to the main image.

4) Peripheral Board (G700)

- 4)-1 Iris control> With every type of scope, the luminance signal is converted into the 12 bit iris signal on Preprocess board(J700).
- The 12 bit iris signal is sent to the FPGA (U19) to measure if the current iris position is adequate against the brightness set by the front panel.
 - The digital signal controller (U12) creates the iris reference signal (analog) by referring to the results measured with the FPGA (U19). The iris reference signal is sent to the iris analog circuit to control the iris.

- 4)-2 Rotary shutter control> To obtain a stiller frozen image, it is necessary to control an exposure time of light. It is accomplished by adjusting the hole on Rotary shutter (M4). The parts related to Rotary shutter consist of Rotary shutter (M4), Space motor (M6), Photo interrupter (PI1) and Shutter (M3). These are controlled with Peripheral Board (G700).
- 4)-3 Pump control> The pump control signal (Pump ON-OFF, Air flow level 1-5) are sent from the front panel to Peripheral Board (G700) through Process Board (H700) to turn the pump ON-OFF.
- The pump control signal is sent to the micro controller (U32) to turn the pump ON-OFF.
 - After the micro controller (U32), a part of the pump control signal is sent to the digital potentiometer to set the air flow level.
- 4)-4 Auxiliary lamp control> The lamp power supply unit sends the lamp failure signal to Peripheral Board (G700) when the lamp ignition fails or the main lamp turns off unexpectedly.
- The lamp failure signal from the lamp power supply unit is detected by Peripheral Board (G700) and sent to the FPGA (U19).
 - The FPGA (U19) sends signals to Auxiliary lamp to move its LED lamp into the light axis and turn on the LED lamp.
- 5) **SBC Board (F700 / SBC: Single Board Computer)**
- 5)-1 Touch Panel and LCD Display control> To control the capacitive type touch panel and manage the various operation buttons and menu tabs.
- 5)-2 USB Memory control> When the image is captured with the setting that the image output has been assigned to "SERIAL OUT1, 2" port, the captured image will be sent to the USB memory connected to the port.
- 5)-3 Patient Data management> To provide the graphical user interface for the patient data and store the data.
- 5)-4 Serial port control> To control the RS-232C port for "ENDONET" database software.
- 5)-5 LAN control> To control the port for a local area network.

4. Configuration (Main parts)

Covers for Card cage and Power supply are available

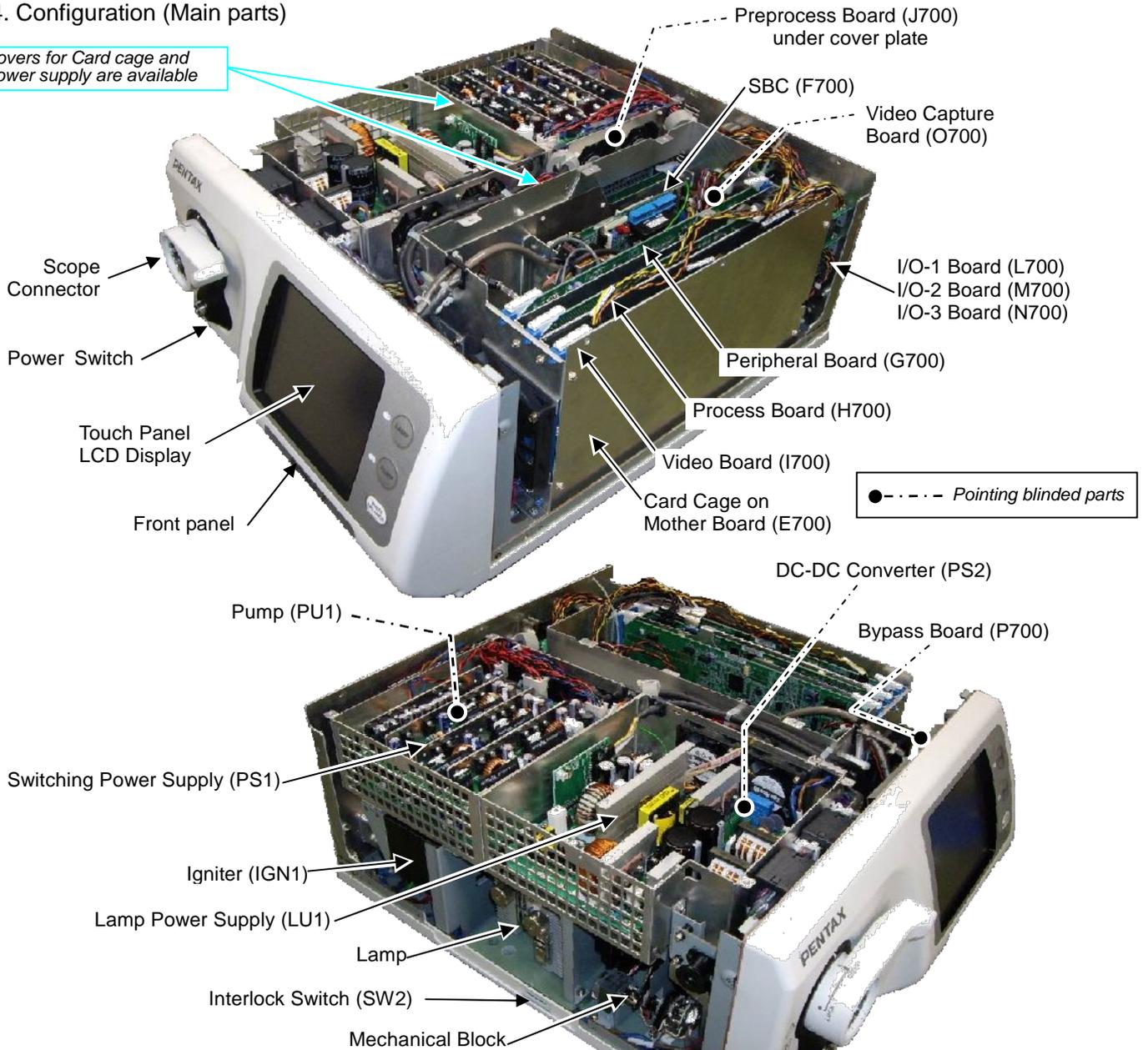


Photo-1 EPK-i Main parts

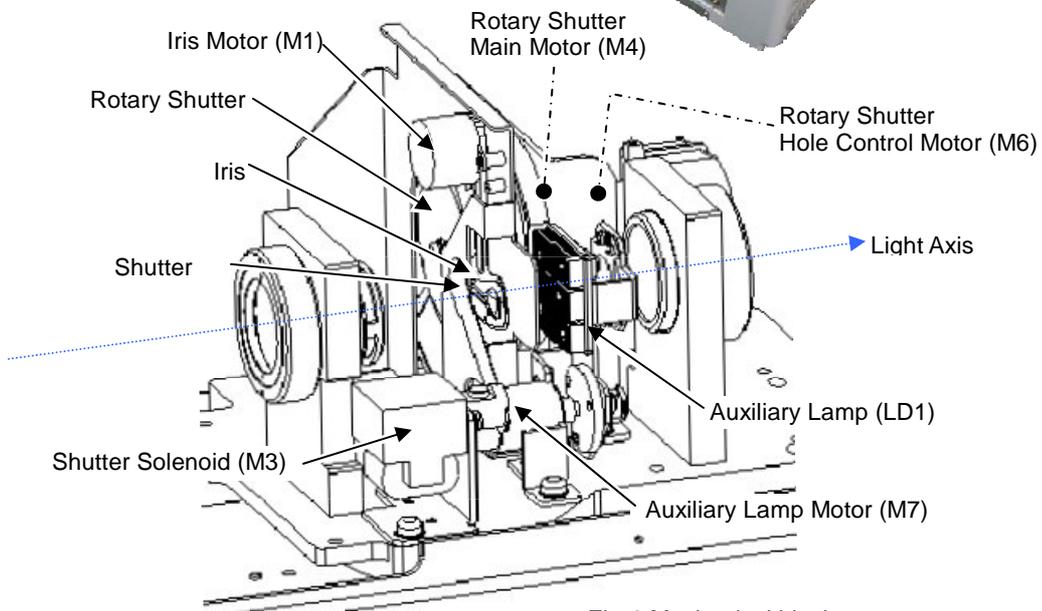


Fig-1 Mechanical block

5. Precaution - Important

1) General

You have to take utmost care to follow the general rules and practice for safety in servicing electrical medical equipment.

2) Power off before servicing

For electrical safety, make sure to disconnect the power cable before opening the cover.

3) Route of electrical wire

Be sure to keep the original routes of the electrical wires and the original positions of the cores.

Otherwise it may break the compatibility with the EMC regulation or may cause problems such as lamp ignition failure. You must put the wires back to the original routes after the maintenance. You should take photos of the wires and cores beforehand.

4) High temperature on the lamp

Just after turning off the lamp it may be hot. Be careful not to suffer heat injuries when replacing a lamp.

5) Electrostatic Discharge

To avoid damaging PCBs, wear anti-static protection such as a wristband and discharge the electrostatic charge before servicing.

6) Disassembling parts

The procedures of disassembling the mechanical and electrical parts are not described in detail in the service manual. Unless otherwise mentioned, detach from the outer parts to the inner parts or from the upper parts to the lower parts. In the case a special technique is necessary, it is described. You can refer to the exploded view pages as well.

7) Electrical safety test

Be sure to do the following tests when you did a repair by opening the cove, after putting back all of the disassembled parts and the cover to the original position. The procedures are described in following pages.

a) Dielectric strength test, b) Protective earthing circuit resistance, c) Leakage current test

6. Service

Note: Refer to Photo-1 for the location of the parts to be replaced. And also refer to appendix pages for wire routing.

6.1 Lamp block

A way of replacing the lamp bulb and reusing the heat sink is described below.

Important: 1) This job must be done by a person who has got the service training for the EPK-i.

2) The IR cut filter **cannot be reused**, must be **replaced** together with the lamp bulb. A spoiled filter may cause heat injury due to intensive light through the scope.

- 1) Take out the lamp block from the lamp house.
- 2) To detach the old lamp, unscrew the three screws and release the hook.
See Photo-2. Remove Front heat sink by rocking it.

Hint: It may be hard to detach Front heat sink and occasionally Filter ring comes off attaching on the lamp bulb. In this case, put Filter ring back to Front heat sink.

- 3) Replace the IR cut filter with a new one in the following order:
 - a) To remove Spring ring from the ditch in Filter ring, insert the tip of the thin screw driver into the hole of Filter ring and push the end of Spring ring toward the center a little bit and lift it by the tip of the screw driver. See Photo-3 left.

Hint: If the end of Spring ring is not located at the hole of Filter ring, rotate Spring ring by pressing the other end with a screw driver to be so.

Caution: 1) Do not apply excessive force to Spring ring when detaching it so as not to spoil it.

2) Spring ring may pop out when detaching it. Cover it by a palm.

- b) Replace IR cut filter with new one without tainting nor scratching it.
Hint: Confirm if IR cut filter has settled horizontally in Filter ring.
 - c) Pinch both ends of Spring ring (shown by coloring in red) with two pairs of tweezes and then put Spring ring into the ditch of Filter ring while narrowing the cut in Spring ring. See Photo-3 Right hand side.

Hint: The opposite part (shown by coloring in green) against the cut in Spring ring should be put into the ditch of Filter ring first and the rest of the ring will be put into the ditch subsequently.

Caution: Do not taint nor scratch IR cut filter while attaching Spring ring. If it is tainted, clean it carefully with isopropyl alcohol solution. If it is scratched, discard it.

- d) Confirm if IR cut filter and Spring ring have been attached correctly by waving Front heat sink. If a click sound can be heard from IR cut filter, it is **OK**. If not, do it from scratch.

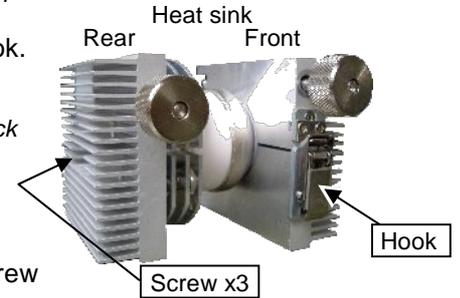


Photo-2 Lamp block

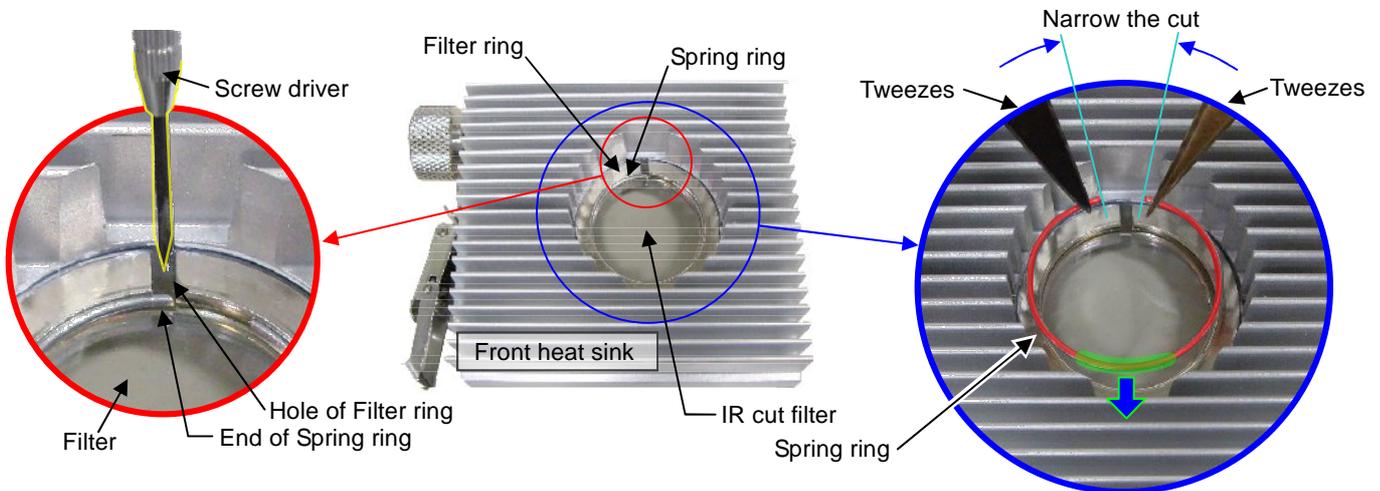


Photo-3 IR cut filter replacement

- 4) Apply heat sink grease (RM-3505) to the places on the new lamp bulb as shown in Fig-2 (Side, Bottom, Top side, Top inside, Filter ring inside). And assemble the lamp block in reverse order of 2).

Hint: When fixing Front heat sink, adjust its angle by rotating it so that the lamp cartridge does not rock on the flat top.

Caution: 1) Use only the lamp that PENTAX supplies, because PENTAX uses lamps that have a specific ignition property and luminance.

2) It is not good to apply too much heat sink grease. This may cause lamp ignition failure. Apply the grease so that the metal part can be seen under the grease.

3) When you apply grease, do not contaminate the top of the bulb and IR cut filter with the grease.

4) When you attach Front heat sink, pay attention to IR cut filter. Do not remove it. Do not contaminate it with a finger print and so on. Do not scratch it.

5) Filter ring has a hole. The hole must come up (See Fig-2 Right hand side).

6) Screw the three screws and fasten the hook firmly. Otherwise it may cause lamp ignition failure.

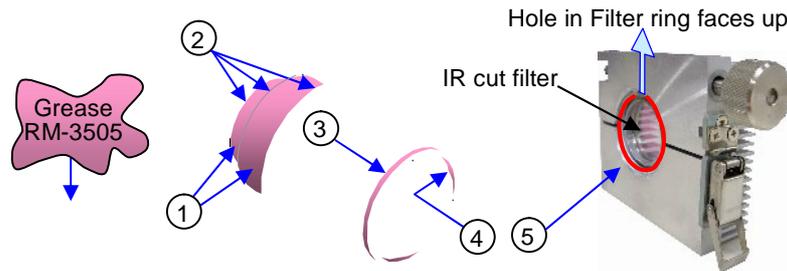


Fig-2 Places where heat sink grease applied

- 5) Attach the new lamp block firmly in the reverse order of above.

Note: If you perform a lamp replacement using a lamp block, procedures from 2) to 4) can be skipped.

- 6) Reset the lamp life meter with the following procedures a) to i).

a) Power on the EPK-i, press the "Menu" key of the exclusive keyboard to show the menu cabinet.

Note: The menu cabinet will appear on the monitor that has been selected with "SD Monitor" or "HD Monitor" of "Keyboard Menu Output" in the second page of the 3 pages of "System" operated with the touch panel.

b) Select "Setup" menu by pressing the left or right arrow key.

c) Select "Lamp Data" item by pressing the up or down arrow key.

d) Actuate "Lamp Data" menu by pressing the right arrow key.

e) Select "Life Count Time Reset" item by pressing the down arrow key.

f) Actuate "Life Count Time Reset" item by pressing the right arrow key.

g) Select "Yes" answer by pressing the up arrow key and press "Enter" key.

h) Answer "Life Count Time Reset. True?" by selecting "Yes" by pressing up arrow key and "Enter" key.

i) Press "Esc" key twice to exit the menu.

6.2 Pump

6.2.1 Pump replacement

- 1) The pump is located underneath Switching Power Supply (PS1). Thus you need to remove Switching Power Supply with the following procedures:
 - a) Remove Cove for power supply.
 - b) Remove Switching Power Supply by unscrewing the four screws and disconnecting the two connectors.
 - c) Remove Switching Power Supply Tray by unscrewing the three screws. Then the pump cover is visible.
- 2) Remove the pump cover by unscrewing the four screws.
- 3) Disconnect the pump cable from CN16 on Mother Board (E700).

Note: The rear panel should be removed for easy operation.
Caution: Do not detach another connector by mistake.
- 4) Disconnect the pump tube from Pump (PU1).
- 5) Remove Pump (PU1) by unscrewing the four screws.
- 6) Assemble the new pump in reverse order of above.

6.2.2 Pump air flow adjustment

<Equipment>

For the Pump air flow adjustment, the following equipment is necessary.

- 1) Air flow meter (8300MM-0-Rc1/4-Air-10SLM-1-1-00.1MPa <http://www.kofloc.co.jp/>)
- 2) Air pressure meter (Nagano Keiki GC-16-170-1000 <http://naganokeiki.co.jp>)

Note: Please order the meters with the complete model code shown above. And the air inlet adapter that meets ST-7022 will come with the meters.
- 3) Connecting tube (ST-7022)

<Procedures>

- 1) Attach the air flow meter to the air outlet using the tube ST-7022 (Refer to Photo-4).

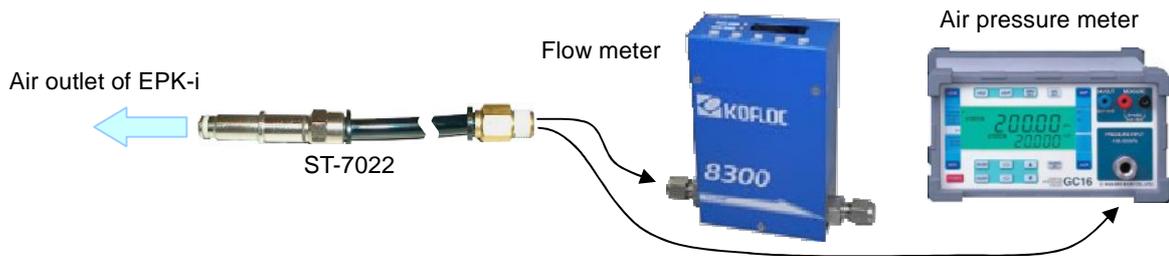


Photo-4 Air flow & pressure meter

- 2) Turn on the EPK-i and wait until the system is ready. Then tap “Set up” button on the touch panel (Refer to Photo-5 Left).
- 3) Tap “Printer” button on the next screen (Refer to Photo-5 Middle).
- 4) Tap the place “A” three times and then tap the place “B” twice on the next screen (Refer to Photo-5 Right).



Photo-5 Touch panel operation

5) Confirm if the touch panel has changed in the next screen as shown in Photo-6 Left.

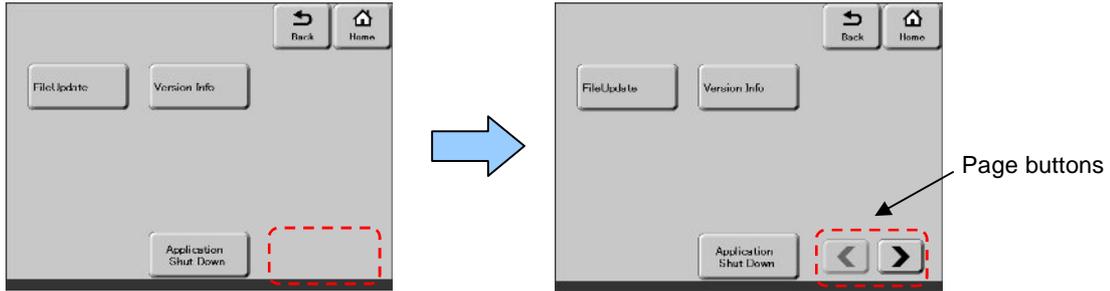


Photo-6 Jig mode on touch screen

6) Enter key command “Ctrl+Alt+Contrast enhance” (with the ordinary keyboard, “Ctrl+Alt+F7”) to show “PASSWORD?” prompt on the CRT monitor (Refer to Photo-7).



Photo-7 Password operation

7) Answer “PASSWORD?” with the password “excalibur” (Refer to Photo-7). And the page button “<” and “>” appear on the touch screen (Refer to Photo-6 Right).

Important: Please share the password between the persons only who have been qualified for servicing with the service training. Please keep it secret to customers.

8) Tap the page button “>” to call “Processor Adjust Menu” on the touch screen (Refer to Photo-8).

9) Tap “Pump Level” button (Refer to Photo-8) to call “Pump Level Adjustment” screen (Refer to Photo-9).

- 10) Select “Level-1” by tapping the level select button (Level 1 to 5) and adjust the air flow by tapping the adjusting buttons so that the measuring value attains to the defined value shown in Table-2 below. Adjust all of the levels with the same methods.

Note: 1) The selected level button turns in yellow.

2) It is not necessary to turn on the pump. When the level is selected with the level select button and the value is changed with the adjusting button, the pump turns on automatically.

3) Just after selecting another level, the selected level has not been actuated. Its value is changed, then the selected level is actuated.

Level	Air flow(L/min)	Tolerance(L/min)
1	2.50	+/-0.10
2	3.10	
3	3.70	
4	4.30	
5	5.40	

Table-2 Air flow rate

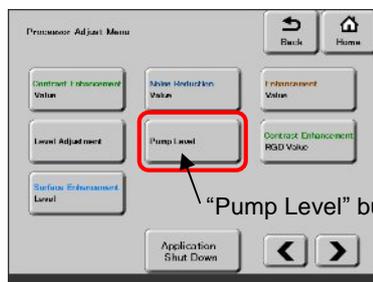


Photo-8 Processor Adjust Menu

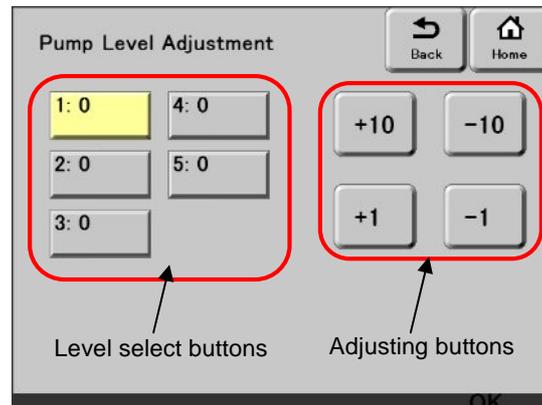


Photo-9 Pump Level Adjustment

- 11) Detach the air flow meter and attach the air pressure meter to the EPK-i (Refer to Photo-4).

- 12) Select “Level-1” and record the adjusted value and the measured air pressure value.

Note: It would be about 50KPa.

- 13) Record all of the levels with the same methods.

- 14) Tap “Home” button to exit “Processor Adjust Menu”.

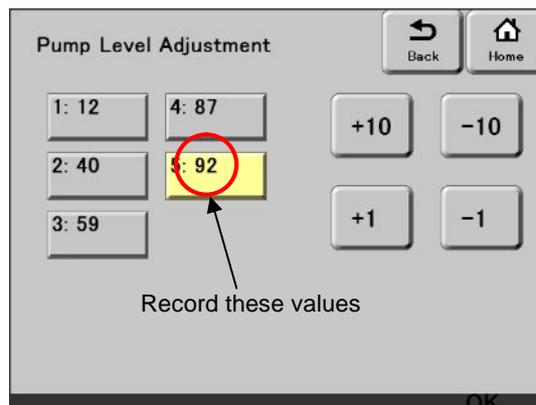


Photo-10 Adjusted values

6.3 Iris

6.3.1 Iris replacement

- 1) The iris unit is located underneath Lamp Power Supply (LU1). Thus you need to remove Lamp Power Supply first with the following procedures:
 - a) Remove Cove for power supply.
 - b) Remove Lamp Power Supply (LU1).
 - c) Remove Lamp Power Supply Tray by unscrewing the three screws. Then the iris unit is visible.
- 2) Remove the front panel by removing the scope connector handle first. And it is easy to access the iris wire connector CN32 on Mother Board (E700).
- 3) Remove the iris unit.
- 4) Attach the new iris unit in reverse order of above.

6.3.2 Iris position adjustment

<Equipment>

For the iris position adjustment, the following equipment is necessary.

- 1) Extension card (ST-5031)
- 2) Iris positioning jig (ST-5503)

Note: Iris positioning jig has two sides. One is for adjusting the iris close position and the other is for adjusting the iris open position (Refer to Photo-11). To be held due to plungers on it.

- 3) Digital volt meter
- 4) Oscilloscope (100MHz)

<Procedures>

Connect the extension card (ST-5031) in order to access the test pins and trimmers on Peripheral board (G700).

Note: The test pins and trimmers are indicated in Photo-14.

Caution: Pay attention to the connection between the extension card and Mother Board (E700), the extension card and Peripheral Board (G700).

6.3.2-1 Hole element current adjustment

- 1) Connect the probes of the meter to TP31(+) and TP32(common).
- 2) Adjust RT7 so that the voltage attains +800mVDC+/-20mV.

6.3.2-2 Vref voltage – Close position adjustment

Caution: When you move the jumper, please do not apply force to the board. It may cause the board connection failure and may cause a short circuit.

- 1) Move the jumper from 9-10 pin of P2 to 1-2 pin of P18.
- 2) Connect the probes of the meter to TP52(+) and TP53(common).
- 3) Adjust RT14 so that the voltage attains 0mVDC+/-5mV.

6.3.2-3 Iris position – Close adjustment

- 1) Set Iris positioning jig –Close side (ST-5530) to the iris unit frame as shown Photo-12.
- 2) Turn RT8 counter clockwise until LD4 turns ON.
- 3) Slowly turn RT8 clockwise and then stop just when LD4 turns OFF.
- 4) Confirm if the edge of the iris plate just touches to the face for Close position of the jig by eye.

6.3.2-4 Vref voltage – Open position adjustment

Caution: When you move the jumper, please do not apply force to the board. It may cause the board connection failure and may cause a short circuit.

- 1) Move the jumper from 1-2 pin of P18 to 3-4 pin of P18.
- 2) Connect the probes of the meter to TP52(+) and TP53(common).
- 3) Adjust RT13 so that the voltage attains -2.00VDC+/-0.01V.

6.3.2-5 Iris position – Open adjustment

- 1) Set Iris positioning jig – Open side (ST-5530) to the iris frame as shown Photo-13.
- 2) Turn RT6 counter clockwise until LD4 turns ON.
- 3) Slowly turn RT6 clockwise and then stop just when LD4 turns OFF.
- 4) Confirm if the face for Open position of the iris plate just touches to the edge of the jig by eye.
- 5) To close the iris adjustment, put back the jumper pin to the original position 9-10 pin of P2.

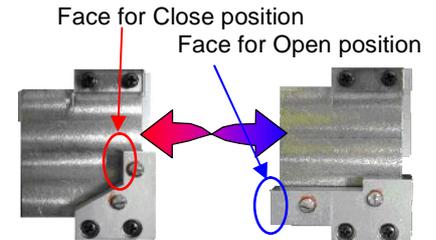


Photo-11 Iris Positioning Jig

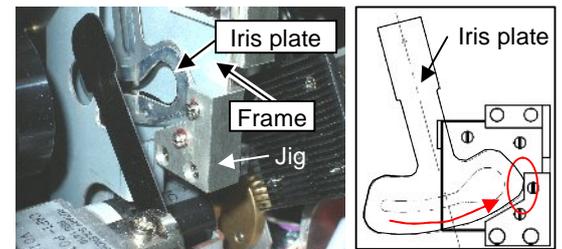


Photo-12 Iris Position - Close

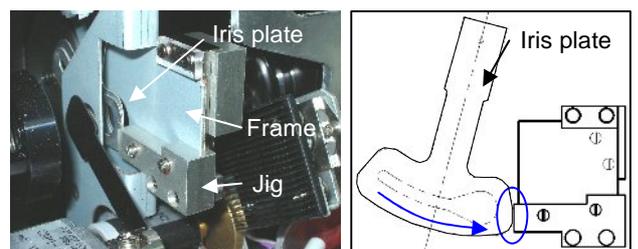


Photo-13 Iris Position - Open

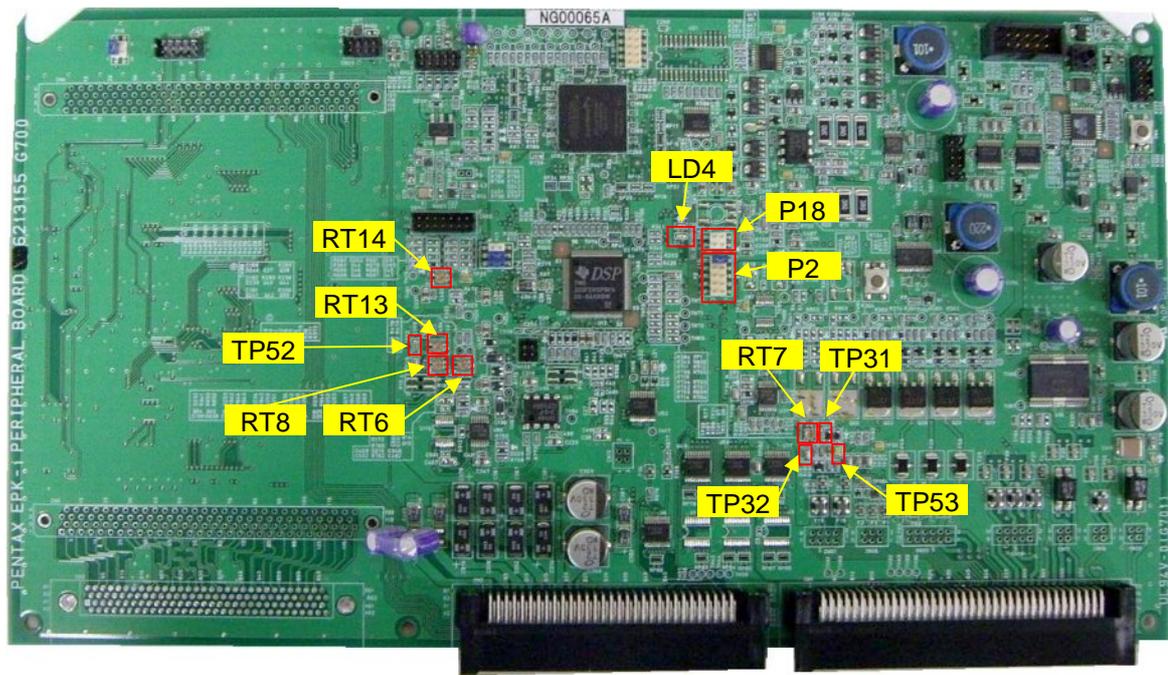


Photo-14 Peripheral Board (G700)

6.4 Peripheral Board (G700)

After Peripheral Board (G700) is replaced, the following adjustments are necessary.

6.4.1 Pump air flow adjustment

Perform "6.2.2. Pump air flow adjustment".

6.4.2 Iris adjustment

Perform "6.3.2. Iris position adjustment".

6.5 Process Board (H700)

When Process Board (H700) is replaced, the following preparation and adjustments are necessary.

Note: Elapsed time data such as the lamp using time is managed between Process Board (H700) and SBC (F700). Thus the adjustment of Process Board must be performed with the original SBC Board.

6.5.1 Pump air flow data backup

Because the pump air flow data has been stored in Process Board (H700), the data must be transferred from the old board to the new one. The data can be read with the following procedures.

Note: If the backup fails, the pump air flow adjustment is necessary after replacing Process Board (H700).

<Procedures>

- 1) Read the pump air flow data on “Pump Level Adjustment” dialog box with the procedures 2) - 9) of “6.2.2 Pump air flow adjustment”.
- 2) Replace the old Process Board (H700) with the new one.

6.5.2 VGA output adjustment

<Equipment>

- 1) Extension card (ST-5031)
- 2) Oscilloscope (100MHz)
- 3) VGA monitor with VGA cable

<Procedures>

Note: Test pins and trimmers are indicated in Photo-15.

- 1) Connect the extension card (ST-5031) in order to access the test pins and trimmers on Process board (H700). Be sure to connect back the VGA inner cable (B522) to CN4 on Process board (H700).

Caution: Pay attention to the connection between the extension card and Mother Board (E700), the extension card and Process Board (H700).

- 2) Connect a VGA monitor to the DVI port of the EPK-i.

Note: 1)VGA monitor is necessary to be connected for the VGA port termination.

- 2)“VGA” must be selected for DVI Output in System Category of Setup menu of the EPK-i. Also select “VGA” for the signal input of the VGA monitor.

- 3) Turn ON the EPK-i.

- 4) Confirm if the VGA monitor shows a plain screen (white).

Note: Process board provided as a spare part usually shows a plain screen. But if it shows a normal screen (Dark gray screen with the characters), you need to load the jig file (PC provides “33UH071-J1.rbf”). For the way to load it, please follow the procedures 6.5.3 File update and select file “33UH071-J1.rbf” at procedure 8).

- 5) Set the oscilloscope as follows:

Ch1: TP74 200mV/div DC 4.00µs/div GND: TP43
 Trigger: Ch1 Edge Band limit: 20MHz

- 6) Adjust RT1 so that the signal attains 700mV+0mV/-20mV (Refer to Fig-3).

- 7) Check if the signal from TP75 is the same as 700mV+0mV/-20mV (Refer to Fig-3).

- 8) Check if the signal from TP76 is the same as 700mV+0mV/-20mV (Refer to Fig-3).

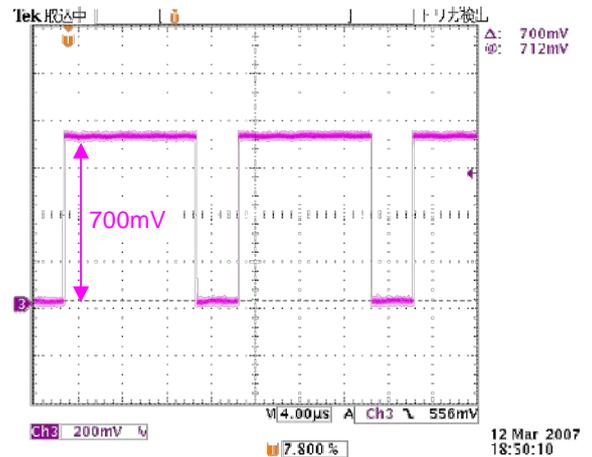


Fig-3 VGA output signal

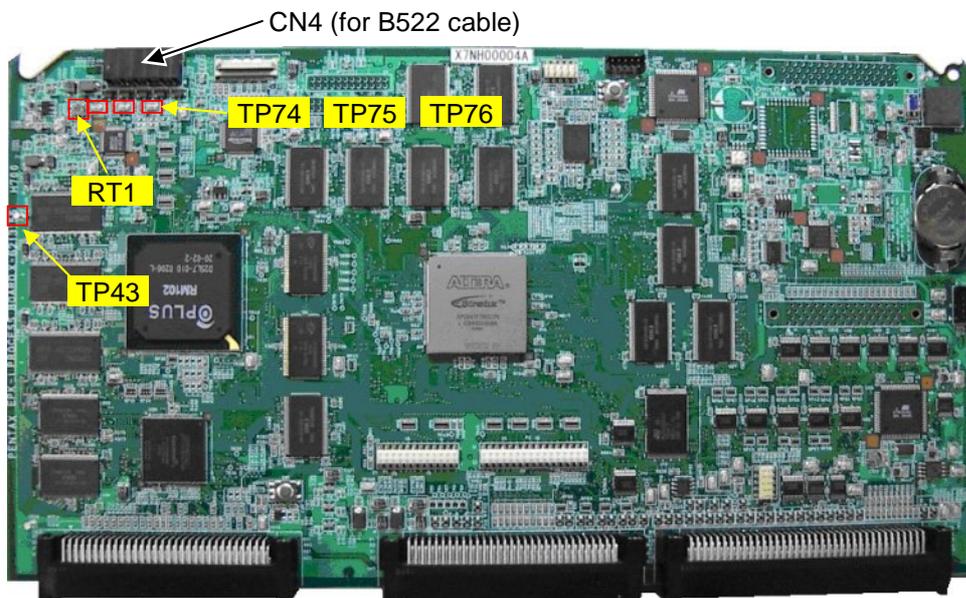


Photo-15 Process Board (H700)

6.5.3 File update

<Equipment>

- 1) USB memory (Copy the file defined below for preparation)
- 2) System file "33UH071-xx.rbf" (The adequate version file is provided by PENTAX. "xx" version number)

<Procedures>

- 1) Connect the USB memory to the USB port and turn on the EPK-i and wait until the system is ready. Then tap "Set up" button on the touch panel (Refer to Photo-16 Left).
- 2) Tap "Printer" button on the next screen (Refer to Photo-16 Middle).
- 3) Tap the place "A" three times and then tap the place "B" twice on the next (Refer to Photo-16 Right).

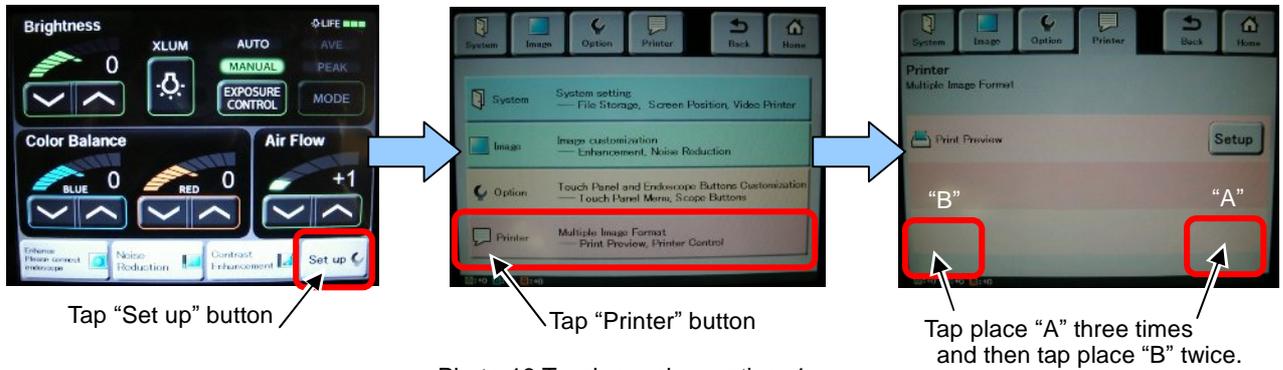


Photo-16 Touch panel operation -1

- 4) Tap "FileUpdate" button on the next screen (Photo-17 Left).
- 5) Tap "Process" button on the next screen (Photo-17 Middle).
- 6) Tap "FPGA(Cyclone)" on the next screen (Photo-17 Right).

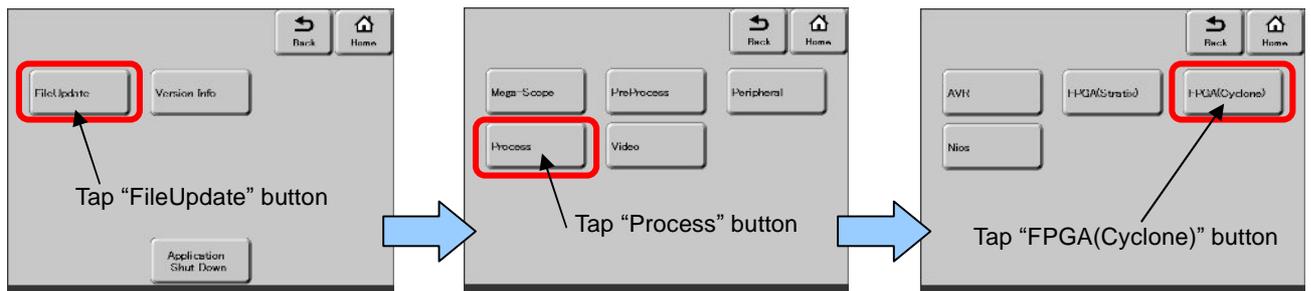


Photo-17 Touch panel operation -2

- 7) Tap the button assigned with the USB memory drive on the next screen (Photo-18 Left).
- 8) Tap "33UH071-xx.rbf" icon on the next screen (Photo-18 Middle).
- 9) Tap "Yes" button on the next screen after confirming if the selected file is correct (Photo-18 Right).

Note: If you select a wrong file to write, the warning message "File is Not Correct!! Please Select Again!!" appears.

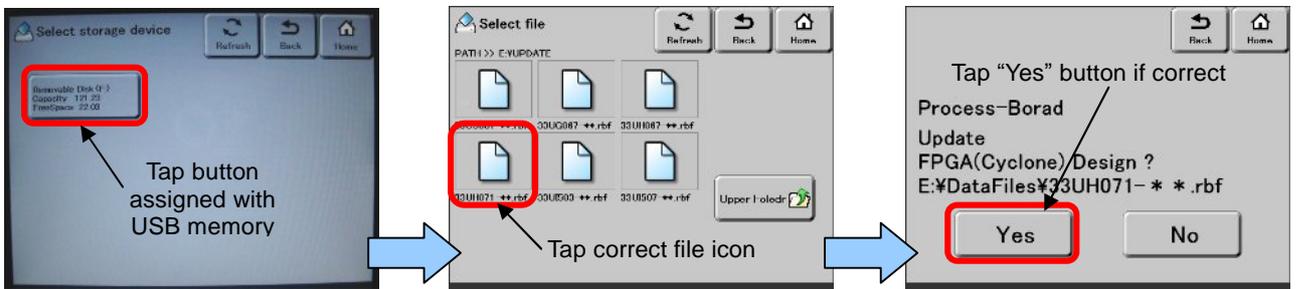


Photo-18 Touch panel operation -3

- 10) Tap "Start" button on the next screen (Photo-19 Left). And the Updating starts (Photo-19 Middle).
- 11) After the Updating finishes, message "Complete" appears on the next screen (Photo-19 Right).
Note: If the Updating has failed, message "Complete" will not appear. In this case tap "Quit" button and repeat the procedures from 6).
- 12) Turn OFF the EPK-i.

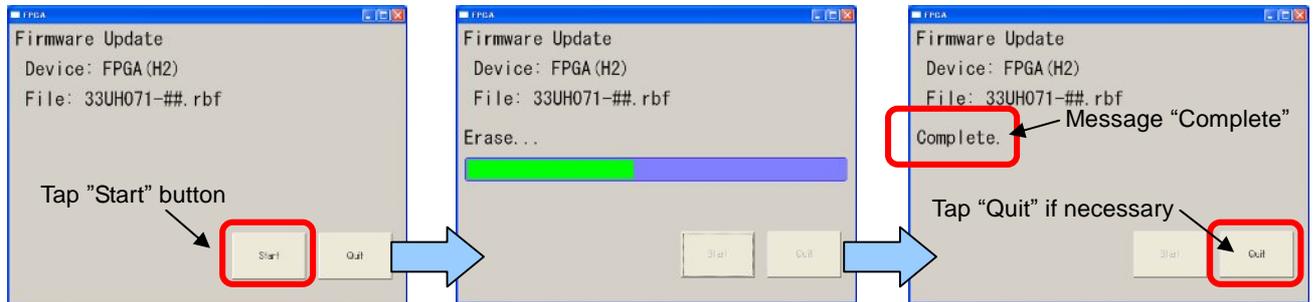


Photo-19 Touch panel operation -4

6.5.4 Pump air flow data restore

Restore the pump air flow data with the data that has been recorded in the section "6.5.1 Pump air flow data backup"

<Procedures>

- 1) Restore the pump air flow data to the new Process Board (H700) with the backup data with the procedures 2) - 9) of "6.2.2 Pump air flow adjustment".
- 2) If the backup has failed in the section "6.5.1 Pump air flow data backup", perform "6.2.2 Pump air flow adjustment".

7. Electrical safety test

Important: After opening the cover of the unit for repair, the electrical safety test is indispensable.

7.1 Dielectric strength test

Caution: 1) Be sure to keep away from the equipment while the high voltage is being applied to the EPK-i.

2) This test is one kind of destructive tests. Multiple tests may damage the EPK-i.

- 1) Connect the probes of the dielectric strength tester according to Table-3. Refer to Fig-4 for the connection.
- 2) Set the voltage according to Table-3, applying HV time to 60 seconds and the cut off current to 15mA, then start the test by pressing the start button on the tester.
- 3) Confirm that there is no break down during the test period 60 seconds.

No.	Dielectric strength test	Probe (+)	Probe (-)	Apply voltage
1	Primary circuit to Chassis	Point-A	Point-B	1,500VAC
2	Primary circuit to Patient circuit	Point-A	Point-C	4,000VAC
3	Signal terminal to Patient circuit	Point-C	Point-D	1,500VAC

Table-3 Dielectric strength test condition

Point-A: Point of shorted together with the live and neutral terminals of the AC cable.

Point-B: Equipotential terminal of the EPK-i.

Point-C: Equipotential wire of the dummy scope for dielectric strength test.

Point-D: Video signal BNC connector (outer shell) of the EPK-i.

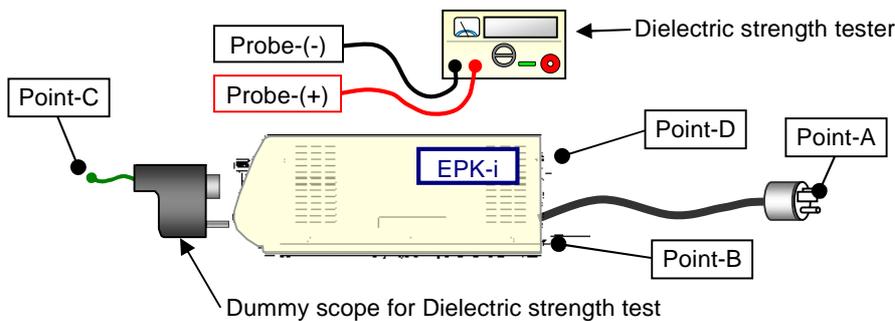
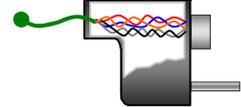


Fig-4 Dielectric strength test

Dummy scope



- Every wire of the scope connector is connected to the one wire (indicated in green above).
- No PCB, no light coherent bundle.
- You can make the dummy scope like above.
- It has yet to be available as a Special Tool.

7.2 Protective earthing circuit resistance

Measure the protective earthing circuit resistance with a low resistance meter and check whether it is within the value described below: Refer to Fig-5.

- 1) Resistance between GND pole of AC inlet (Point-A) and Equipotential terminal (Point-B). It must be less than 0.1 ohms.
- 2) Resistance of GND wire within AC cable (between Point-C and D). It must be less than 0.1 ohms.

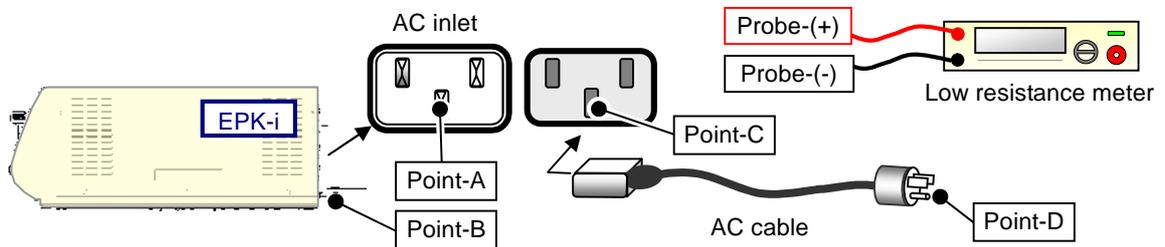


Fig-5 Protective earthing circuit resistance measurement

7.3 Leakage current test

Table-4 shows the limit values of leakage current in the specific test condition.

Check that each measured leakage current value is within the specific value with the following procedures:

- 1) Set the leakage current meter as shown in Fig-6 (Meter-A: Casing and Protective earthing leakage test / Meter-B: Patient applied part leakage test).

Note: 1) Put a capacitor (0.15uF) between the probes of the meter as shown below as a bypass for the leakage current of a certain frequency which is not harmful for the human body.

2) Equipotential terminal is equal to the chassis ground.

3) ST-5911 is a jig to connect the leakage current meter to the patient circuit ground.

4) We recommend a leakage tester which has a capability of automatically measuring all kinds of leakage current required for the medical equipment safety.

- 2) Set the AC power line condition described in Table-4 depending on the test type and connect the AC cable to the EPK-i.

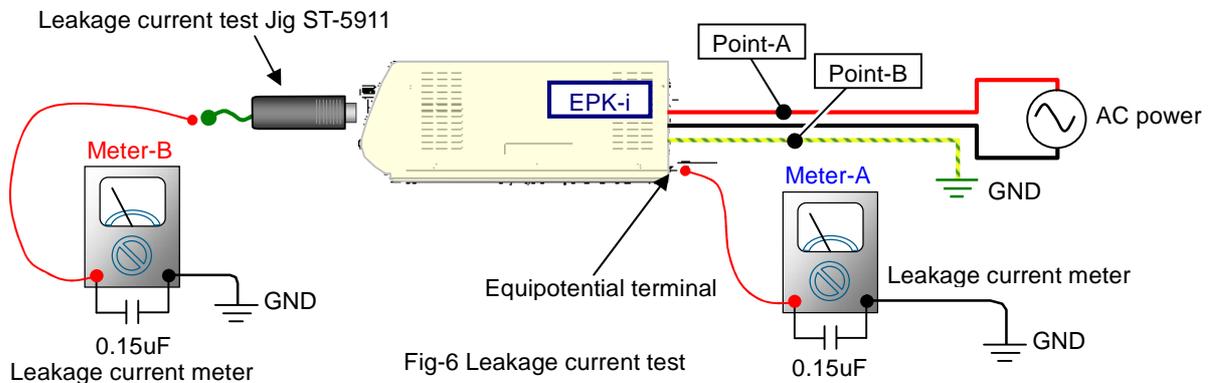
- 3) Apply 110% AC voltage, turn on the EPK-i and turn on the lamp and pump in high-mode.

- 4) Measure the leakage current value indicated on the meter and record it.

- 5) Turn off the EPK-i and change the polarity of the AC power by reversing the AC plug.

Caution: Surely turn off the EPK-i before the polarity of the AC input is switched. Because the EPK-i has a protect function against momentary power down, the DC power supply unit may not work when the power has been turned off and on momentarily.

- 6) Do the item 3) and 4) again. Take the worse value (higher one) as a result of each test.



Leakage Test & its condition		Point-A	Point-B	AC input ^{*4}	Standard	
1	Casing Leakage	N.C.	Connected	Connected	110% VAC	100μA ^{*1}
2	Protective earthing leakage	N.C. ^{*2}	Connected	Open	110% VAC	500μA
3		S.F.C. ^{*3}	Open	Open	110% VAC	1000μA
4	Patient applied part leakage	N.C.	Connected	Connected	110% VAC	100μA
5		S.F.C.	Connected	Open	110% VAC	500μA
6			Open	Connected		

Table-4 Leakage Current Criteria

N.C.: Stands for "Normal Condition". Status assuming that AC power lines of Live and Neutral and GND are correctly connected.

S.F.C.: Stands for "Single Fault Condition". Status assuming that accidentally either one of the AC power lines or GND is disconnected.

*1. The regulation value is 500μA, however in logical terms the actual value is more or less zero. If there is some value, you need to check whether the GND line has been connected correctly or not, or the quality of the GND line.

*2. The condition without GND line is the Normal Condition at the Protective earthing leakage test.

*3. The condition without both the AC line(either one of AC lines) and GND line is the Single Fault Condition at the Protective earthing leakage test.

*4. Supply 110% voltage of AC. For example, if the normal voltage is 100Vac, the supply voltage will become 110Vac. 120Vac > 132Vac, 230Vac > 253Vac. If you can supply only 100% voltage instead of 110%, convert the measured leakage current into the value at with 110% voltage of AC.

8. Trouble shooting

Symptom	CHECK	ACTION
Power does not turn ON	Fuse	Check the fuses in the fuse box located above the AC inlet. If they have been brown, you need to find a part that may cause the excessive load by disconnecting parts one by one.
	Interlock switch	This interlock switch is depressed by the key attached to the lamp house lid. Thus it must be closed completely. This interlock switch breaks AC power line. See Photo-1.
Lamp does not light	Lamp block	Ignition sound can be heard from the Lamp power supply unit. It means that the LPSU and its control line are OK. 1) Replace the lamp. It's been worn out or defective? 2) The lamp has been held by the heat sink firmly? 3) The lamp block has been attached to the lamp house firmly?
	Lamp power supply (LU1) w Igniter (IGN1)	1) Check the cable (B703) between the LPSU and Igniter if it has been connected firmly. 2) Check the cable (B707) between the AC terminal (TB1) and the LPSU if it has been connected firmly. 3) Check if the fans have been connected to the LPSU correctly. If not, the LPSU won't supply power. 4) Check if the LPSU or inside of the unit is heated. It may cause the protection circuit of the LPSU to go off. Check the cooling fans. 5) Check the flat cable (B504L) where the ignition signal goes through if it has been connected firmly. 6) Check if the high voltage wires between Igniter and the lamp house are routed correctly. If it is near the metal part, it may cause high voltage leakage. 7) Replace the LPSU or Igniter.
	Others	1) Check the cable (B508) between the Control Panel (PB1) and CN38 on Mother Board (E700) if it has been connected firmly. 2) The lamp switch on the front panel is OK? This switch is independent from the touch panel operation. 3) Peripheral Board (G700) is OK?
Iris does not work	Iris unit	After transportation or iris unit replacement, the followings may occur: 1) Check if the iris plate is detached or bended and touches to the frame or something. 2) Check if the iris cable is connected firmly to CN32 on Mother Board (E700).
	Preprocess Board (J700)	The signal that controls the iris varies depending on the scopes. For example, with 90i scope, the iris control signal is created from the LVDS signal (DO+/DO-), with 70 K scope, it is Yout. Thus, if the iris works correctly with another type of scope, Preprocess Board may be malfunctioning.
No image from DVI port	System Setting	DVI output setting is not suitable for the type of the connected monitor. If the monitor is DVI-V, the DVI Output setting is "DVI". If the monitor is DVI-A, the setting must be "VGA".
No image or strange image	Process Board (H700) Video Board (I700) I/O-1 Board (L700)	If the image doesn't show or becomes strange depending on the video output terminal, the boards listed in the left column are suspected. If no image or strange image from RGB, Y/C or Video terminal, Video Board or I/O-1 Board may be malfunctioning. If no image or strange image from DVI port, Process board or I/O-1 Board may be defective.

9. Wiring Diagram

