Service Manual

Chassis 449P

15" High Resolution Colour Monitor
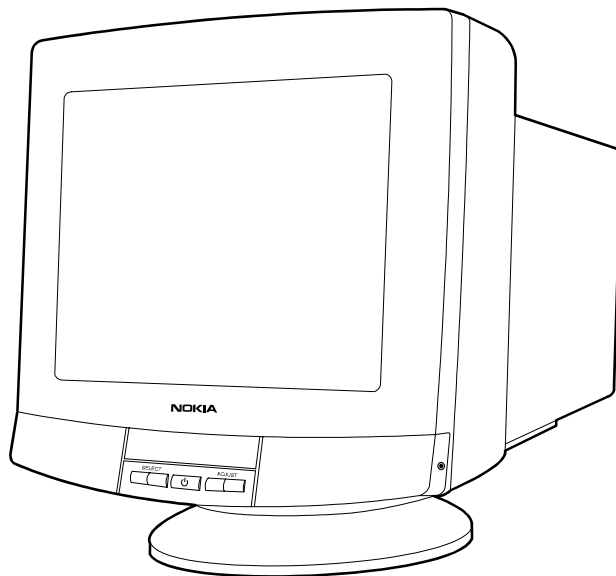
Contents

Service

Monitor Dismantling

Parts List

PCB Part List

PCB Layout Pictures

Circuit Diagram

	1	**2**
Base Board..........................	SMA188D/189D	SMA188E/189E/205E/206E
RGB Board Assy.................	SMH124D	SMH124E
Key board	SMZ048A	<
Audio connector board........	SMZ049A	<
DDC board..........................	SMZ052B	<

< no change, refer to the previous level

When re−ordering manuals, please quote the model name and part number.

**ZB1560**
04.97

Service

Contents

1. Product Overview

1.1. Technical Specifications

Cathode Ray Tube . . . . 15" in diagonal, 90° deflection angle
Dark, non−glare, antistatic coating
medium persistence (P22)
Dot pitch 0.25 mm

Picture Size . . . . 270 mm x 202 mm with specified geometric distortion

Bezel opening . . . . 279 mm x 208 mm, diagonally 344 mm

Power Input Requirements Voltage 90−264 V, 50/60 Hz Autosence
Current 2.0 A/110 V, 1.0 A/240 V

Power Dissipation . . . . < 100 W Normal Operation
< 100 W Stand−by
< 15 W Suspend
< 5 W Auto power off

Memory Locations . . . . 8 for factory preset timings
8 for user adjusted timings

Geometric Distortion . . . . . . The distance between bezel and active screen edge shall not vary more
than 2 mm in both vertical and horizontal dimensions

Luminance . . . . Min. 70 cdm^{-2} at center, with full white field

Video Input . . . . Input Signal: RGB, analog, positive, max 0.7 V/75 Ω
Horizontal addressability: 1024 dots maximum
Vertical addressability: 768 dots maximum

Synchronization Range . . . Horizontal: 30 kHz to 65 kHz automatic
Vertical: 48 Hz to 120 Hz automatic

Synchronization Signal . . . . Separate TTL, positive/negative
Composite TTL, positive/negative

Max. Dot Frequency Capability>200 MHz

Temperature . . . . Operating: +10°C to +40°C
Packed: −20°C to +60°C

Humidity . . . . Operating: 15% to 85 %
Packed: 5% to 95 %

Weight . . . . 14 kg net
17 kg gross

Size, Tilt and Swivel
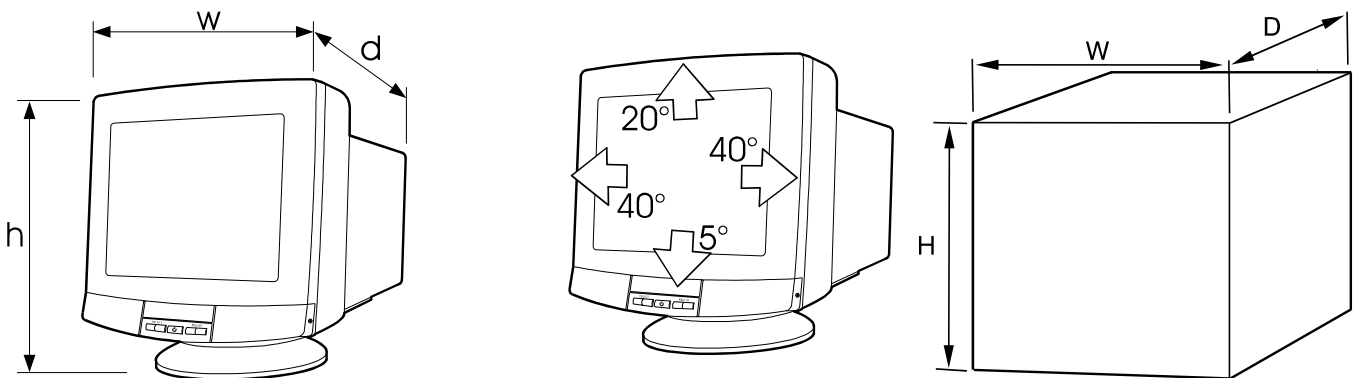
Dimensions

Monitor . . . . h . . . . 394 mm

w . . . . 363 mm

d . . . . 410 mm

Package . . . . H . . . . 523 mm

W . . . . 505 mm

D . . . . 542 mm

1.2. Preset Display Modes

Video

Full intensity
0.7 V
Blanking 0 V

Right Border   Left Border

H Blanking   H Active Video

H Back porch

H Front Porch

H Sync

H Sync. Signal

Video

Full intensity
0.7 V
Blanking 0 V

Bottom Border   Upper Border

V Blanking   V Active Video

V Back Porch

V Front Porch

V Sync

V Sync. Signal
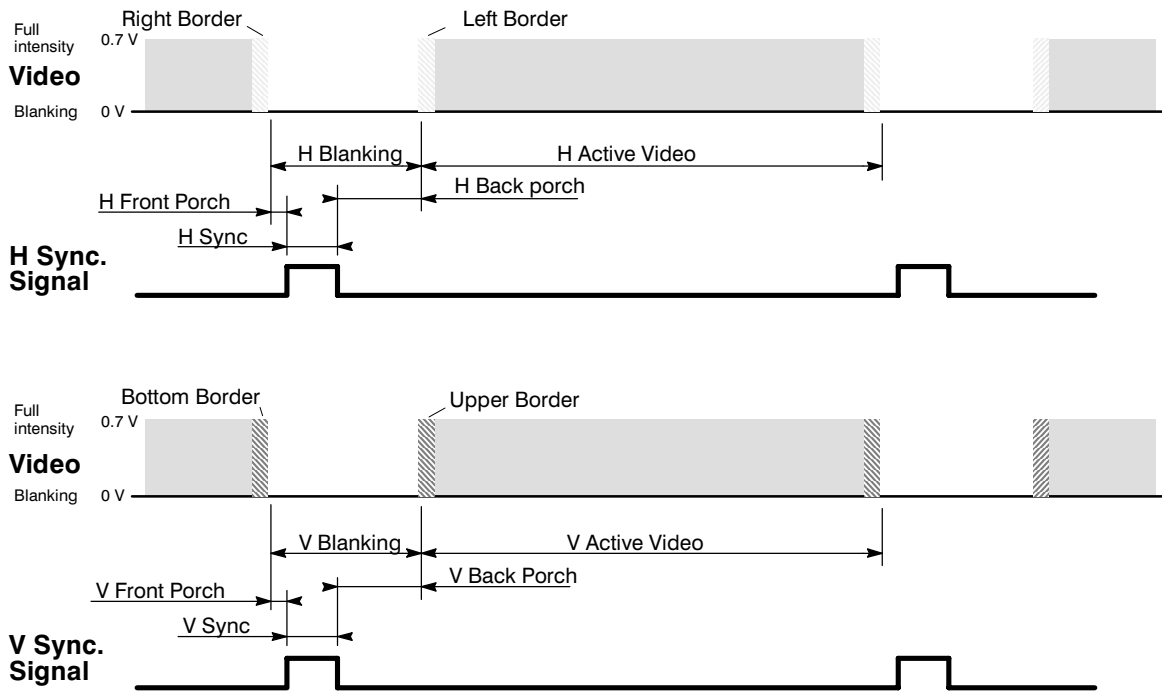
Display Mode –>	1	2	3	4	5
Display Mode Name	NCE300	NCE406	NCE010	NCE506	NCE561
H Frequency/kHz	31.472	46.875	49.718	60.023	61.101
H Period/µs	31.774	21.333	20.113	16.660	16.366
H Active Video/µs	25.420	16.162	14.527	13.003	11.903
H Resolution	640	800	832	1024	1024
H Sync/µs	3.81	1.616	1.12	1.22	3.72
H Back Porch/µs	1.91	3.232	3.91	2.23	0.66
V Period/Lines	525	625	667	800	806
V Resolution	480	600	624	768	708
V Sync/Lines	2	3	3	3	8
V Back Porch/ Lines	33	21	39	28	30
H sync Polarity	–	+	–	–	+
V sync Polarity	–	+	–	–	+
H Front Porch/µs	0.64	0.32	0.56	0.20	0.08
V Front Porch/ Lines	10	1	1	1	0
Dot Frequency/ MHz	25.177	49.500	57.275	78.750	86.030
Interlacing	no	no	no	no	no

1.3. Monitor Connection

Make sure that the monitor is disconnected from mains and the power switches of the computer and all attached devices are turned off before connecting the monitor.

1. Connect the signal cable plug to the videocontroller connector at the back of the computer.

2. Tighten the screws on the plug by hand.

3. Connect the power cord first to the monitor and then to a grounded power outlet.
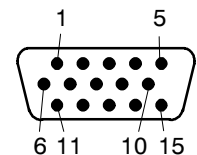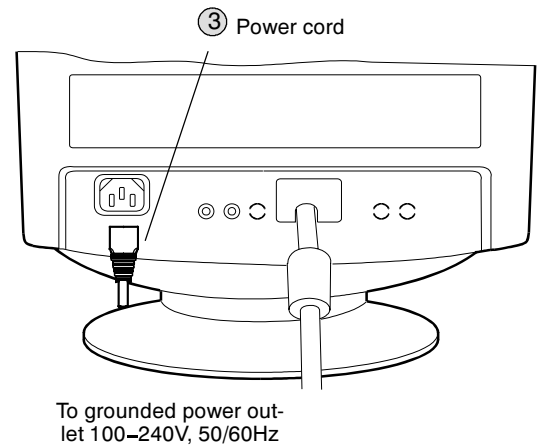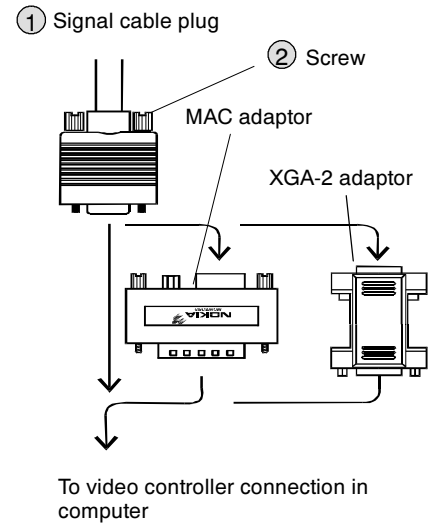
If your monitor is DDC compatible (PC)

− Do not use any adapter when connecting signal cable to your computer.

− Do not extend the signal cable with extension lead. The DDC signals will not accept extended cable.

If there is no DDC in your computer (PC)

− Normally there is no need for adaptor when connecting signal cable to your computer.

− Use a XGA−2 adaptor in the signal cable if you are going to use XGA−2 display mode (1024 x 768, 75 Hz)

− Use MAC adaptor in signal cable when connecting the monitor to an Apple Macintosh computer.

Signal connector

Pin		Signal	
1	−>	RV	Red video
2	−>	GV	Green video
3	−>	BV	Blue video
4	<−	ID2	ID2 (tied to LG with 332 ohms inside monitor)
5		ST	DDC GND
6		RG	Red ground
7		GG	Green ground
8		BG	Blue groun
9	−>		+ 5V
10		LG	Logic ground
11	<−	ID0	ID0 (tied to LG with 332 ohms inside monitor)
12	<−	SDA	DDC SDA
13	−>	Hs	Hor. sync., Comp. sync.
14	−>	Vs	Vert. sync.
15	<−	SCL	DDC SCL

① Signal cable plug

② Screw

MAC adaptor

XGA-2 adaptor

To video controller connection in computer

③ Power cord

To grounded power outlet 100−240V, 50/60Hz

1   5

6 11   10 15

1.4. Audio Features

Monitor has built–in basic audio features. The sound system is capable of producing stereo sound via R and L loudspeakers.

⚠ **If the audio signal input level exceeds the specified range, the acoustic waves may cause disturbancies in the picture with high VOLUME setting. The picture returns to normal by reducing the sound volume.**

1.4.1. Headphones

– On the right side of the monitor there is a jack socket for head-phones. Inserting of the headphones plug silences the loud-speakers.

1.4.2. Connections

– As an example the illustration shows a connection to a computer sound board (Sound Blaster, Creative Labs, Inc.). Note that other types of sound boards may use different names for connectors.
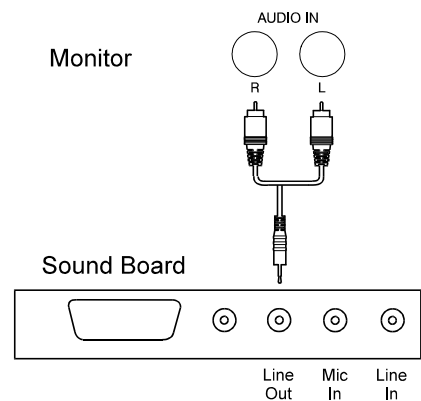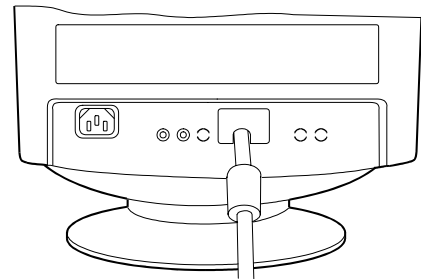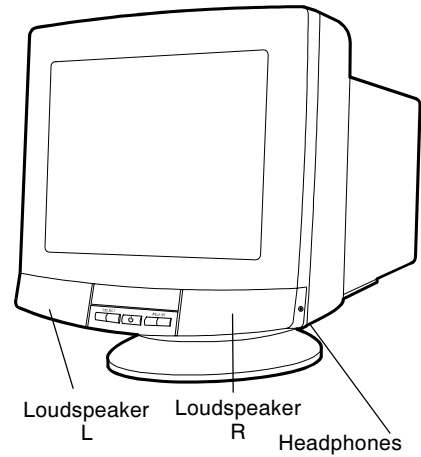
1.5. User Controls

1.5.1. Power Switch

Turning the Monitor ON and OFF

Push the **power switch** to turn the monitor on or off

When the power is turned on, the **power—on indicator** will light.
The colour of the the power—on light indicates the operating state of the monitor.

Green . . . . The monitor is in normal operation

Orange . . . . The monitor is in automatic power off state

Not illuminated . . The monitor is turned off with power switch
or disconnected from mains outlet.
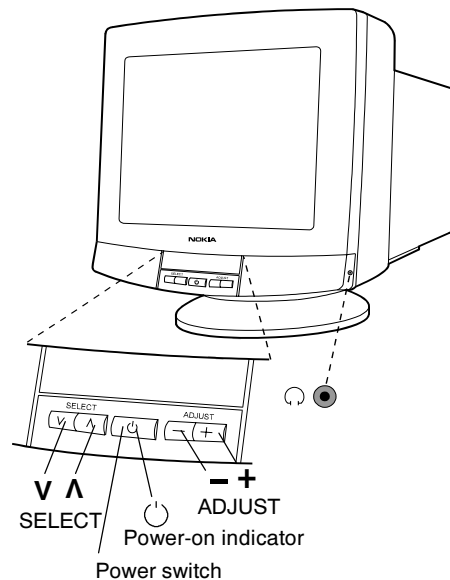
If the power management function working properly in your computer, you do not need to switch the monitor on or off. It happens automatically.

> ⚠ **The power switch does not disconnect the monitor from mains. In oder to make the monitor completely powerless, unplug the power cord from power outlet.**

1.6. Menu

Basic Adjustments

The adjustments and settings are carried out using menu display. The menu is called to the screen by pushing the Ⓥ or Ⓐ button.

The lowest header line belongs to the group which is visible in the menu window.

You may rotate the headers with the Ⓐ button. When the inverted line points to the uppermost adjustments, the next push moves the pointer to the header area. Subsequent pushes rotate the headers, and the corresponding adjustments appear in the window in turn. The selected item in the menu is indicated by ⊙ and ⊙.

Adjust the selected property (WIDTH) with − or +. The menu disappears and a scale shows the position of the adjustment. The − button increases and + button decreases the property.

After adjusting, the new setting will be stored automatically.

Some of the menu items consist of selection alternatives + scans the alternatives upwards and − downwards. If there are only two alternatives, + button switches the property ON and − button OFF.

All menu displays disappear automatically in a few seconds or at once by pushing Ⓥ and Ⓐ simultaneously.

Default Item

The menu selection is in force 20 seconds after the menu has disappeared. During that time the latest item can be called to the screen simply by pushing − or +. After the time has expired the menu selection returns to the default item.

```
IMAGE
GEOMETRY
► BASIC MENU          ◄
   ◑ CONTRAST
   ☼ BRIGHTNESS
   ◢ VOLUME
   CREATE DEFAULT ITEM ◑
   PRESET RECALL
   LANGUAGE
1024 x 768  75 Hz
```

```
BASIC MENU
IMAGE
► GEOMETRY            ◄
   ☐ VERTICAL CENTRING
   ⊞ HEIGHT
   ☐ HORIZ CENTRING
   ↔ WIDTH
   ☐ PINCUSHION CORRECT
   ☐ TRAPEZOID CORRECT
   ▱ ORTHOGONAL CORRECT
   ▱ TILT CORRECTION
1024 x 768  75 Hz
```

```
GEOMETRY
BASIC MENU
► IMAGE              ◄
   ◑ CONTRAST
   ☼ BRIGHTNESS
   COLOUR        9300 K
   RED
   BLUE
   MOIRE
   CONTRAST MODE
   ⋏ DEGAUSSING
1024 x 768  75 Hz
```

2. Site Preparation

2.1. Location

This Monitor is designed for normal office conditions. It is equipped with own power supply. It is not to be serviced or repaired on site

2.2. Troubleshooting

Local service facilities should perform simple maintenance such as trimming. More advanced maintenance and repair that requires replacement of components which in turn requires testing and re-trimming should be carried out in a central workshop.

Symptom		Measures
Picture screen is blank	The indicator on the front panel is not illuminated	Check that the power cord is correctly connected to the monitor and to the power outlet. If the monitor is powered through the computer, check that the computer is switched on with the mains switch. Use a desk light, for example, to verify that current is connected to a power outlet. If no electricity is connected to the outlet, call an electrician.
		Unplug the monitor from power outlet for about one minute.
	The indicator on the front panel is illuminated	The monitor might be in stand−by position. Push one of the buttons or move the mouse.
		Check that the keyboard's connection to the computer is OK.
		Check that the signal cable connector is connected. If the connector is loose, tighten the connector's screws.
		Unplug the monitor from power outlet for about one minute.
		Switch off the monitor and the computer. Remove the signal cable from the computer. Switch on the monitor using the power switch. If a gray, slightly blinking frame (background) appears on the screen, it is evident that the monitor functions correctly and the problem is caused by an error in other parts of the system.
		Check the signal cable's connection pins. If the pins are slightly distorted, use nose pliers to straighten them.
		The computer may use a timing values which are out of the monitor's synchronization range.
Picture has colour defects		Demagnetize the monitor
		If colour defect is repeated without the monitor having been moved, it is possible that the monitor is influenced by a strong magnetic interference field (near to a high power cable, for example). Try to find a better location for the monitor or the interference source. Note that another monitor placed too near (less than 30 cm.) may also generate interference in the picture.
Picture is stable but distorted		Your computer may use a timing for which the corresponding picture characteristic adjustments have not been set at the factory. Adjust the picture characteristics
Picture is unstable		Make sure your computer and video card are properly configured for your monitor
		Check the proximity of other electrical devices that generate magnetic fields, such as speakers, other monitors, electric fans and fluorescent light fixtures.
Picture is black and white		Check that the signal cable's connector is completely inserted. Switch off the computer and restart.

2.3. Checking the Operation of PowerSaver

The proper operation of the function requires a computer with VESA DPMS power management capabilities. Note that the power saving feature must be activated in the computer when checking the operation.

State	Colour of the power−on indicator	5V	7V	12V	Video
Normal Operation	Green	Yes	Yes	Yes	Yes
Stand−by	Green	Yes	Yes	Yes	No
Suspend	Green	Yes	Yes	No	No
Power Off	Orange	Yes	No	No	No

DPMS (Display Power Management Signaling) is a trade mark of Video Electronics Standard Association (VESA)

3. Controlling the Memory for Picture Adjustments

The picture adjustment values are stored in non-volatile memory. The memory has separated areas for User Adjustments and for Factory Adjustments.

3.1. Memory for User Adjustments

3.1.1. Adjustment

[1] If there are values available in the memory for user adjustments, corresponding to the present timing signals, they are always used.

[2] New user made adjustments are stored to the memory for user adjustments.

### 3.1.2. Resetting the User made settings for geometry or image

[3] User memory can be emptied from user made settings. **Resetting affects only the timing which is currently active**. The reset function is inhibited if no corresponding factory preset display mode exists. Please refer to chapter "User controls".

After resetting all picture properties are coming from memory for factory adjustments.

3.2. Memory for Factory Adjustments

3.2.1. Adjustment

[4] Factory adjustments can be updated with service menu in service mode. If there is no location in factory adjustment memory for timings currently in use, the adjustment affects the memory for user adjustments.

— If the memory location mentioned in case [1] is empty, the picture adjustment values are read from memory for factory adjustments. Factory adjustments, corresponding to the current timings, are transferred to user memory if any picture property is adjusted. After that the operation is as in case [1].
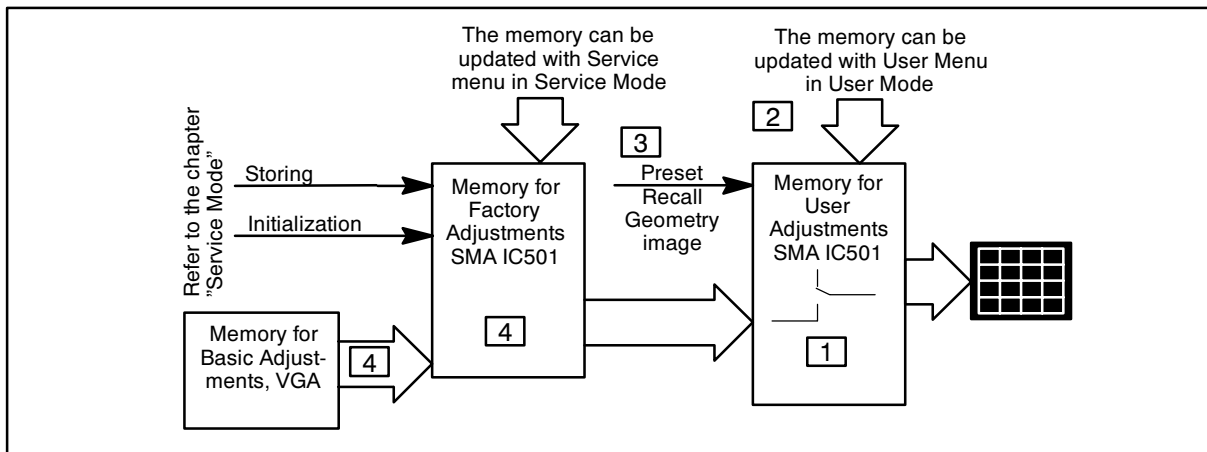
4. Service Mode

Service Mode is needed for updating of the factory adjustments for timings listed in the chapter Preset Display Modes. If there is no location in factory adjustment memory for display mode currently in use, the adjustment affects the memory for user adjustments.

4.1. Grouping of the Adjustments

There are two groups of software adjustments in service mode:
– geometry adjustment set
– grey scale adjustment set

The following table shows how the adjustments act in relation to the display modes.

Adjustment	Common for all Display modes	Separate for each Display mode	Available in User Mode	Available in Service Mode
Contrast	X		X (Common memory for both modes)	
Brightness	X		X (Common memory for both modes)	
Horizontal centring		X	X	X
Vertical centring		X	X	X
Height		X	X	X
Width		X	X	X
Pincushion		X	X	X
Trapezium		X	X	X
Orthogonality		X	X	X
Moire	X		X	
Pincushion balance	X			X
Horizontal raster centring	X			X
Tilt	X		X	X
G2	X			X
Max/Min contrast	X			X
R Blacklevel	X			X
G Blacklevel	X			X
B Blacklevel	X			X
R Gain	X			X
G Gain	X			X
B Gain	X			X

Common adjustments need to be adjusted only once. Separate adjustment must be performed for every display mode to be stored.

SELECT   SELECT
⋀ ⋁   ↺   ⋀ ⋁

　1)　　2)　　3) 3)

SELECT

⋀ ⋁   ↺

　4)

SERVICE MODE

+
GEOMETRY
+
GREY SCALE
INITIALIZING   ⓥ ⒶΛ
EXIT

　　　　+

HEIGHT
VERT CENTRING
WIDTH
HOR CENTRING
PINCUSHION
TRAPEZOID   ⓥ ⒶΛ
ORTHOGONALITY
PINCUSHION BAL
TILT
RASTER

BRIGHTNESS
CONTRAST
G2
RED ampl   ⓥ ⒶΛ
BLUE ampl
MAX/MIN CONTR

4.2. Service Menu

4.2.1. Access to Service Mode

First switch OFF the monitor with power switch.
1) Push ⓥ down
2) While keeping ⓥ down, switch ON the monitor
3) During 0,5 seconds release ⓥ and push ⒶΛ down.
4) Release ⒶΛ **after 0,5 seconds**.

Select the items in the menu with ⒶΛ or ⓥ buttons. Push + to open Geometry or Grey Scale Submenu or to initialize the memory IC. Adjust each property with − and + .

4.2.2. Geometry

Geometry submenu contains placement, size and shape adjustments.

4.2.3. Grey Scale

This monitor has three preset tints. With tint numbers smaller than 2 the picture becomes reddish and with tint numbers greater than 2 the picture turns blue.

Tint no	1	2	3
Colour Temperature	6500K	7000K	9300K

The grey scale adjustment affects directly tint number 3 (9300K) only. Other tints are derived automatically from 9300K colour temperature.

4.2.4. Initializing the Replacement IC501 on SMA board

If the memory for factory adjustments is replaced, it must be initialized. During initializing all memory locations are written with approximate values. They must be updated in service mode as explained in the chapter 'Adjustment Procedure'.

− Activate service mode as explained before.
− Select INITIALIZING in the service mode Basic menu.
− Initialize of the memory by pushing +.
− Switch OFF the monitor

Caution
Initializing of a programmed memory IC deletes all user and factory made adjustments.

4.2.5. Monitor Type Setting

After initializing the monitor continue with the setting of the monitor version to the memory.

First switch OFF the monitor with power switch.
1) Push − down
2) While keeping − down, switch ON the monitor
3) During 0,5 seconds release − and push + down.
4) Release +.
5) 449P151 /159 repeat sequence (1−4) two times.
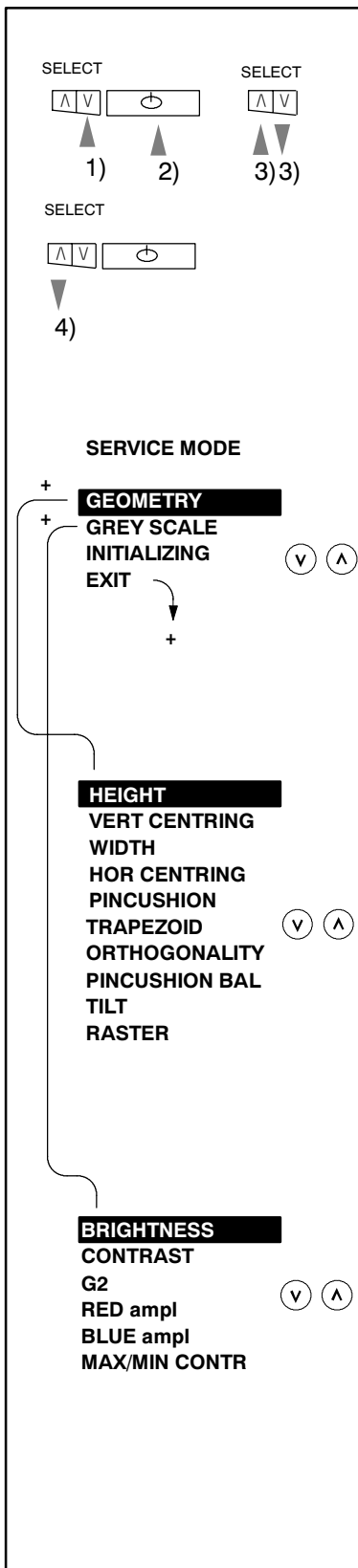
4.2.6. Storing the mode related adjustments

1. Return to the SERVICE MODE menu

2. Wait for five seconds and select a new display mode.

Caution

Make all adjustments at a time. If you return afterwards to the display mode, which you have already done, you have to adjust it totally again.

4.2.7. Exit from service mode

1. Return to the SERVICE MODE menu

2. Select EXIT from the SERVICE MENU

3. Switch off the monitor

4. Wait for one minute before switching on the monitor.

5. Workshop Maintenance

5.1. Important Safety Notice

The components, which are important for safety, are marked with special mark ⚠ on the circuit diagram. It is essential that these critical parts should be replaced with manufacture's specified parts to prevent X−radiation, shock, fire or other hazards.

For your own safety, use always safety isolating transformer when repairing the monitor.

5.1.1. Discharging the CRT

High voltage circuitry includes bleeder resistor which normally discharges the tube in about 5 seconds after the power is switched off. If you − for safety reasons − want to be sure about the discharging, do as follows:

Wear safety goggles. A cracked CRT may implode when discharged.
The signal cable must be disconnected from the computer.

To discharge the CRT, a flat−head screwdriver with grounding cable is required.

- Disconnect the power cable.
- Connect the metal chassis of the monitor to reliable earth.
- Connect the grounding wire to the screwdriver.
- Connect the other end of the grounding wire to the chassis (earth).
- Insert the screwdriver under the rubber cap of the EHT connector to discharge the tube.
- Disconnect the power cable.

5.2. ESD−Sensitive Parts

To prevent damage, when working with electrostatic discharge (ESD) sensitive parts, observe the following instructions:

- Keep the ESD−sensitive part in its original shipping container until you are ready to install the part into the component card.
- Just before touching the ESD−sensitive part, discharge to the monitor any static electricity in your body; do this by touching the metal frame or cover of the machine. If possible, keep one hand on the frame when inserting or removing a logic card, for example.
- Hold the ESD−sensitive part by its edge; do not touch its pins.

5.3. Test Equipment

The following test equipment are required to adjustment procedure.

- Safety isolating transformer
- Digital multimeter: Fluke 87 or equivalent true RMS multimeter
- High voltage probe: e.g. Fluke 80−40k
- Signal generator: VTG220 + PC or programmable video generator
- Color analyzer: e.g. Minolta TV Color Analyzer CA100
- Convergence Gauge (CM7AR or equivalent)
- Oscilloscope 40−100 MHz band width
- Hi−Pot tester (Flash tester with insulation measurement / Leakage current / Break down voltage)
- ESD protection necessary

5.4. Test Patterns
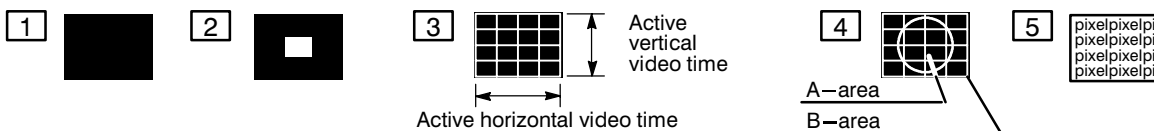
1. Black Picture
- Signal level = 0 V at each RGB input
2. Highlight grey scale tracking
- Signal level = 700 mV in the window at each RGB input
3. Crosshatch Picture
- Squares e.g. 20 mm x 20 mm
- Outmost lines correspond the active vertical/horizontal video time
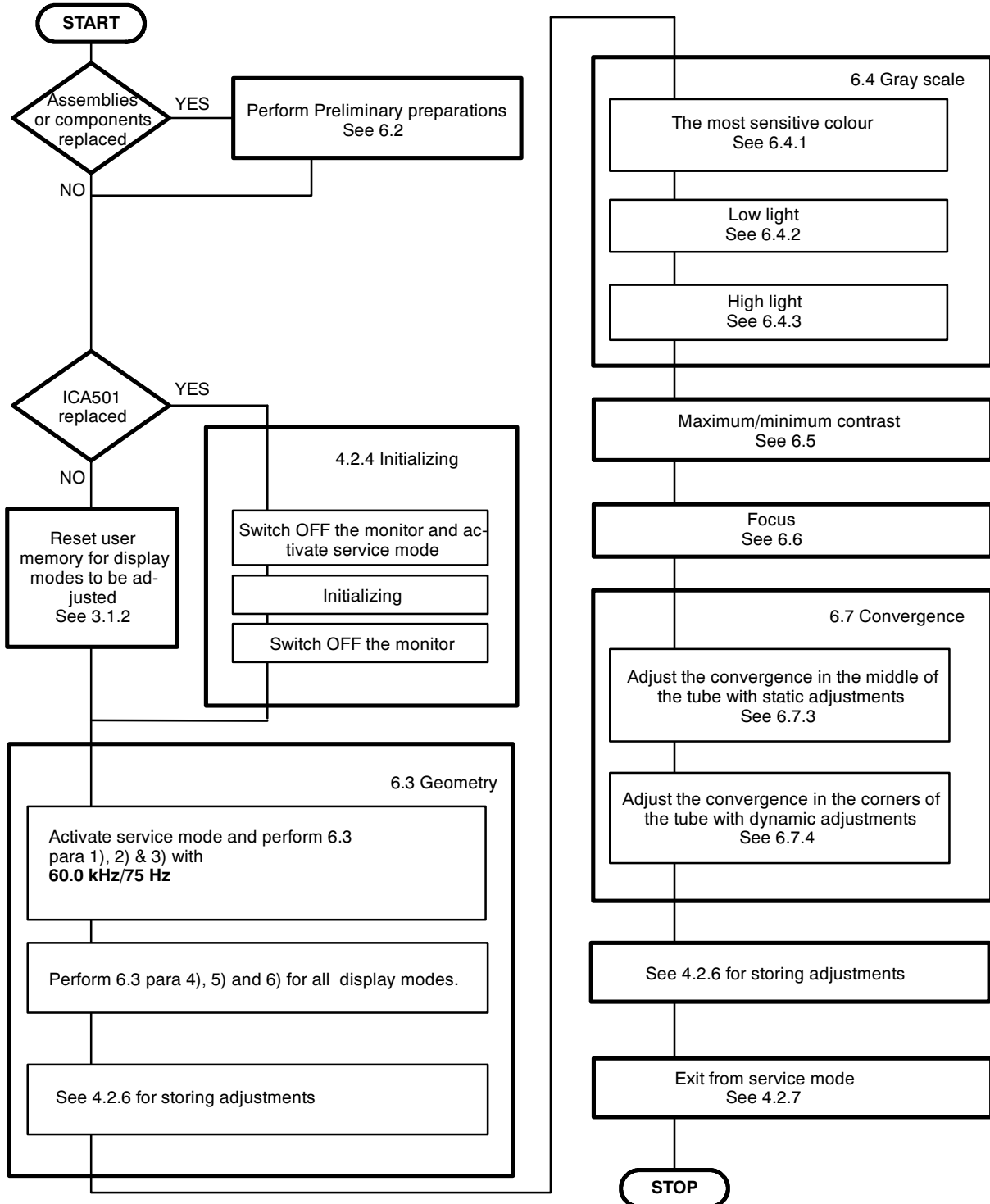4. Convergence test pattern
5. Focus test pattern

6. Adjustment Procedure

The following procedure must be carried out in case of large service operations e.g. when a circuit board or nonvolatile memory ICA501 has been replaced by a new one.

The order of adjustments explained here has been found to produce the desired result with the minimum of effort. Adjustments can also be made in another order or completely separately.

6.1. Adjustment Flow Diagram

```
                    ┌─────────┐
                    │  START  │
                    └────┬────┘
                         │
                    ╱────┴────╲      YES    ┌──────────────────────────┐
                   ╱ Assemblies ╲──────────▶│ Perform Preliminary      │
                  ╱ or components ╲          │ preparations             │
                  ╲   replaced   ╱           │ See 6.2                  │
                   ╲────┬───────╱            └──────────────────────────┘
                      NO │
                         │
                    ╱────┴────╲      YES
                   ╱  ICA501   ╲──────────┐
                   ╲ replaced  ╱          │
                    ╲────┬────╱           │
                      NO │                │
                         │                │
```

4.2.4 Initializing

Switch OFF the monitor and activate service mode

Initializing

Switch OFF the monitor

Reset user memory for display modes to be adjusted
See 3.1.2

6.3 Geometry

Activate service mode and perform 6.3 para 1), 2) & 3) with **60.0 kHz/75 Hz**

Perform 6.3 para 4), 5) and 6) for all display modes.

See 4.2.6 for storing adjustments

6.4 Gray scale

The most sensitive colour
See 6.4.1

Low light
See 6.4.2

High light
See 6.4.3

Maximum/minimum contrast
See 6.5

Focus
See 6.6

6.7 Convergence

Adjust the convergence in the middle of the tube with static adjustments
See 6.7.3

Adjust the convergence in the corners of the tube with dynamic adjustments
See 6.7.4

See 4.2.6 for storing adjustments

Exit from service mode
See 4.2.7
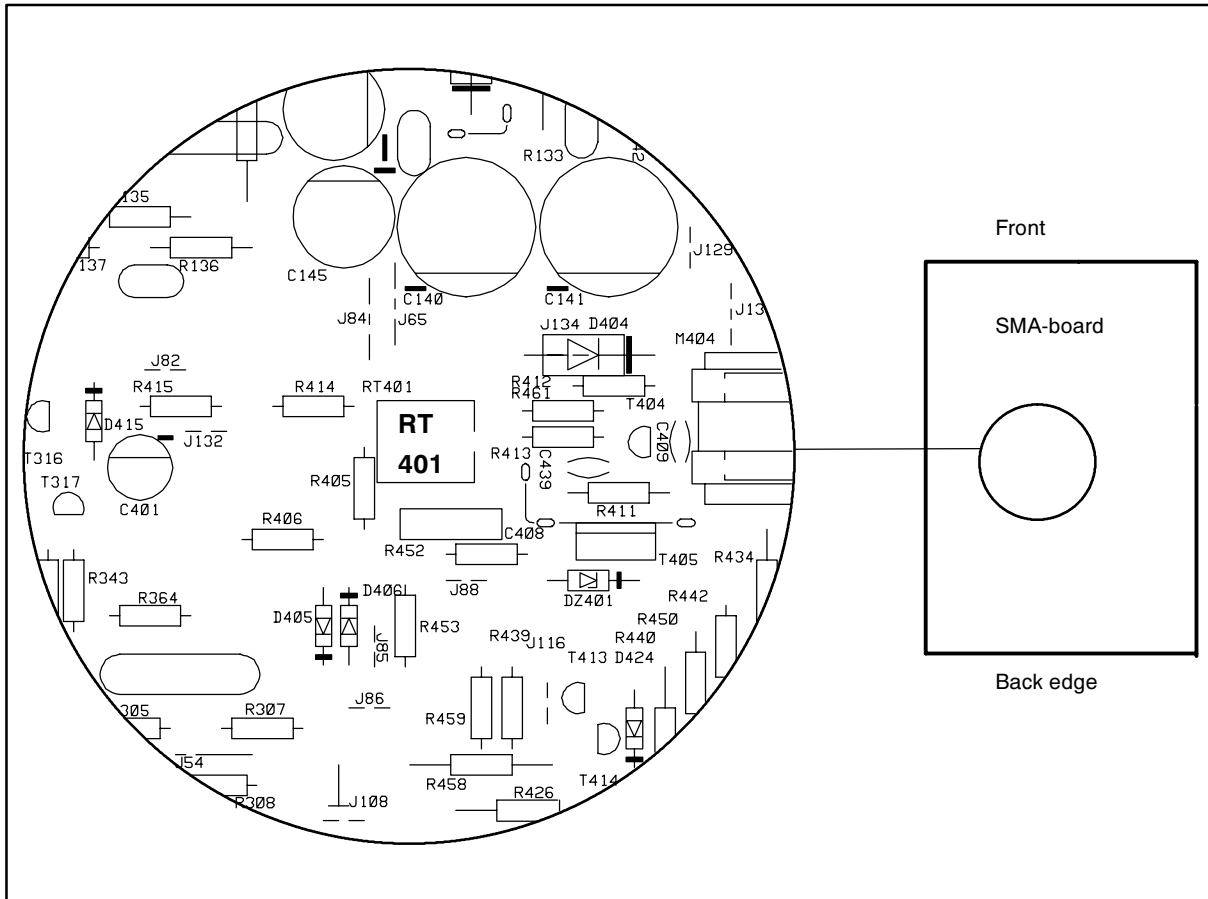
┌─────────┐
│ STOP   │
└─────────┘

6.2. Preliminary Preparations

Connect the signal cable to the PC. Switch on the monitor and the PC. Let the monitor warm up for 20 minutes before starting the adjustments.

6.2.1. Coarse width

- Select 31,47 kHz/60 Hz crosshatch test pattern
- Set width to the maximum with menu adjustment
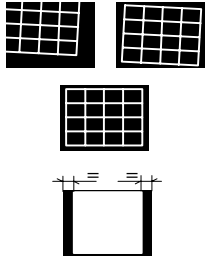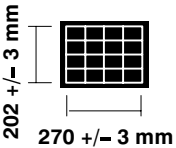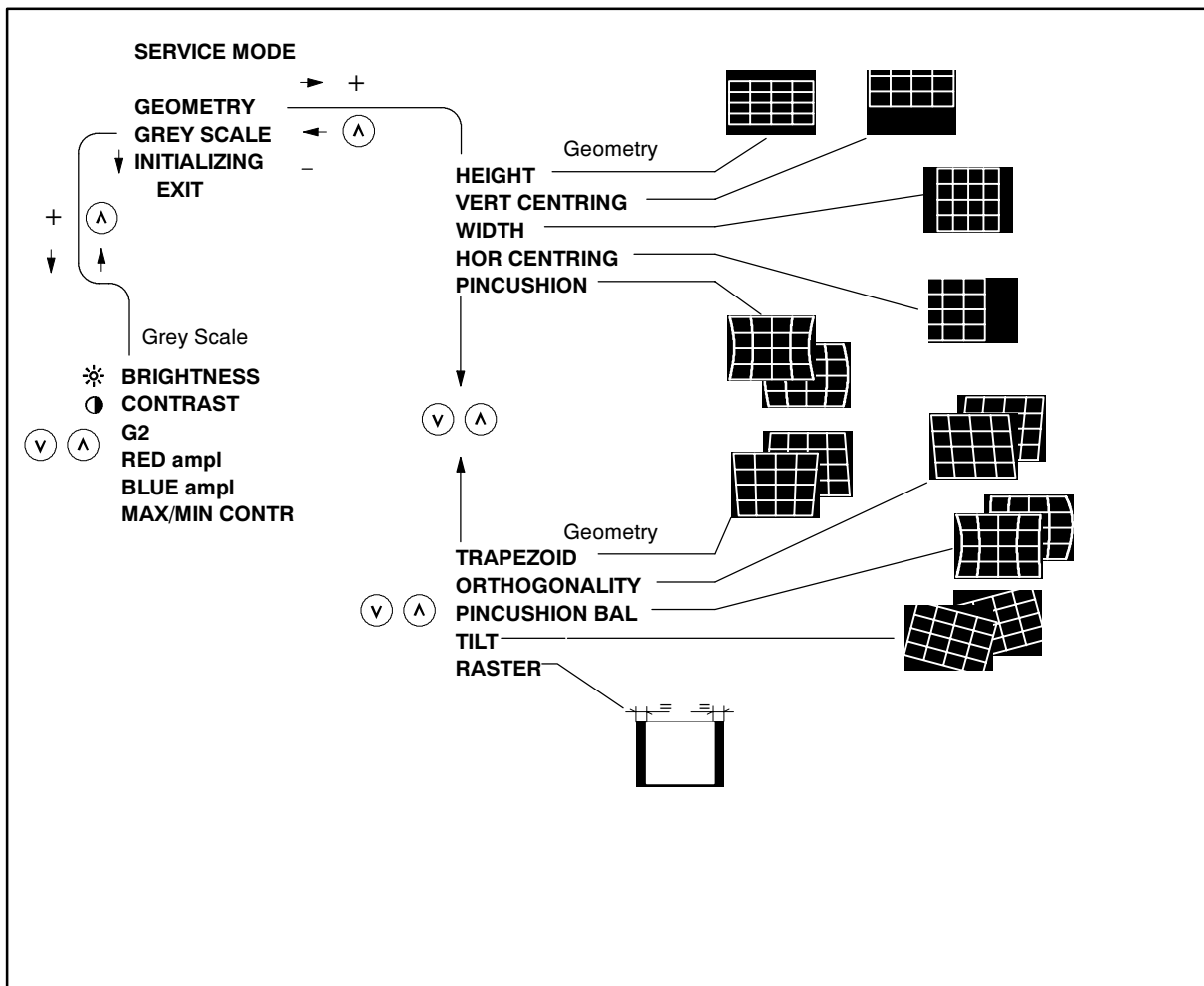- Set width approximately 270 mm with coarse adjustment **RT401**

6.2.2. High Voltage

− Select 31.47kHz/60Hz crosshatch test pattern.
− Connect the high voltage meter to the anode of the picture tube.
− Adjust the high voltage to **25.0 ±0.2 kV** with **RT301** on SMA−board.

SMA-board

Back edge

RT
301

6.2.3. Preliminary Picture Adjustments

1) Select 60.0 kHz/75 Hz crosshatch test pattern.
2) Set ◑ to maximum and adjust ❈ until the background is faintly visible.
3) Adjust focus if poor.

Remember

− Do not adjust **G2**−voltage with potentiometer or keypanel if you have reason to belive that there is no need to adjust gray scale.

6.3. Geometry

Activate Service Mode.

Degaussing must be carried out before the picture adjustments. Degaussing shall be repeated if the monitor is moved.

---

1) Select **60 kHz/75 Hz** crosshatch test pattern.
   Set ◑ to maximum and adjust ☀ until the background is faintly visible.
   Reduce width until both vertical edges of the **background** are visible.
2) Straighten the picture if tilted.
   This adjustment is common for all display modes.
3) Centre the background.
   This adjustment is common for all display modes.

---

4) Adjust size, position and shape of the picture equal to the mask aperture Adjust first the properties with largest deviation from the correct value.
5) Adjust final width and height.

202 +/− 3 mm

270 +/− 3 mm

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6) Return to the main menu.

---

7) Repeat steps 4) , 5) and 6) for every display mode to be stored. Note that the display mode can be changed without leaving the service mode.

SERVICE MODE

GEOMETRY
GREY SCALE
INITIALIZING
    EXIT

Geometry

HEIGHT
VERT CENTRING
WIDTH
HOR CENTRING
PINCUSHION

Grey Scale

☀ **BRIGHTNESS**
◑ **CONTRAST**
G2
RED ampl
BLUE ampl
MAX/MIN CONTR

Geometry

TRAPEZOID
ORTHOGONALITY
**PINCUSHION BAL**
TILT
RASTER

6.4. Grey Scale

The grey scale is adjusted for 9300K colour temperature. Memorizing of G2 and Max/Min Contrast takes place in five seconds when you return to the main menu from submenu.

6.4.1. The Most Sensitive Colour

The most sensitive colour has been marked in a label on the deflection yoke. It may not be correct if tube or SMH card has been changed. In that case judge the most sensitive colour from the tone of the picture after you have made the following adjustments.
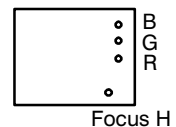1) Select **60 kHz**/**75 Hz** black test pattern.
2) Set ☀ and ◑ to maximum.
3) Set **RED**/**BLUE ampl** menu adjustments to center
4) Set **G2 menu** adjustment to center
5) Place the probe of the colour analyzer in the middle of the screen and adjust with **G2 trimmer** until the picture brightness to 5±1 nit.

FOCUS V
G2
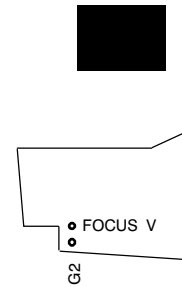
Left side view
of the chassis

6.4.2. Low Light

1) Select **60 kHz**/**75 Hz** black test pattern.
2) Adjust picture brightness to 5±0.8 nits with **G2 menu** adjustment.
3) Adjust with ☀ adjustment the brightness to 2±0.5 nits.
4) Adjust the colour coordinates to (9300K)
    x = 0.281±0.020
    y = 0.311±0.020
    with **RED**/**GREEN**/**BLUE trimmer** adjustments in SMH
    Do not adjust the most sensitive colour.
5) Set ☀ and ◑ to the maximum and check that the brightness is still 5±0.8 nits. If not, repeat steps 3) and 4).

B
G
R
Focus H

6.4.3. High Light

1) Select **60 kHz**/**75 Hz** black test pattern.
2) Adjust with ☀ the picture brightness to 2±0.5 nits.
3) Select 60 kHz/75 Hz window test pattern.
4) Adjust with ◑ the picture brightness in the window to 100±5 nits.
5) Adjust with **RED**/**BLUE ampl** the colour coordinates in the window to
    x = 0.281±0.020
    y = 0.311±0.020
    Check after adjustment that the brightness reading is in limits.
6) Check 6.4.2 para 3) and 4). Readjust color temperature if out of tolerance.

6.5. Maximum/Minimum Contrast

1) Set ◑ to the maximum.
2) Adjust with ☀ the picture brightness outside window to 2±0.5 nits.
3) Adjust brightness in the window to 150±3 nits with **MAX**/**MIN CONTR**.
4) Set ◑ to minimum.
5) Adjust brightness to 10±1 nits with **MAX**/**MIN CONTR**.
6) Return to the main menu.
7) Exit from service mode.

6.6. Focus

1) Select **60 kHz**/**75 Hz** crosshatch test pattern
2) Set ◑ to the maximum and adjust ☀ until the background is faintly visible
3) Adjust the sharpness with **FOCUS V trimmer** on SMA and **FOCUS H trimmer** on SMH to optimum.
4) Adjust ☀ until the background is invisible
5) Select focus test pattern. Check that all letters are clearly visible.

pixelpixelpi
pixelpixelpi
pixelpixelpi
pixelpixelpi
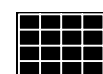
6.7. Convergence

Reduce first the convergence error in the middle of the screen to minimum using static adjustments. After the convergence is faultless in the middle of the tube, use dynamic adjustments to eliminate the error in the edges of the tube.

Static adjustments affects the whole picture area:

– magnet ring set on the tube neck (horizontal + vertical)

Dynamic adjustments affects a part of the picture area:

– deflection yoke trimmers.

6.7.1. Measuring Conditions

– Adjust convergence with 60.0 kHz line frequency
– Make sure that focus is correctly set at the mid-point between the screen center and the edge of the picture.
– Use white crosshatch test pattern with circle.
– Adjust ◖ to near the maximum and reduce ☼ until the background disappears.

6.7.2. Convergence Measuring Gauge CM7AR

The use of the Klein CM7AR Convergence Gauge has been explained here but other types of gauges can be used as well.

Check that the adjusting knobs (A & B) are set to zero.
– Place the gauge on the line with marking **Y up** upwards when measuring horizontal line.
– Place the gauge on the line with marking **X up** upwards when measuring vertical line.
– If the line has convergence error, the line in the window seems to be broken.
– Use knobs A and B to adjust the line continuous.
– If the readings are on the opposite side of zero, the convergence error is A+B (e.g. 0.2 + 0.1 = 0.3).
– If the readings are on the same side of zero, the convergence error is equal to A if A > B or B if B > A
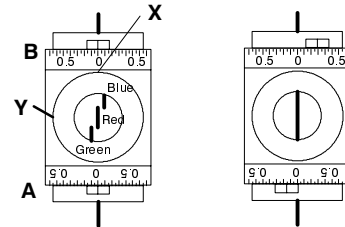
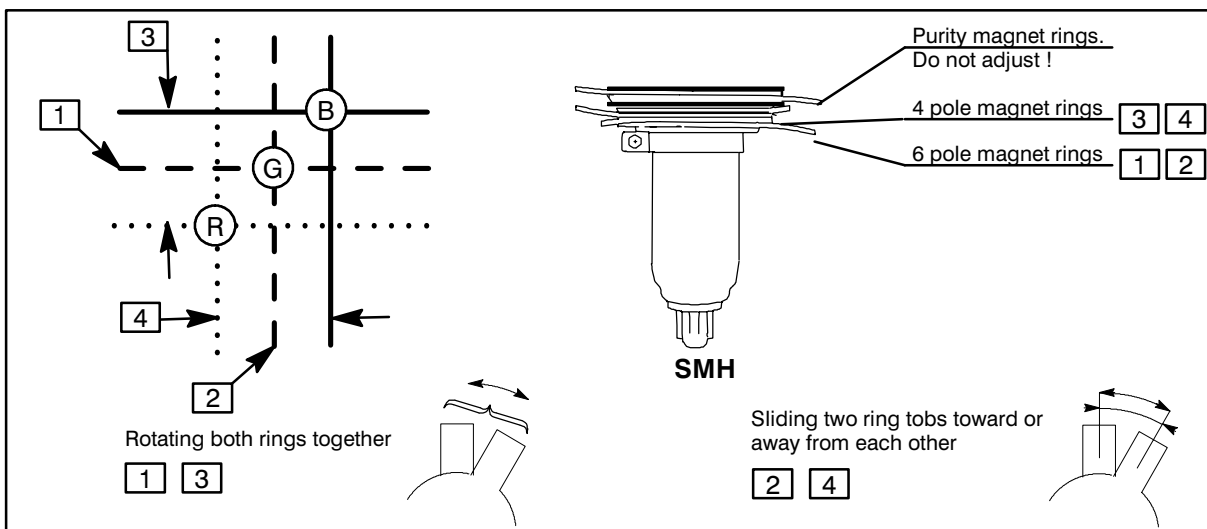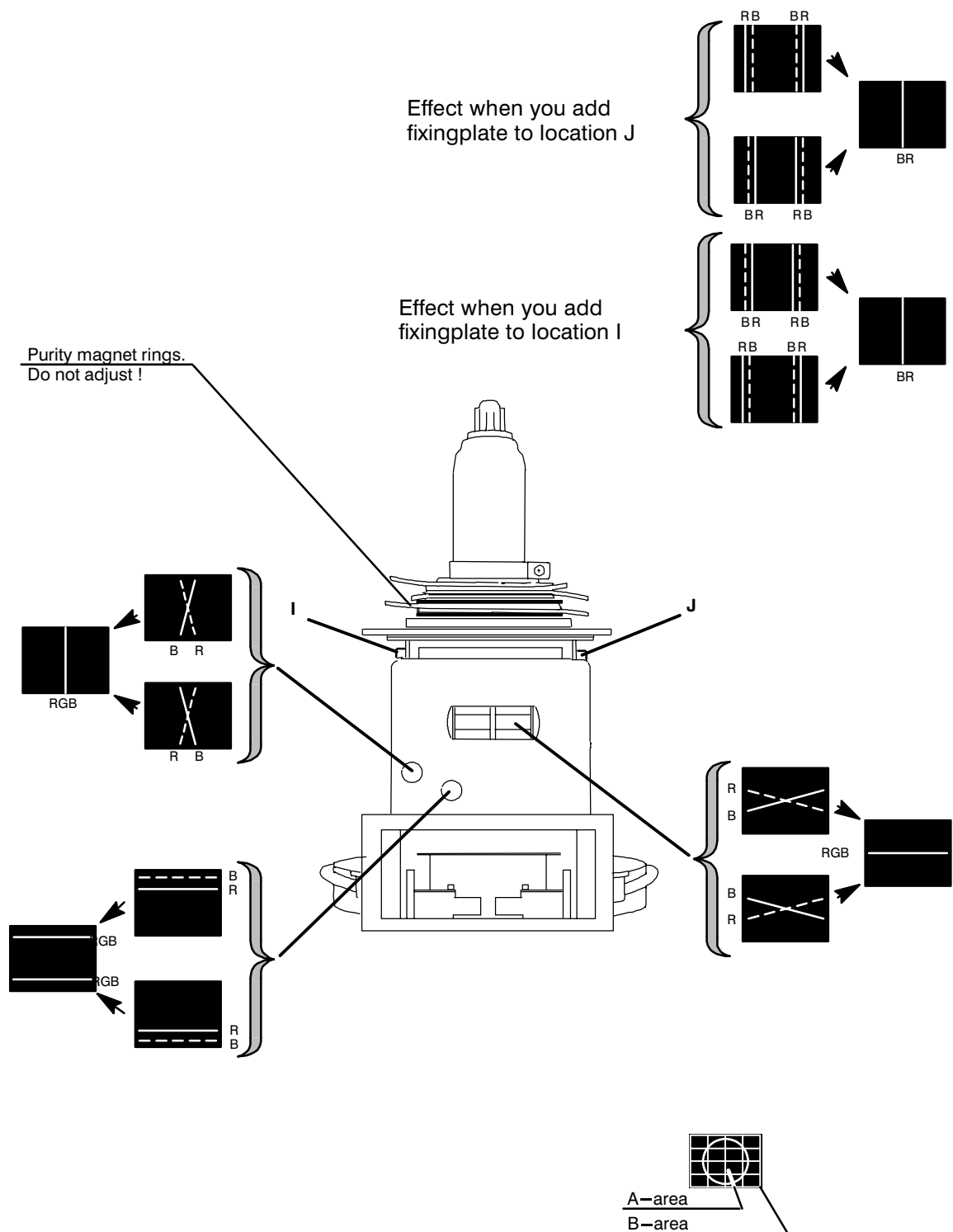## 6.7.3. Static Convergence

The magnet rings has been set to the optimum in the factory. Readjustment is necessary only in case the adjusting magnets have been accidentally moved.

1. Adjust G vertically in the middle between R and B with 6 pole magnet rings.
2. Adjust G horizontally in the middle between R and B with 6 pole magnet rings.
3. Adjust R and B vertically to the same position with G line with 4 pole magnet rings
4. Adjust R and B horizontally to the same position with G line with 4 pole magnet rings

Lock the rings with paint

6.7.4 Dynamic Convergence

Effect when you add fixingplate to location J

Effect when you add fixingplate to location I

Purity magnet rings.
Do not adjust !

I

J

RGB

RGB

A–area
B–area

6.7.5 Allowed Error Levels for Convergence

For horizontal sync frequencies above 48 kHz

Area A: ≤ 0.25 mm
Area B: ≤ 0.35 mm

For horizontal sync frequencies below 48 kHz

Area A: ≤ 0.4 mm
Area B: ≤ 0.5 mm

6.8. Colour Purity

Do not move purity magnet rings. If the purity magnet rings are found to have moved during transportation or handling, set them just in the original position by tracing the locking paint put on purity magnet rings and holder of beam bender and then readjust the static convergence.

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