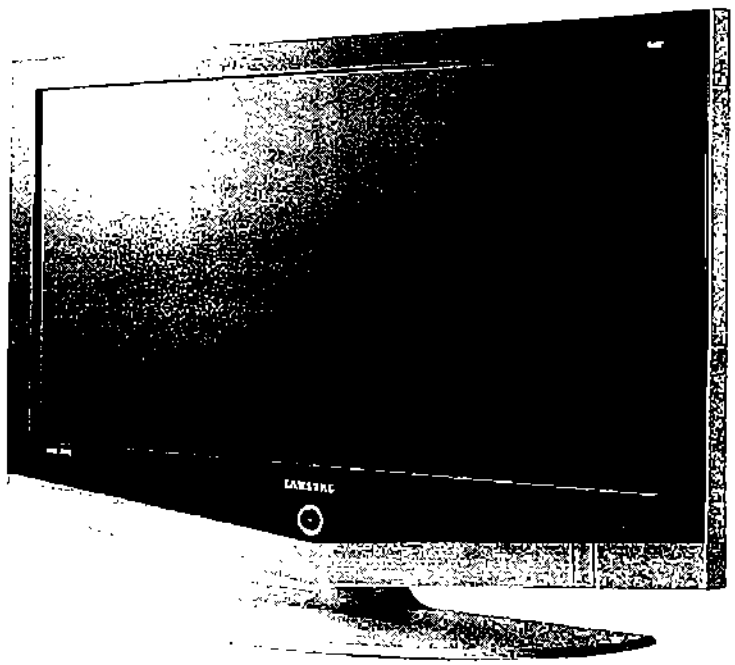
LCD TV ROME PROJECT
EUROPE MODEL
TRAINING MANUAL
DEC. 2004



SAMSUNG Electronics

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everyone's invited

Agenda

I. Understanding of LCD TV

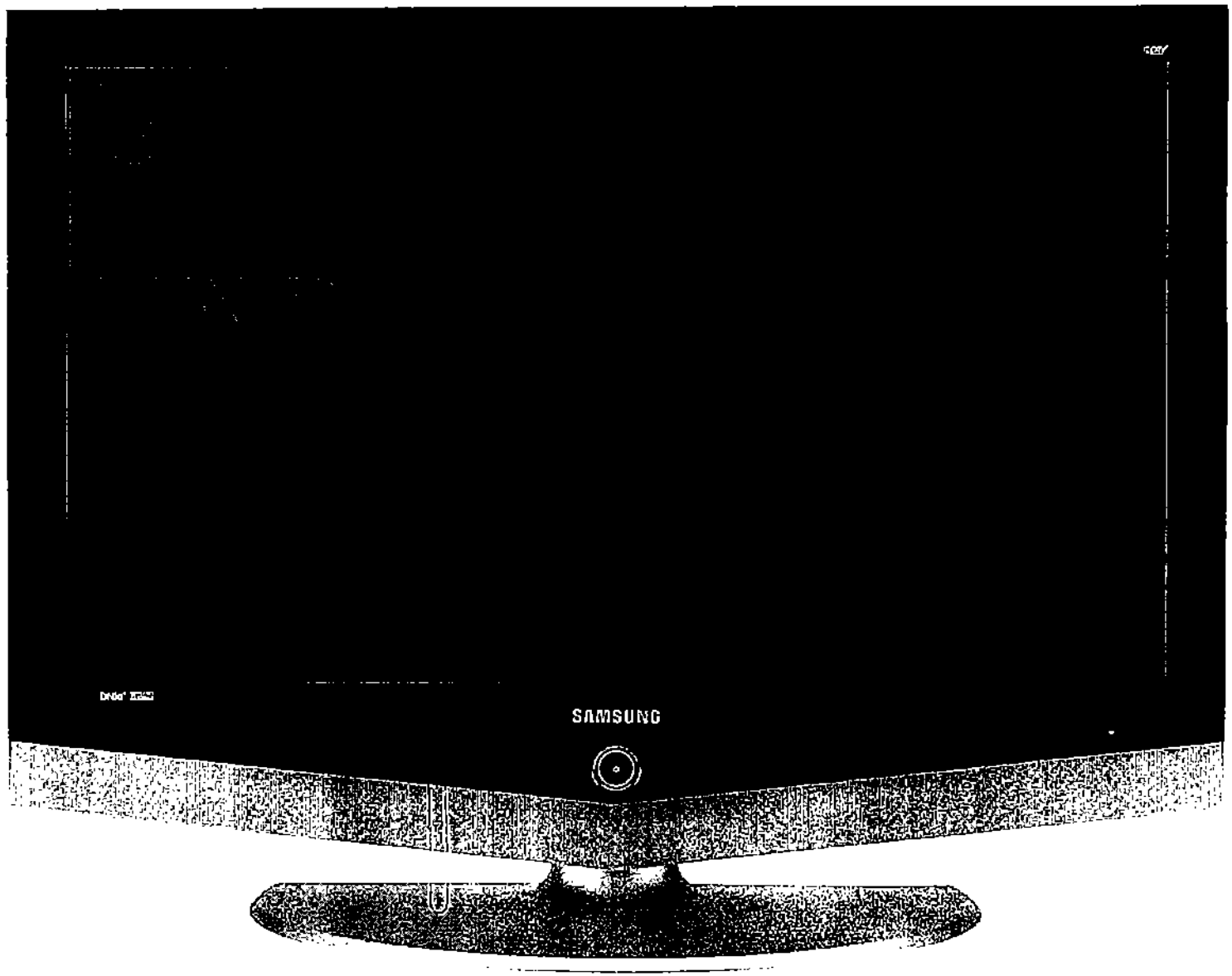
II. Inside of ROME Model

III. Board description

IV. Disassembly

V. Trouble Shooting

VI. Attachment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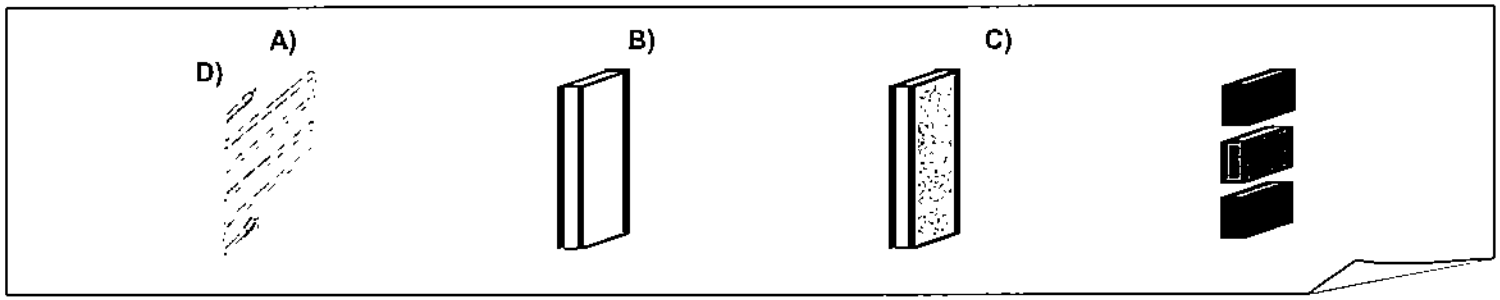
CONTENTS

LCD TV Advantage

- High Sharpness, Resolution
- Thin and Light (40 Inch is 5cm thickness)
- Low Power Consumption
- Real HDTV
- Long Life

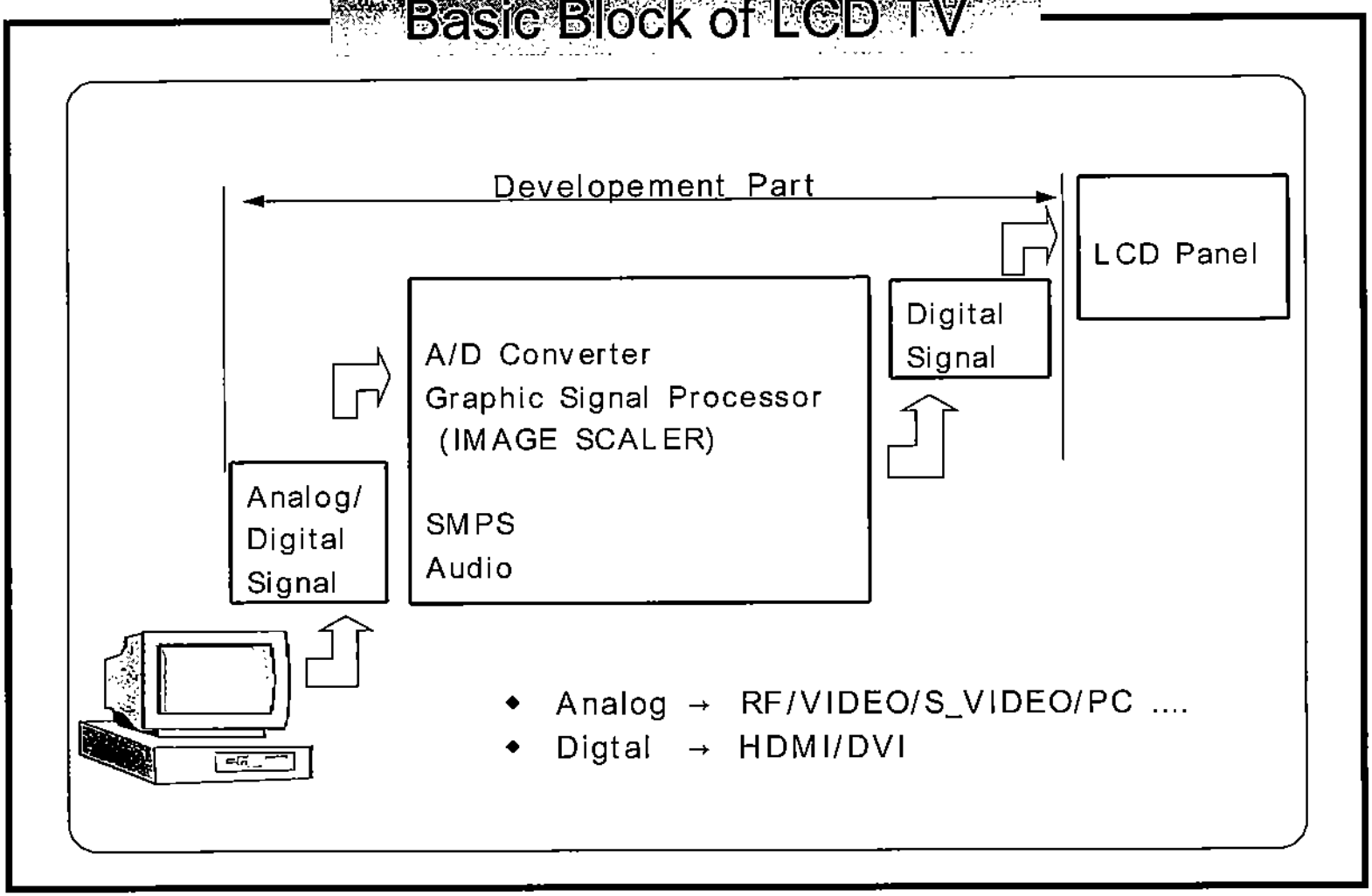
Basic Theory Of LCD PANEL

A) Lamp Make Light
B) TFT Adjust LCD Array
C) LCD Array can Adjust Light amount (Like Camera Iris)
D) Color Filter Make RGB Color

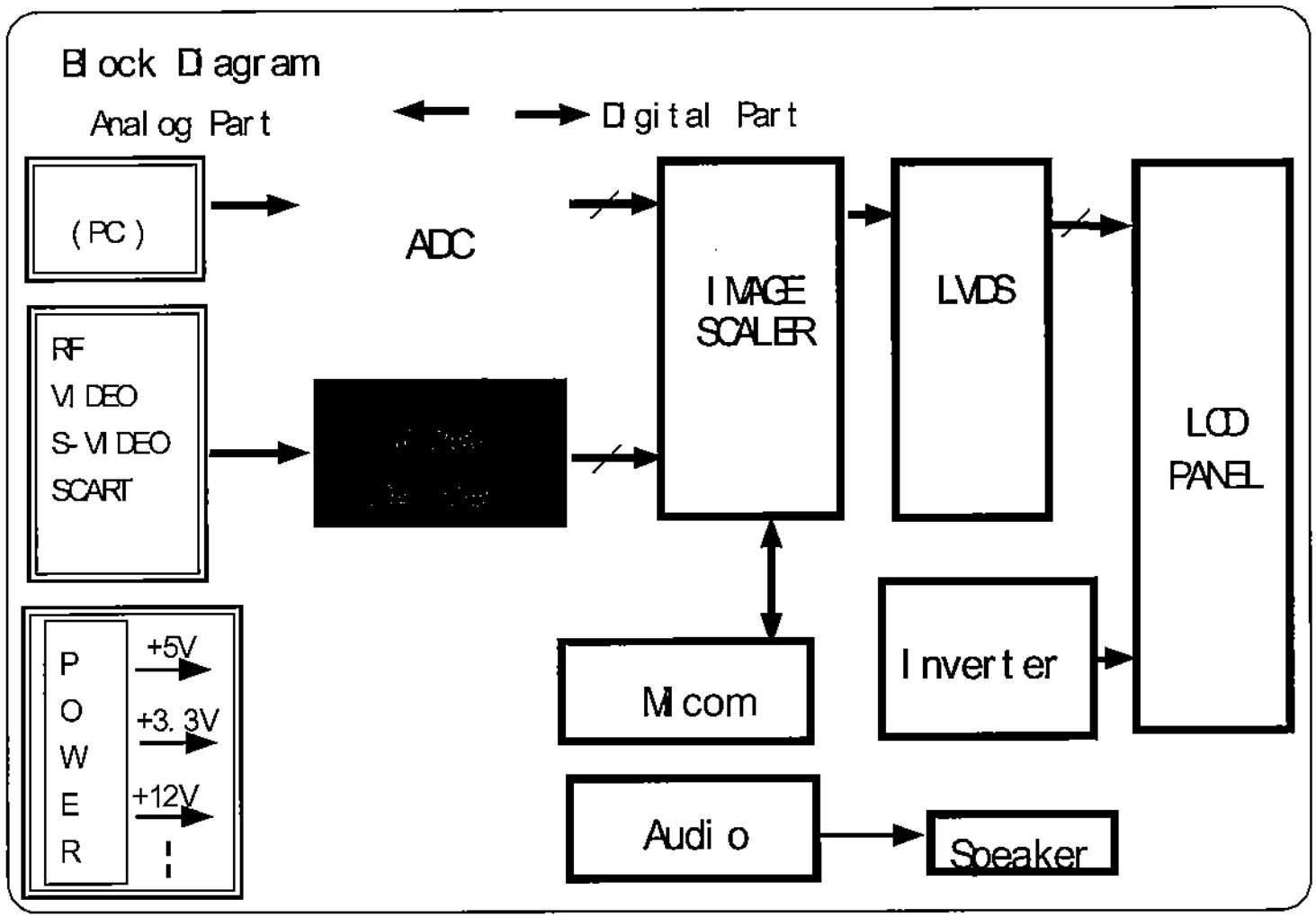


A) Back Light B) TFT C) LCD D) Color Filter

Basic Block of LCD TV

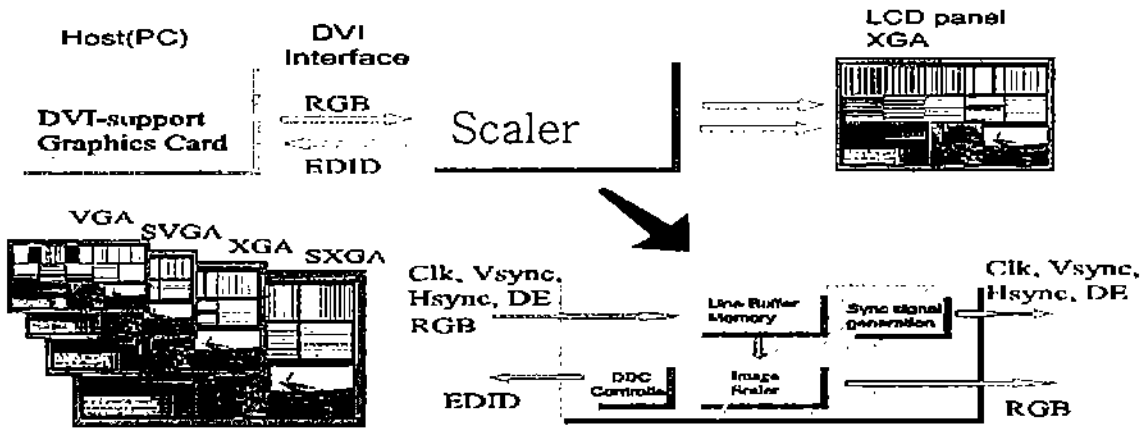


Basic Block of Main PBA



What is SCALER?

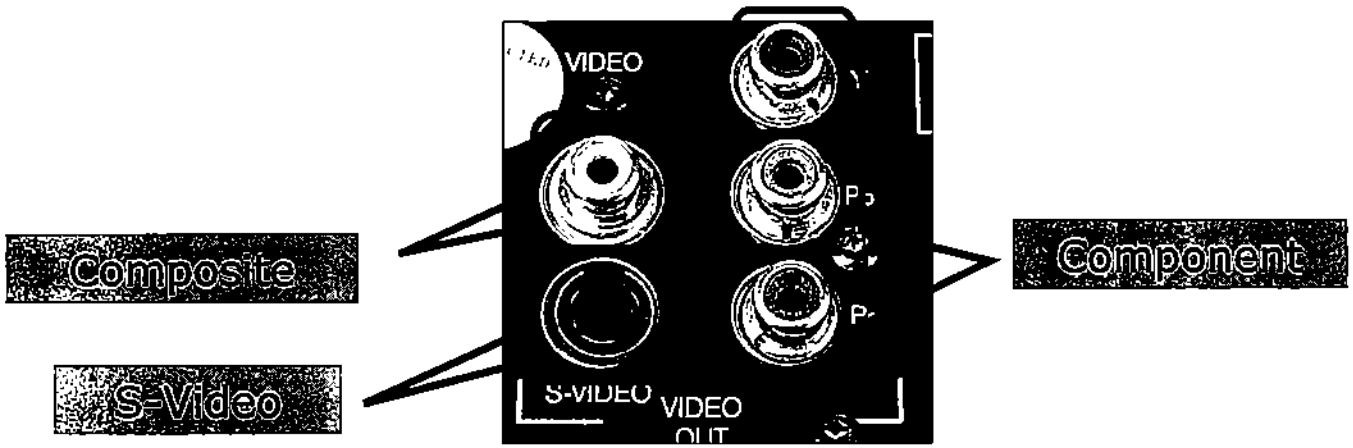
- CRT can display any resolution picture without conversion
  but LCD and PDP can do only with scaler
- Accepting input images from multiple sources and displaying
  them on any flat panel display
- Scaler is most important IC in flat panel display

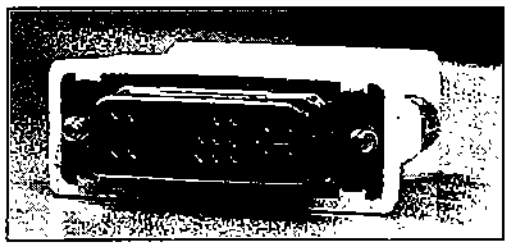


Signal types

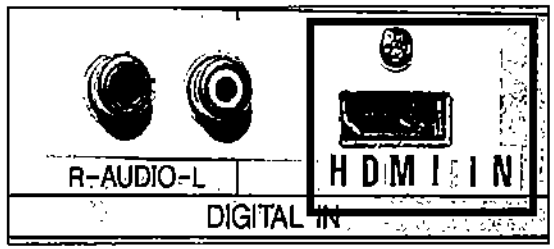
1. RF(Radio Frequency)
   - 50~900Mz Frequency Domain
   - Composite signal+sound signal
2. CVBS(Usually AV)
   - Composite video and sound signal
3. Super VHS
   - Separate Y and C from composite signal
4. RGB
   - Usually use PC, 15pin D-sub
5. Analog Component (Y,Pb,Pr)
   - Usually Component
6. Digital Component(Y,Cb,Cr)
7. DVI(Digital Visual Interface)
   - Standard from DDWG(Digital Display Working Group)
   - TMDS(Transition Minimized Differential Signaling Signal)
8. HDMI(High Definition Multimedia Interface)
   - DVI+Digital Sound

TV signal connector types

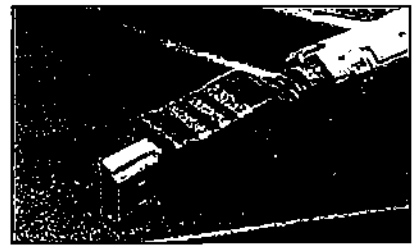




DVI Cable

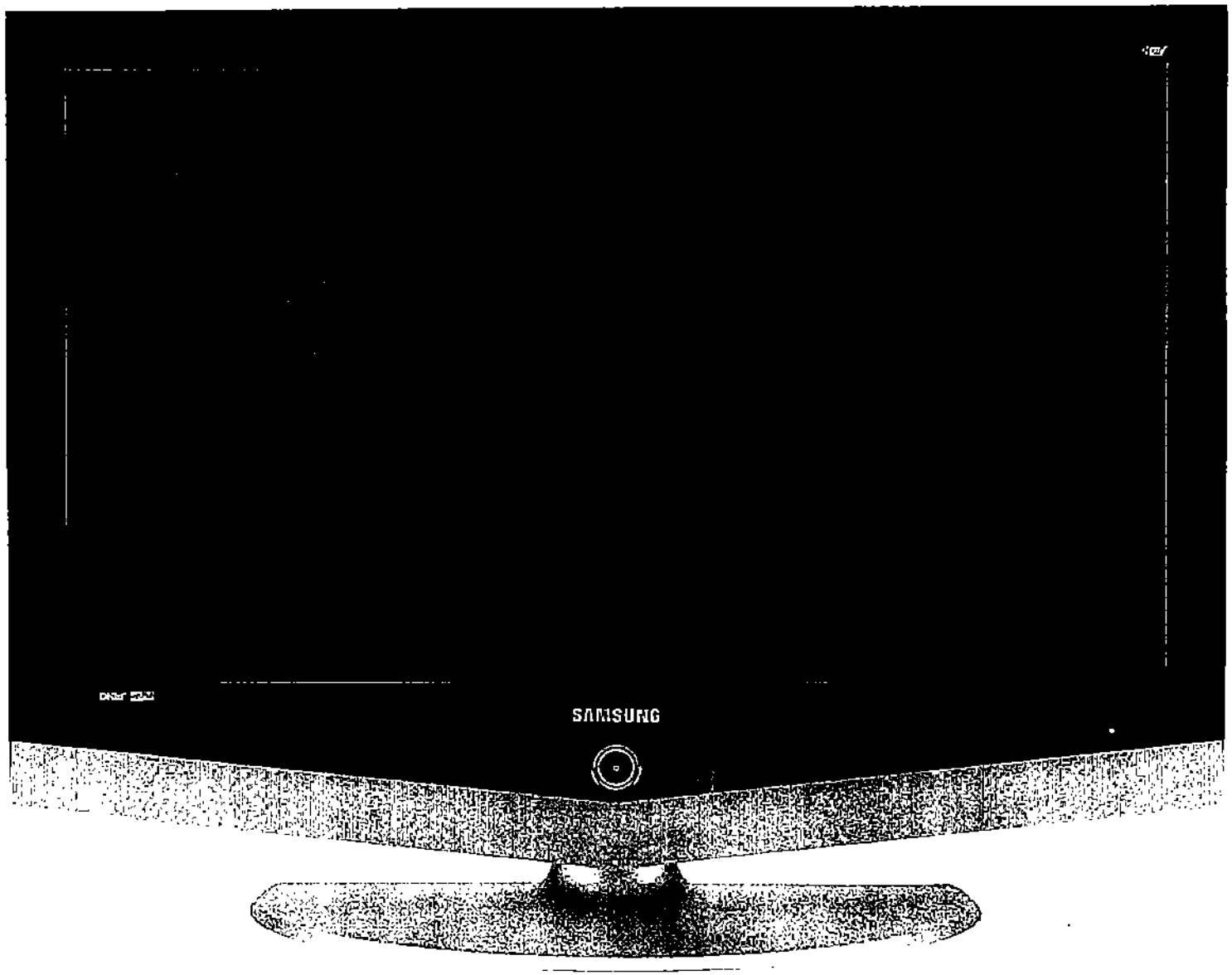


HDMI



HDMI Cable

Model



CONTENTS

Introduction

- Best Picture Quality
- Simple Function, New Design
- Acceptable Price
- Support HDMI(DTV Only)
- Some Functions (My Color Control, Brightness Sensor, Dynamic Contrast)

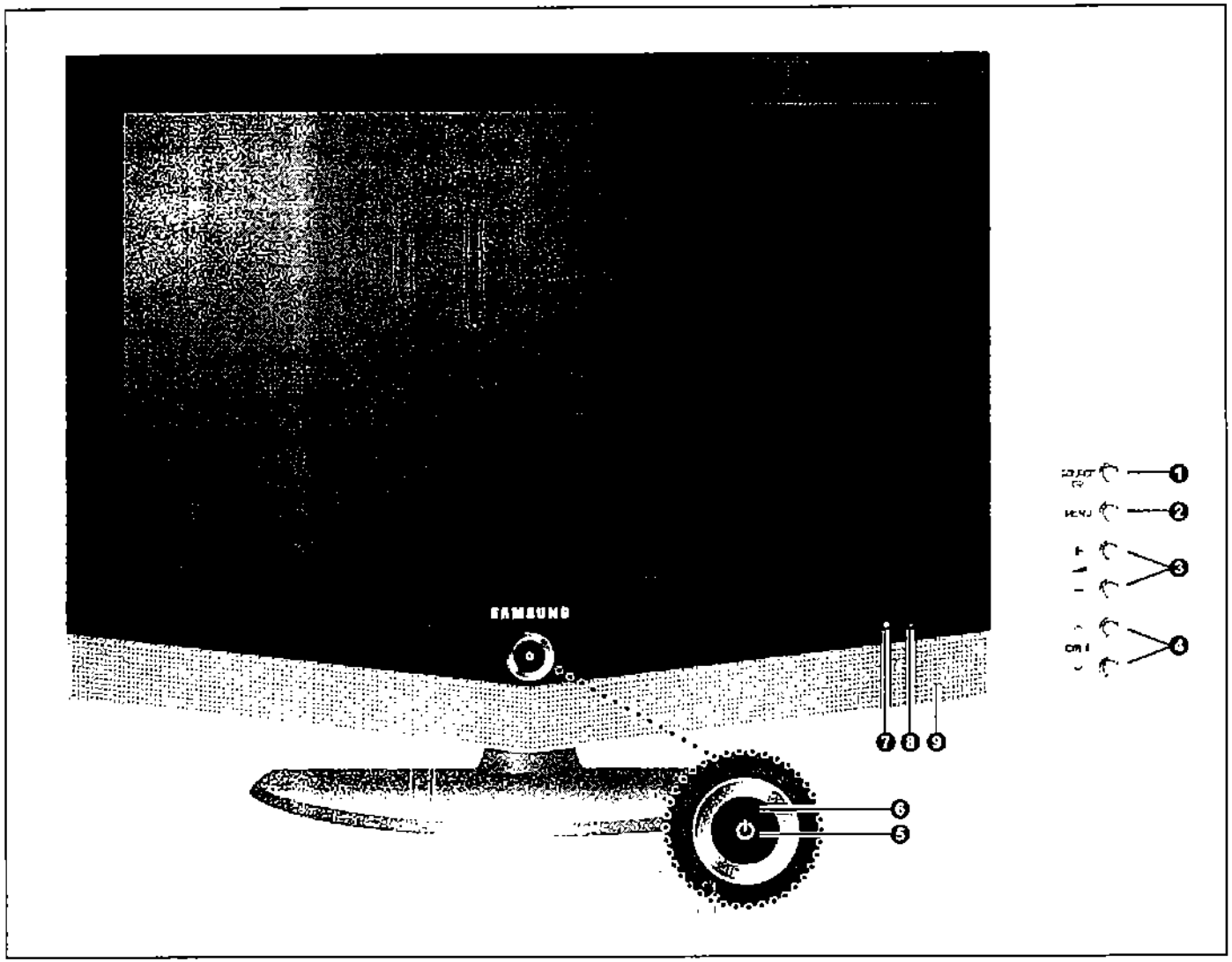
# of ROME Model

Items		ROME	
Model Name		LE23R51B	LE26R51B
General	Size (W*D*H) w/o Stand	583*90*443 (mm)	662*94*498 (mm)
	Display area	508.125(H) x 285.696(V)	575.77(H) x 323.71(V)
	Weight with Stand	8.6kg	11.3kg
	Panel Resolution	1366*768	1366*768
	A/V	2 Scarts in back	2 Scarts in back
	S-Video	1 S-video in back	1 S-video in back
	DVD	1 component in back 480i/p,/576i/p,720p,1080i	1 component in back 480i/p,/576i/p,720p,1080i
	PC	1 Dsub in back	1 Dsub in back
	HDMI	X	1 HDMI in back
	Tuner	1 RF analog tuner	1 RF analog tuner
	Sound Output	16 ohm, 3W	16 ohm, 5W
	PIP	O	O
	Sound option	SRS TruSurround XT	SRS TruSurround XT
	DNIe	O	O
	Headphone	O	O
	Response time	<10ms	<16ms
	Luminance [cd/m2, typical]	500	500
	C/R [typical]	800	800
	Anynet	X	X
	View Angle(H/V)	170/170	170/170
	Power Supply	AC 220~240V,60/50Hz	AC 220~240V,60/50Hz
	Power Consumption	130W	140W
	Color System	PAL/SECAM/NT4.43	PAL/SECAM/NT4.43
	Sound System	BG,DK,I,L	BG,DK,I,L

# of ROME Model

Items		ROME	
Model Name		LE32R51B	LE40R51B
General	Size (W*D*H) w/o Stand	797*99*592 (mm)	989*110*703 (mm)
	Display area	697.6845(H) x 392.256(V)	885.168(H) x 497.664(V)
	Weight with Stand	17.7kg	27.2kg
	Panel Resolution	1366*768	1366*768
	A/V	2 Scarts in back	2 Scarts in back
	S-Video	1 S-video in back	1 S-video in back
	DVD	1 component in back 480i/p,/576i/p,720p,1080i	1 component in back 480i/p,/576i/p,720p,1080i
	PC	1 Dsub in back	1 Dsub in back
	HDMI	1 HDMI in back	1 HDMI in back
	Tuner	1 RF analog tuner	1 RF analog tuner
	Sound Output	8 ohm, 10W	8 ohm, 10W
	PIP	O	O
	Sound option	SRS TruSurround XT	SRS TruSurround XT
	DNIe	O	O
	Headphone	O	O
	Response time	<16ms	<13ms
	Luminance [cd/m2, typical]	450	500
	C/R [typical]	1000	800
	Anynet	X	X
	View Angle(H/V)	170/170	170/170
	Power Supply	AC 220~240V,60/50Hz	AC 220~240V,60/50Hz
	Power Consumption	150W	230W
	Color System	PAL/SECAM/NT4.43	PAL/SECAM/NT4.43
	Sound System	BG,DK,I,L	BG,DK,I,L

Control & Connection Panel



Control & Connection Panel

❶ SOURCE ⏎

Displays a menu of all of the available input sources (TV, Ext. 1, Ext. 2, AV, S-Video, Component, PC, HDMI).
You can also use the SOURCE ⏎ button on the TV's control panel to make selections.

❷ MENU

Press to see an on-screen menu of your TV's features.

❸ - ▬ +

Press to decrease or increase the volume.
Also used to select items on the on-screen menu.

❹ ∨ C/P. ⏻ ∧

Press to change channels.
Also press to highlight various items on the on-screen menu.
(Without the Remote Control, You can turn on TV by using the Channel buttons.)

❺ ⏻(Power)

Press to turn the TV on and off.

❻ Power Indicator

Blinks and turns off when the power is on and lights up in stand by mode.

❼ Light Detecting Sensor

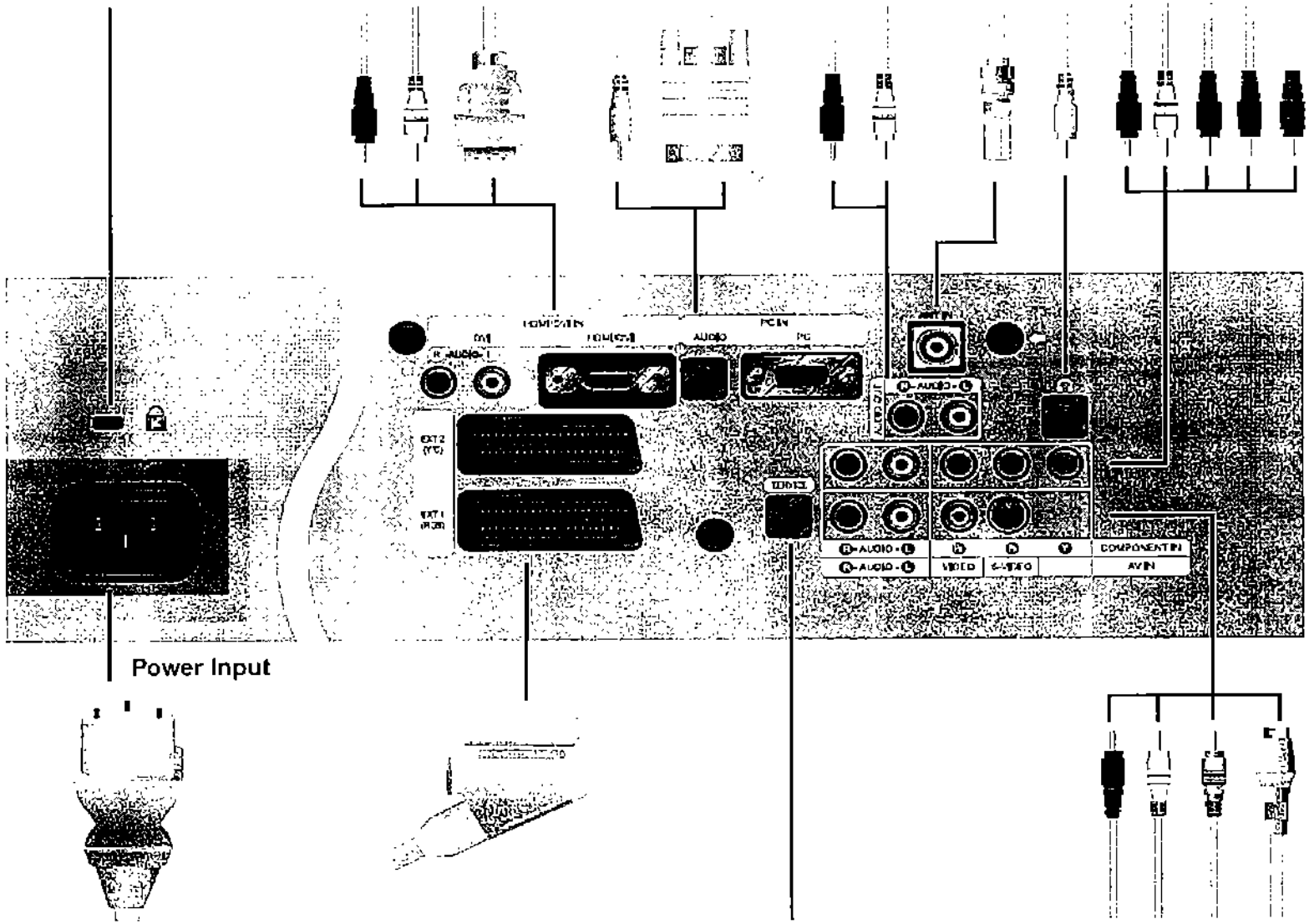
Adjusts brightness of screen automatically by detecting brightness of surrounding environment. This sensor works when Brightness Sensor is on.

❽ Remote Control Sensor

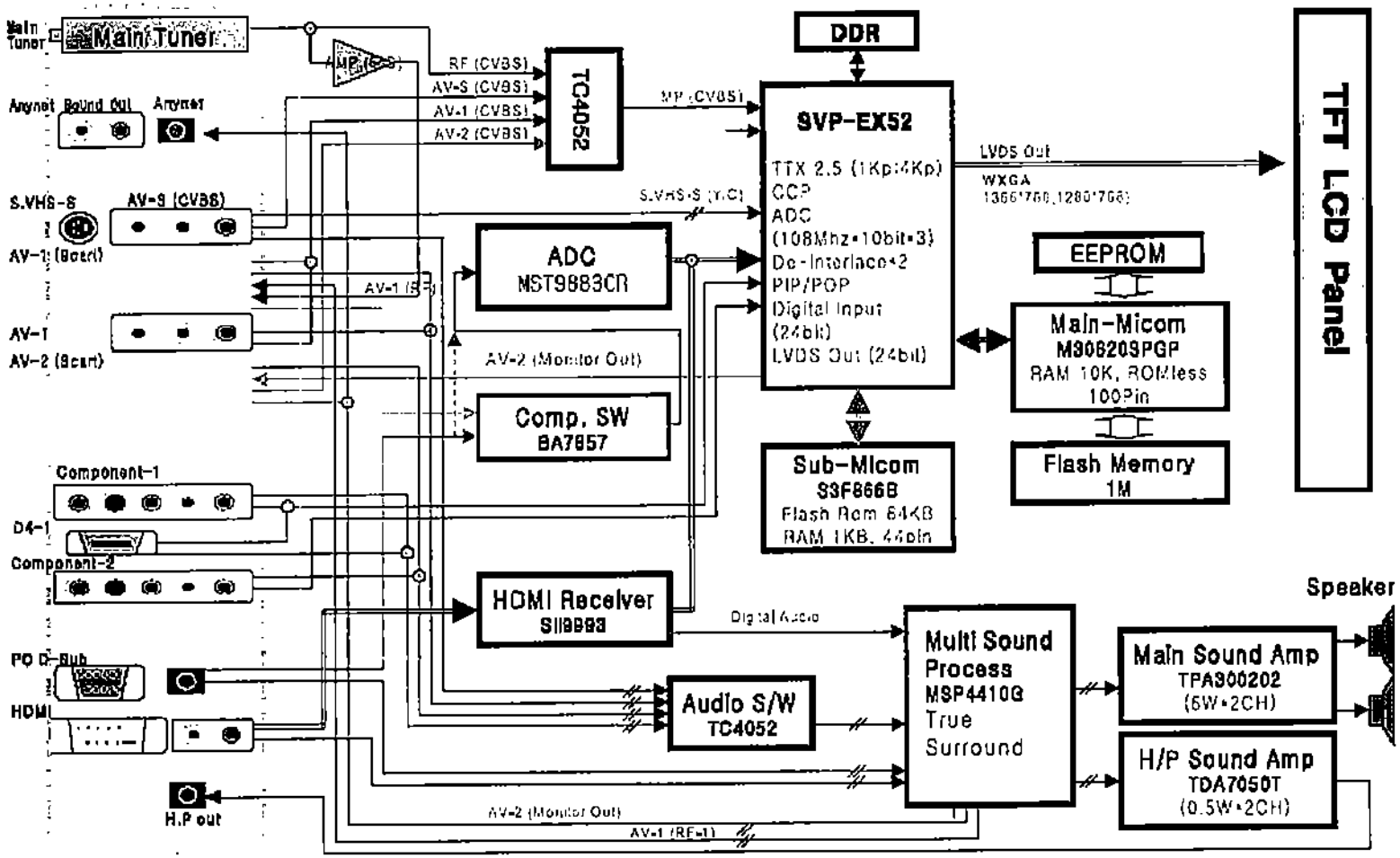
Aims the remote control towards this spot on the TV.

❾ Speakers

Control & Connection Panel

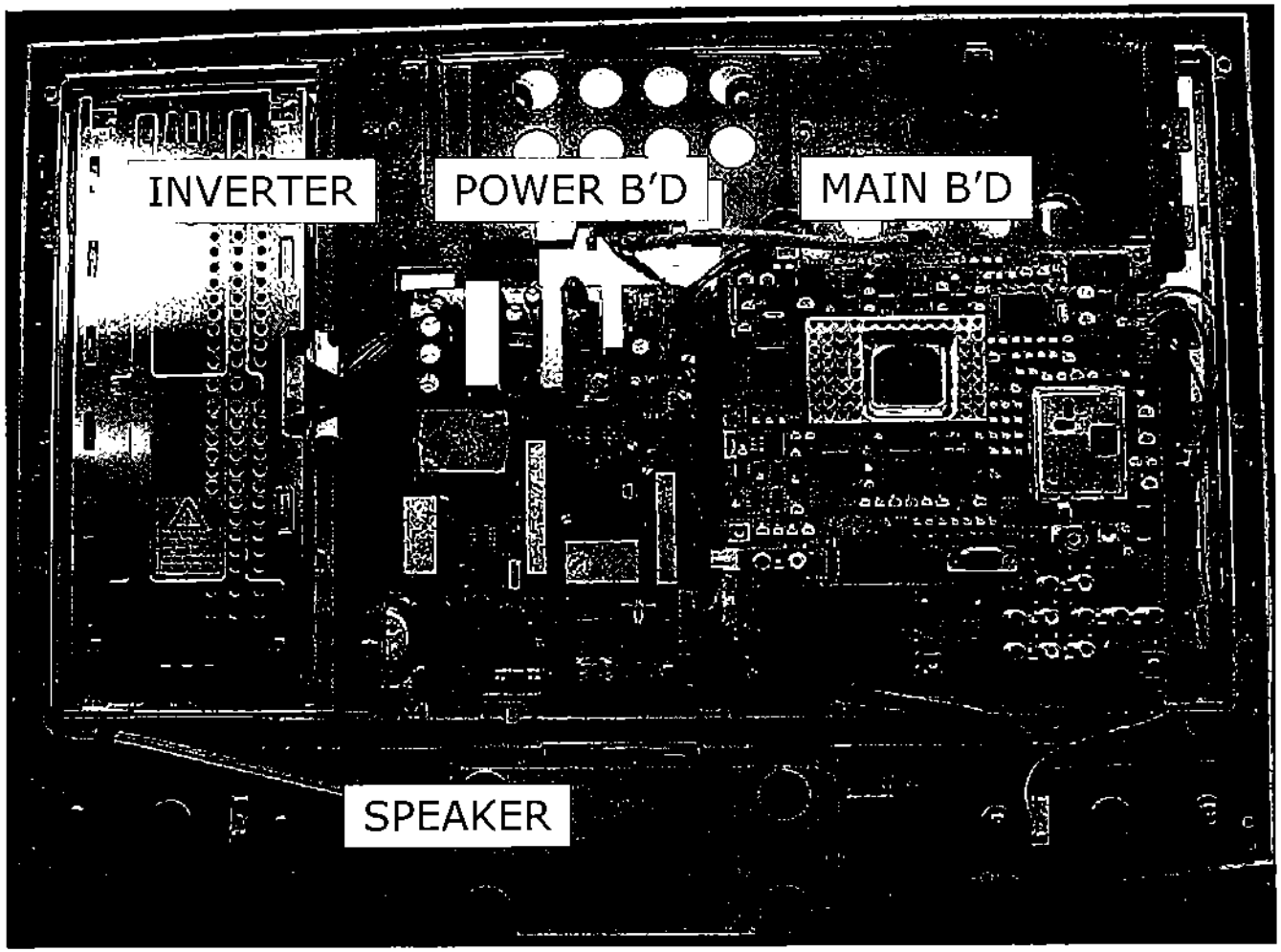


Block Diagram



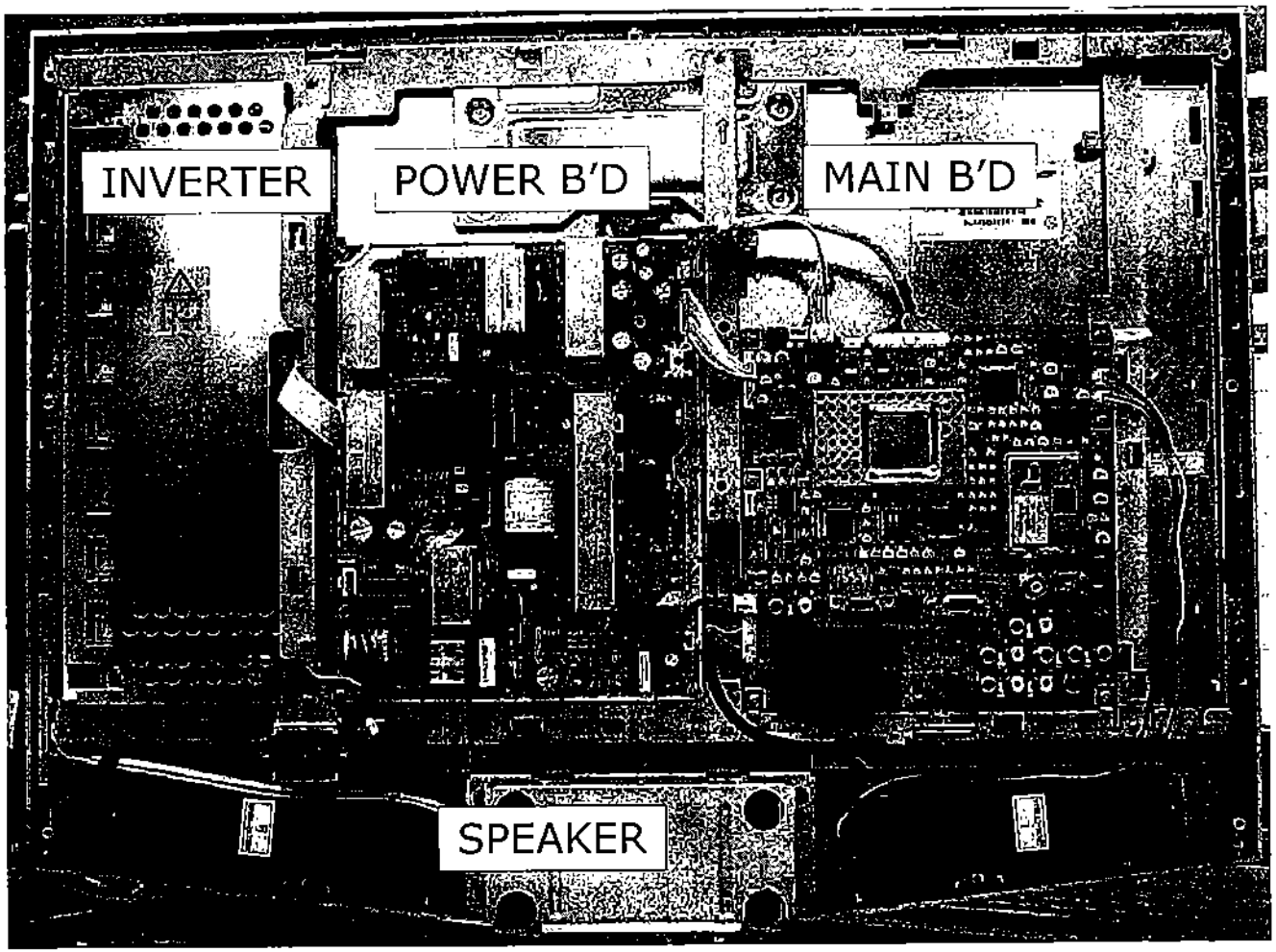
Inner Feature of 23"

- Power, Main Board, Panel(with Inverter)



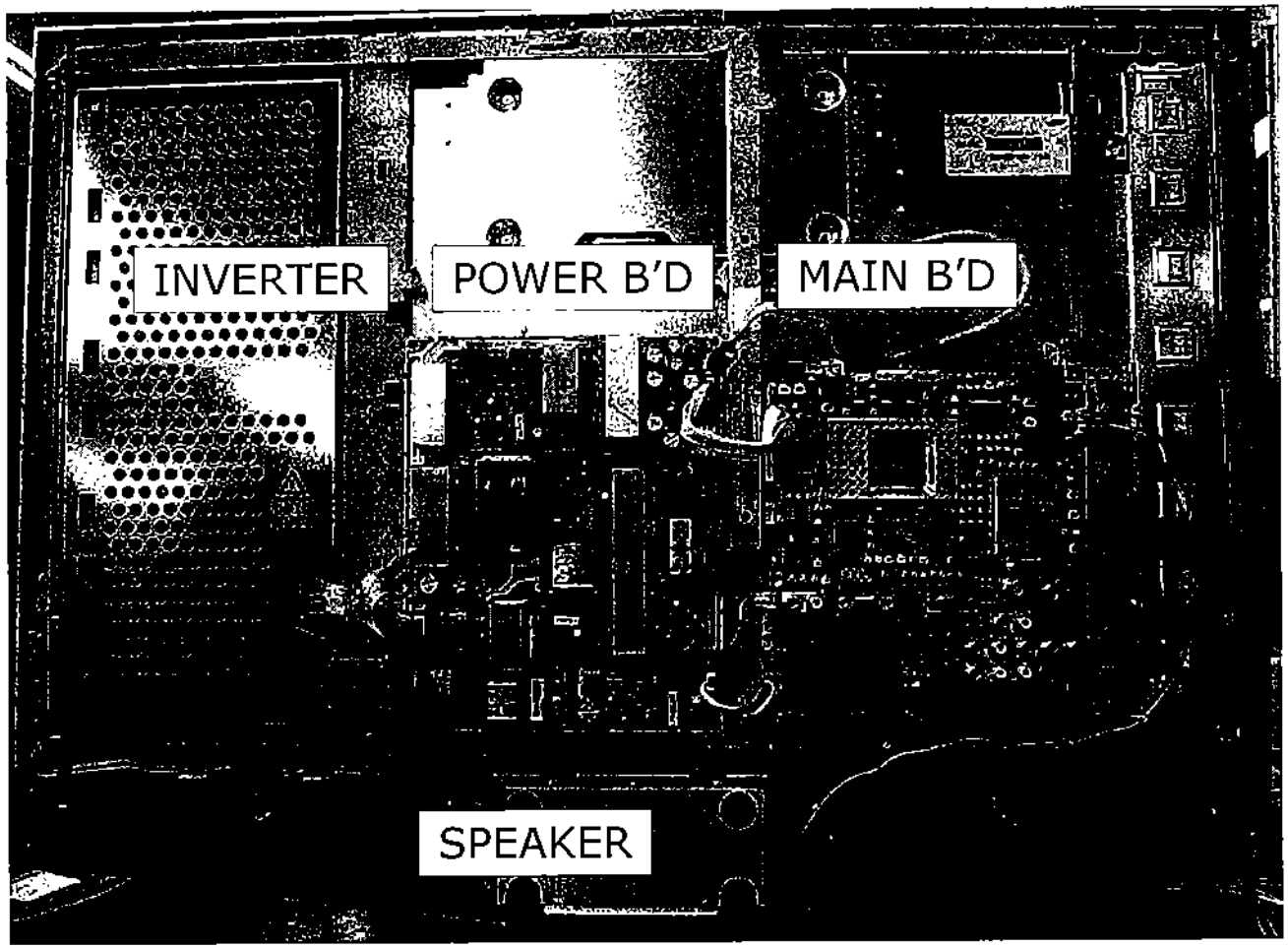
Inner Feature of 26"

- Power, Main Board, Panel(with Inverter)



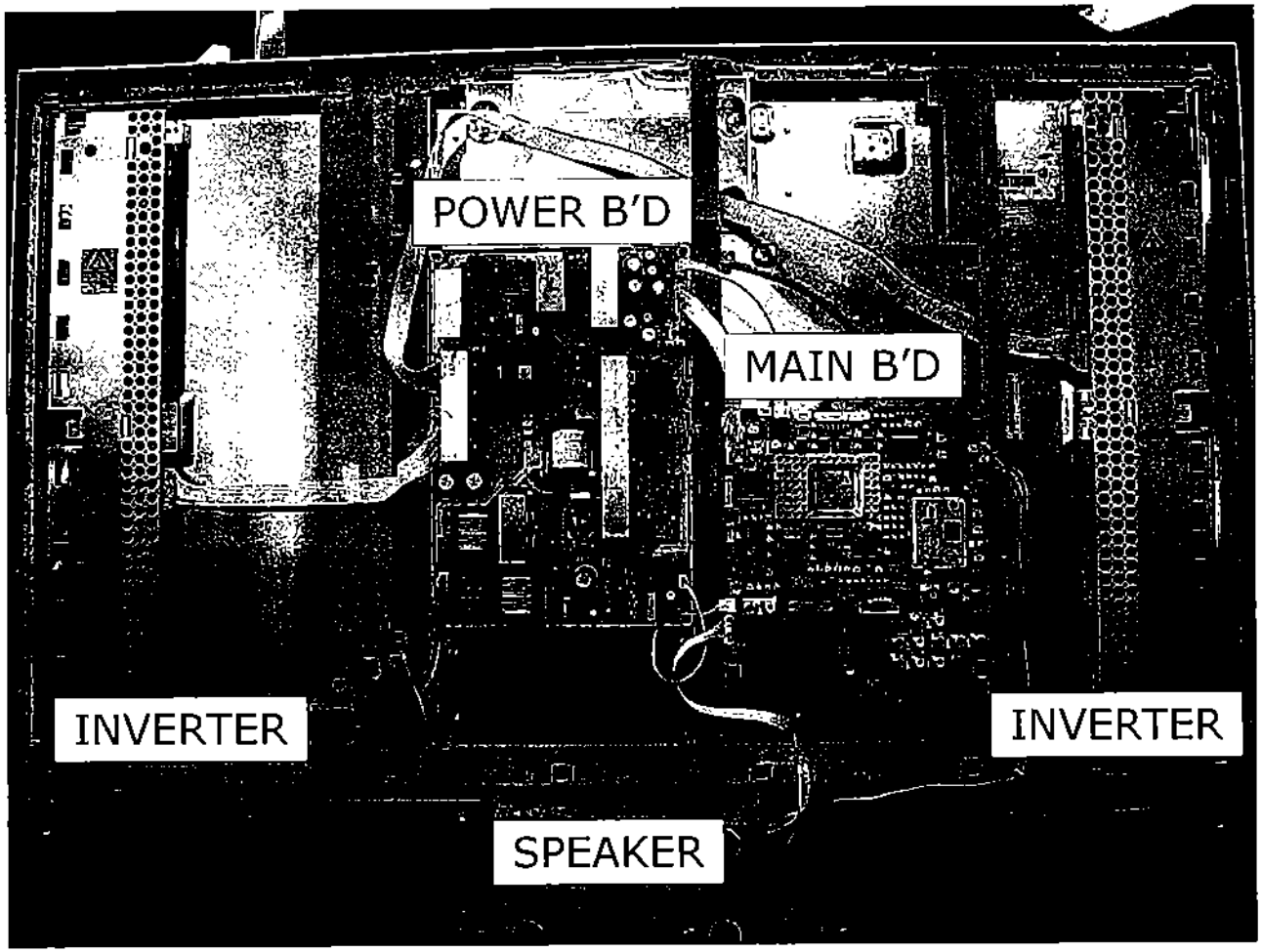
Inner Feature of 32"

- Power, Main Board, Panel(with Inverter)



Inner Feature of 40"

- Power, Main Board, Panel(with Inverter)



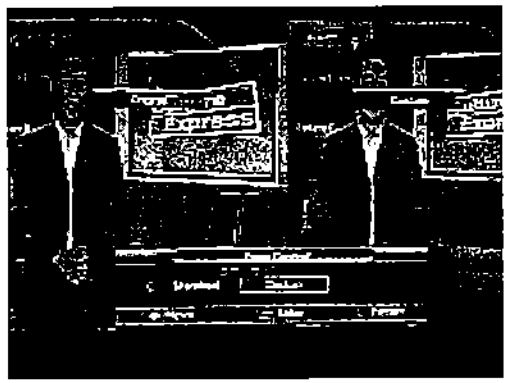
Some Functions of ROME

- My Color Control : Preferred Color Adjustment
  (Blue, Green, Pink)
- Dynamic Contrast : Enhancing Contrast Ratio
  (Up to 1600:1)
- Brightness Sensor : Sensing the outside
  brightness and controlling brightness

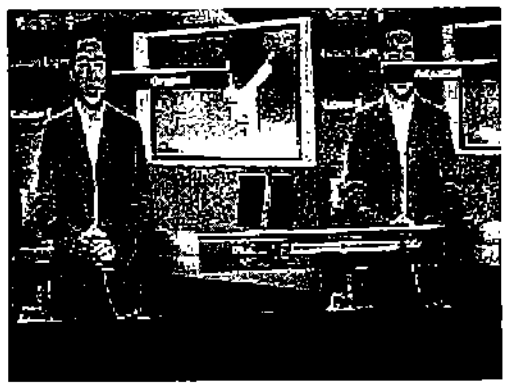
Some Functions of ROME

-My Color Control

- Easy Control mode: Pink, Blue, Green, Standard, Custom.
  "You can choose your favorite color mode."
- Detail Control
  "You can set your favorite Pink, Green , Blue by adjusting R, G, B tone."



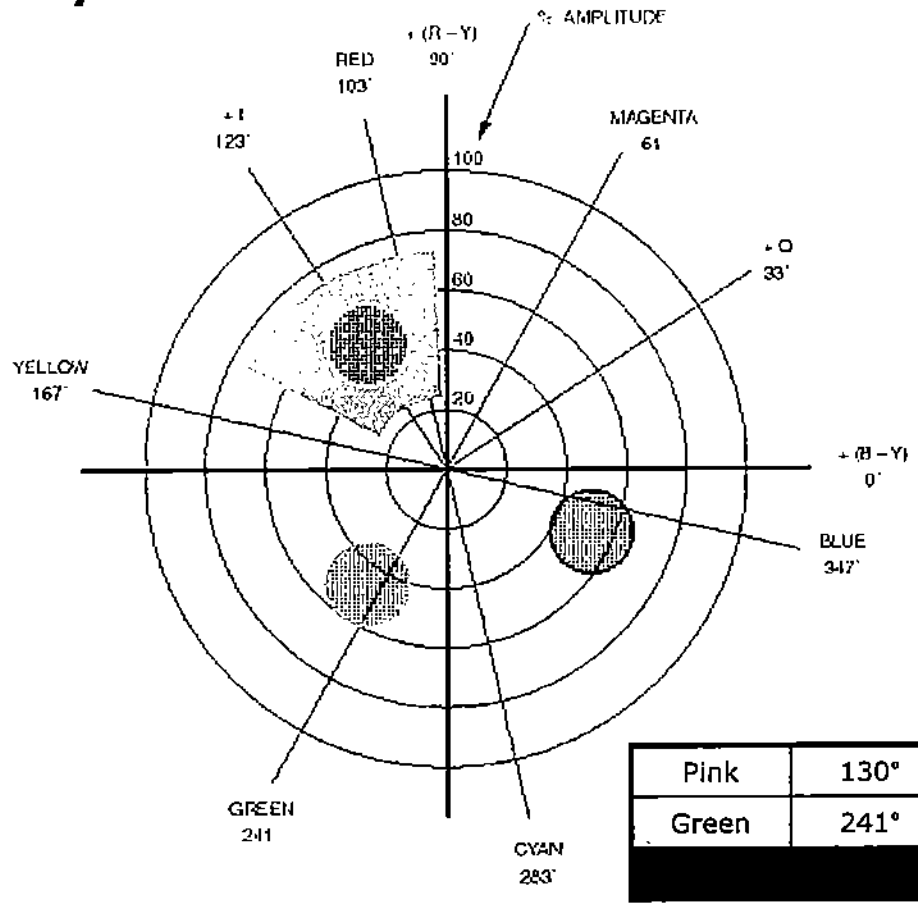
EX: Easy Control



EX: Detail Control

Some Functions of ROME

-My Color Control



Pink	130°
Green	241°

$$Y = 0.29900*R + 0.58700*G + 0.11400*B$$

$$Cb = -0.16874*R - 0.33126*G + 0.50000*B + 0x80$$

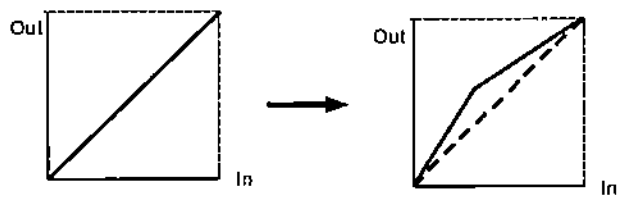
$$Cr = 0.50000*R - 0.41869*G - 0.08131*B + 0x80$$

Some Functions of ROME

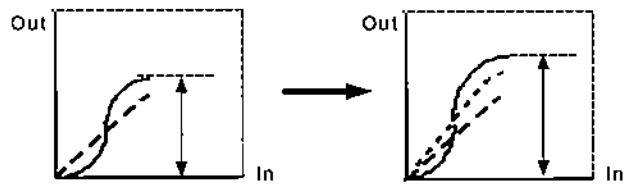
-Dynamic Contrast

※ Reproducing optimized contrast by detecting the characteristics and contrast level of input signal.

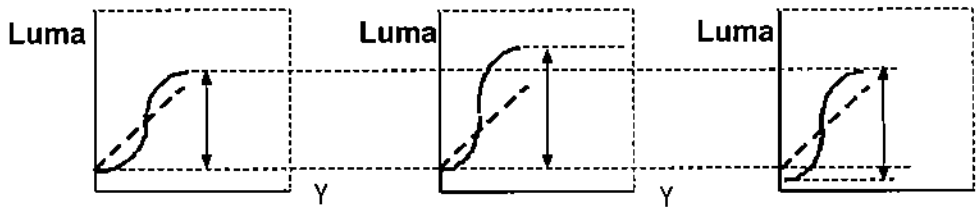
→ Enhancing dynamic contrast (Up to 1600:1)



⇨ Mid range dynamic range Enhancement



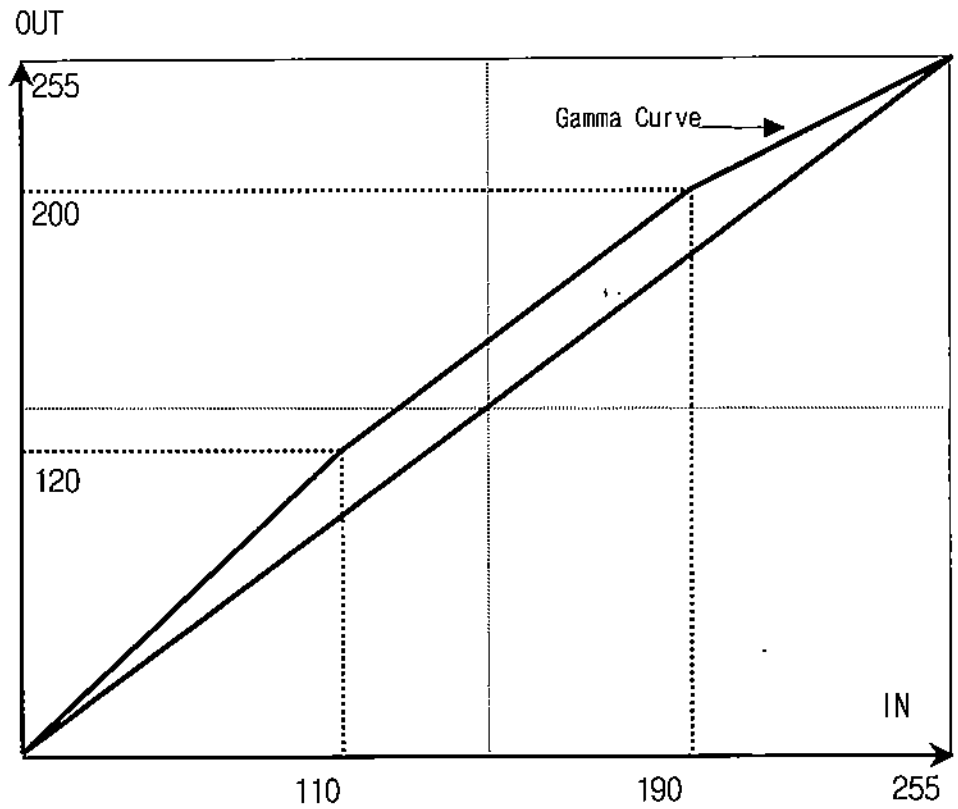
⇨ Contrast Enhancement



⇨ Dimming

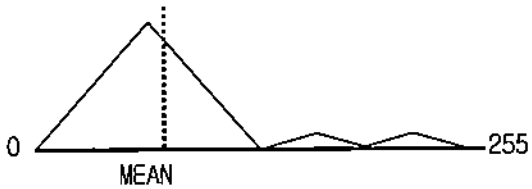
Some Functions of ROME

-Contrast Enhancement Factor



Some Functions of ROME

-Contrast Enhancement & Dimming



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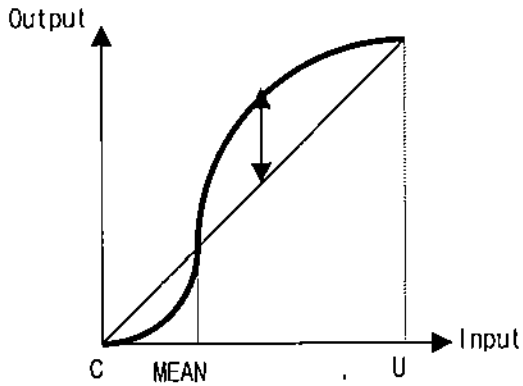

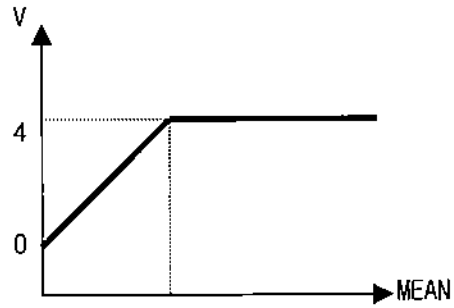

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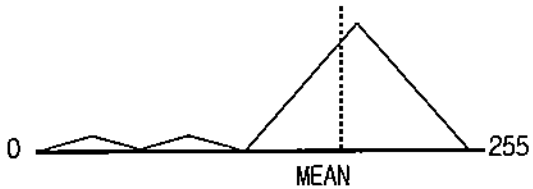
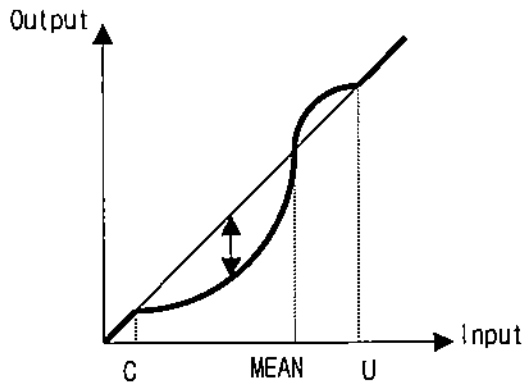
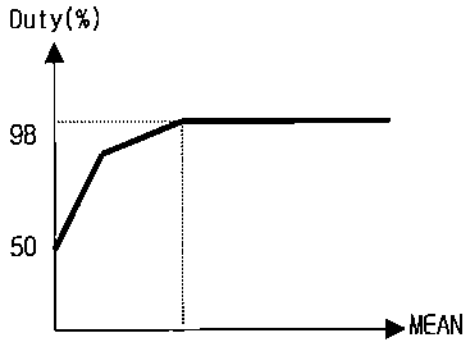


< Bright Image >





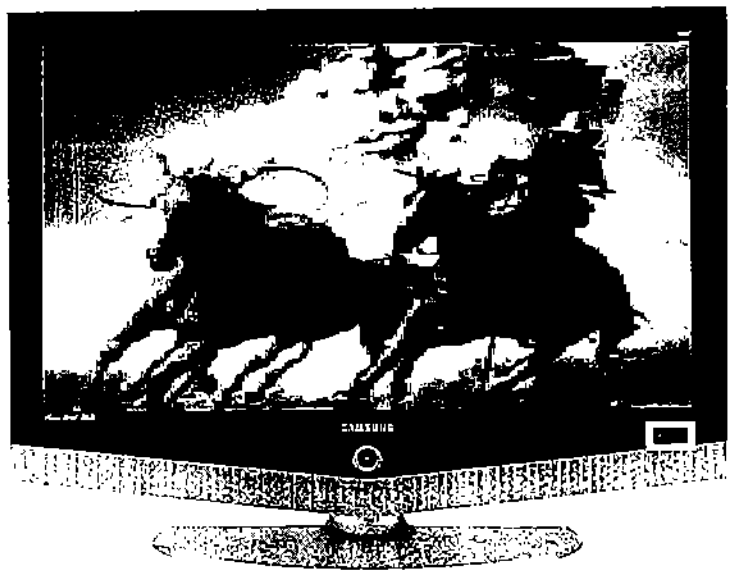
< PWM Dimming >

Some Functions of ROME

-Brightness Sensor

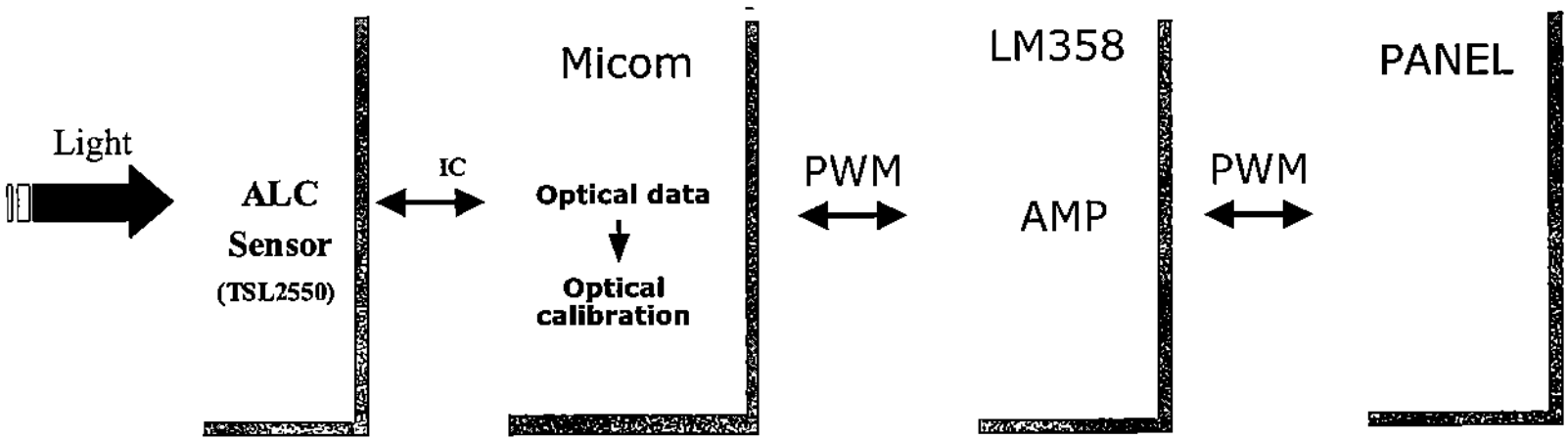
Sensing the outside brightness and controlling the brightness of screen intelligently

30% power saving from backlight control



Some Functions of ROME

-Brightness Sensor



Some Functions of ROME

-Brightness Sensor

SENSOR Input Brightness(LUX)	OUTPUT (PWM DUTY)	OSD Status
0-9	0 (50.0%)	0(MIN)
10-19	8 (55.9%)	1
20-29	16 (61.8%)	2
30-39	24 (67.8%)	3
40-49	32 (73.7%)	4
50-58	40 (79.6%)	5
59-68	48 (85.6%)	6
69-78	56 (91.5%)	7
Over 79	63 (97.5%)	8 (FULL)

Some Functions of ROME

User control functions

1. Source key : Select Video source
   1.1 : Cabinet side Function key
   PAL 23" : TV→Ext.1→Ext.2→AV→S-Video→Component→PC
   PAL 26"~40" : TV→Ext.1→Ext.2→AV→S-Video→Component→PC→HDMI
   1.2 : Remote control Function key
   PAL 23" : Ext.1→Ext.2→AV→S-Video→Component→PC
   PAL 26"~40" : Ext.1→Ext.2→AV→S-Video→Component→PC→HDMI

2. Menu key : Open the OSD and Exit the highlighted function.

3. ◀ ▶ : - Moves the selector left or right on the OSD.
   - Increase or decrease the values of the selected function
   - VOL + : Increase or decrease the level of audio volume.
   (in the Anynet mode, You can control only TV volume)

4. ▼ ▲ : Moves the selector up or down on the OSD.
   - CH + : Increase or decrease the channel number .

5. Power : 1) Turn ON/OFF the TV.
   2) Indicates the status of the Monitor.
   - Black : Normal Operation.
   - Red : Power Off or Disconnected Signal Cable.
   - Red Blinking : PC DPMS Mode.

Some Functions of ROME

OSD functions and adjustments

1. Input - TV/Video Change the image
   PAL 23" : TV→Ext.1→Ext.2→AV→S-Video→Component→PC
   PAL 26"~40" : TV→Ext.1→Ext.2→AV→S-Video→Component→PC→HDMI
   Edit Name : Edit Mode Name

2. Picture
   - Mode : Change the image to Standard/Dynamic/Movie or adjust Custom setting.
   - Custom setting : Contrast/Brightness/Sharpness/Colour/
     Tint(Not Used in PAL System)
   - Color Tone : Change the display color to Warm1/Warm2/Normal/Cool1/Cool2.
   - Size : Change the aspect ratio
     AutoWide/Wide/Panorama/Zoom/ 4:3
     (Enable mode: RF, AV, Component 480i/p the others: disable)
     Wide/Zoom/ 4:3 (Enable mode: Component 720p, 1080i, the others: disable)
     Wide/Normal(4:3) (Enable mode: PC&DVI the others: disable)
   - Digital NR : Noise Reduction Filter On/Off
   - DNIe DEMO: Compare Original and enhanced image (On/Off)
   - My Colour Control : Change the colours of image for private taste
     Easy Control : Select an one setting, Custom/Standard/Pink/Green/Blue
     Detail Control : Change colour status, Pink/Green/Blue
     Reset : Reset all values for default

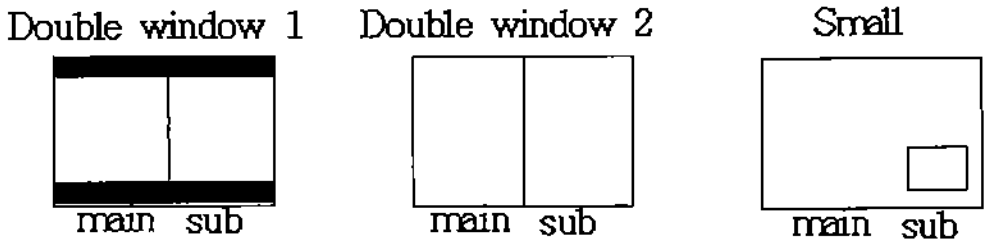
Some Functions of ROME

OSD functions and adjustments –continue-

- Dynamic Contrast : Enhance Contrast ratio for image (On/Off)

- Brightness Sensor : Control Max brightness for ambient luminescence (On/Off)

- PIP : Turn ON/OFF
  Source : Select PIP source
  Mode change : Sub Picture selection
  Swap : Exchange Main&Sub picture
  Size : DW1, DW2, SMALL



Position : When PIP size is small size mode, change picture location
Prog. : When sub PIP source is TV, changes the channel

Some Functions of ROME

OSD functions and adjustments –continue-

3. Sound : - Mode : Change the sound mode to
Standard/Music/Movie/Speech or adjust Custom setting.
- Custom Sound : Change EQ. and balance
- Sound Enhance : Model option
23" : SRS WOW : Select mode of SRS (On/Off)
26"~40" : SRS TSXT : Select mode of SRS
(Off/3D Mono/Stereo)
- Auto Volume : On/Off
- Internal Mute : On/Off
- Sound Select : Main/Sub (at PIP Mode)

4. Channel
- Country/Auto Store/Manual Store/Add-Delete/Sort/Name/Fine tune

Some Functions of ROME

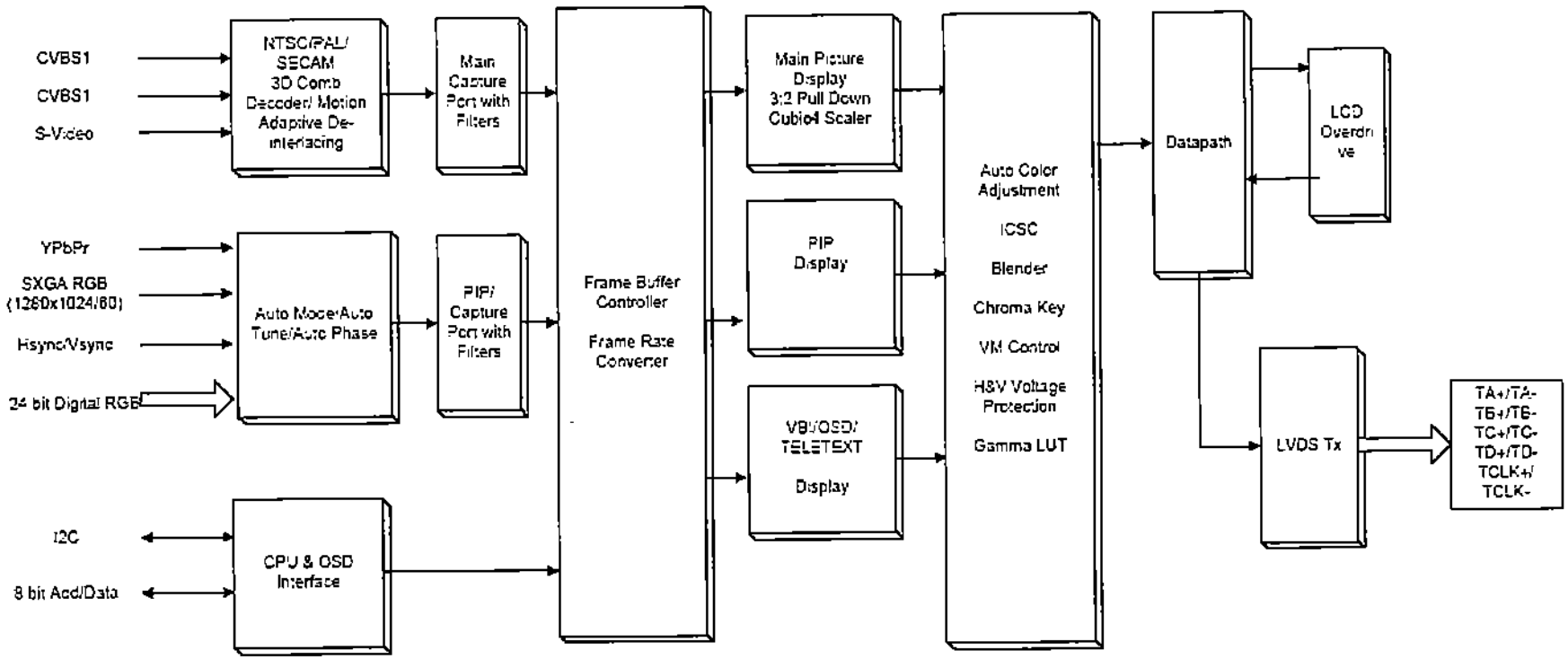
OSD functions and adjustments –continue-

5. Setup
   - Plug & Play : Execute PNP
   - Language : Select country language
   - Time : Setting the current clock
     Setting the Sleep Timer
     Setting the On Time / Off Time
   - Child Lock : Execute child lock On/Off
     Select the CH. be locked
     Lock On/Off
   - Blue Screen : Turn On/Off
   - Melody : Turn On/Off
   - Setting the PC (at PC Mode)
     Lock image : Setting the Coarse/Fine
     Position : Change the position of image
     Auto Adjustment : Execute auto adjustment
     Image Reset : Change the Coarse/Fine as default

Key parts of ROME

1. SCALER : SVP-EX52
2. AUDIO : MSP44x0G
3. HDMI : SIL9933
4. ADC : MST9883CR

SCALER: SVP-EX52



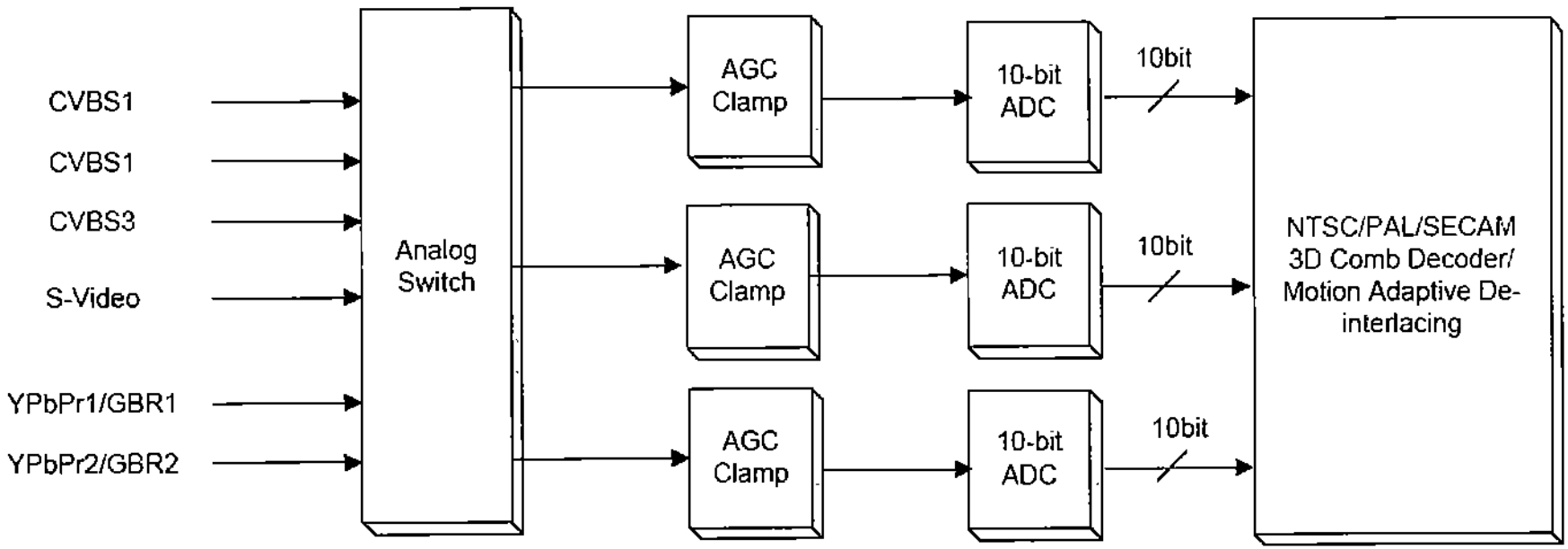
SVP™EX-52/51 Functional Block Diagram

SCALER: SVP-EX52

The SVPTMEX52/51 system implementation key advantages

1. 256-pin QFP package
2. SVPTMEX52/51 supports two CVBS and one Svideo, two HD YPrPb component or PC RGB input and one 24-bit digital input ports
3. Digital input ports support either one 24-bit port, two 8- bit ports or one 16-bit mode
4. ADC single port with 3 channels.
   a. For SD/HD analog video input modes of CVBS/Svideo/Component, and HD D1/D2/D3/D4 modes
   b. For PC RGB input modes. It has PC auto mode/auto clock phase detection.
5. LVDS "single" port is built-in, supporting output resolution up to SXGA, 1280x1024x60P
6. Supports HD YPRPB de-interlacing mode and 3D-comb video mode.
7. Picture-in-Picture mode and Picture-on-Picture mode supported.
8. SCART support
9. Built-in two motion adaptive de-interlacers
10. Cubic-4 Image Scaling Engine

SCALER: SVP-EX52



TCD3 NTSC/PAL/SECAM Video Decoder Block

SCALER: SVP-EX52

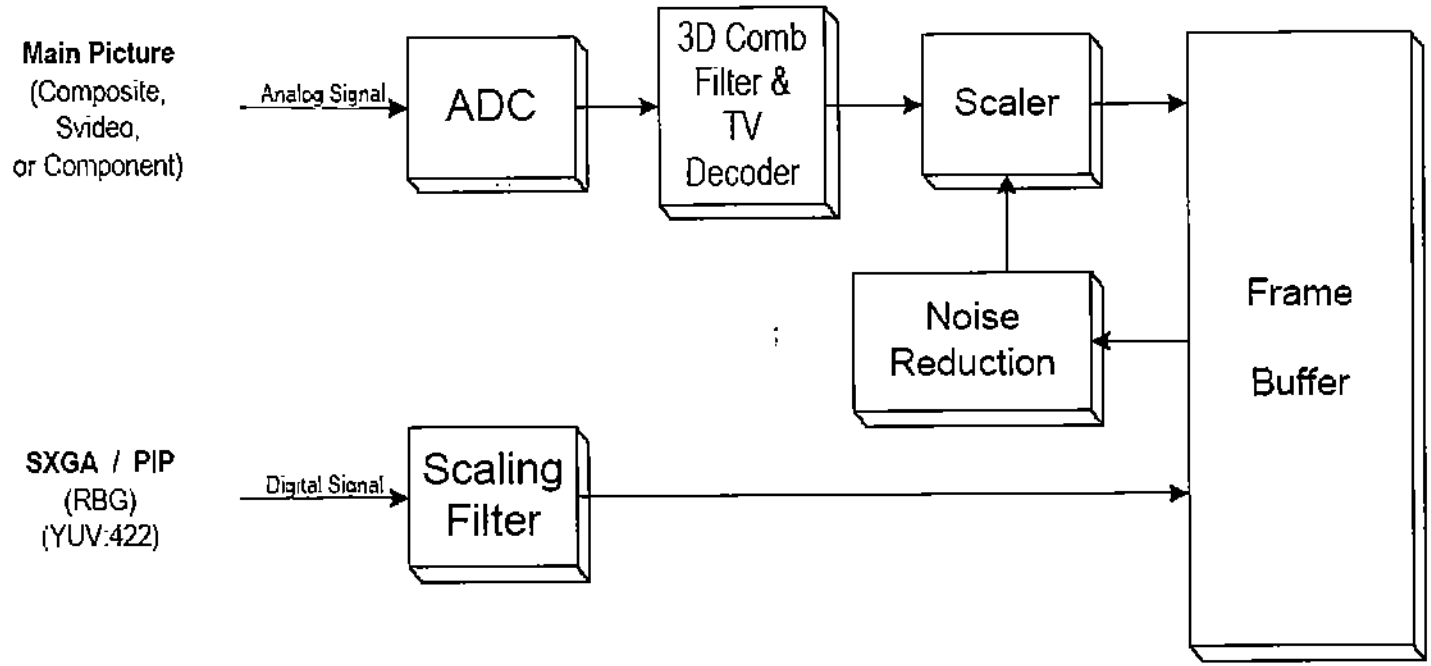
NTSC/PAL/SECAM Video Decoder

The integrated TCD3 NTSC/PAL/SECAM 3D comb video decoder can take an analog TV signal and convert it to digital format. The analog TV signal can be in the composite, S-Video, or component format.

The two internal analog switches can be programmed to select different input signal formats. The selected analog TV signal is sent to Automatic Gain Control (AGC) and then to a 10-bit ADC. The input sampled by ADC's can be NTSC, PAL, SECAM, and all progressive modes. The input signal can have Macrovision, which the decoder will detect and compensate for.

It also supports WSS input detection. The non-decoded signal goes to a programmable 3D comb filter to maintain the vertical chrominance resolution during luminance (Y) and chrominance (C) separation.

SCALER: SVP-EX52



Capture Block

SCALER: SVP-EX52

Capture Port

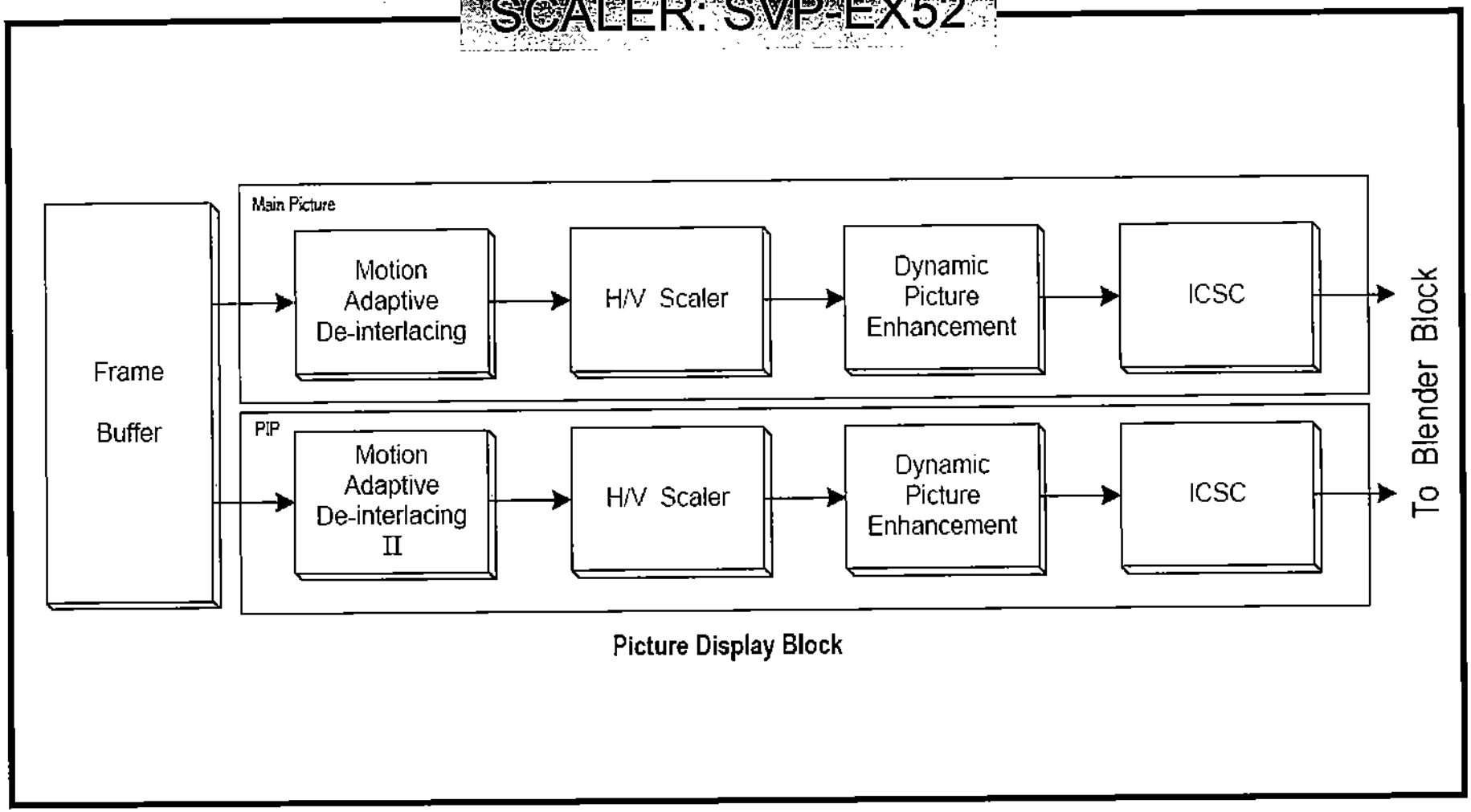
The capture block consists of two separate components, the Main Picture block and the PIP block. The Main Picture block accepts an analog signal through the Analog Front End (AFE), and is processed through a TV decoder.

The TV decoder is equipped with a motion detector that can identify the area of picture containing motion such that a good mix between the temporal and spatial (2D-filter) can be determined.

The filtered signal is then piped through a scaler to produce the preferred format as determined by the selected display mode. SVP™EX digital capture ports support 1080i, 480i, 480p, and 720p, up to SXGA (1280x1024x60) resolution.

The PIP block accepts a digital signal, and provides a preferred format like the Main Picture block. It is not equipped with 3D Digital Comb Filter/TV-decoder, and has a simpler noise reduction circuitry.

SCALER: SVP-EX52



Picture Display Block

SCALER: SVP-EX52

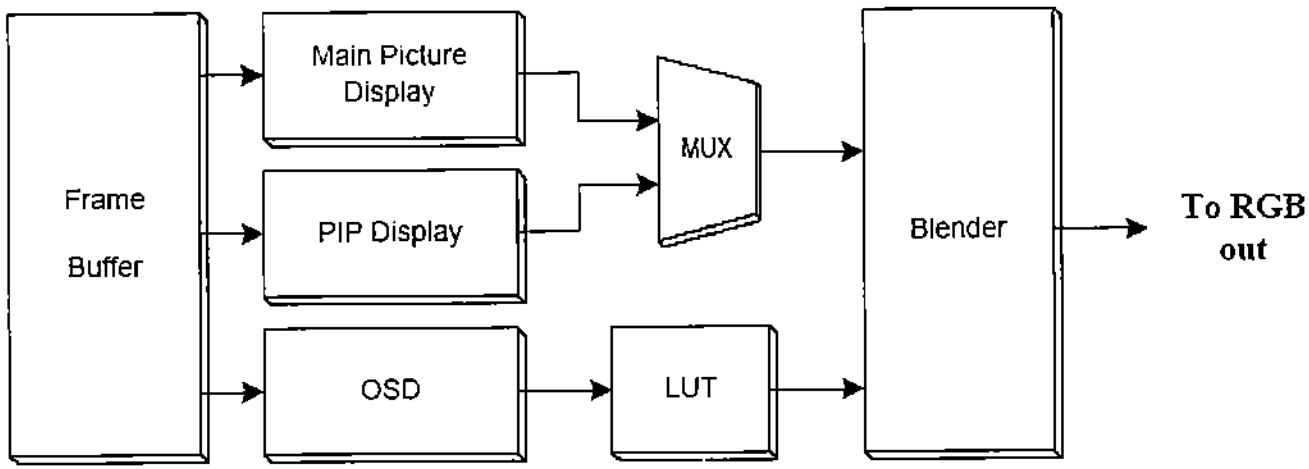
Picture Display

Adaptive Anti-motion Detect De-interlacing is one of the 14 dynamic picture enhancement(s).

This feature is only useful when displaying an image in the progressive mode.
At all other instances, the signal is passed through to the scaler.

1. In a typical progressive display, the video fields can be separated into two groups, namely the Even/Top field and the Odd/Bottom field.
2. There are two modes of progressive displays available—Bob and Weave—that can enhance the "clarity" of the picture. Weave is applied to the static (including text) portion of the picture, and Bob is applied to the motion portion of the picture that is not good. The SVP™EX uses the pixel base adaptive static motion detection algorithm to implement both Bob and Weave methodology on the same picture.
3. For example, a moving object will have the Bob mode applied to it, while the Weave mode is applied to the Understand.
4. Under the 1080i mode, SVP™EX supports either Bob mode de-interlacing or motion adaptive de-interlacing.
5. For PC requirements, SVP™EX supports up to SXGA (1280x1024x60p) output resolution.

SCALER: SVP-EX52



OSD Display Block

The OSD feature is a graphic overlay that can be superimposed over part or all of the decoded video data.

In the SVP™EX, the OSD also supports blending (the OSD has 16-levels of transparency degrees) with the video picture.

SCALER: SVP-EX52

The CPU can write OSD data to the OSD memory located in the frame buffer at any time. When the frame buffer allocates one area for display, the CPU can write new OSD data into another area of the frame buffer for future display. The CPU can also choose the OSD area for current display. All OSD data on the screen is treated as one block in the frame buffer.

The block is in rectangular shape and is defined by four registers. These four registers describe the horizontal start position, the horizontal end position, the vertical start position, and the vertical end position of the OSD block on the screen. An OSD block consists of a pixel bitmap of the OSD, 4/8-bits per pixel. There are a total of 16 colors for OSD display.

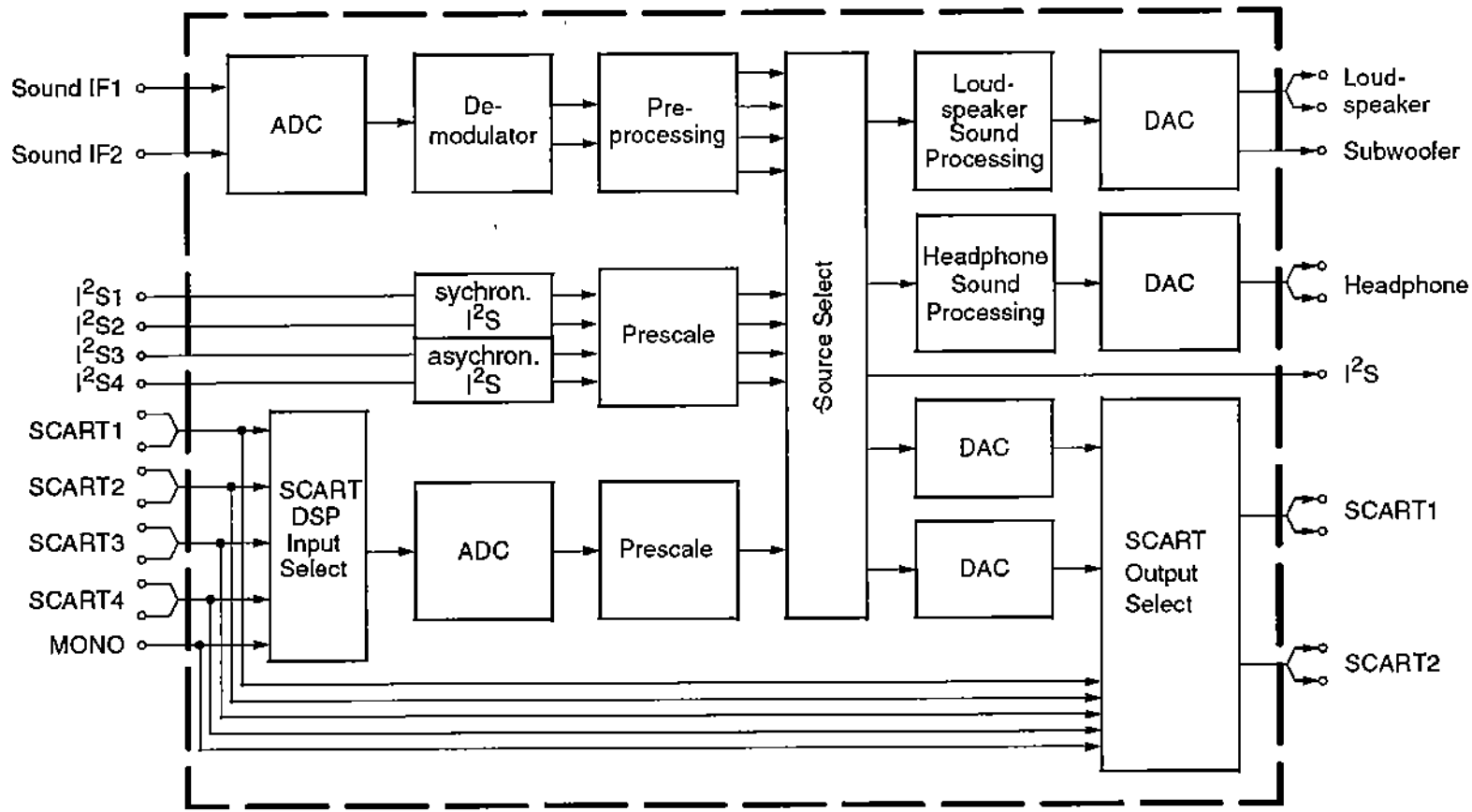
There is a 16x29 bits Look-Up table in the SVP™EX. Each 4-bit OSD index corresponds to a 29-bit color attribute, including 24 bits for RGB true color data and 1 bit for the blink function, which enables/disables color blinking. A register controls the blinking frequency. Another 4 bits are defined as a blend factor, which blends one of the 16-transparency degrees of current OSD color with the Understand OSD.

SCALER: SVP-EX52

The OSD area on screen can be magnified and minified in the horizontal and vertical directions respectively. Two registers control the degree to which the OSD area can be magnified and minified. The OSD supports two basic methods of updating the OSD memory: single-buffer and double buffer. In the single-buffer operation, the OSD display is disabled before the CPU writes new OSD data. In double-buffer operation, the OSD display does not need to be disabled before the CPU updates the OSD data. The available OSD memory in frame buffer is typically partitioned into two equal size buffers, with one buffer being displayed while the other is being updated.

The OSD content on screen can be scrolled up or down in a display window. The scrolling speed is adjustable. The Understand of the OSD is selectable with a control register bit. OSD content can be shown on a normal video or a masking video with pure color, which is a 24-bit RGB color register. The OSD supports analog overlay with outside video or SVGA signals. The SVP™EX provides a signal for this kind of outside analog overlay. There are two kinds of OSD outside overlay methods, the pixel level and the block level. They are controlled by a register bit. The OSD also supports both the interlaced and the non-interlaced display methods.

AUDIO: MSP44x0G



Simplified functional block diagram of the MSP 44x0G

AUDIO: MSP44x0G

Analog Sound IF Input

The input pins ANA_IN1+, ANA_IN2+, and ANA_IN– offer the possibility to connect two different sound IF (SIF) sources to the MSP 44x0G.

The analog-to-digital conversion of the preselected sound IF signal is done by an A/D-converter. An analog automatic gain circuit (AGC) allows a wide range of input levels.

The highpass filters formed by the coupling capacitors at pins ANA_IN1+ and ANA_IN2+.

Some combinations of SAW filters and sound IF mixer ICs, however , show large picture components on their outputs. In this case, further filtering is recommended.

AUDIO: MSP44x0G

Demodulator: Standards and Features

The MSP 44x0G is able to demodulate all TV-sound standards worldwide including the digital NICAM system.

Depending on the MSP 44x0G version, the following demodulation modes can be performed:

A2 Systems:
NICAM Systems:
Very high deviation FM-Mono:
BTSC-Stereo:
BTSC-Mono + SAP:
Japan Stereo:
FM-Satellite Sound:
FM-Stereo-Radio:
Standard Selection:
Automatic Standard Detection:
Automatic Carrier Mute:

AUDIO: MSP44x0G

Preprocessing of Demodulator Signals

The NICAM signals must be processed by a deemphasis filter and adjusted in level. The analog demodulated signals must be processed by a deemphasis filter, adjusted in level, and dematrixed.

The correct deemphasis filters are already selected by setting the standard in the STANDARD SELECT register. The level adjustment has to be done by means of the FM/AM and NICAM prescale registers.

The necessary dematrix function depends on the selected sound standard and the actual broadcasted sound mode (mono,stereo, or bilingual). It can be manually set by the FM Matrix Mode register or automatically by the Automatic Sound Selection.

AUDIO: MSP44x0G

Automatic Sound Select

In the Automatic Sound Select mode, the dematrix function is automatically selected based on the identification information in the STATUS register. No I2C interaction is necessary when the broadcasted sound mode changes (e.g. from mono to stereo).

The demodulator supports the identification check by switching between mono-compatible standards (standards that have the same FM-Mono carrier) automatically and non-audible. If B/G-FM or B/G-NICAM is selected, the MSP will switch between these standards.

The same action is performed for the standards:
D/K1-FM, D/K2-FM, D/K3-FM and D/K-NICAM.

Switching is only done in the absence of any stereo or bilingual identification. If identification is found, the MSP keeps the detected standard. In case of high bit-error rates, the MSP 44x0G automatically falls back from digital NICAM sound to analog FM or AM mono.

AUDIO: MSP44x0G

Source Selection and Output Channel Matrix

The Source Selector makes it possible to distribute all source signals (one of the demodulator source channels, SCART, or I2S input) to the desired output channels (loudspeaker, headphone, etc.).

All input and output signals can be processed simultaneously. Each source channel is identified by a unique source address.

For each output channel, the sound mode can be set to sound A, sound B, stereo, or mono by means of the output channel matrix.

If Automatic Sound Select is on, the output channel matrix can stay fixed to stereo (transparent) for demodulated signals.

AUDIO: MSP44x0G

SCART DSP In and SCART Out Select

The SCART DSP Input Select and SCART Output Select blocks include full matrix switching facilities.

To design a TV set with four pairs of SCART-inputs and two pairs of SCART-outputs, no external switching hardware is required.

The switches are controlled by the ACB user register.

AUDIO: MSP44x0G

I2S Bus Interfaces

The MSP 44x0G has three I2S bus input data lines and one I2S bus output data line.

They are all operated in 48 kHz mode.

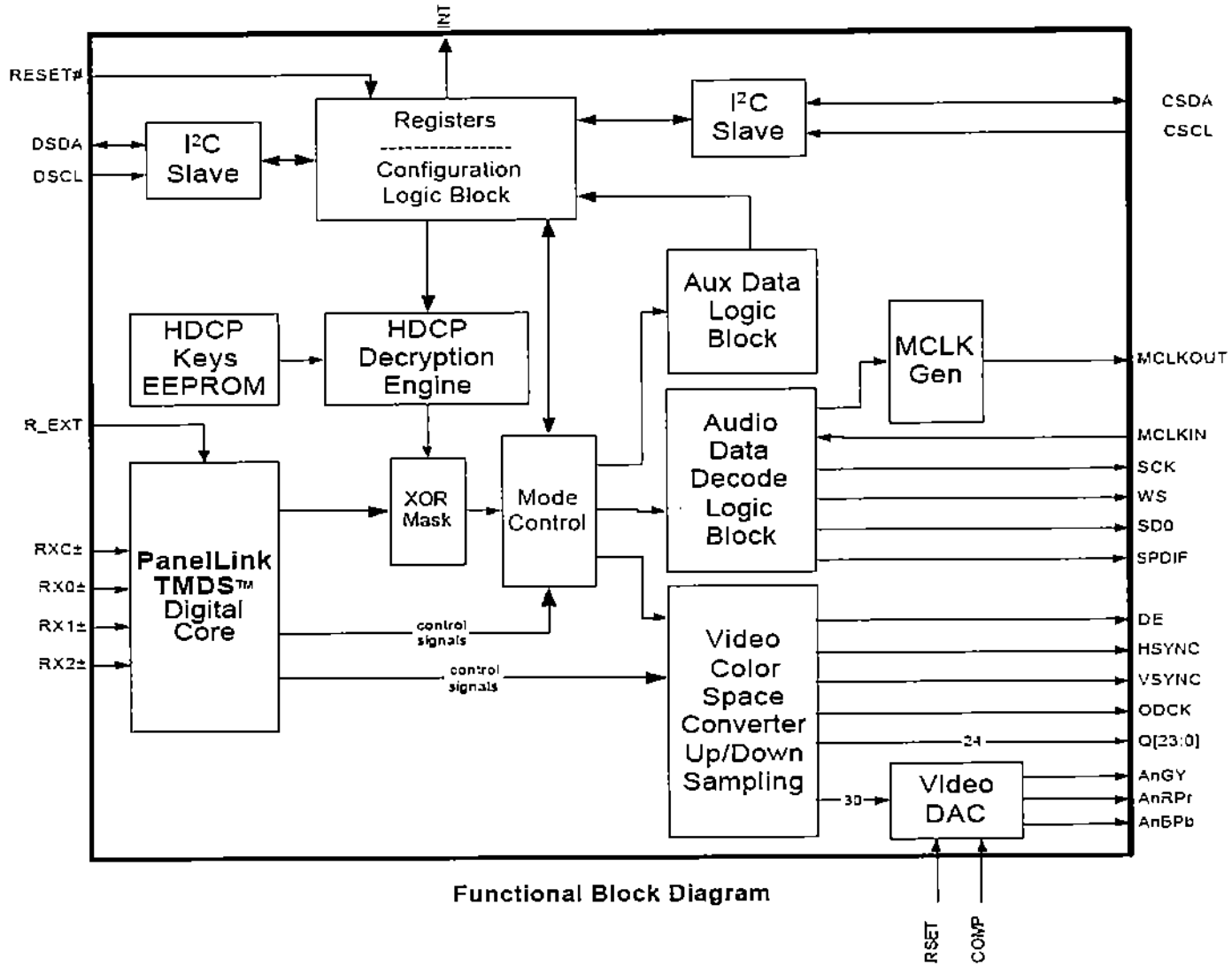
Together with I2S_WS/CL or I2S_WS3/CL3, the data lines form two I2S bus interfaces with various operational modes.

Both interfaces work in synchronous master or slave mode.

They accept a variety of formats with different sample width, bit-orientation, and wordstrobe timing.

All I2S options are set by means of the MODUS and the I2S_CONFIG register.

HDMI: SIL9993



Functional Block Diagram

HDMI: SIL9993

PanelLink TMDS Digital Core
The PanelLink core performs 10-to-8-bit TMDS decoding on the audio and video data received from the three TMDS differential data lines along with a TMDS differential clock. The PanelLink core may sense a stopped clock or stopped video and put the receiver into power-down mode. A resistor tied to the EXT_RES pin is used to match the input impedance to the attached cable.

HDCP Decryption Engine/XOR Mask
The HDCP decryption engine contains all the necessary logic to decrypt the incoming audio and video data. The decryption process is entirely controlled by the host microcontroller/microprocessor through a set sequence of register reads and writes through the DDC channel. Pre-programmed HDCP keys and Key Selector Value (KSV) stored in the on-chip EEPROM are used in the decryption process. A resulting calculated value is applied to an XOR mask during each clock cycle to decrypt the audio/video data.

I2C Slave Interface
The SiI 9993 provides two I2C interfaces: one to communicate back to the HDMI or DVI host across the DDC channel; the other for initialization and control by a local microcontroller in the display.

DDC Bus Interface to HDMI Host
The DDC I2C interface (DSDA,DSCL) on the SiI 9993 is a slave interface capable of running up to 400kHz (3.3Vonly). This bus is connected to the DDC bus and is used for HDCP authentication. These pins are only 3.3V tolerant and should be electrically isolated from the DDC bus which may carry 5V signals.

HDMI: SIL9993

I2C Interface to Display Controller

The Controller I2C interface (CSDA,CSCL) on the SiI 9993 is a slave interface capable of running up to 400kHz (3.3Vonly). This bus is used to configure the SiI 9993 by reading/writing to the appropriate registers.

HDCP Key EEPROM

The SiI 9993 comes pre-programmed with a set of production HDCP keys (or B1 public keys for sample parts) stored in the internal EEPROM. System manufacturers do not need to purchase key sets from the Digital-Content LLC. All purchasing, programming and security for the HDCP keys is handled by Silicon Image. The preprogrammed HDCP keys provide the highest level of security, as keys cannot be read out of the device after they are programmed. Before receiving samples of the SiI 9993 customers must have signed the HDCP license agreement (www.digital-cp.com) or a special NDA with Silicon Image.

Data Input and Conversion

Mode Control Logic

The mode control logic determines if the decrypted data is video, audio or auxiliary information, and directs it to the appropriate logic block.

Video Data Conversion and Output

The SiI 9993 can output video in many different formats. The receiver can also process the video data before it is output, as shown in Figure 3. Each of the processing blocks may be bypassed by setting the appropriate register bits.

Color Space	Video Format	Bus Width	HSYNC/ VSYNC	Output Clock [MHz]			
				480i	480p	720p	1080i
RGB	4:4:4	24	Separate	13.25/27	27	74.25	74.25
YCbCr	4:4:4	24	Separate	13.25/27	27	74.25	74.25
YCbCr	4:4:2	16/20/24	Separate	13.25/27	27	74.25	74.25
YCbCr	4:4:2	16/20/24	Embedded	13.25/27	27	74.25	74.25
YCbCr	4:4:2	8/10/12	Separate	27	54	-	-
YCbCr	4:4:2	8/10/12	Embedded	27	54	-	-

HDMI: SIL9993

Color Space Conversion

The integrated Color Space Converter can convert from RGB to standard definition (ITU.601) or to high definition (ITU.709) YCbCr formats. The HDMI AVI packet defines the color space of the incoming video. If no AVI packets are received, then the default conversion listed by video format in Table 3 should be enabled in the receiver. If a received AVI packet specifies a different conversion, then that specification takes precedence.

Color Range Scaling

The color range depends on the video format, according to the CEA-861 specification. In some applications the 8-bit input range uses the entire span of 0x00 (0) to 0xFF (255) values. In other applications the range is scaled narrower.

The receiver cannot detect the incoming video data range, and there is no required range specification in the HDMI AVI packet. Therefore the receiver chooses scaling depending on the detected video format.

HDMI: SIL9993

Up Sample / Down Sample

Additional logic can convert from 4:2:2 to 4:4:4 or from 4:4:4 to 4:2:2 YCbCr format.

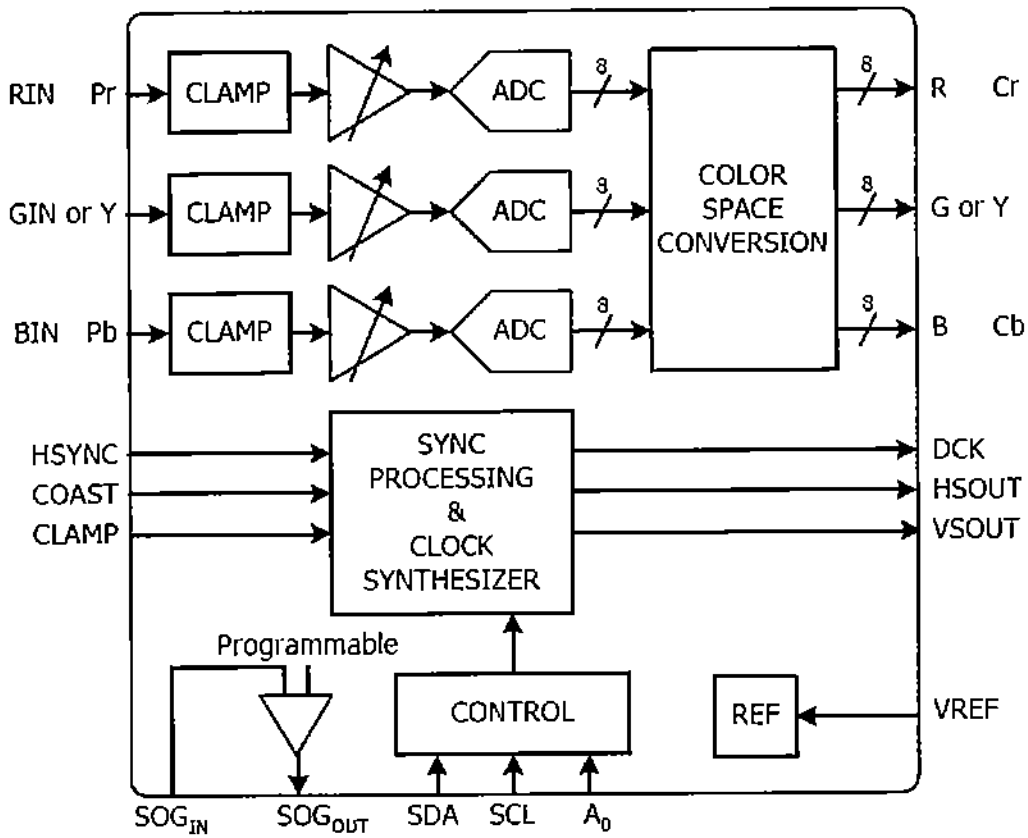
Audio Processing Logic

The audio processing logic block receives the audio stream packets from the HDMI data bus and puts them into an audio FIFO. The audio sample clock is recovered using information in the N/CTS packets and uses that sample clock to pull the data out of the FIFO. The audio data can be output from the receiver as S/PDIF or I2S or both.

Registers are provided to control the byte formatting of the I2S data to simplify direct connection to a variety of audio DACs.

Audio sample rates from 32kHz to 48kHz are supported by both the I2S and S/PDIF outputs. PCM data (IEC 60958) and compressed (IEC 61937) data can be output on the I2S and S/PDIF outputs.

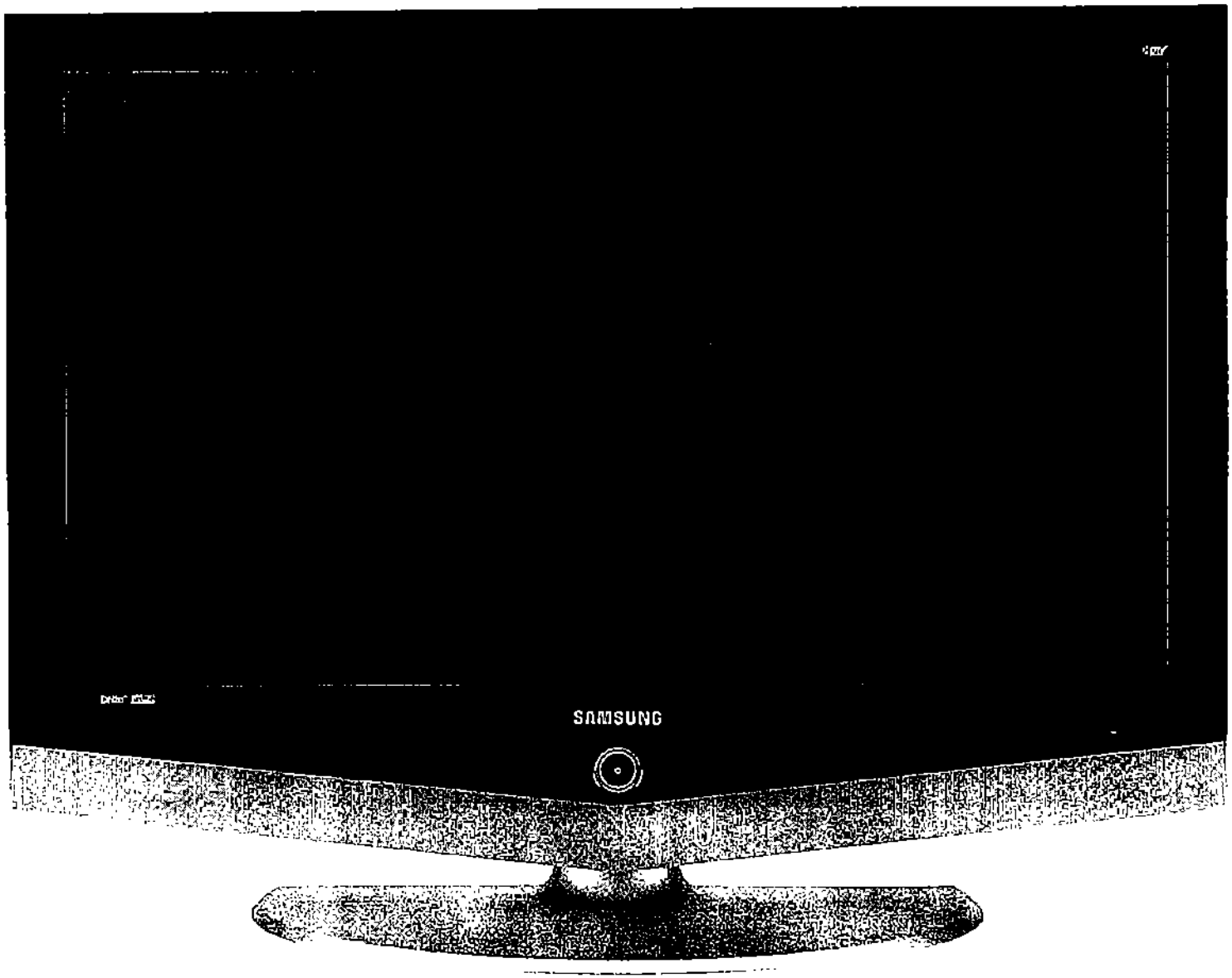
ADC: MST9883CR



Functional diagram

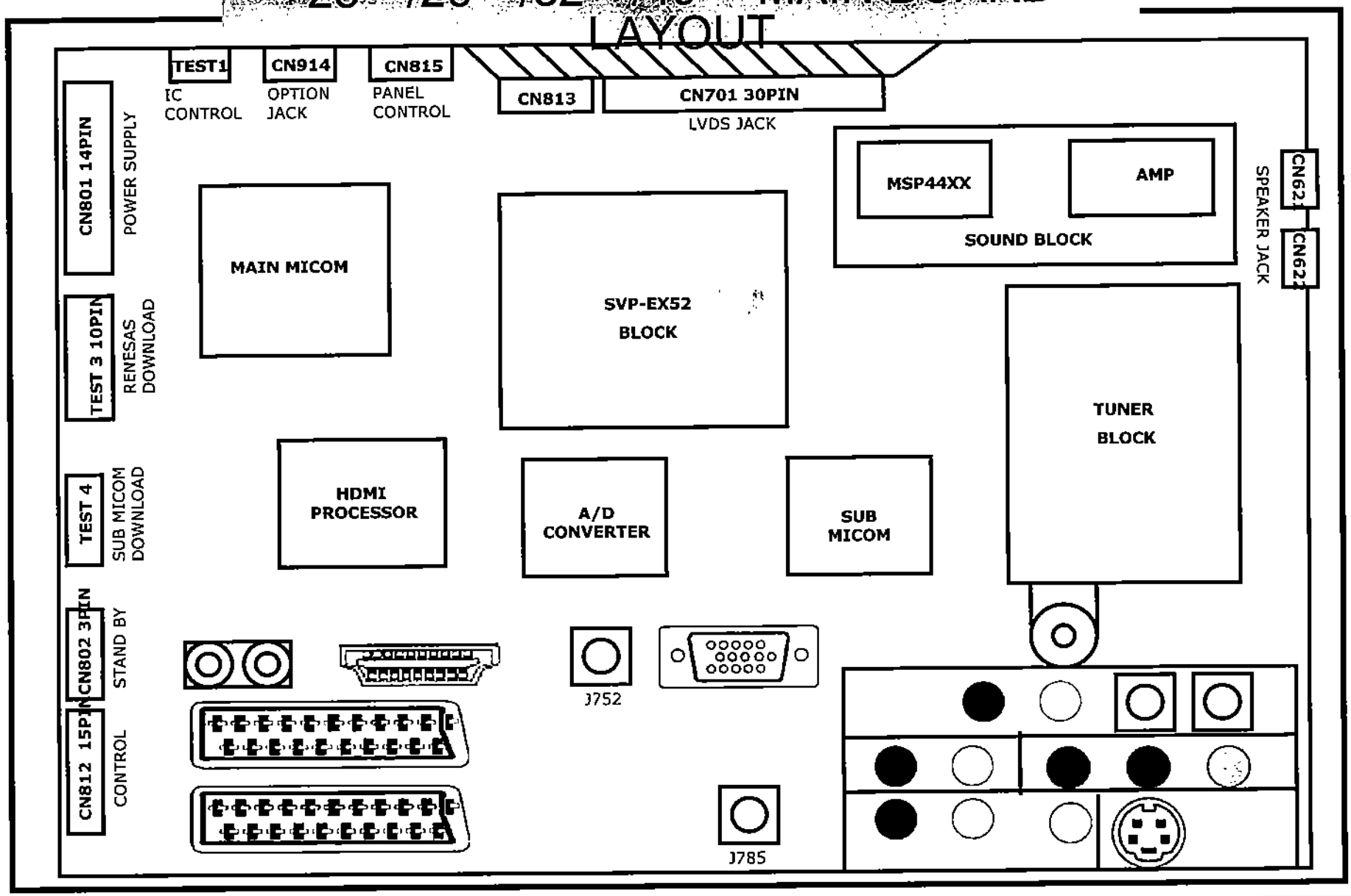
ADC: MST9883CR

. Triple ADC with 12 - 140 MHz Sampling Rate
. Integrated line locked PLL generates pixel clock from HSYNC
. Integrated 5-bit pixel clock phase adjustment for precise sample timing control
. Integrated clamp with timing generator
. Integrated Brightness & Contrast controls
. Integrated precision voltage reference
. Compatible with VGA through SXGA RGB graphics signals, and component TV, DTV and HDTV
. Pin Compatible with AD9883A
. Serial port programming interface
. Mid-Scale Clamping
. Fully Sync Processing
. 4:2:2 and 4:4:4 Output Format Mode
. Color space conversion (RGB to YCbCr)
. Internal pattern generator*
. Sawtooth vertical deflection signals for VSYNC input
. BT656 output format mode*
. Black and mid-level precision clamp and calibration


SAMSUNG

CONTENTS

23" /26" /32" /40" MAIN BOARD LAYOUT



23" /26" /32" /40" PIN characteristic

CN801- Main Board power supply

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14
NAME	12V	GND	5V	5V	5V	GND	GND	GND	12VS	12VS	12VS	GND	GND	GND

FUNCTING DEFINE:

-- 12V B5V_VCCA B5V_VCCB IC611 POWER SUPPERLY

-- 5V B5V B3.3V B2.5V_VDD B3.3VD VCC50

-- 12VS B12VS

CN802-stand by supply

PIN	1	2	3
NAME	POWER	GND	SW_POWER
VOLTAGE	6V	0V	ON/OFF

FUNCTING DEFINE:

-- POWER 6V STAND BY 5V , Sub-MICOM power supply

-- SW_POWER L: Power OFF , H: Power ON

CN621/CN622-SPEAKER CONNECTOR

PIN	1	2	3
NAME	R-OUT	NOP	R-REFERENCE

PIN	1	2
NAME	L-OUT	L-REFERENCE

23”/26”/32”/40” PIN characteristic

CN812-Front control

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
NAME	GND	GND	A5V	-	KEY INPUT1	KEY INPUT2	GND	-	IR	-	LED_ GREEN	LED_ RED	GND	SDA	SCL

FUNCTING DEFINE:

-- A5V Front control board power supply

-- KEY INPUT1,2/SDA/SCL key control, form the Menu , channel up/down Etc.

-- IR remote control signal

-- LED_GREEN/LED_RED control the timing and standby LED color

CN815-panel control

PIN	1	2	3	4	5
NAME	SW_inverter	Ana_dimming	PWM_dimming	GND	SENSOR POWER

FUNCTING DEFINE:

-- SW_inverter panel inverter control, about 5V

-- Ana_dimming panel dimming control

-- PWM_dimming panel PWM control, duty 40%~90%

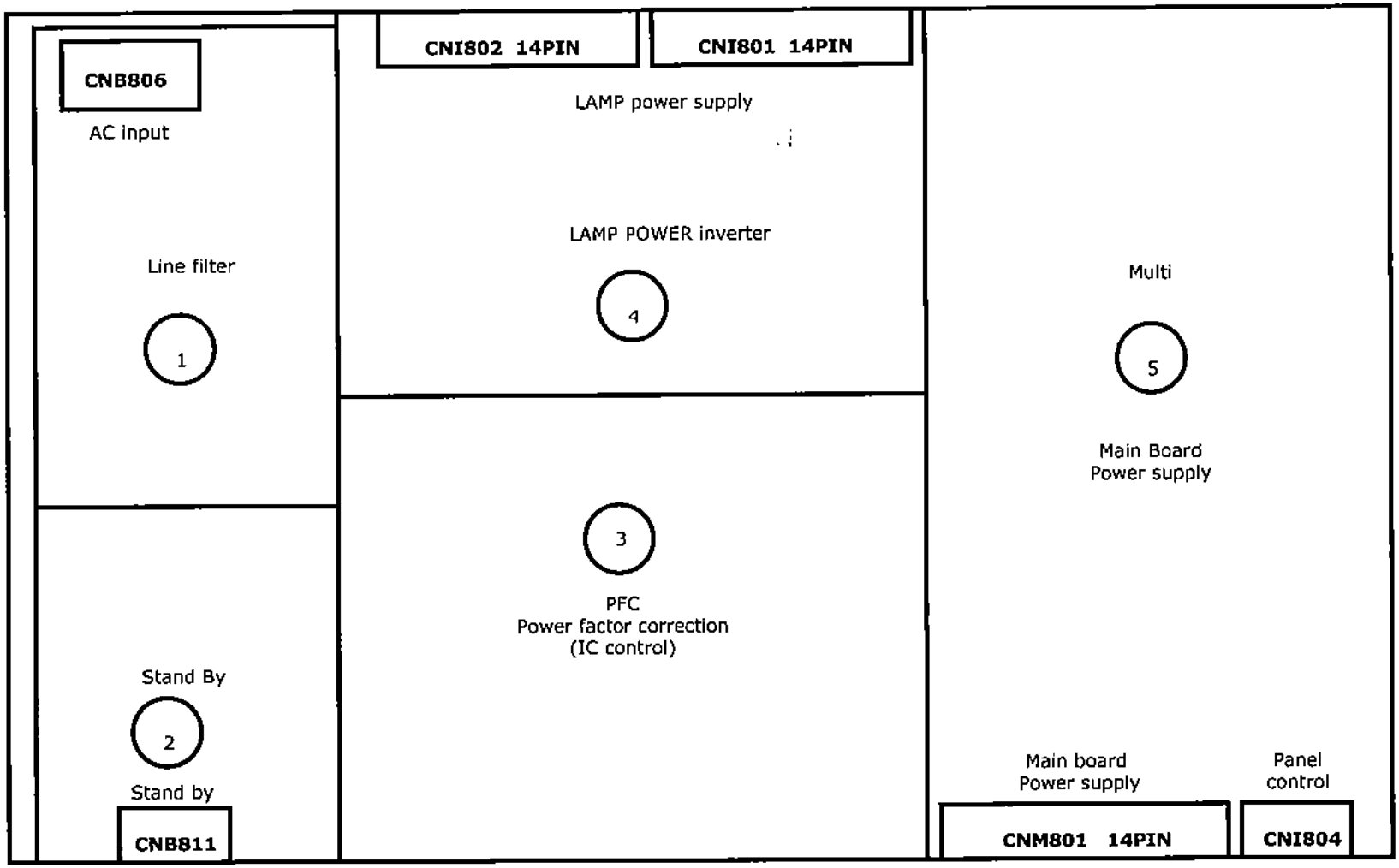
-- SENSOR POWER brightness sensor power supply

23”/26”/32”/40” PIN characteristic

CN702-LVDS Signal

PIN	NAME	PIN	NAME
1	VCC	16	TXOUTCLK+
2	VCC5P	17	TXOUTCLK-
3	VCC5P	18	GND
4	VCC5P	19	TXOUT2+
5	VCC5P	20	TXOUT2-
6	GND	21	GND
7	GND	22	TXOUT1+
8	NOP (NOT USE)	23	TXOUT1-
9	SDA1	24	GND
10	SCL1	25	TXOUT0+
11	PANEL_SYNC_EN	26	TXOUT0-
12	GND	27	GND
13	TXOUT3+	28	SW_INVERTER
14	TXOUT3-	29	ANA_DIMMING
15	GND	30	PWM_DIMMING

26" /32" /40" POWER BOARD LAYOUT



26" /32" /40" POWER BOARD LAYOUT

CNB811-stand by supply

PIN	1	2	3
NAME	POWER	GND	SW_POWER
VOLTAGE	6V	0V	ON/OFF

FUNCTING DEFINE:

Refer to: CN802 function define

CNM801- Main Board power supply

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14
NAME	12V	GND	5V	5V	5V	GND	GND	GND	12V	12V	12V	GND	GND	GND

FUNCTING DEFINE:

Refer to: CN801 function define

CNI804-panel control

PIN	1	2	3	4	5
NAME	SW_inverter	Ana_dimming	PWM_dimming	GND	SENSOR POWER

FUNCTING DEFINE:

Refer to: CN815 function define

26”/32”/40” POWER BOARD LAYOUT

CNI801- Main Board power supply

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14
NAME	24V	24V	24V	24V	24V	GND	GND	GND	GND	GND	GND	B/L	A_D	P_D

FUNCTING DEFINE:

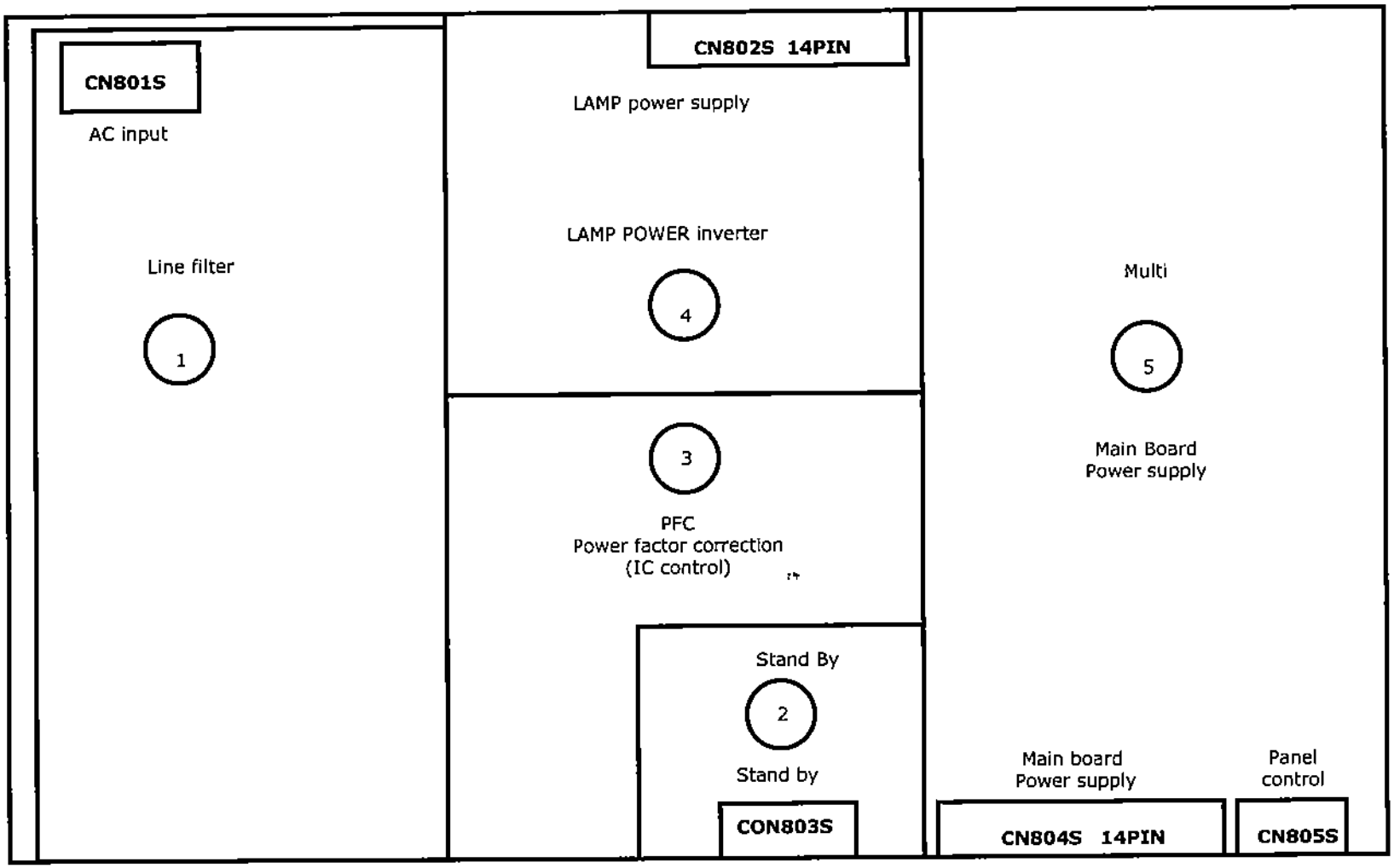
--24V LAMP INVERTER Voltage

--B/L Brightness sensor power

--A_D ANA_DIMMING

--P_D PWM_DIMMING

23" POWER BOARD LAYOUT



23" PIN characteristic

CON803S-stand by supply

PIN	1	2	3
NAME	POWER	GND	SW_POWER
VOLTAGE	6V	0V	ON/OFF

FUNCTING DEFINE:

Refer to: CN802 function define

CN804S- Main Board power supply

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14
NAME	12V	GND	5V	5V	5V	GND	GND	GND	10V	10V	10V	GND	GND	GND

FUNCTING DEFINE:

Refer to: CN801 function define

CN805S-panel control

PIN	1	2	3	4	5
NAME	SW_inverter	Ana_dimming	PWM_dimming	GND	SENSOR POWER

FUNCTING DEFINE:

Refer to: CN815 function define

23" PIN characteristic

CNI801- Main Board power supply

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14
NAME	24V	24V	24V	24V	24V	GND	GND	GND	GND	GND	NC	B/L	A_D	P_D

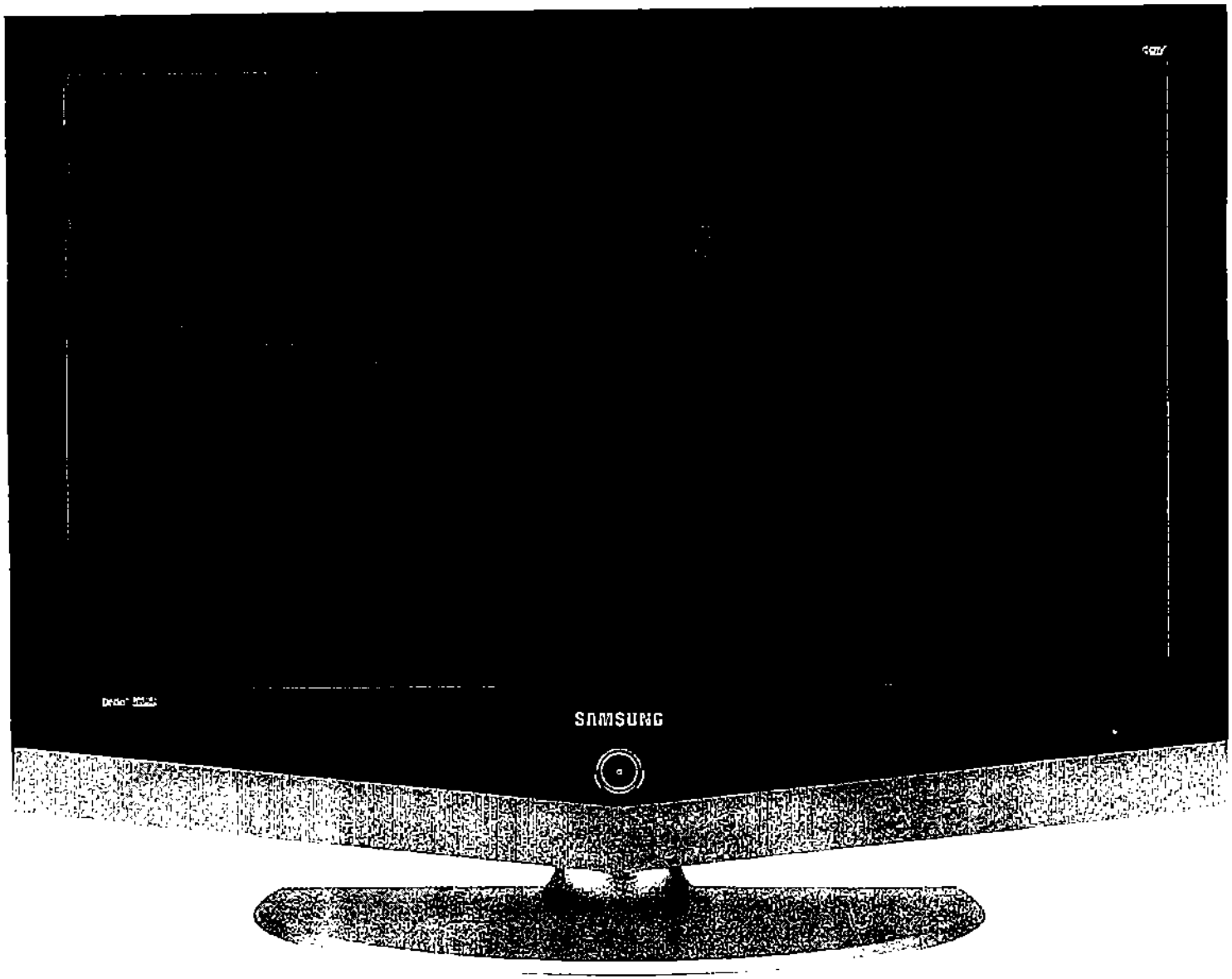
FUNCTING DEFINE:

--24V LAMP INVERTER Voltage

--B/L Brightness sensor power

--A_D ANA_DIMMING

--P_D PWM_DIMMING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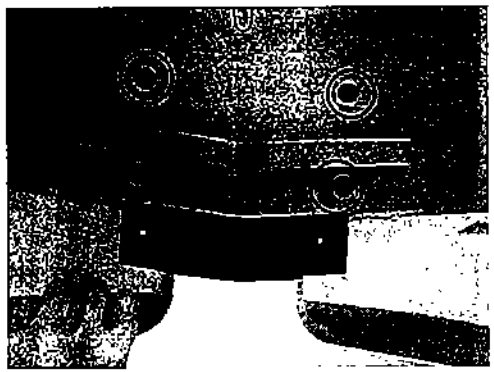
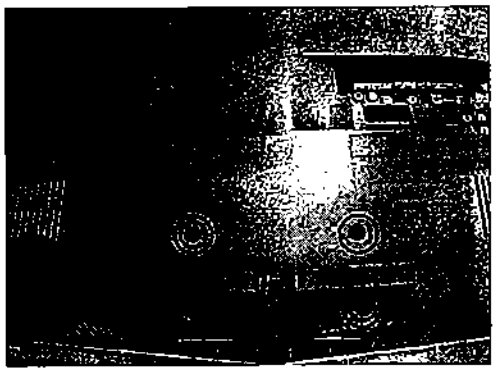
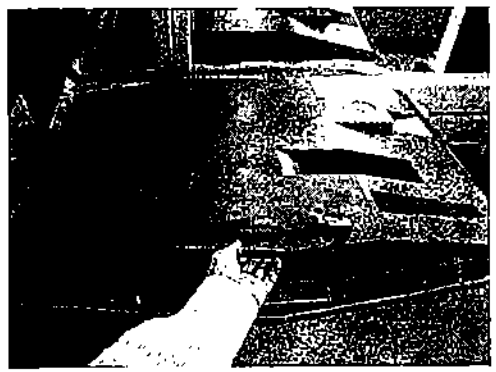
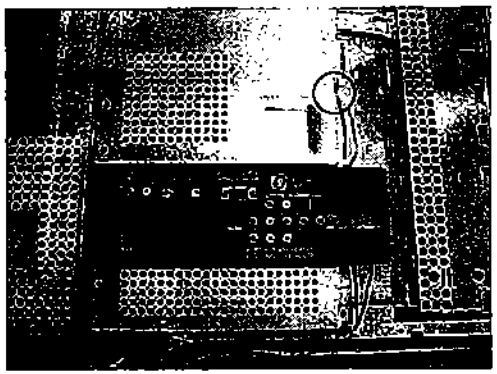
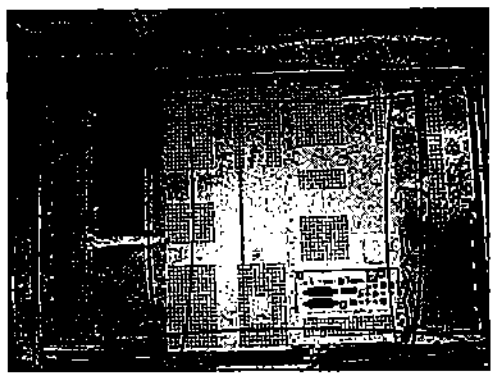
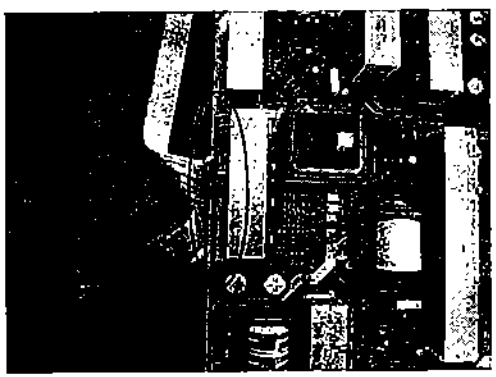
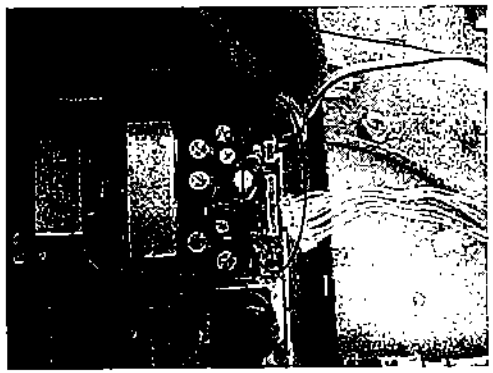
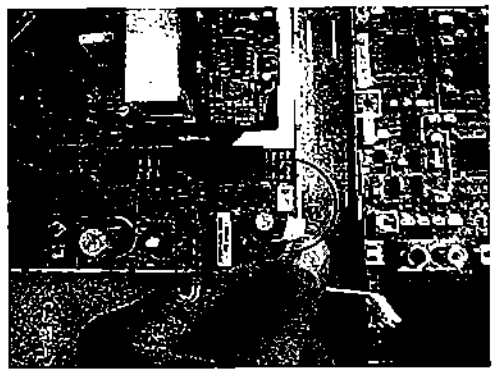
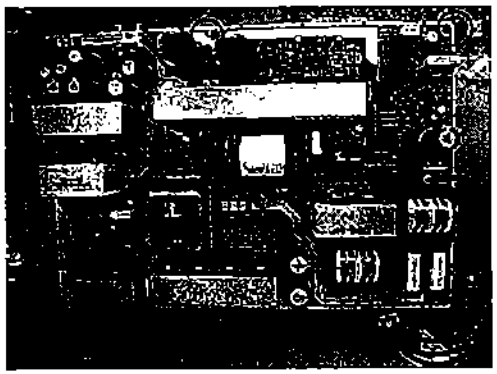
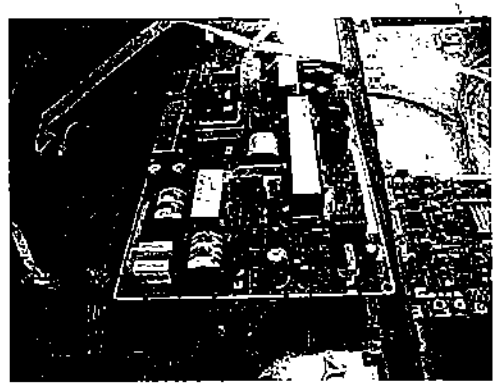
Disassembly ROME

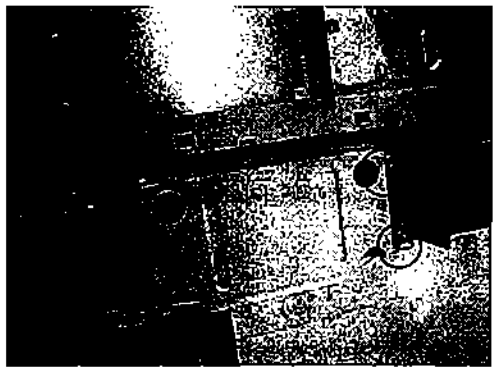
- Remove screws from rear cover. Remove screws from grip on the stand
- Remove the stand and lift up the rear cover
- Disconnect speaker cable, function cable and Remove screws from the shield

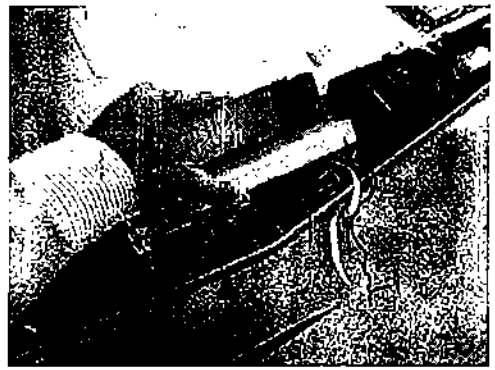
- Disconnect Power Cables, LVDS Cable from the power board
- Remove screws from the Main board and lift up the board

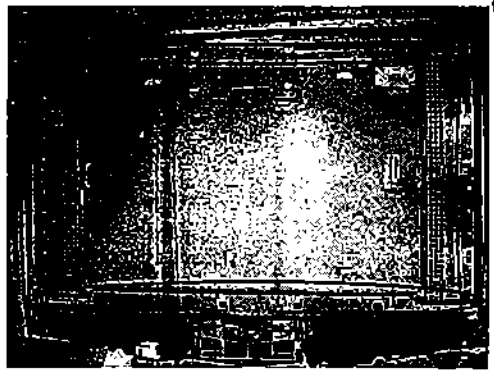




- Remove screws from the power board.
- Disconnect inverter cable.
  Lift up the power board.

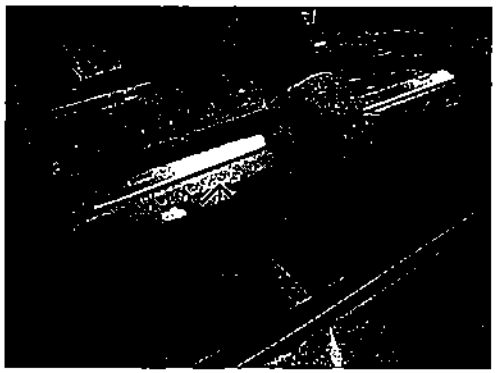


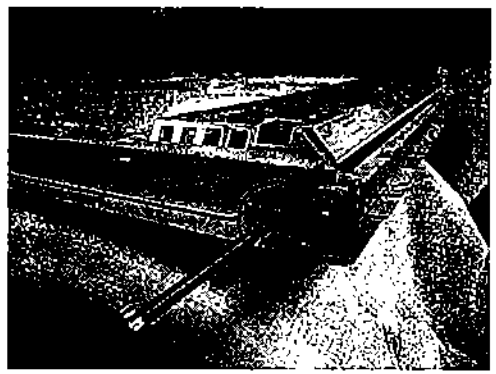


- Remove screws



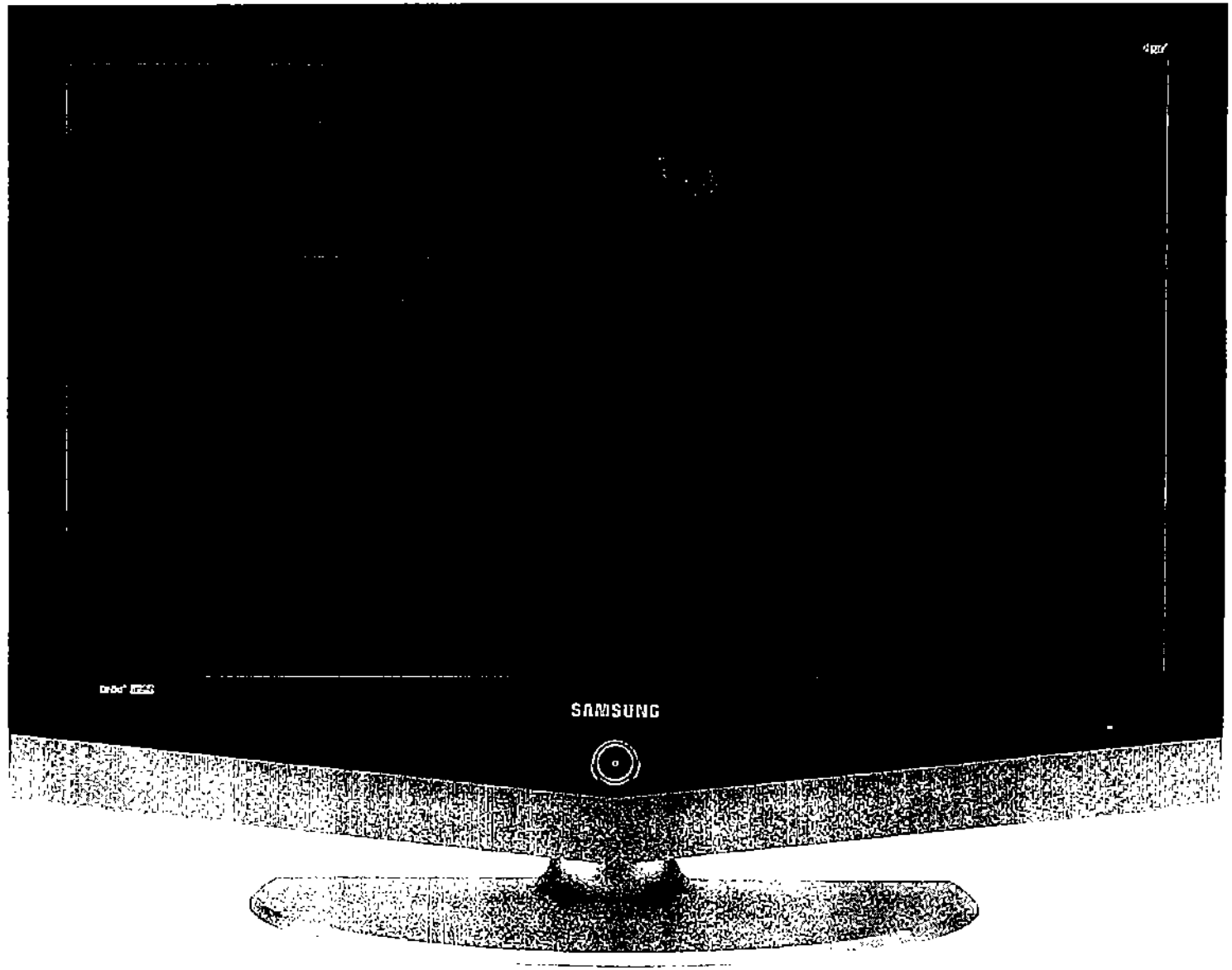
- Remove screws from the panel BRKT. Remove screws from the cabinet BRKT and lift up the panel Assy





- Lift up the panel, Remove screws from the panel BRKT(R/L). Disconnect BRKT from the panel.

- Another ROME models are almost same to disassemble.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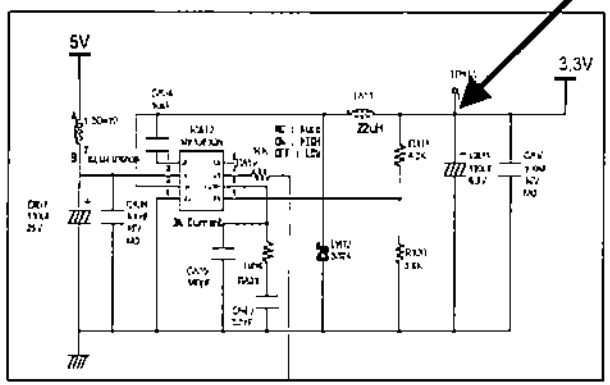
CONTENTS

A) Power Trouble Shooting

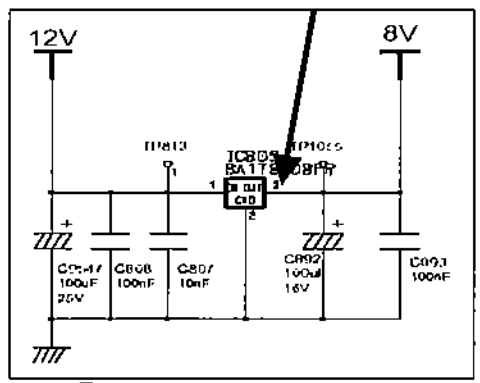
- Power part is composed of power board and main board(small power)
- Check connectors between power board and main board
- Check main board power output on the board
- When you check main board power(small power IC), There are two types of power IC. One is PWM type, another is regulator type. PWM type should check after inductor. Regulator type should check on the output pin.
- Check each Voltage output

Check After Inductor



PWM Type

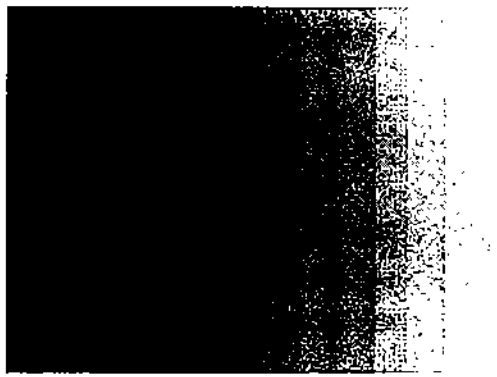
Check On Pin



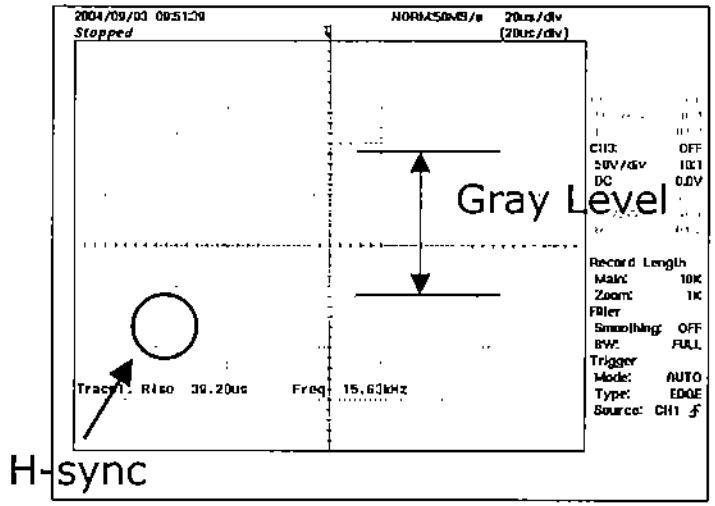
Regulator Type

B) Analog Part

- It is easy to check analog video signal than digital video signal
- Use reference signal input (EX. 16 Gray)
- Check Signal Level and sync
- Check Signal path until input of Video decoder
  (Tuner → Switch → Video Decoder, AV Connecter → Switch → Video Decoder, Scart → Switch → Video Decoder)



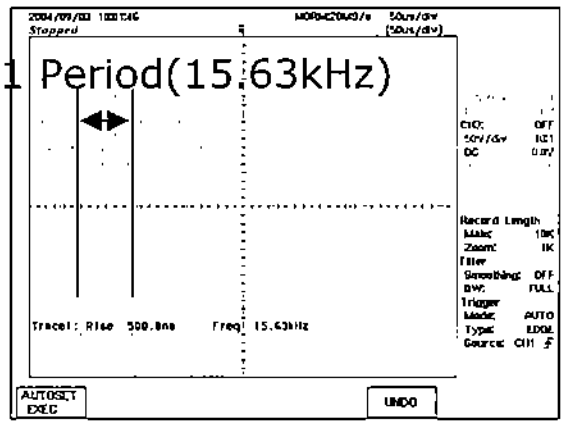
16 Gray Patten



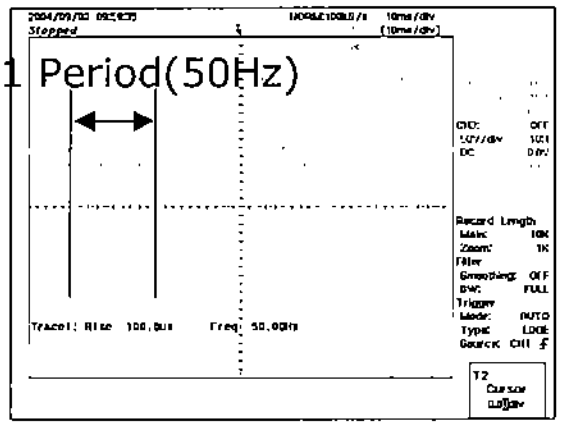
16 Gray Wave Form

C) Digital Part

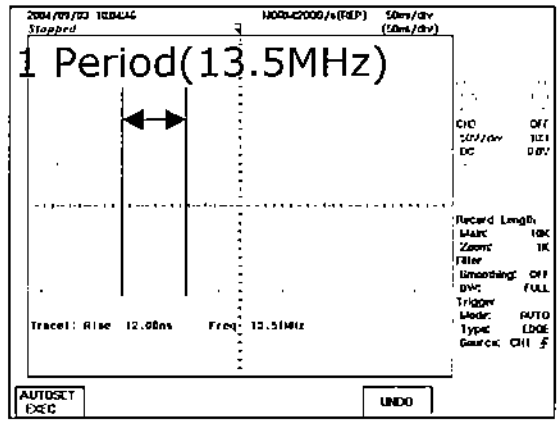
- It is difficult to check digital video signal because of too fast and small signal
- Check digital video signal, Use H-sync, V-sync and Clock for basic
- Each digital video ICs connected with data line, H-sync, V-sync and Clock line
- Check H-sync period, V-sync period, Clock period
- If period is out of spec, Change the IC



H-Sync



V-Sync

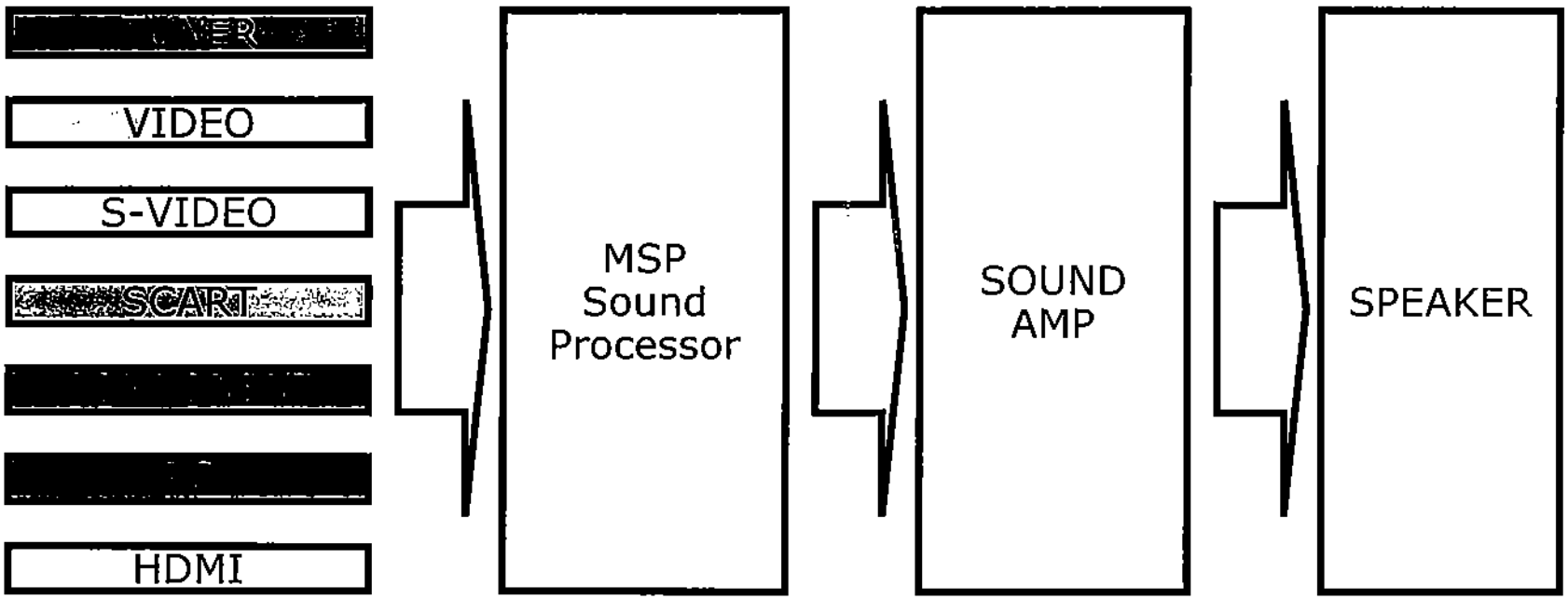


Clock

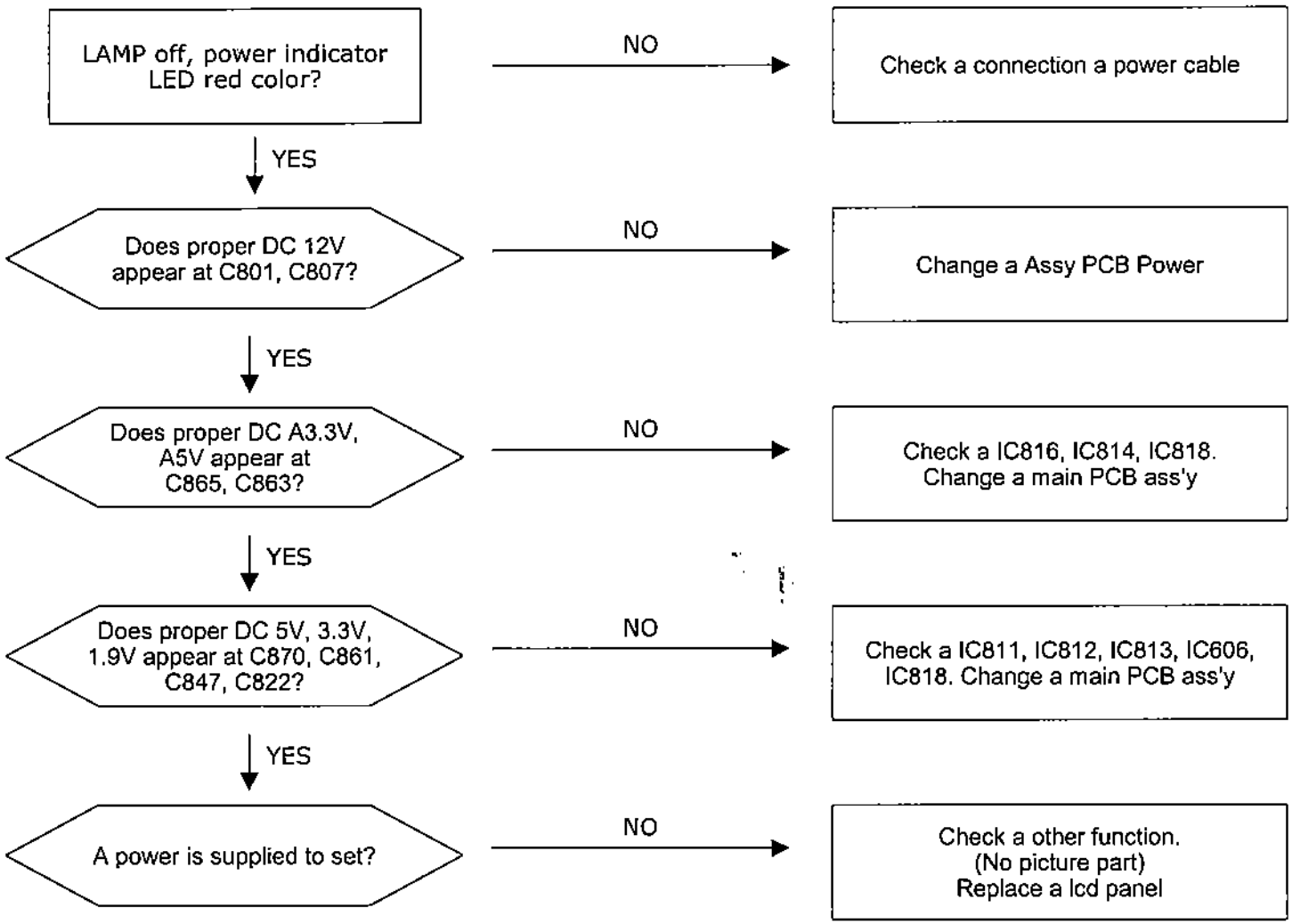
This example is Normal PAL TV signal Sync and Clock

D) Sound Part

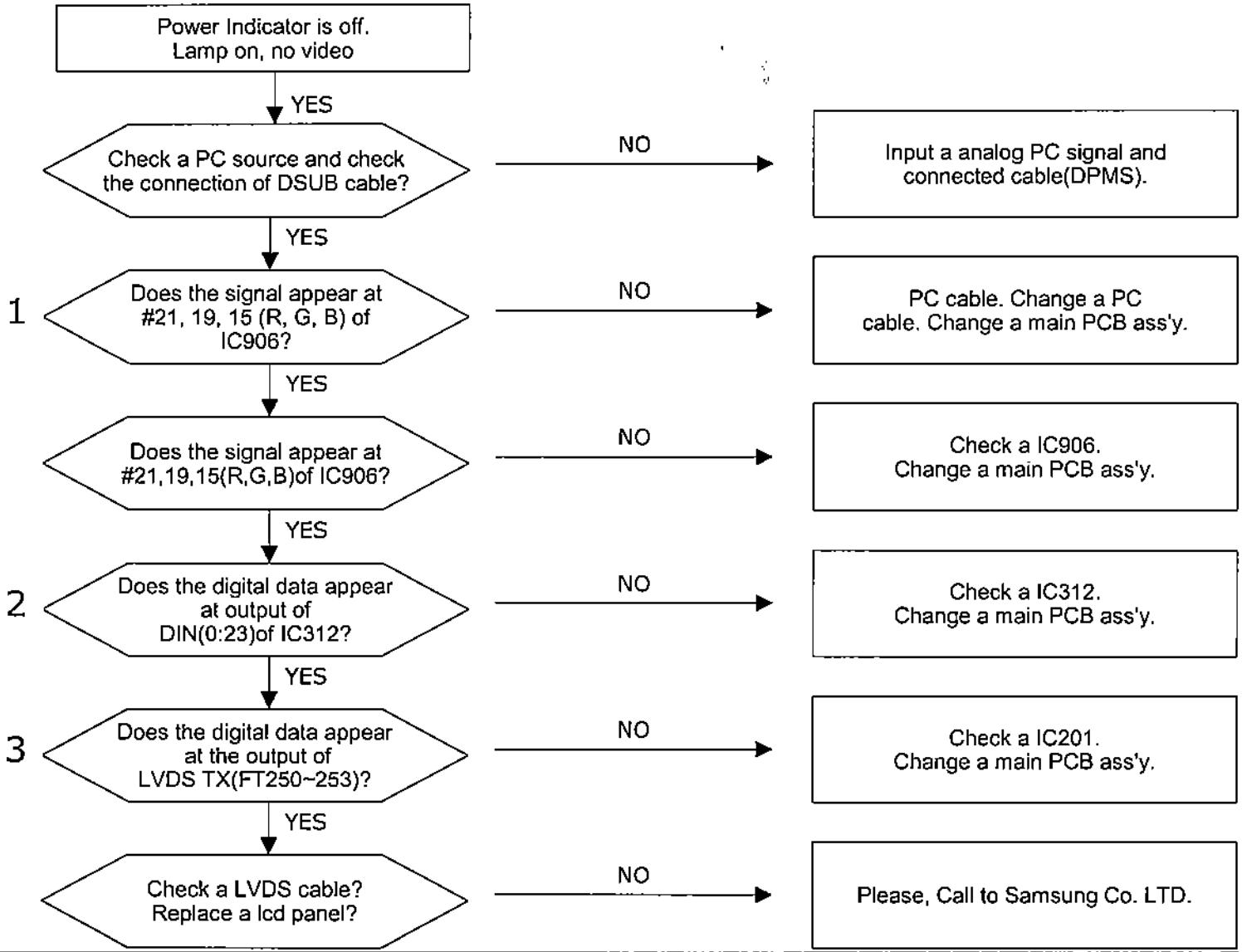
- Sound block of ROME is composed of Sound Processor, AMP, Speakers.
- If there is no sound or sound noise ,Trace the sound path
  (Input → Sound Processor → AMP → Speaker)



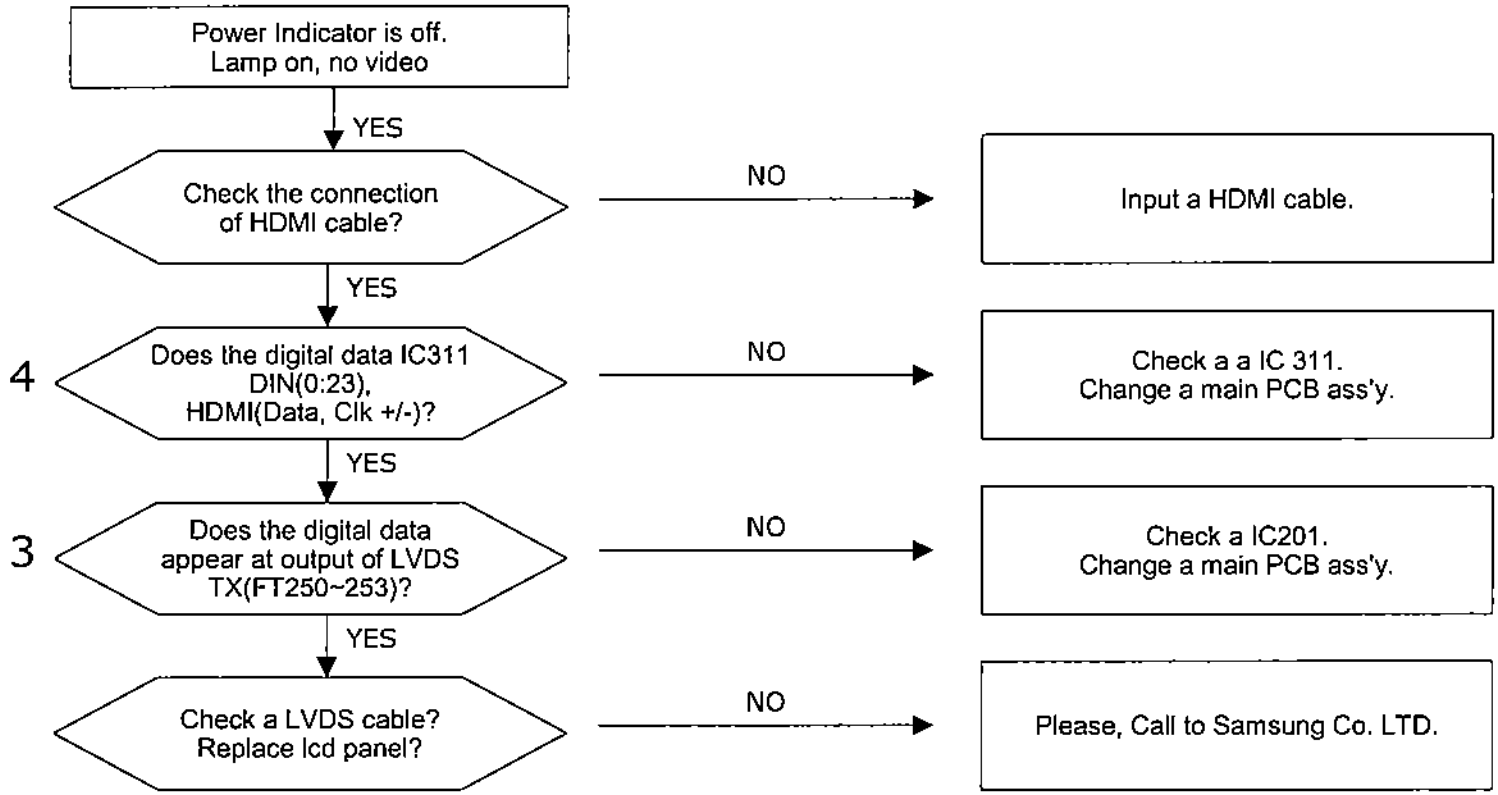
No power


LAMP off, power indicator LED red color?
NO
Check a connection a power cable
YES
Does proper DC 12V appear at C801, C807?
NO
Change a Assy PCB Power
YES
Does proper DC A3.3V, A5V appear at C865, C863?
NO
Check a IC816, IC814, IC818. Change a main PCB ass'y
YES
Does proper DC 5V, 3.3V, 1.9V appear at C870, C861, C847, C822?
NO
Check a IC811, IC812, IC813, IC606, IC818. Change a main PCB ass'y
YES
A power is supplied to set?
NO
Check a other function. (No picture part) Replace a lcd panel

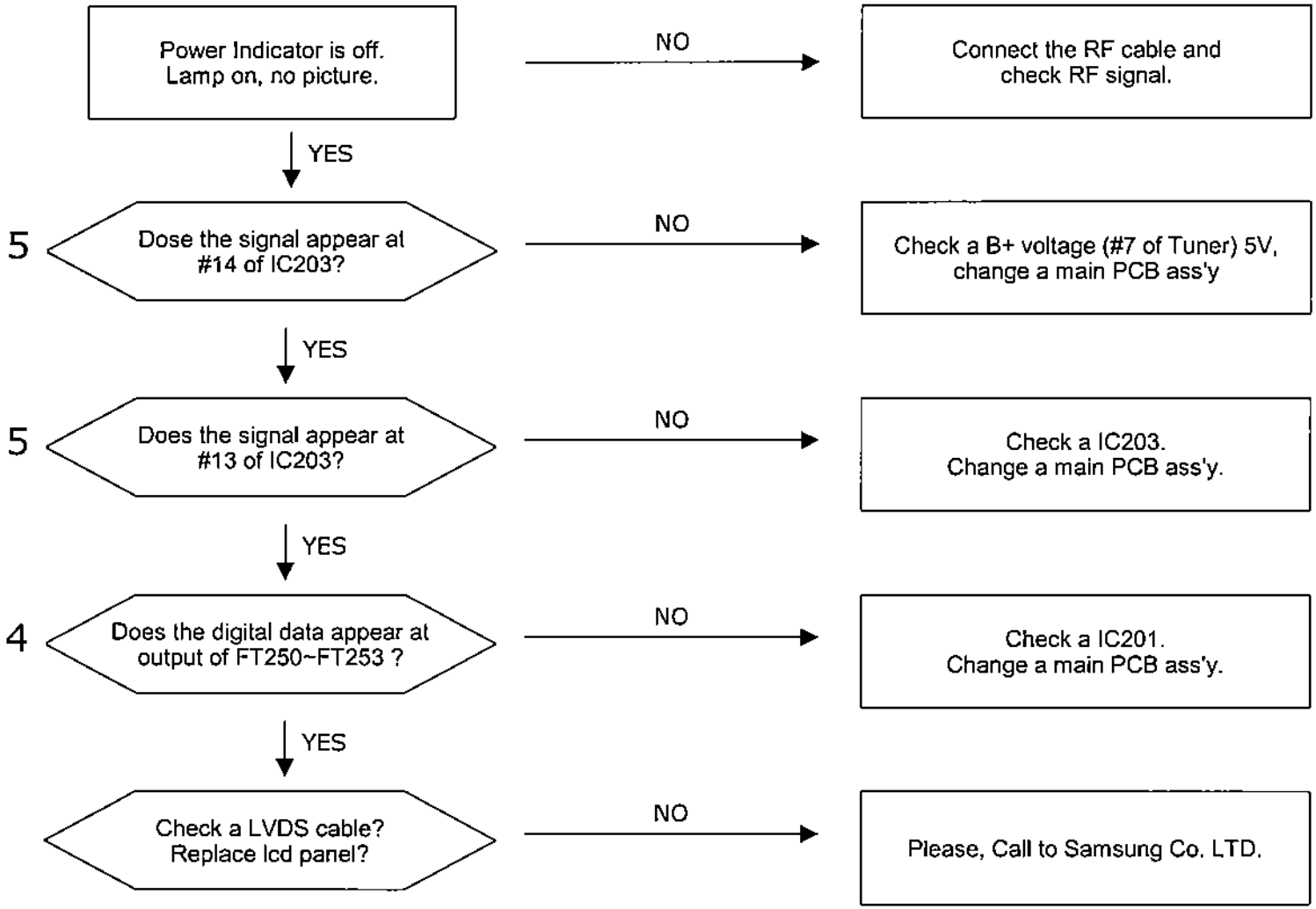
No Video [Analog PC]



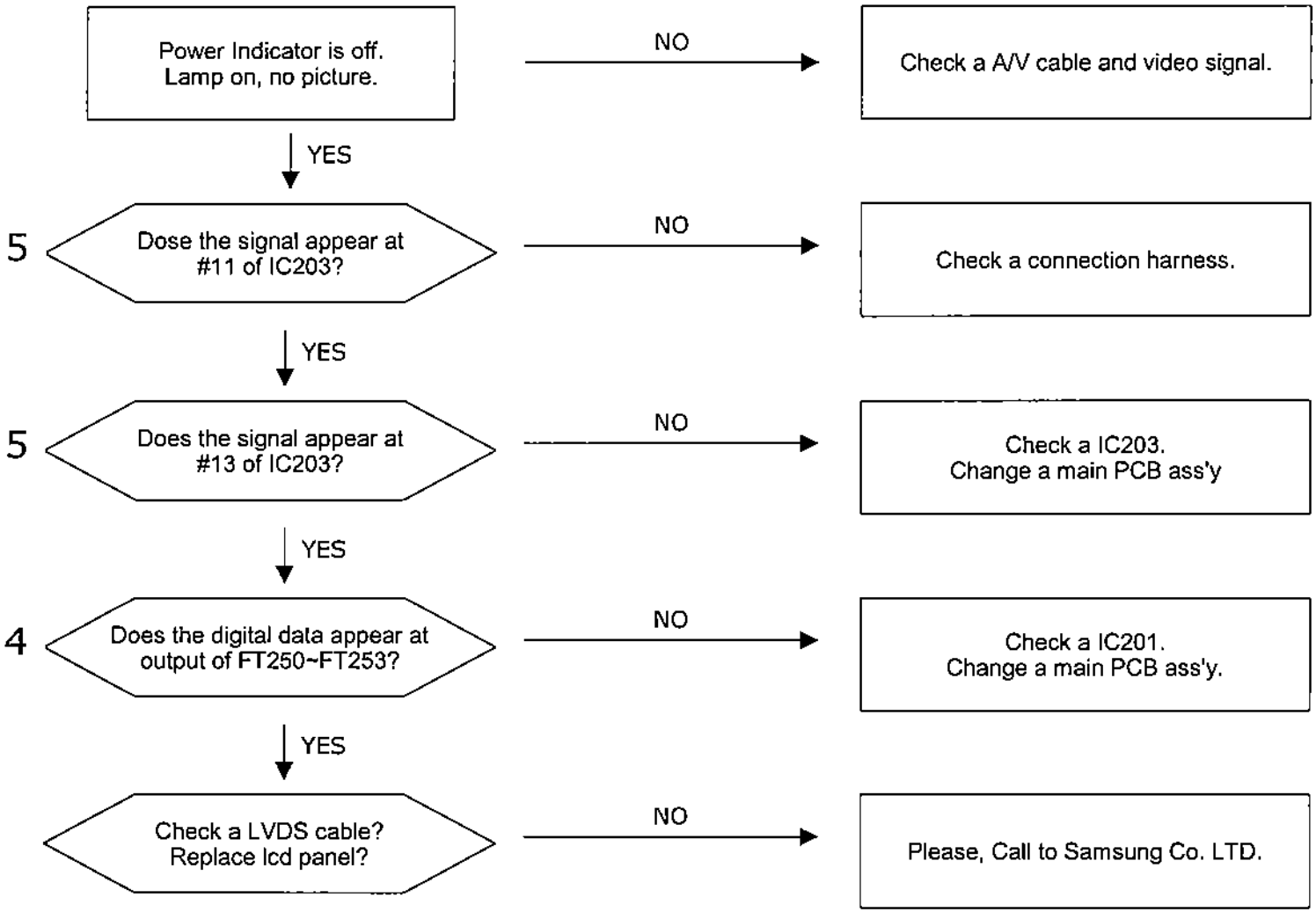
No Video [Digital-HDMI]



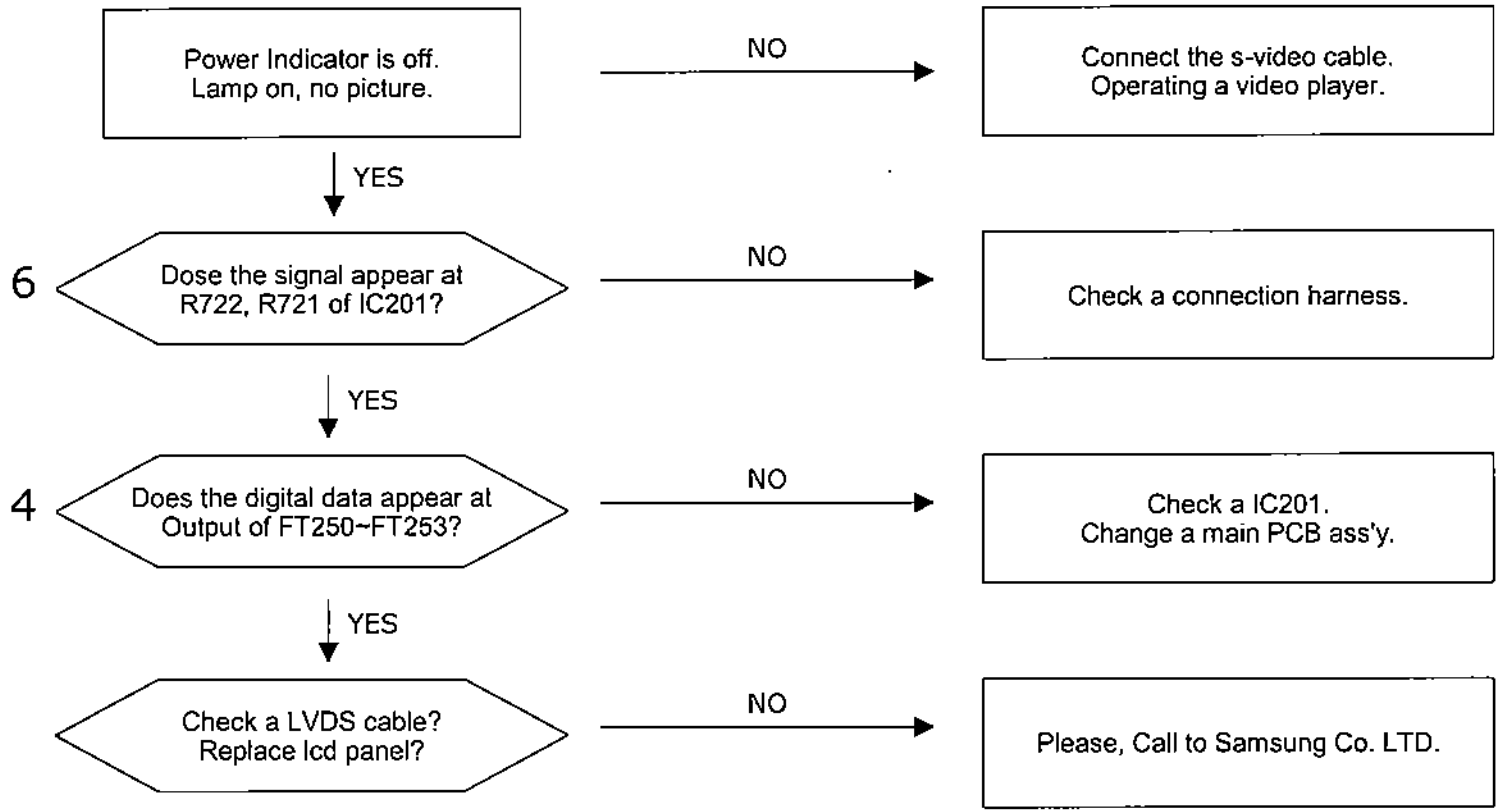
No Video [Tuner-CVBS]



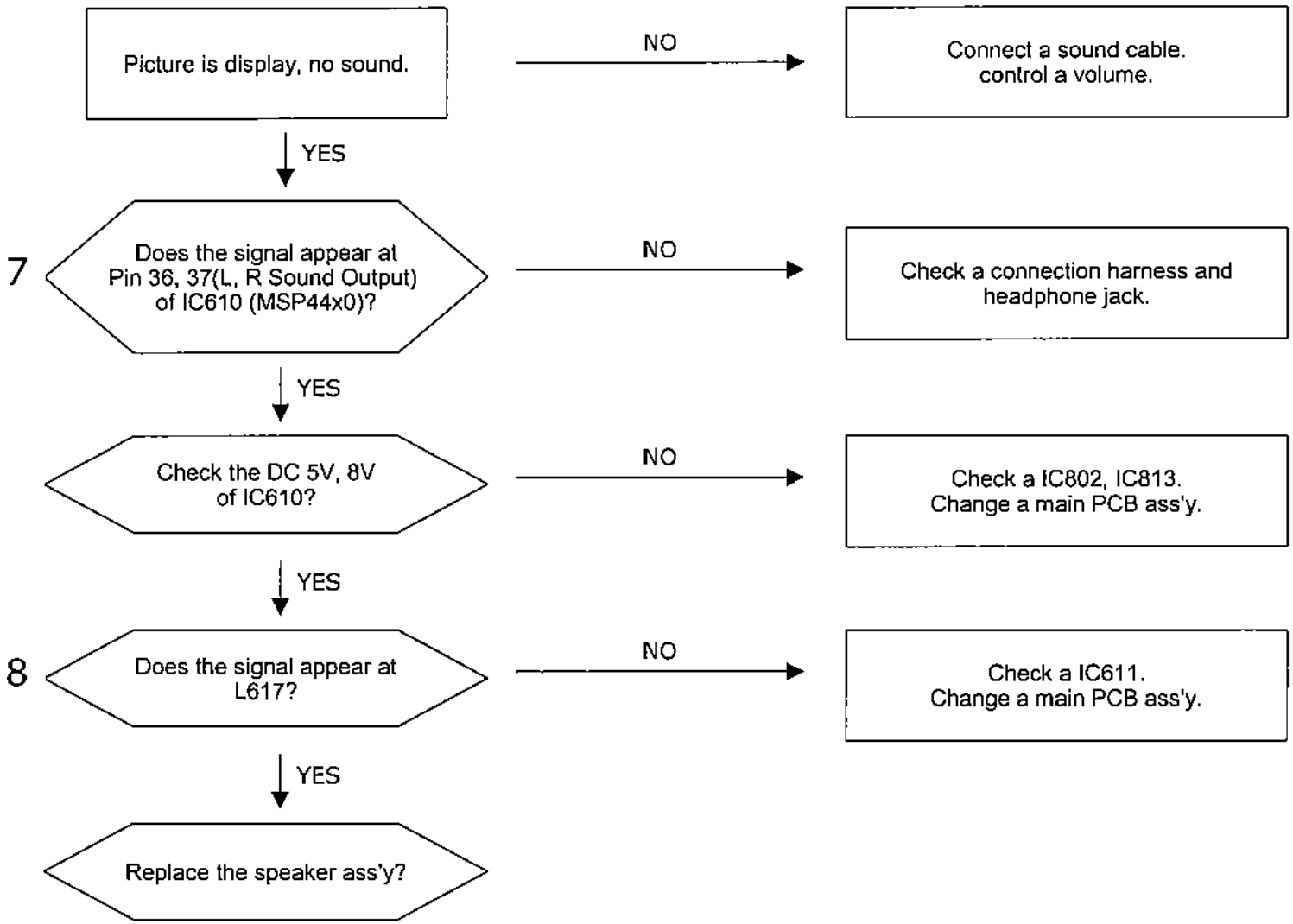
No Video [Video-CVBS]



No Video [SVideo-Y/C]

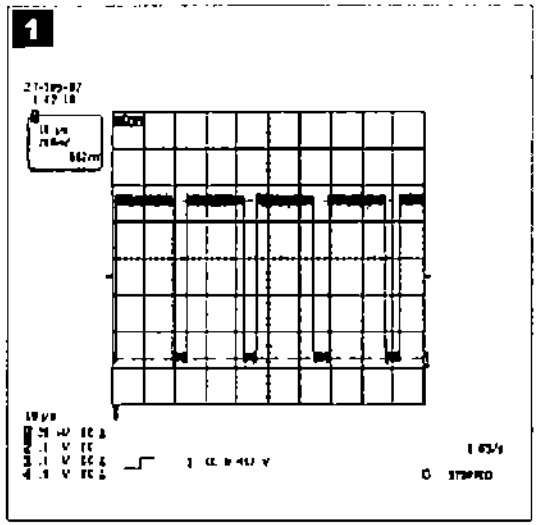


No Sound

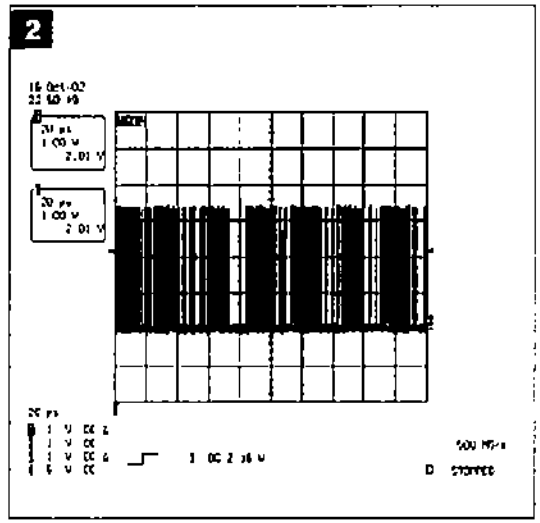

Picture is display, no sound.
NO
Connect a sound cable.
control a volume.
YES
7
Does the signal appear at
Pin 36, 37(L, R Sound Output)
of IC610 (MSP44x0)?
NO
Check a connection harness and
headphone jack.
YES
Check the DC 5V, 8V
of IC610?
NO
Check a IC802, IC813.
Change a main PCB ass'y.
YES
8
Does the signal appear at
L617?
NO
Check a IC611.
Change a main PCB ass'y.
YES
Replace the speaker ass'y?

Waveforms

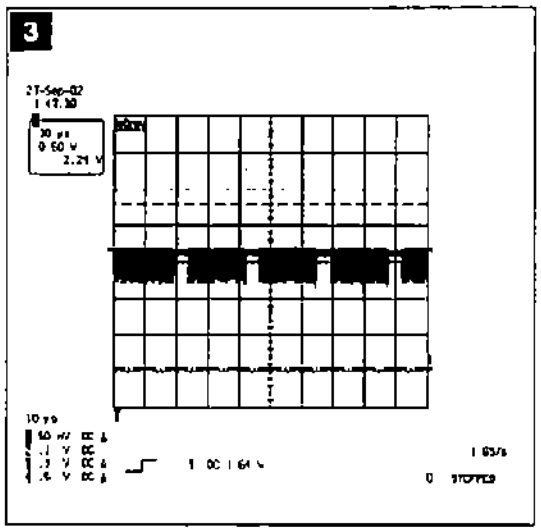
1



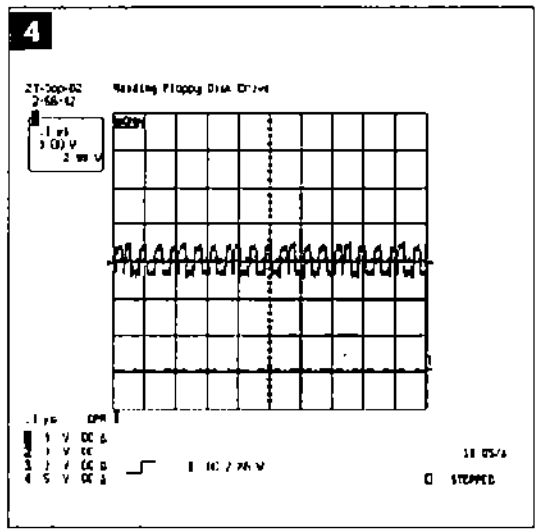
2



3

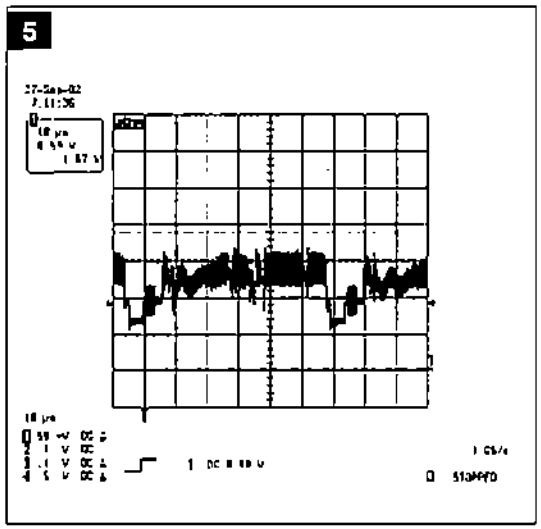


4

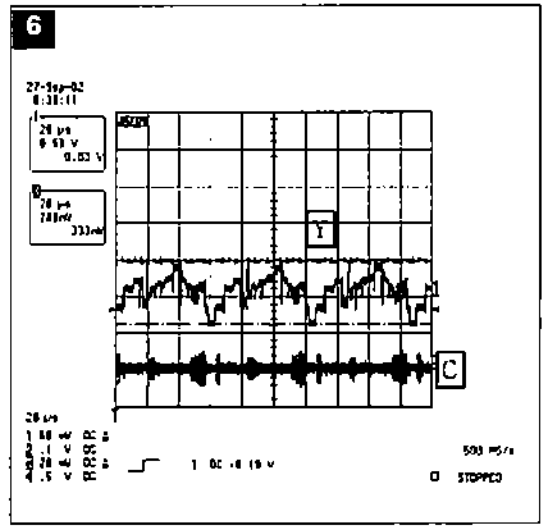


Waveforms

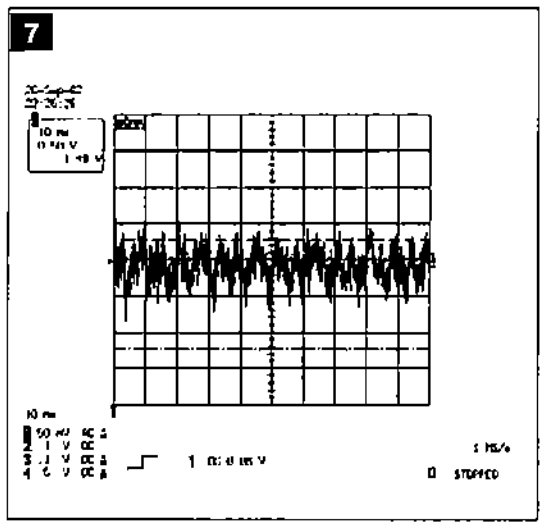
5



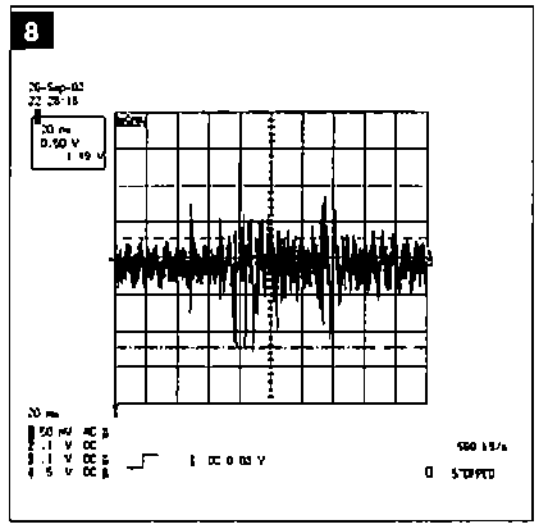
6



7

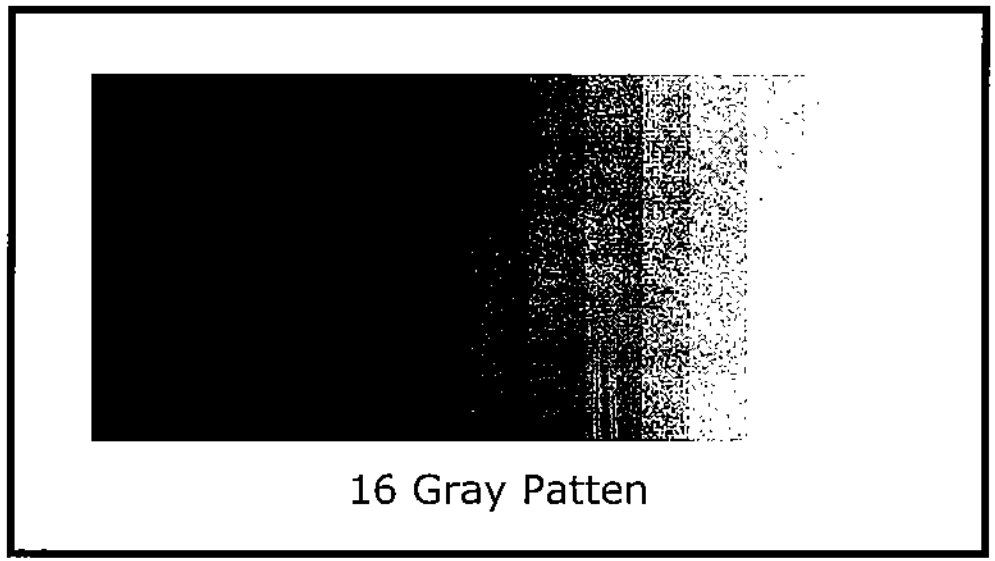


8



E) White Balance - Calibration

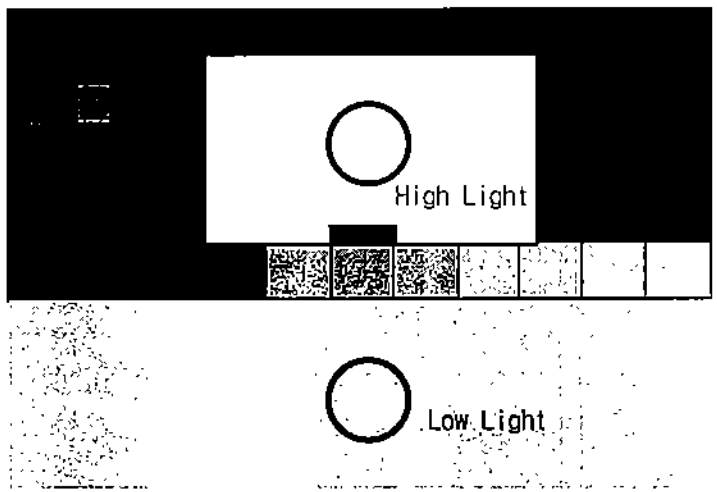
- If picture color is wrong, do calibration first
- Equipment : CA210, Patten : 16 gray
- Execute calibration in Factory Mode
- Source AV : PAL composite, Component : 1280*720/60Hz
  PC : 1024*768/60Hz



16 Gray Patten

F) White Balance - Adjustment

- If picture color is wrong, check White Balance condition
- Equipment : CA210, Patten : Toshiba
- Adjust W/B in Factory Mode
- Sub brightness and R/G/B Offset controls low light region
- Sub contrast and R/G/B Gain controls high light region
- Source AV : PAL composite, Component : 1280*720/60Hz
  HDMI[DVI] : 1280*720/60Hz

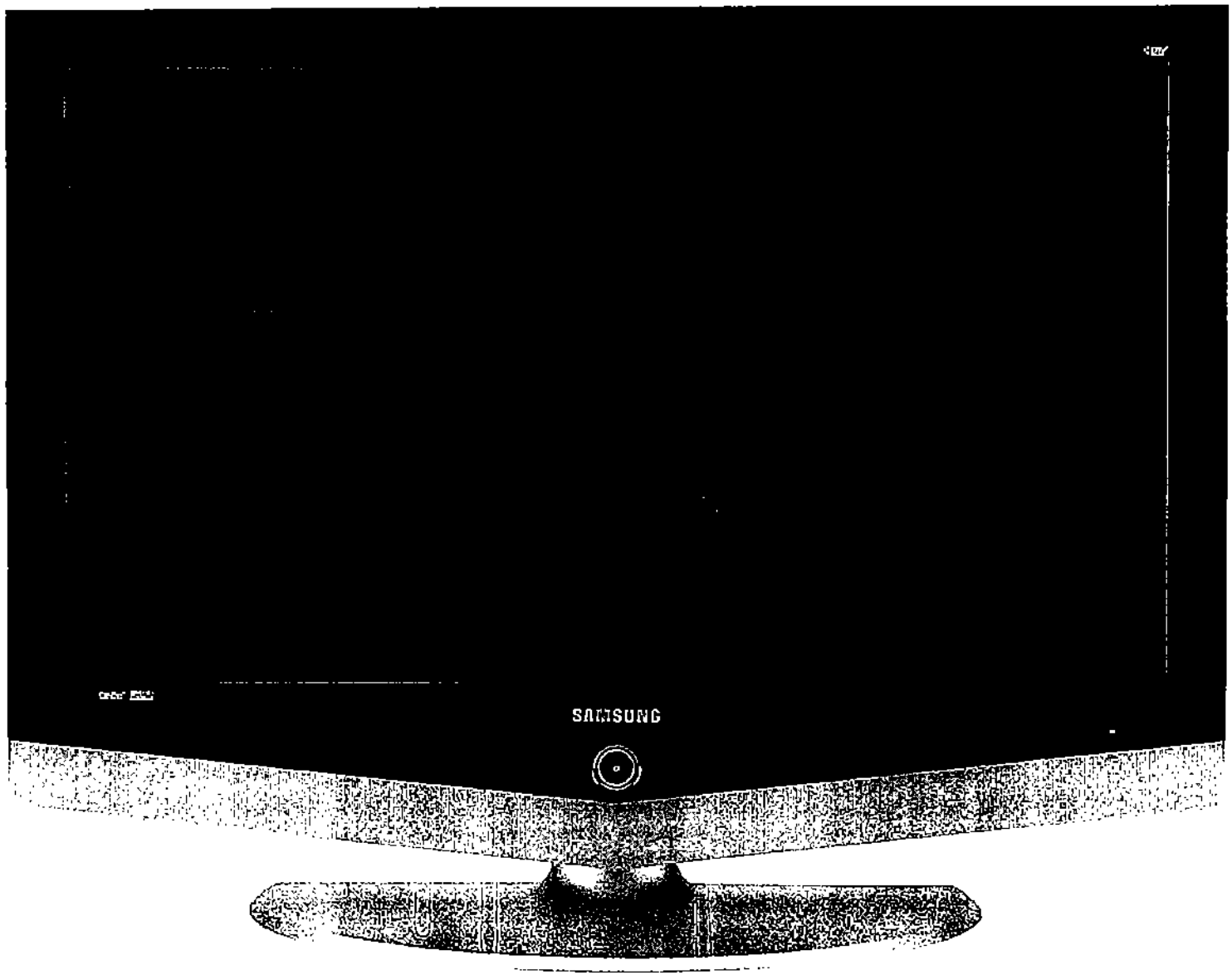


Toshiba Patten

[Test Pattern : MSPG-945 Series Pattern #16]

*Color temperature
1500K +/-500, -6 ~-20 MPCD

*Color coordinate
H/L : 267/263 +/- 2 35.0 Ft +/- 2.0Ft
L/L : 270/260 +/- 3 1.5 Ft +/- 0.2Ft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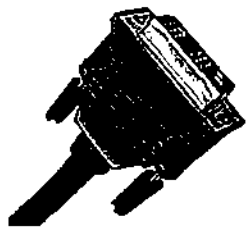
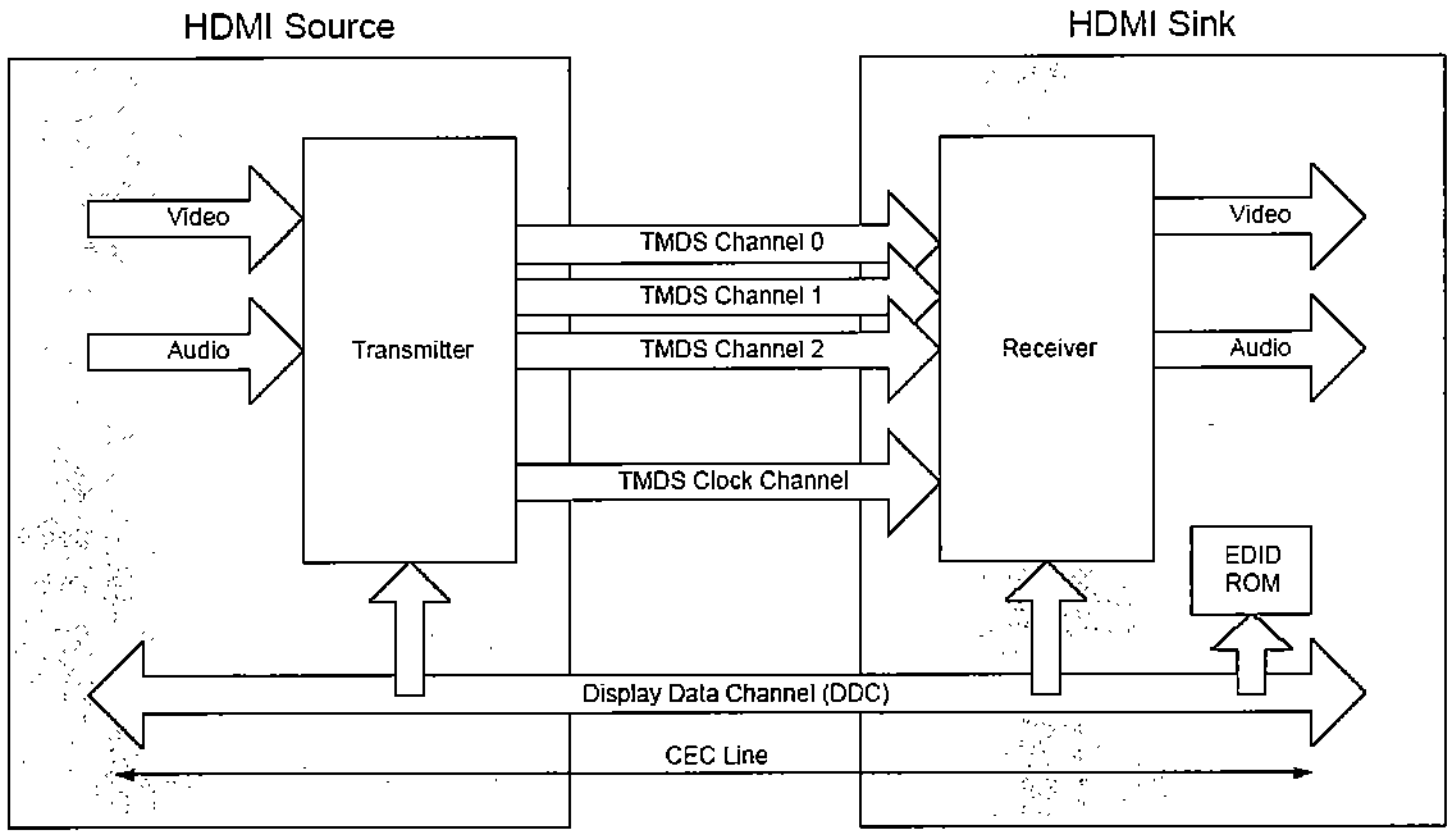
CONTENTS

ITEM	DVI	HDMI
DATA SPEED	1.78G BPS	2.2G BPS
AUDIO	NONE	CD OR HIGHER QUALITY DATA
REMOTE CONTROL	NONE	AV-LINK CAPABILITIES REPLACES INFRARED REPEATERS INTEGRATED REMOTE CONTROL SYSTEM
CONNECTOR		
FUTURE COMPATIBILITY	NONE	ACCOMMODATES ATSC DTV FORMATS SUPPORTS 8 CHANNEL AUDIO SPARE BANDWIDTH FOR FUTURE APP. (55% EXTRA AFTER HD TRANSMISSION)



HDMI block diagram

HDMI system architecture is defined to consist of Sources and Sinks. A given device may have one or more HDMI inputs and one or more HDMI outputs. Each HDMI input on these devices shall follow all of the rules for an HDMI Sink and each HDMI output shall follow all of the rules for an HDMI Source.

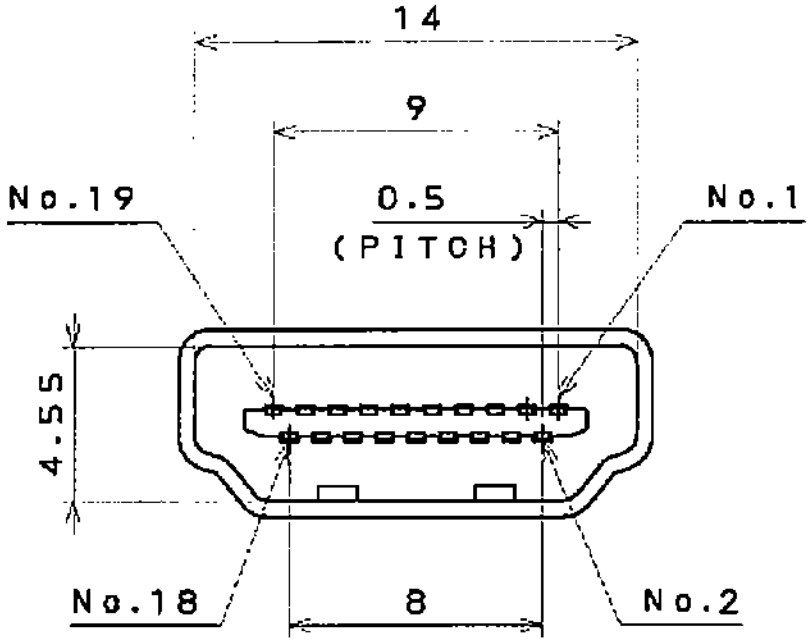
As shown HDMI block diagram the HDMI cable and connectors carry four differential pairs that make up the TMDS data and clock channels. These channels are used to carry video, audio and auxiliary data. In addition, HDMI carries a VESA DDC channel. The DDC is used for configuration and status exchange between a single Source and a single Sink. The optional CEC protocol provides high-level control functions between all of the various audiovisual products in a user□s environment.

Audio, video and auxiliary data is transmitted across the three TMDS data channels. The video pixel clock is transmitted on the TMDS clock channel and is used by the receiver as a frequency reference for data recovery on the three TMDS data channels. Video data is carried as a series of 24-bit pixels on the three TMDS data channels. TMDS encoding converts the 8 bits per channel into the 10 bit DC-balanced, transition minimized sequence which is then transmitted serially across the pair at a rate of 10 bits per pixel clock period.

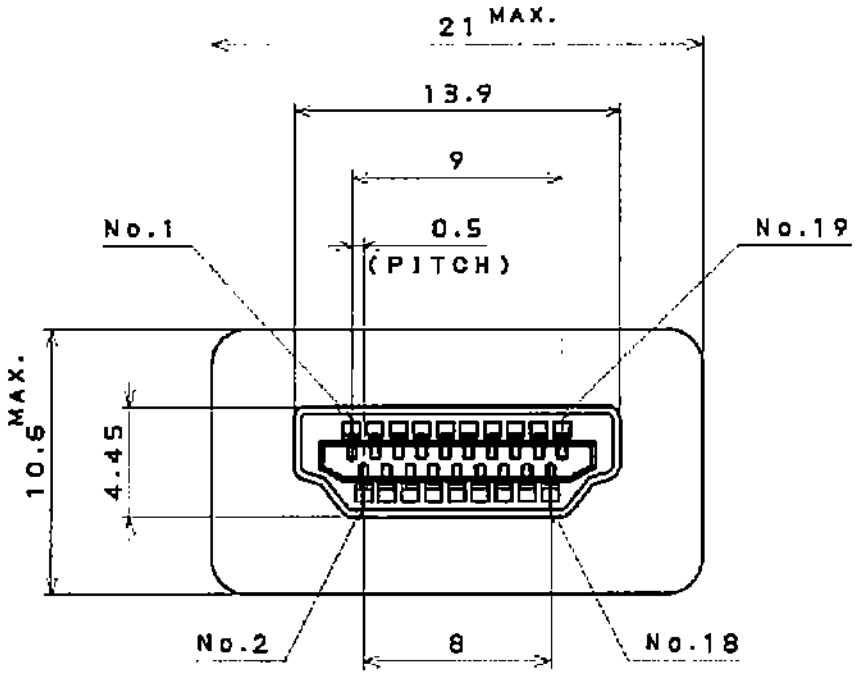
Connector Drawings

All dimensions in millimeters

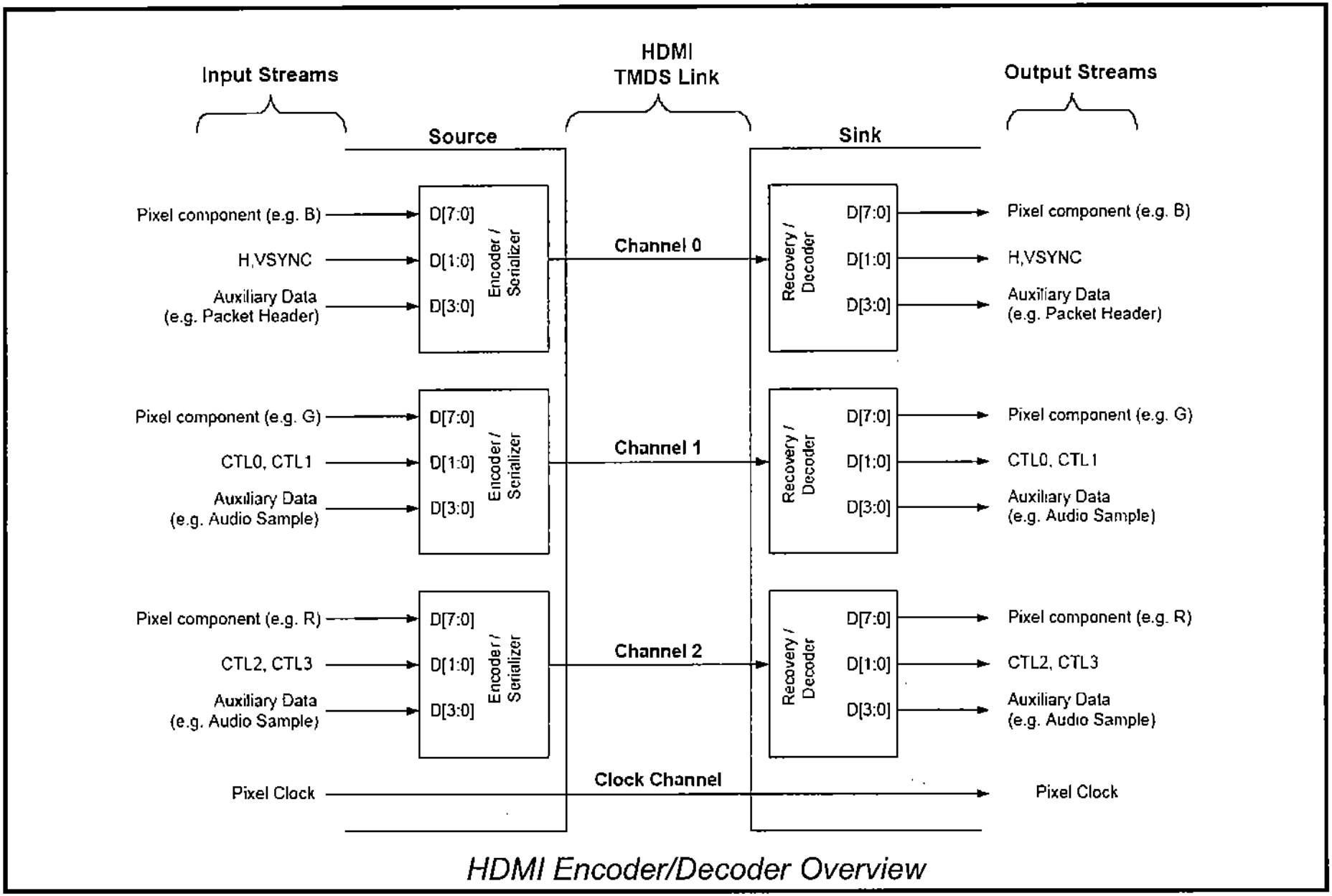
Type A Receptacle



Type A Plug



HDMI Connector pin configuration			
NO	Function	NO	Function
1	D2_RX2+	11	D2_RXCLK GND
2	D2_RX2 GND	12	D2_RXCLK
3	D2_RX2-	13	No connection
4	D2_RX1+	14	No connection
5	D2_RX1 GND	15	HDMI_DDC_SCL
6	D2_RX1-	16	HDMI_DDC_SDA
7	D2_RX0+	17	HDMI_DDC_GND
8	D2_RX0 GND	18	HDMI VCC (5V)
9	D2_RX0-	19	Ident_HDMI
10	D2_RXCLK+	20	Common GND



HDMI Encoder/Decoder Overview

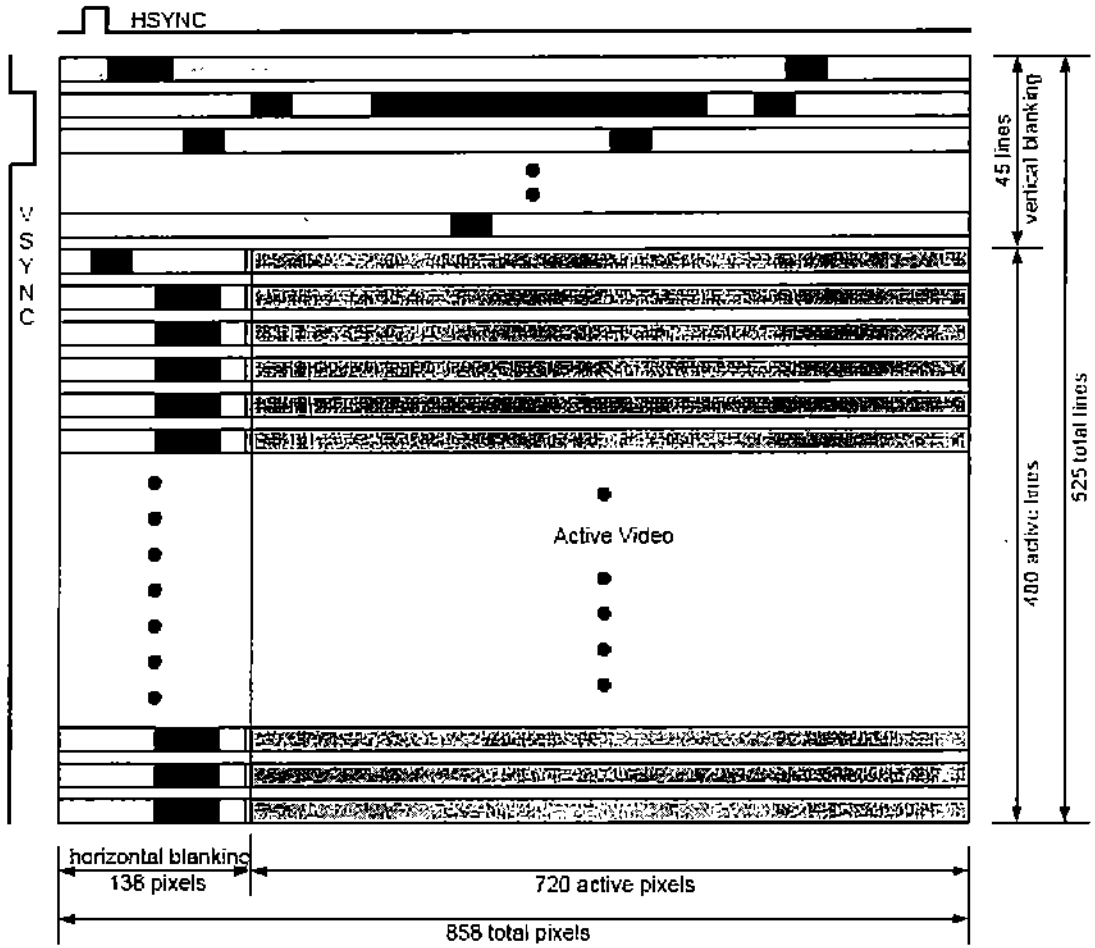
Link Architecture

As shown in an HDMI link includes three TMDS Data channels and a single TMDS Clock channel. The TMDS Clock channel constantly runs at the pixel rate of the transmitted video. During every cycle of the TMDS Clock channel, each of the three TMDS data channels transmits a 10-bit character. This 10-bit word is encoded using one of several different coding techniques.

The input stream to the Source□s encoding logic will contain video pixel,
packet and control data. The packet data consists of audio and auxiliary data and associated error correction codes.

These data items are processed in a variety of ways and are presented to the TMDS encoder as either 2 bits of control data, 4 bits of packet data or 8 bits of video data per TMDS channel. The Source encodes one of these data types or encodes a Guard Band character on any given clock cycle.

Example: TMDS periods in 720x480p video frame



Operating Modes Overview

The HDMI link operates in one of three modes: Video Data Period, Data Island period, and Control period. During the Video Data Period, the active pixels of an active video line are transmitted. During the Data Island period, audio and auxiliary data are transmitted using a series of packets. The Control period is used when no video, audio, or auxiliary data needs to be transmitted.
A Control Period is required between any other two periods.

Video Data Periods use transition minimized coding to encode 8 bits per channel, or 24 bits total per pixel.
Data Island Periods are encoded using a similar transition minimized coding, TMDS Error Reduction Coding (TERC4), which transmits 4 bits per channel, or 12 bits total per pixel clock period.
During Control Periods, 2 bits per channel, or 6 bits total are encoded per pixel clock using a transition maximized encoding. These 6 bits are HSYNC, VSYNC, CTL0, CTL1, CTL2 and CTL3. Near the end of every Control Period, a Preamble, using the CTLx bits, indicates whether the next Data Period is a Video Data Period or a Data Island Period.

Video Format Support

In order to provide maximum compatibility between video Sources and Sinks, specific minimum requirements have been specified for Sources and Sinks

Primary Video Format Timings

- 640x480p @ 59.94/60Hz
- 1280x720p @ 59.94/60Hz
- 1920x1080i @ 59.94/60Hz
- 720x480p @ 59.94/60Hz
- 720(1440)x480i @ 59.94/60Hz
- 1280x720p @ 50Hz
- 1920x1080i @ 50Hz
- 720x576p @ 50Hz
- 720(1440)x576i @ 50Hz

Audio Sample Rates and Support Requirements

If an HDMI Source supports audio transmission across any output, then it shall support HDMI audio transmission. If an HDMI Source supports any HDMI audio transmission, then it shall support 2 channel L-PCM using an IEC 60958 Subpacket structure, with either 32kHz, 44.1kHz or 48kHz sampling rate and a sample size of 16 bits or more.

An HDMI Source is permitted to transmit L-PCM or encoded audio data at sample rates of 32kHz, 44.1kHz, 48kHz, 88.2kHz, 96kHz, 176.4kHz and 192kHz using either IEC 60958 format or IEC 61937 format. If an HDMI Sink supports audio reception across any input, then it shall support audio reception from all HDMI inputs.

Basic Audio. is defined as two channel L-PCM audio at sample rates of 32kHz, 44.1kHz, *or* 48kHz, with a sample size of at least 16 bits. For EIA/CEA-861B references to DTV devices, .Basic Audio. is defined as two channel L-PCM audio at sample rates of 32kHz, 44.1kHz, *and* 48kHz.

There is no sample size usage restriction for DTV devices. An HDMI Sink may optionally accept audio at sample rates of 88.2kHz, 96kHz, 176.4kHz and/or 192kHz using either IEC 60958 format or IEC 61937 format, and should indicate these capabilities in the E-EDID data structure.

Compatibility With DVI

All HDMI Sources shall be compatible with DVI 1.0 compliant sink devices (i.e. "monitors" or "displays") through the use of a passive cable converter. Likewise, all HDMI Sinks shall be compatible with DVI 1.0 compliant sources (i.e. "systems" or "hosts") through the use of a similar cable converter.

When communicating with a DVI device, an HDMI device shall operate according to the DVI 1.0 specification, with the following exception - these devices are not required to comply with DVI 1.0 rules regarding:

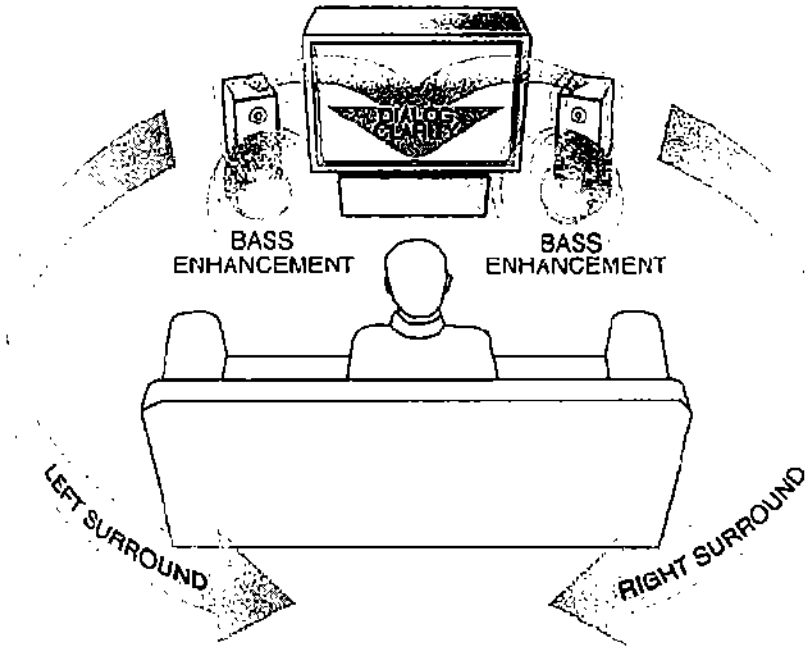
- Monitor scaling requirements
- Physical Interconnect specifications
- System Low Pixel Format Support Requirements

Furthermore, for HDMI devices which do not have a "BIOS" or "operating system", there are the following additional exceptions:

- "BIOS" requirements
- "Operating system" requirements
- "System level event" requirements
- Power management requirements

TruSurround XT for Virtual Surround Sound

DVD players have transformed the household into an entertainment center. While DVD owners can now enjoy 5.1 multichannel soundtracks for movies and music in the comfort of their living room or at their computer, most televisions and computer playback systems have only two speakers.



TruSurround XT□ bridges this gap. It processes any multichannel audio source, as is usually found on DVDs, and transforms the material into breathtaking virtual surround sound from just two speakers or headphones.

Based upon the patented TruSurround® technology from SRS Labs, which is the established standard for virtual surround sound, TruSurround XT also includes the unique features of SRS Dialog Clarity and TruBass and creates a stunning 3D sound image from standard stereo material.

TruSurround XT features

☐ **TruSurround:** TruSurround is a patented SRS technology that solves the problem of playing 5.1 multichannel content over two speakers. TruSurround delivers a compelling, virtual surround sound experience through any two-speaker playback system, including internal television speakers and headphones. It is fully compatible with all multichannel formats up to 6.1 channels.

☐ **SRS Dialog Clarity Enhancement:** Playback of dialog often suffers due to competing signals from other speakers. In addition, feature film soundtracks are mixed specifically for cinema playback and are loaded with the latest advancements in special audio effects. When translated over home theatre or computers systems, dialog may become unintelligible. This patented SRS algorithm enhances signal clarity to address these problems, thus improving dialog intelligibility from all such source material.

TruSurround XT features

☐ **TruBass:** TruBass is a patented SRS technology that enhances bass performance utilizing proprietary psychoacoustic techniques. These techniques restore the perception of fundamental low frequency tones by dynamically augmenting harmonics, which are more easily reproduced by contemporary loudspeakers.

Using TruBass, TruSurround XT takes the bass information contained within the original audio track and helps the speakers or headphones re-create it – even if it is below the speaker's low frequency limitations.

☐ **WOW**: WOW™ is an award winning stereo enhancement technology that significantly improves the performance of stereo (non-surround sound encoded material) signals through any two-speaker system, including headphones. It extends the sound image in both the horizontal and vertical planes well beyond the speakers themselves. In addition, WOW incorporates TruBass and SRS Dialog Clarity Enhancement.

When TruSurround XT accepts a stereo signal, WOW is enabled for a better listening experience. Wow is also used by Microsoft in their new Media Player for Windows XP and Windows Media Player 7.

LE23R51B	
BN90-00695B	ASSY COVER REAR
BN90-00696B	ASSY COVER FRONT
BN90-00697A	ASSY STAND
BN91-00793T	ASSY SHIELD
BN91-00826S	ASSY CHASSIS
BN91-00833C	ASSY LCD-SPZ
BN92-00920B	ASSY LABEL
BN92-01295A	ASSY P/MATERIAL
BN92-01296B	ASSY BOX
BN92-01324F	ASSY ACCESSORY

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BN90-00690A	ASSY COVER REAR
BN90-00691A	ASSY STAND
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BN91-00833E	ASSY LCD-SPZ
BN92-01044V	ASSY LABEL
BN92-01288B	ASSY ACCESSORY
BN92-01291A	ASSY P/MATERIAL
BN92-01292A	ASSY BOX