
RM-2443W Series

- RM-2443W-2C
- RM-2443W-2HD
- RM-2443W-HD

2RU, 4-Screen, 4.3" HD/SD-SDI and
CVBS Audio/Video Monitors

User Guide

Part Number 821712, Revision D



31055 Huntwood Avenue
Hayward, California
94544 USA



1 800 5 WOHLER
+1 (510) 870-0810
Fax +1 (510) 870-0811



www.wohler.com
info@wohler.com



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Customer Support

Wohler Technologies, Inc.
31055 Huntwood Avenue
Hayward, CA 94544
www.wohler.com

Phone: 510-870-0810
FAX: 510-870-0811
US Toll Free: 1-888-596-4537
(1-888-5-WOHLER)
Web: www.wohler.com
Sales: sales@wohler.com
Support: support@wohler.com

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RM-2443W Series User Guide

Introduction

Overview

These 2RU rack-mounted audio/video monitors set a new standard in LCD monitors for broadcast and professional video applications. The monitors have 480 x 272 resolution. All three have anti-glare TFT screens, and full digital signal processing support: HD-SDI and analog composite video standards. All video formats are scaled to fit on screen in the highest quality using full, digital processing, precision scaling and gamma correction to produce the best images available.

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Safety Instructions

1. Read, keep, and follow all of these instructions; heed all warnings.
2. Do not use this equipment near water.
3. Use only a dry cloth to clean the equipment.
4. Do not block any ventilation openings. Install only in accordance with the instructions in the section entitled, “[Installation Recommendations](#)” on [page 3](#).
5. Do not install near any heat source such as a radiator, heat register, amplifier, or stove.
6. Do not expose the equipment to rain or moisture.
7. Do not attempt to plug the unit into a two-blade outlet (with only two prongs of equal width).

IMPORTANT: By design, these audio/video monitors will only plug into a three-prong outlet for your safety. If the plug does not fit into your outlet, contact an electrician to replace the obsolete outlet.

8. Protect the power cord from being walked on or pinched, particularly at plug's source on the equipment and at the socket.
9. Use only the attachments/accessories specified by the manufacturer.
10. Unplug the equipment during lightning storms or when unused for long periods of time.
11. Refer all servicing to qualified service personnel. Servicing will be required under all of the following conditions:
 - The equipment has been damaged in any way, such as when the power-supply cord or plug is damaged.
 - Liquid had been spilled or objects have fallen onto the equipment.
 - The equipment has been exposed to rain or moisture.
 - The equipment does not operate normally.
 - The equipment has been dropped.

Installation Recommendations

Mounting

The unit is designed to install into a standard 19" rack. The unit should be mounted at approximately eye level for optimum visual observation.

Heat Dissipation

No special physical mounting considerations are necessary regarding heat dissipation except under adverse conditions, provided the ambient temperature inside the mounting enclosure does not exceed 40°C (104°F). Adjacent devices can be rack mounted (or stacked) in proximity to the unit. If the temperature is above 40°C, allow a 1RU (1.75"/44.45mm) space above and below the unit for air circulation.

DC Power

Connect the unit to its external 100 to 240VAC (50 to 60Hz) to 12VDC power supply (included).

FCC Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Features

Common Features

All three audio/video monitors are designed for confidence monitoring of video broadcast signal (CVBS) video sources. HD and 2HD models also monitor HD/SD-SDI video sources. Input signals are automatically detected and accommodated. Up to eight of the sixteen audio channels embedded in an HD/SD-SDI bit stream may be selected for visual monitoring on eight on-screen bar graph style level meters on the HD and 2HD models. A **Headphone Jack** provides audible stereo monitoring of the left/right channels.

Each of the four high-resolution LCD screens display high definition or standard definition video at either 4:3 or 16:9 aspect ratio. Parameters are selected and adjusted using an On Screen Display (OSD) MENU. One function button may be programmed as a hot key for quick parameter settings. A DB9 connector serves as the interface to the four tally lights on the front panel.

Additional overlays can be added by the operator for safe area and safe title markers, center mark, time code, and display name. **Time code** is derived from embedded HD/SD-SDI source.

The slim and light weight design provides four screens in a very compact rack-size (2RU) while the chassis only has 2.2 inches of depth.

The feature-rich audio/video monitors provide all of the following:

- Four 4.3" widescreen LCDs:
- Selectable 16:9 or 4:3 screen aspects for on screen video
- Rack mount mechanical design with vertical tilt
- Monitoring of embedded audio through headphones (except on the -2C model)
- Visually monitor audio levels on meters assignable to any channel (except on the -2C model)
- Level meters can display VU, PPM (PK) or both with assignable -20db to -18db level (except on the -2C model)

- Local control (via menu operation) for all functions including:
 - Blue gun as mono
 - Safe area
 - Safe title
 - Center markers
 - H/V delay
 - Monochrome display mode
 - Over/underscan
 - Display of **Input Signal** format
 - Display of input time code (SDI only) and up to 10 characters of user-defined text
 - **Time Code** and text position in top or bottom of screen
 - Red/green/yellow/white text color
 - Built in color bars 75% full field
 - User-defined configuration
 - Auto sets at power up
 - **Waveform/Vectorscope** monitor (except for the -2C model)
- User defined hot key functionality provides any of the following:
 - H/V delay toggle through functions
 - Underscan toggle on/off
 - On Screen Display (OSD) on/off
 - Color bar on/off
 - Audio monitor display on/off (except on the -2C model)
 - Area marker toggle

Product Distinctions

For a complete list of all the variations among these monitors, refer to the [Specifications](#) below.

HD vs. 2HD

The RM-2443W-HD has four multi-rate inputs (one per screen) accepting composite (CVBS) or HD/SD-SDI video with re-clocked outputs of the HD/SD-SDI input on BNC connectors.

The RM-2443W-2HD has eight multi-rate inputs (two per screen) accepting composite (CVBS) or HD/SD-SDI video with no outputs. Each monitor also has a button on the front panel that toggles the two signal inputs to the screen.

HD vs. 2C

The *HD* designation represents HD/SD-SDI inputs on both the RM-2443W-HD and the RM-2443W-2HD. These two monitors also feature an audio demux and display for up to eight of the sixteen embedded channels in each HD/SDI-SDI source.

The *2C* represents the two composite analog inputs on the RM-2443W-2C and has no outputs. Also, the *2C* model has no audio capabilities.

Specifications

The specifications of the audio/video monitors are listed below.

Table 1–1 RM-2443W Series Specifications

Specification	RM-2443W-2HD Values	RM-2443W-HD Values	RM-2443W-2C Values
Number of Screens	4		
Display	4.3" diagonal		
Native Aspect Ratios	16:9		
Viewing Angle (Tilt)	160°H x 160°V		
Screen Colors	16.7M		

Table 1–1 RM-2443W Series Specifications (Continued)

Specification	RM-2443W-2HD Values	RM-2443W-HD Values	RM-2443W-2C Values
Resolution (Dots, H x V)	480 x 272		
Dot Pitch (H x V, mm)	0.1125 x 0.1095		
Contrast Ratio	400:1		
Pixel Response (ms)	<30 typical		
Luminance	400 cd/m ²		
Dimensions (W x Hmm)	19" x 3.74" x 2.1" (486 x 95 x 53.3 mm)		
Shipping Weight	8 lbs. (3.63 kg)		
Power Consumption	12VDC/10 Watts (3.8 Amps max) CE & UL power supply		
Operating Temperature	0°C (32°F) to 40°C (104°F)		
Video Format	NTSC/PAL auto recognition		
Inputs	HD/SD-SDI, Analog Composite (2 BNCs per screen)	HD/SD-SDI, Analog Composite (1 BNC per screen)	Analog Composite (2 BNCs per screen)
Outputs	None	HD/SD-SDI Re- clocked output (1 BNC per Screen)	None
Space Required	2 rack units of an EIA-19 standard equipment rack		
Supplied Accessories	AC power adapter		

Note: All specifications are subject to change without notice.

The signal input formats are listed in [Table 1-2](#) below.

Table 1–2 Acceptable Signal Formats for the RM-2443W Series Monitors

Input Format	HD	2HD	2C
NTCS (CVBS)	✓	✓	✓
PAL (CVBS)	✓	✓	✓
480i-59.94	✓	✓	—
576i-50	✓	✓	—
720p-23.97	✓	✓	—
720p-24	✓	✓	—
720p-25	✓	✓	—
720p-29.97	✓	✓	—
720p-30	✓	✓	—
720p-50	✓	✓	—
720p-59.97	✓	✓	—
720p-60	✓	✓	—

Table 1–2 Acceptable Signal Formats for the RM-2443W Series Monitors (Continued)

Input Format	HD	2HD	2C
1035i-59.94	✓	✓	—
1035i-60	✓	✓	—
1080i-50	✓	✓	—
1080i-59.94	✓	✓	—
1080i-60	✓	✓	—
1080p-23.97	✓	✓	—
1080p-24	✓	✓	—
1080p-25	✓	✓	—
1080p-29.97	✓	✓	—
1080p-30	✓	✓	—
1080PsF-23.97	✓	✓	—
1080PsF-24	✓	✓	—

Front Panel Controls

The front panel feature descriptions refer to [Figure 1-1](#) and [Figure 1-2](#) below.

Figure 1–1 Front Panel Overview



- **Tally Lights:** These tri-color (red/green/amber) lights are controlled through a DB9 connector on the rear of the panel. For more information about the rear panel DB9 connector, refer to “[Rear Panel Connectors](#)” on [page 11](#).
- **Headphone Jack:** Monitor the assigned left/right stereo audio channels with stereo headphones from this mini-stereo connector (except on the -2C model).

- **Power:** Each of the four **Power** buttons turn the associated LCD screen on and off; the LED glows green to indicate on. When the indicator above the power switch is green then the unit is receiving power. When the indicator is flashing, the unit is in stand-by mode.
- **Aspect:** This button toggles the aspect ratio between 4:3 and 16:9 for the associated LCD screen when the input signal is SD-SDI. HD-SDI images are always 16:9 and will not be affected by the Aspect switch. The LED glows green to indicate 16:9.
 - Note:** The **Aspect** button is only available on the RM-2443W-HD.
- **F1:** The **F1** button (also called the **User** or **User 1** button) is programmable as a hot key for parameter adjustments. Refer to “[Programming the Hot Key Buttons](#)” on [page 23](#) for more information.
 - Note:** The **F1** button is only available on the RM-2443W-HD. The other two models have the **User1** button in its place which is functionally identical.

Figure 1–2 RM-2443W-HD Front Panel Menu



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Front Panel Controls

- **Menu:** Pressing the **Menu** button displays the **OSD** (On-Screen Display) **Menu**. Refer to “Using the OSD Menu” on page 14 for more information.
- **Blue** or \wedge : When the **OSD Menu** is not active, pressing this button cycles between three settings: blue monochromatic, grey scale monochromatic, and full color. When the **OSD Menu** is active, this button serves as the up (\wedge) navigation button in the menu.
- **Mute** or \vee : When the **OSD Menu** is not active, this button is used to select the audio source for monitoring through the headphones. Press this button on whichever LCD section you wish to audibly monitor, and the green LED will light to indicate your selection. Pressing it a second time will mute the audio. Subsequent presses will toggle the mute off and on. The green LED flickers to indicate the mute is on. When the **OSD Menu** is active, this button serves as the down (\vee) navigation button in the menu. (The Mute has no function on the -2C model.)

Figure 1–3 RM-2443W-2HD and RM-2443W-2C



- **Enter:** When the **OSD Menu** is displayed, pressing this button enters items and accepts selections in the **OSD Menu**. Otherwise, it acts as a quick menu to select parameters for adjustment. Refer to “[Programming the Hot Key Buttons](#)” on [page 23](#) for more information.
- **LCD Screen:** The LCD screens display the selected video and OSD features.
- **In A/B:** This button toggles the screen’s display between the two input sources for each monitor.
 - Note:** The **A/B** button is not available on the RM-2443W-HD.
- **User:** The functionality of the **User** button is identical to that of the **F1** button on the HD model.

Rear Panel Connectors

- **Power:** To provide power to the unit, attach the supplied 100 to 240VAC to 12VDC power supply to this connector.
- **Tally Interface (on DB-9):** This connector controls the tally lights on the front panel. Refer to [Figure 1-4](#) below for the pin out.

Figure 1-4 Rear Panel DB9 Connector Pin Out

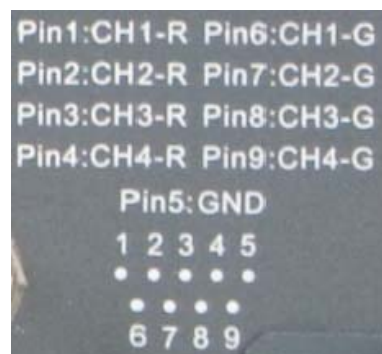
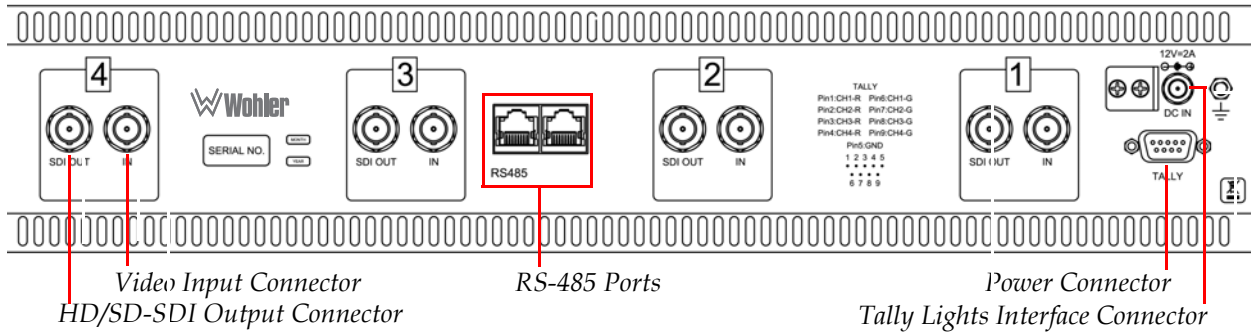


Figure 1–5 RM-2443W-HD Rear Panel



- HD/SD-SDI Output (on BNC):** The system re-shapes and re-clocks an HD/SD-SDI signal before outputting it to this female BNC connector.

Note: The output ports are only available on the RM-2443W-HD.
- Video Input (on BNC):** This auto-detecting, input connector accepts HD/SD-SDI or analog CVBS video signals. The inputs comply with SMPTE259M, SMPTE292M/ITU-R BT601. Composite video inputs comply with SMPTE-170M.

Note: The input connectors of the RM-2443W-2C will only accept CVBS signal types.
- RS-485 I/O (on RJ-45):** These two ports are used for system software upgrades and dynamic IMD controls.

Note: The RS-485 ports are not available on the RM-2443W-2C.

Figure 1–6 RS-485 I/O Pin Out

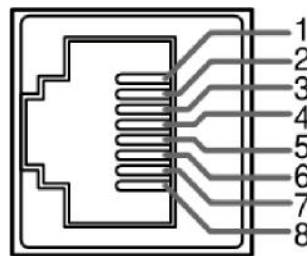


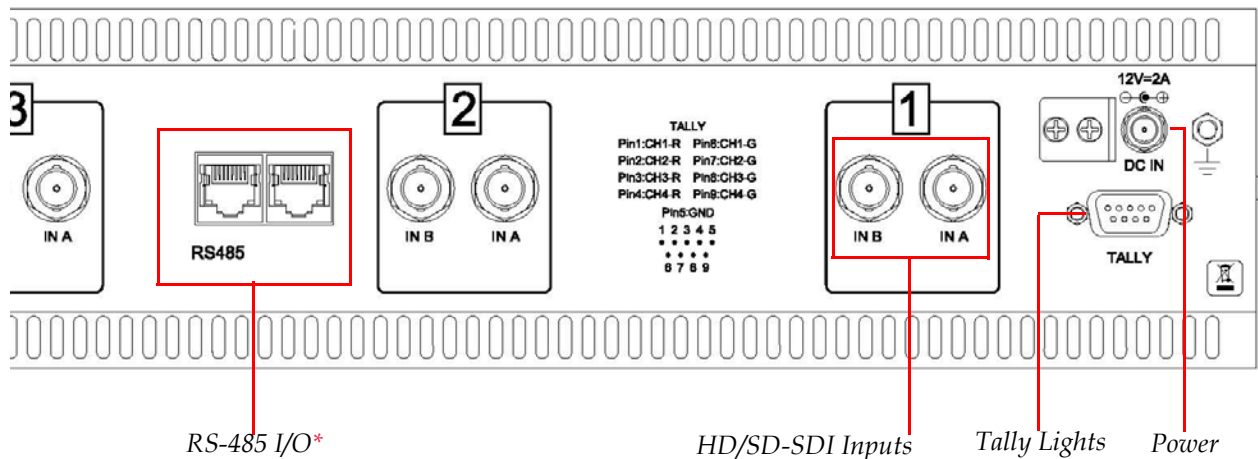
Table 1–3 RS-485 Pin Out

Pin	RS485 In terminal	RS485 Out Terminal
1, 2	GND	GND
3	Tx-	Tx-

Table 1–3 RS-485 Pin Out

Pin	RS485 In terminal	RS485 Out Terminal
4	Rx+	Rx+
5	Rx-	Rx-
6	Tx+	Tx+
7, 8	NC	NC

Figure 1–7 RM-2443W-2HD and RM-2443W-2C Rear Panel



*The RS-485 ports are not available on the RM-2443W-2C.

On-Screen Display Features

Some of the buttons and **OSD Menu** control the display of features on the screen as shown in [Figure 1–8](#) on the next page.

- **Input Signal:** The input signals are automatically detected.
- **Audio Levels:** Levels for the selected audio channels are displayed on up to eight meters (four pair). Up to four meters on the left side and four on the right (except on the -2C model).
- **IMD:** The **OSD Menu** provides settings to customize the IMD (In Monitor Display) text area to show a line of characters, numbers, and some symbols.

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Using the OSD Menu

- **Time Code:** The de-embedded time code from the HD/SD-SDI source displays in the bottom right corner (except on the -2C model).

Figure 1–8 Display Features



Using the OSD Menu

A description of how to use the **OSD Menu** follows. Also refer to [Table 1-5](#) below for typical values and domain ranges.

1. Press the **Menu** button to display the menu.

Note: If you do not press another button for approximately 10 seconds, the menu will disappear from the screen.

- Use the **Up** and **Down** buttons to navigate through the seven sub-menu icons. The sub-menus are:

Table 1–4 Menus for the RM-2443W Series Monitors

HD and 2HD	2C
STATUS (No configurable options)	
VIDEO	
AUDIO	MARKER
MARKER	ZOOM
OSD	H/V DELAY
USER CONTROL	STATUS INDICATION
USER CONFIG	CONFIG

- Press the **Enter** button to enter the parameter selections in the chosen sub-menu.
- Use the **Up** or **Down** buttons to cycle through the sub-menu selections.
- When the desired option is highlighted, press the **Enter** button to select it.
- Use the **Up** or **Down** buttons to adjust the parameter value up or down, make a selection, or turn a function on or off.
- Press the **Menu** button to back out of a parameter or sub-menu. Press the **Menu** button again to remove the menu from the screen.

The OSD Menu for the HD and 2HD Models

Table 1–5 HD and 2HD OSD Menu Structure

Menu	Parameters	Default Value	Domain Range
STATUS	FORMAT	N/A	Not configurable, signal dependent
	COLOR TEMP	D65	
	MON SOURCE	N/A	
	SCAN	UNDER SCAN	
	SD ASPECT	4:3	
	MODEL	RM-2443W-XX	
VIDEO	BRIGHTNESS	000	-116 through 139
	CONTRAST		-128 through 127
	SATURATION		000 through -15
	SHARPNESS		-032 through -031
	HUE		
	RESET	YES	Loads system defaults
	COLOR TEMP	D65	<ul style="list-style-type: none"> • D65 • D56 • D95 • USR
	R GAIN	128	0 through 255
	G GAIN		
	B GAIN		
	R OFFSET		
	G OFFSET		
	B OFFSET		
RESET	YES	Loads system defaults	
AUDIO	AUDIO MON	OFF	ON or OFF; toggles audio enable between the two monitors, (i.e., enabling the ON selection on one turns the other OFF).

Table 1–5 HD and 2HD OSD Menu Structure (Continued)

Menu	Parameters	Default Value	Domain Range
AUDIO (Continued)	MON SOURCE	MET 1	<ul style="list-style-type: none"> • MET 1 • MET 2 • MET 3 • MET 4
	VOLUME	-30db	-30 db through 0 db
	METER SIZE	SMALL	Not Configurable
	METER H POS L	000	000 through 255
	METER H POS R		
	TEST LEV	-20 DB	-20DB or -18DB
	IN A:MET 1	VU+PK	<ul style="list-style-type: none"> • VU • PK • VU+PK • NONE
	IN A:MET 2		
	IN A:MET 3		
	IN A:MET 4		
	IN A:MET 1-L	CH 1	EDB1 through EDB16
	IN A:MET 1-R	CH 2	
	IN A:MET 2-L	CH 3	
	IN A:MET 2-R	CH 4	
	IN A:MET 3-L	CH 5	
	IN A:MET 3-R	CH 6	
IN A:MET 4-L	CH 7		
IN A:MET 4-R	CH 8		
MARKER	SAFE MARKER	OFF	ON or OFF; If SAFE MARKER is set to OFF, none of the other options on this menu are configurable.
	CENTER	OFF	ON or OFF
	90%	OFF	
	80%	OFF	

Table 1–5 HD and 2HD OSD Menu Structure (Continued)

Menu	Parameters	Default Value	Domain Range	
MARKER (Continued)	AREA	OFF	<ul style="list-style-type: none"> • 2.35:1 • 1.85:1 • 15:9 • 14:9 • 13:9 • 4:3 • OFF 	
OSD	STD DISP	OFF	<ul style="list-style-type: none"> • AUTO OFF • ON • OFF 	
	WFM/VT DISP		<ul style="list-style-type: none"> • VECTOR • WFM • OFF 	
	TC DISP		ON or OFF	
	UMD (IMD: In Monitor Display) DISP			
	OSD TLY DISP	ON	ON or OFF	
	OSD TLY MODE	RGY	<ul style="list-style-type: none"> • RG • GR • RGY • T1T2 • T2T1 • T1- • T2- 	
	LED TLY DISP	ON	ON or OFF	
	UMD FIXED SET UP			
	—	N/A	A user-definable input string of up to 16 alphanumeric characters (also includes some symbols)	

Table 1–5 HD and 2HD OSD Menu Structure (Continued)

Menu	Parameters	Default Value	Domain Range	
OSD (Continued)	COLOR	WHITE	<ul style="list-style-type: none"> • RED • GREEN • YELLOW • WHITE 	
	ALIGN	CENTER	<ul style="list-style-type: none"> • LEFT • CENTER • RIGHT 	
	UMD PROTOCOL			
	—		<ul style="list-style-type: none"> • LOCAL • IMAGE VIDEO • TSL V4.0 • TSL V3.1, 	
	UMD ID	000	000 through 255	
	UMD NAME (S/N)			
	—	N/A	A user-definable input string of up to 16 alphanumeric characters (also includes some symbols)	
	UMD TLY MODE	T1T2	<ul style="list-style-type: none"> • T2 • T1 • T2T1- • T1T2- 	
	UMD BAUD RATE			
	—	N/A	<ul style="list-style-type: none"> • 2400 • 4800 • 9600 • 19200 • 38400 • 57600 • 115200 	

Table 1–5 HD and 2HD OSD Menu Structure (Continued)

Menu	Parameters	Default Value	Domain Range
OSD (Continued)	TALLY SOURCE		
	—	N/A	<ul style="list-style-type: none"> • STANDARD • TSL • STANDARD+IV422 • IMAGE VIDEO 422 • IMAGE VIDEO HW
USER CONTROL	SCAN	NORMAL	NORMAL or UNDER SCAN
	SD ASPECT	4:3	4:3 or 16:9
	H/V DELAY	OFF	<ul style="list-style-type: none"> • OFF • H • V • H/V
	COLOR BAR	DISABLE	DISABLE or "ON"
USER CONFIG	VECTOR REF	75% CB	75% CB or 100% CB
	OSD CONTROL	ON	ON or OFF
	WFM/VT MODE	SOLID	<ul style="list-style-type: none"> • SOLID • 75% • 50% • 25%
	USER1	SCAN	<ul style="list-style-type: none"> • SCAN • AUDIO SOURCE • OSD CONTROL • AREA MARKER • SAFE MARKER • WFM DISPLAY • H/V DELAY

The OSD Menu for the RM-2443W-2C

Table 1–6 2C OSD Menu Structure

Menu	Parameters	Default Value	Domain Range
VIDEO	BRIGHTNESS	0	-116 through 139
	CONTRAST		-128 through 127
	SATURATION		-128 through 127
	SHARPNESS		0 through 15
	HUE		-32 through 31
MARKER	AREA	OFF	<ul style="list-style-type: none"> • 2.35:1 • 1.85:1 • 15:9 • 14:9 • 13:9 • 4:3 • OFF
MARKER (Continued)	SAFE MARKER	OFF	ON or OFF
	CENTER	OFF	
	90%	OFF	
	80%	OFF	
ZOOM	ZOOM	NORMAL	NORMAL or UNDERSCAN
	ASPECT	4:3	4:3 or 16:9
H/V DELAY	H/V DELAY	OFF	<ul style="list-style-type: none"> • H/V • V • H • OFF

Table 1–6 2C OSD Menu Structure (Continued)

Menu	Parameters	Default Value	Domain Range
STATUS INDICATION	STD DISP	AUTO OFF	<ul style="list-style-type: none"> • AUTO OFF • ON • OFF
	TC DISP, UMD DISP	ON	ON or OFF
	TC POS, UMD POS	BOTTOM	TOP or BOTTOM
	UMD COLOR	WHITE	<ul style="list-style-type: none"> • RED • GREEN • YELLOW • WHITE
	UMD	N/A	A user-definable input string of up to 16 alphanumeric characters (also includes some symbols)
CONFIG	DEFAULT	UNSET	UNSET or SET
	F1	OSD CONTROL	<ul style="list-style-type: none"> • H/V DELAY • UNDER SCAN • ASPECT • OSD CONTROL • COLOR BAR • AREA MARKER • SAFE MARKER
CONFIG (Continued)	OSD CONTROL	ON	ON or OFF
	COLOR BAR	DISABLE	DISABLE

Programming the Hot Key Buttons

The Enter Button

When the **OSD Menu** is not displayed, you can press the **Enter** button to quickly adjust the following parameters:

1. **VOLUME:** This option regulates the volume from -30db to 0db.
2. **BRIGHTNESS:** This option regulates the video brightness from -116 to 139, where 0 is the typical value.
3. **CONTRAST:** This option regulates the image contrast from -128 to 127, where 0 is the typical value.
4. **SATURATION:** This option regulates the color saturation of the image from -128 to 127, where 0 is the typical value.
5. **SHARPNESS:** This option regulates the sharpness of the image from 0 to 15, where 0 is the typical value.
6. **HUE:** This option regulates the hue of the image from -32 to 31, where 0 is the typical value.

Note: By selecting the **DEFAULT** option in the **CONFIG** sub-menu, you can reset the parameters of the **BRIGHTNESS**, **CONTRAST**, **SATURATION**, **SHARPNESS**, and **HUE** options to zero (0).

The F1/User1 Button

You can use the **F1/User1** as a hot key. Assigning a parameter to this button allows that parameter to be displayed and adjusted on-screen at the press of the button without displaying and navigating through the **OSD Menu**. To program the hot key:

1. Press the **Menu** button.
2. Use the **Up** and **Down** buttons to find the **USER CONFIG** sub-menu and press the **Enter** button to select it.
3. Use the **Up** and **Down** buttons to cycle to the **USER1** selection and press the **Enter** button to select it.

4. Use the **Up** and **Down** buttons to select the following eight parameters. Press the **Menu** button to exit the sub-menu. (Refer to [Table 1-5](#) starting on [page 16](#) for the domain range for each of these parameters.)
 - SCAN
 - AUDIO SOURCE
 - OSD CONTROL
 - AREA MARKER
 - SAFE MARKER
 - WFM DISPLAY
 - H/V DELAY

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The following block diagrams ([Figure 1-9](#), [Figure 1-10](#), and [Figure 1-11](#)) show the overall functionality of these audio/video monitors.

Figure 1–9 RM-2443W-HD Block Diagram

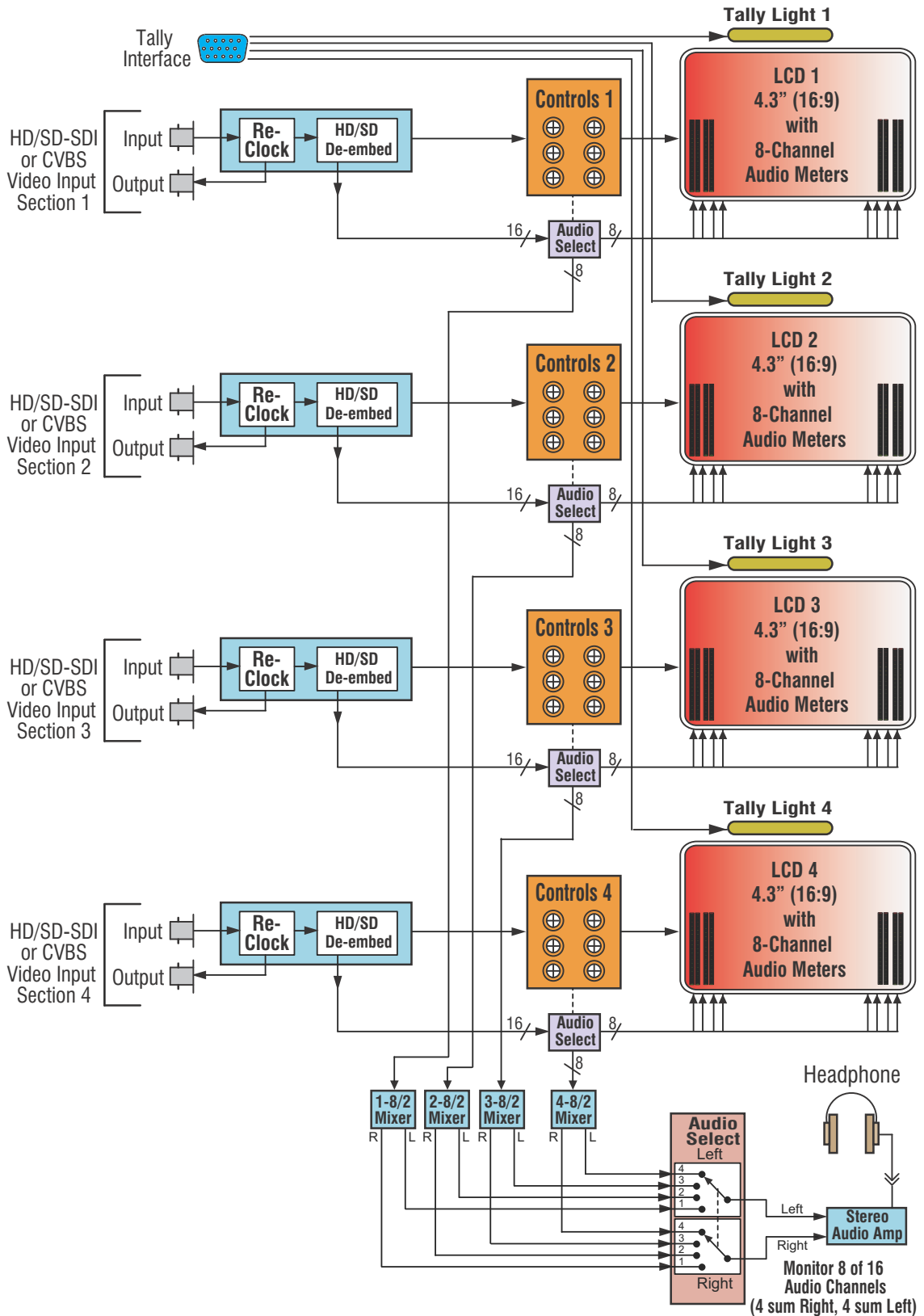


Figure 1–10 RM-2443W-2HD Block Diagram

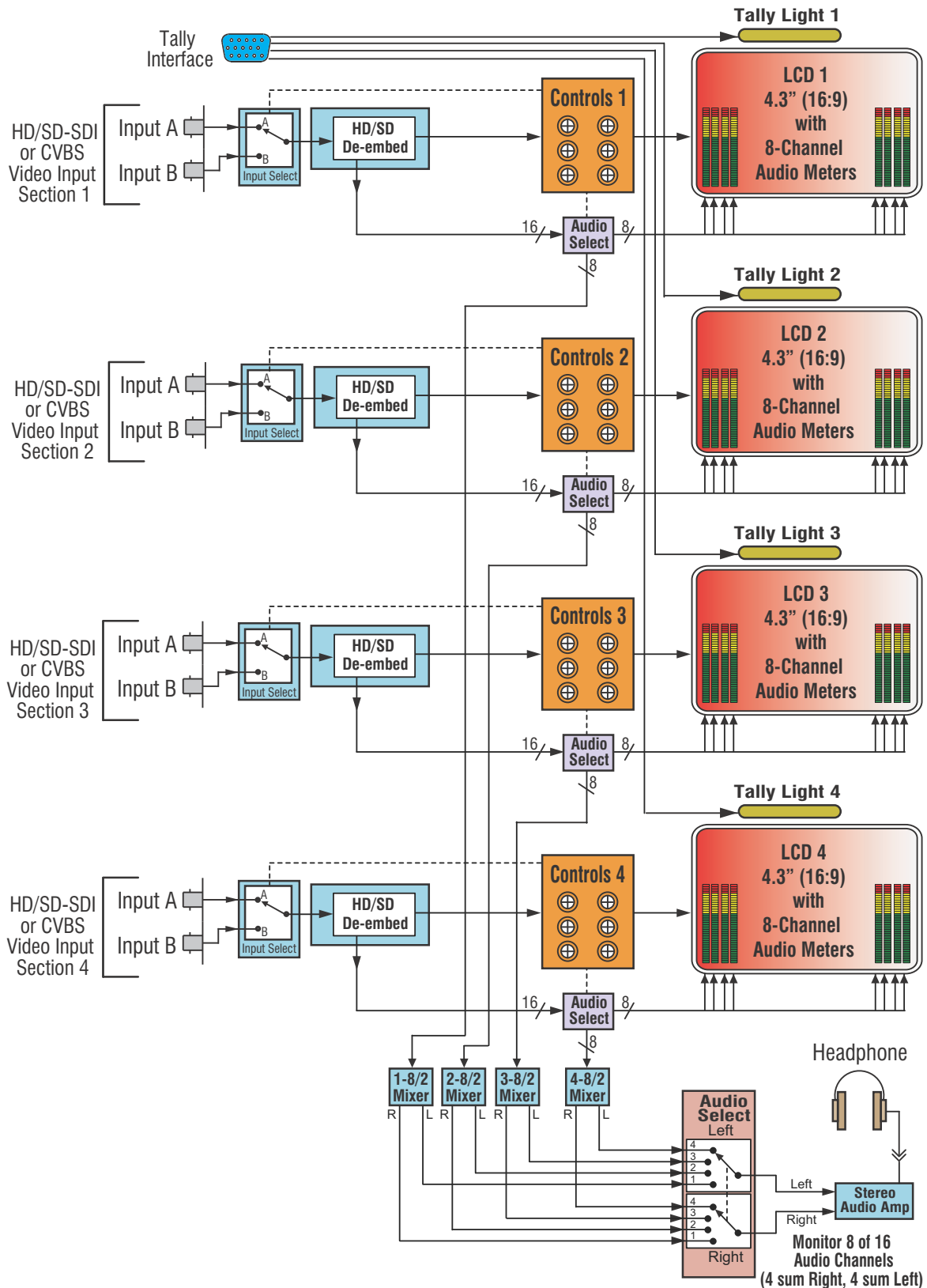
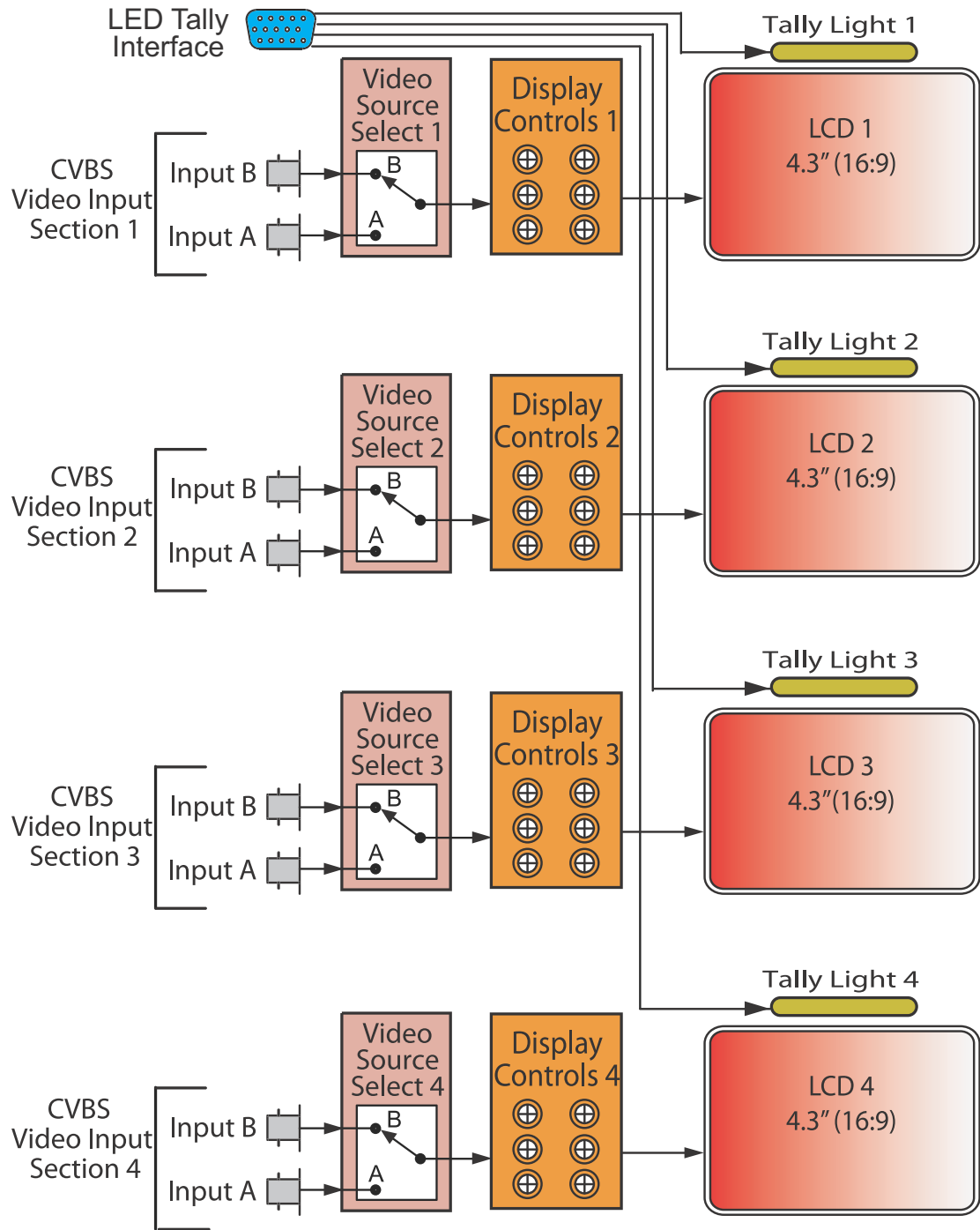


Figure 1–11 RM-2443W-2C Block Diagram



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