Sony MST-2000

MUSE Decoder with BS Tuner

User's Guide

The MST-2000 is a decoder for the bandwidth-compressed analog High Definition Television transmission format developed for direct-to-home satellite broadcasting by NHK, the Japanese State broadcaster, incorporating a DBS receiver which is also capable of receiving conventional NTSC broadcasts. Although a planned wider scope of application did not in fact come about, regular daily MUSE HDTV broadcasts on BS channel 9 began in 1991 and continued until 2007, and the same encoding was used for consumer high-definition videodiscs, under the name *Hi-Vision LD*. These discs can be played back through the MST-2000 using the supplied baseband inputs for external MUSE sources.

MUSE stands for multiple sub-Nyquist sampling encoding, a description of the bandwidth-compression technique employed. In essence, picture elements are deleted in a manner which alternates frame-by-frame and line-by-line, and the result is low-pass filtered. By highly precise sampling of this narrow-band signal, the image can be reconstructed using interpolation and memory circuits. Such a process was first proposed in the early 1950s, but it only became technically feasible with the advance of microelectronics in the 1980s. Separate processing branches are used for moving and stationary image areas, producing an output which is effectively a blend of 1125-line, 15 frame per second, and 562.5-line, 60 fps progressively-scanned pictures. To improve performance during motion of the whole frame, motion vectors are transmitted. Quasi-constant-luminance encoding is used for colour, with differential components transmitted by line-sequential time-division multiplexing. Companded differential PCM digital audio is transmitted by baseband multiplex during the vertical blanking interval.

Notes Descriptions of the functions of the MST-2000 are largely adapted from the Japanese-language owner's manual, with contributions from other documentation and experiment. Information on the MUSE system is taken from various sources, including *Recommendation ITU-R BO.786*, "MUSE system for HDTV broadcasting-satellite services", and numbers of *NHK Laboratories Note*.

Summary

Video		
Lines per Frame	1125 (1032 active)	
Field Rate / Interlace	60.00 Hz / 2:1	
Output Format	YP_BP_R or GBR (switchable)	
Synchronizing Signal	Trilevel, on all components	Trilevel, on green
Bandwidth (figures in parentheses refer to moving image areas)	20 (12) MHz Y 7 (3.5) MHz P_B, P_R	20 (12) MHz
Output Connectors	BNC × 3, RCA × 3 (1 V p-p, 75Ω)	

Audio		
DANCE Mode	**A**	**B**
Channels	4	2
Sampling	32 kHz 15 bits	48 kHz 16 bits
Transmitted Data	8 bits × 8 ranges	11 bits × 6 ranges
Signal-to-Noise Ratio	60 dB	
Channel Separation	60 dB	
Outputs	Analog line-level	RCA × 5 ($LCRL_SR_S$)
	Digital	Coaxial : RCA × 2
		Optical : TOSlink × 2
Input Connectors	MUSE	RCA × 2 (0.8 V p-p 75 Ω)
	BS-IF	F (75 Ω)
Dimensions	470 × 92 × 350 mm (W×H×D), 7.9 kg Including side panels and feet	
Power consumption	AC 100 V, 50/60 Hz, 65 W (7 W in standby mode)	

POWER This is a “soft” power switch, but when power is connected, the unit reverts to the state it was in when power was disconnected. The lamp illuminates when power is switched on. Inference : the MST-2000 was expected to operate with a switched power outlet, eg on an A/V receiver.

EXT MUSE Illuminates when one of the baseband MUSE inputs, Ⓑ①② on the Back Panel diagram, is selected.

MUSE Illuminates when a MUSE signal is being decoded.

ANT LEVEL Displays input RF signal level on-screen for antenna-pointing purposes.

DIGITAL OUT Switches digital audio output on or off.

FRONT DISPLAY Switches the fluorescent display on or off.

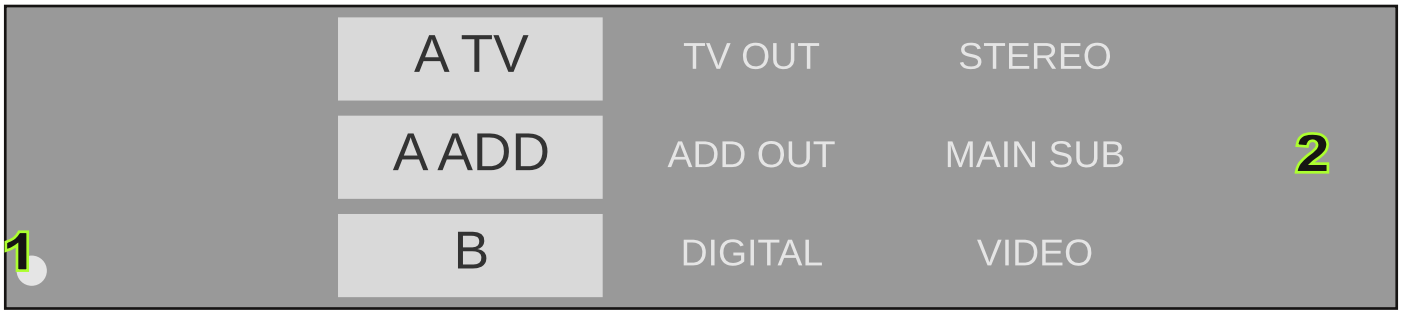
TV/ADD Switches between TV and independent audio programs, when present.

DUAL Switches between main and secondary audio, when present.

Direct Channel Buttons Each of these numbered buttons selects one of the eight 27 MHz channels allocated to Japan in the the 12 GHz satellite broadcast band of ITU-R Region 3. The corresponding lamps permit seeing which channel is selected when the display is shut off.

℟ Receiver for the infrared remote control is located here.

Fluorescent Display



1 The small circular indicator illuminates when a valid remote control command is received.

A TV Illuminates when A-Mode TV audio data is present.

A ADD Illuminate when A-Mode independent audio data is present.

B Illuminates if B-Mode audio data is present.

TV OUT Illuminates when TV audio is being output.

ADD OUT Illuminates when independent audio is being output.

STEREO Illuminates when an audio program of two or more channels is being output.

MAIN SUB The two words illuminate separately or together depending on whether main or secondary audio, or both, are being output.

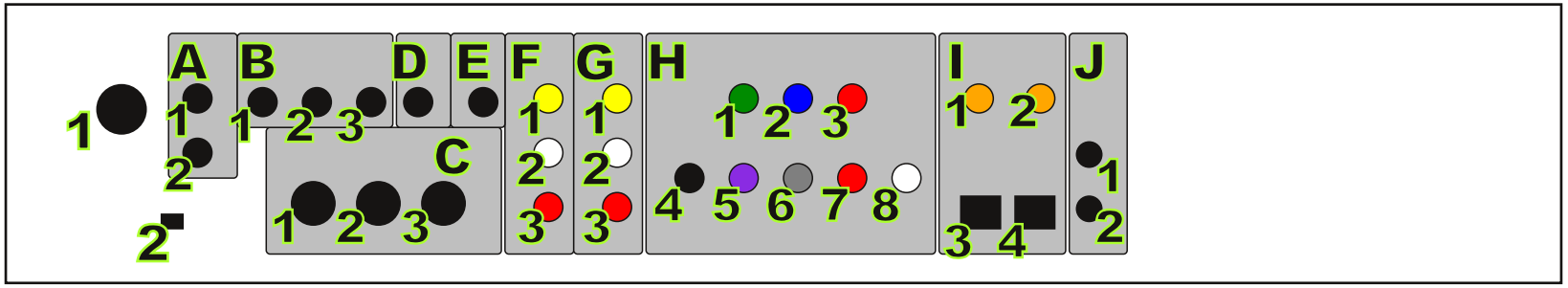
See Audio Format table for more information.

DIGITAL Illuminates when the digital audio outputs are active.

VIDEO Illuminates when the rear panel LINE IN (NTSC input) is selected.

2 A 7+2 segment display here shows the number of the currently selected BS channel.

REAR



PANEL

① The intermediate frequency (1 GHz range) from heterodyning the Ku-band Broadcast Satellite signal is introduced here. When switch ② is in the "on" (right) position, +15 V DC is applied to the center pin, to provide power (maximum 4 watts) for the frequency converter (LNB in American usage).

Ⓐ An Automatic Frequency Control keying pulse, for use with an external tuner, is output at ② when MUSE decoding is in progress. A corresponding input connector is provided at ① for use with an outboard device, such as a pay-TV decoder, using the tuner in the MST-2000. These terminals are not used during NTSC reception.

Ⓑ As MUSE can be delivered from sources other than satellite broadcast, such as videodisc, two baseband inputs are provided at ①②. For use with a pay-TV decoder, each of these inputs can be assigned to a BS channel through an on-screen menu, so that when that channel is tuned (and its signal is present at Ⓓ) the video from the corresponding baseband input is displayed. Otherwise, they are selected using the remote control unit Input command. When a MUSE transmission is being received, the demodulated signal appears at ③, for use with a VCR or other recording device. Question : is the loop-back function active when decoding a signal from the baseband inputs?

Ⓒ BNC output for the 1125-line video signal also present at Ⓗ, for use with monitors or projectors having BNC inputs, such as the Sony PHM-3600 and VPH-1270, or (via an adaptor cable) multiconnector inputs, such as the KW-3600HD and KWP-5500HD. From observations with no signal applied, appears to be active by default. Question : why were horizontal & vertical synch outputs not included, to increase compatibility with displays other than conventional televisions?

Ⓓ The demodulator output for the selected BS channel appears here, regardless of format. Intended for use with an outboard pay-TV decoder, but would presumably allow daisy-chaining decoders if desired. Question : is this output active when decoding a signal from the baseband inputs?

Ⓔ During MUSE decoding, the DANCE data stream is presented here after time-expansion to 1350 kbps, and when a BS-NTSC transmission is received, the data stream from the digital audio subcarrier is likewise presented here. This is required for delivery of data services or use with an outboard pay-TV decoder.

Ⓕ Input for baseband NTSC video input and stereo audio, intended to accept the output of a pay-TV decoder, and assignable to a BS channel as are the MUSE inputs at Ⓑ. Hypothesis : audio is not routed to outputs in Ⓗ or Ⓘ.

Ⓖ Output for baseband NTSC video and stereo audio. When a BS-NTSC signal is received, or an NTSC input is present at Ⓕ and selected, it appears here, with its accompanying audio. Question : when a MUSE signal is being decoded, is downconverted video and (as applicable) downmixed audio output here?

Ⓗ Outputs for 1125-line video and multi-channel audio (see table for output assignments). Video is switchable between YP_BP_R and GBR using an on-screen menu. This output is not active when receiving an NTSC transmission, or when 'line' input Ⓕ is selected.

Ⓘ Digital outputs for audio, in both coaxial and optical SPDIF, left and right channels on one of each type, center and surround on the other. Questions : is there actually a component somewhere which accepts two stereo digital inputs simultaneously, to drive four channels total? when an A-mode signal is being decoded, with 32 kHz sampling rate, is this sampling rate used at the output, or is it resampled to 48 kHz?

Ⓙ These connectors are supplied for linking several Sony components together. It is also possible to control the unit using a computer. Signals are TTL, conforming to the SIRCS protocol.

Rear Panel Labels

1 BS IF 入力 **BS IF input**

2 コンバーター用電源切/入(連動) converter power off/on (switched)

Fields

A AFC
- **1** 入力 input
- **2** 出力 output

B MUSE
- **1** 入力1 input 1
- **2** 入力2 input 2
- **3** 検波出力 detector output

C HD出力(映像) **HD output (video)**
- **1** Y/G
- **2** P_B/B
- **3** P_R/R

D 検波出力 **detector output**

E ビットストリーム出力 **bitstream output**

F ライン入力 **line input**
- **1** 映像 video
- ***2-3*** 音声 audio
- **2** 左(主) left (main)
- **3** 右(副) right (secondary)

G ライン出力 **line output**
- **1** 映像 video
- ***2-3*** 音声 audio
- **2** 左(主) left
- **3** 右(副) right (secondary)

H HD出力 **HD output**
- ***1-3*** 映像 video
- **1** Y/G
- **2** P_B/B
- **3** P_R/R
- ***4-8*** 音声 audio
- ***4-5*** サラウンド surround
- 4 右 right
- **5** 左(モノ) left (mono)
- **6** センタ center
- **7** 右 right
- **8** 左(モノ) left (mono)

I デジタル音声出力 **digital audio output**
- ***1-2*** 同軸 coaxial
- 1 CH1, 2
- **2** CH3, 4
- ***3-4*** 光 optical
- 3 CH1, 2
- **4** CH3, 4

J コントロルS **Control-S**
- **1** 入力 input
- **2** 出力 output

Notes

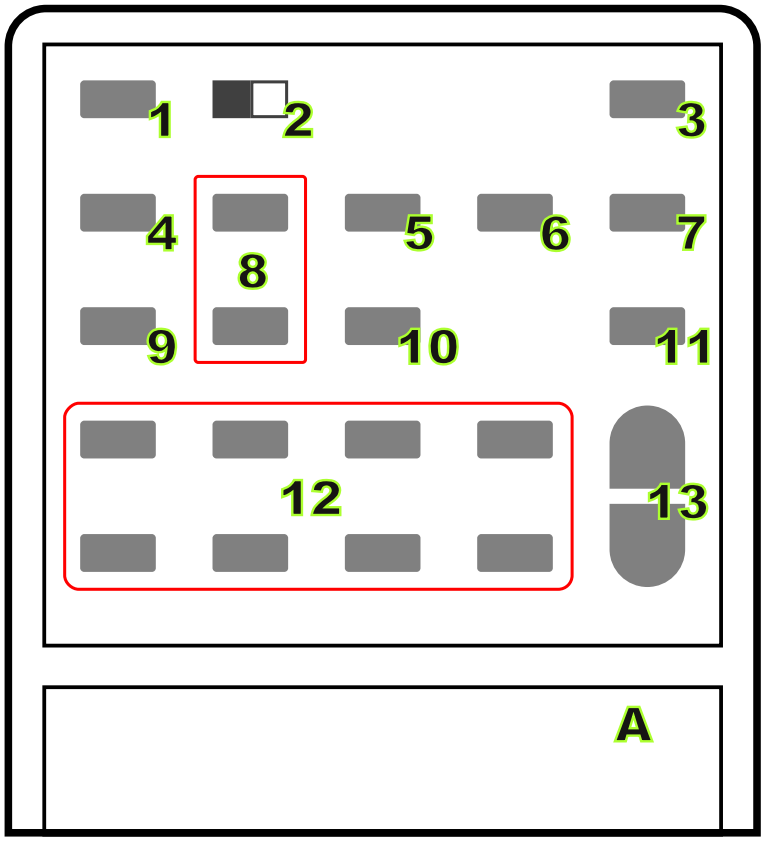
① is an F Connector. ② is a sliding switch ; the left position is OFF. All items in Ⓒ are BNC connectors. Ⓘ③④ are TOSLINK connectors. Both items in Ⓙ are 1/8" mini phone jacks. All other items are RCA connectors, with insulators coloured approximately as illustrated. All connectors are female.

SIRCS Protocol Summary

The *Sony Infra-red Remote Control System* is used to control the MST-2000, either through the front-panel infra-red receiver, or through the Control-S input on the rear panel. For wireless operation, the signal is modulated on a 38 kHz pulse train, while Control-S is at TTL levels. In either case, the complete signal consists of 2.4 milliseconds of High level (carrier present), followed by a seven-bit command code, then a device code, and finally Low level (no carrier) until a total of 45 ms has elapsed since the beginning of the start pulse. This signal is then repeated, and typically must be sent a total of 4 times (180 ms) before it goes into effect. Device codes vary in length ; that for the MST-2000 is 8 bits, and its value is 1011 0111, or in hexadecimal notation, B7. Both device and command codes are sent least-significant-bit first. Logic 0 is represented by 0.6 ms LO followed by 0.6 ms HI, and 1 is represented by 0.6 ms LO followed by 1.2 ms HI.

Command Codes	
00	RCU Direct Channel BS 1
02	RCU Direct Channel BS 3
04	RCU Direct Channel BS 5
06	RCU Direct Channel BS 7
08	RCU Direct Channel BS 9
0A	RCU Direct Channel BS 11
0C	RCU Direct Channel BS 13
0E	RCU Direct Channel BS 15
10	RCU Channel Up
11	RCU Channel Down
15	RCU Power
16	(unknown)
17	(unknown)
25	RCU Input
28	(unknown)
2E	power on
2F	power off
30	RCU Antenna
38	RCU Menu
3A	(unknown)
3B	RCU Digital
72	RCU Up Arrow
73	RCU Down Arrow
76	RCU Enter
7F	(unknown)

Remote Control Unit RM-J134



① **Antenna** Same as front panel ANT LEVEL

② **DBS1/DBS2** (switch) Must be in the DBS2 position to control the MST-2000

③ **Power** When power is connected, toggles On and Standby states

④ **Enter** Used to confirm a selection in Menu mode

⑤ **TV/Independent Audio** Same as front panel TV/ADD

⑥ **Audio Mode** Same as front panel DUAL

⑦ **Display** Toggles visibility of on-screen (*not* front-panel) display

⑧ **Up/Down Arrows** Used to make selections in Menu mode

⑨ **Menu** Enters or exits Menu mode

a

▸チャネル設定
デコーダー入力切換
MUSE出力設定

⇳で選択して実行　　終了メニュー

b

チャネル設定

▸BS1	入	BS 9	切
BS3	入	BS11	切
BS5	切	BS13	切
BS7	切	BS15	入

⇳で選択して実行　　終了メニュー

c

デコーダー入力切換

▸BS1	MUSE1	BS 9	切
BS3	MUSE2	BS11	切
BS5	切	BS13	切
BS7	切	BS15	NTSC

⇳で選択して実行　　終了メニュー

⑩ **Digital** Same as front panel DIGITAL OUT

⑪ **Input** Switches between MUSE 1, MUSE 2, and Tuner, cyclically

⑫ **Direct Channel Buttons** Same as front panel

⑬ **Channel Up/Down** Cyclic (BS 1 and BS 15 are adjacent)

Ⓐ This area is equivalent to a standard Sony TV remote control

d

MUSE出力設定

▸・YP_BP_R
GBR

⇳で選択して実行　　終了メニュー

Menu Operation

ⓐ **Root Menu** This screen appears when Menu is pressed on the remote control or received via the Control-S connector. Select a submenu with Up/Down Arrows, then Enter, or send Menu again to exit.

ⓑ **Channel Menu** Channels marked with 切 will be skipped when using Channel Up/Down. Select a channel with Up/Down Arrows, then Enter ; switch between 入 and 切 using Up/Down Arrows, then Enter. Repeat as desired, then exit with Menu.

ⓒ **Input Menu** Assigning inputs to channels allows switching between them using the front-panel Direct Channel buttons, and is the only way to access the “Line” input. Select a channel with Up/Down Arrows, then Enter ; switch between MUSE1, MUSE2, and NTSC using Up/Down Arrows, then Enter. (The same input can be assigned to multiple channels.) Repeat as desired, then exit with Menu.

ⓓ **Output Menu** Use Up/Down Arrows to select GBR or YP_BP_R, as your display requires, then Enter, and exit with Menu.

Notes Items in sans-serif type are RCU buttons (listed at right) or the equivalent SIRCS commands. The menu choices shown reflect the author's preferences.

Audio Channel Mode			Digital Outputs				Analog Line Outputs				
	TV Audio	**Independent Audio**	**CH 1**	**CH 2**	**CH 3**	**CH 4**	**L**	**C**	**R**	**L_S**	**R_S**
A-Mode	1 Stereo Program	—	TV L	TV R	—	—	TV L	—	TV R	—	—
	1 Mono Program	—	TV	—	—	—	TV	—	TV	—	—
	1 Stereo Program	1 Stereo Program	TV L	TV R	Ind L	Ind R	TV L	—	TV R	—	—
							Ind L	—	Ind R	—	—
	2 Mono Programs	1 Stereo Program	TV Main	TV Sub	Ind L	Ind R	TV Main	—	TV Main	—	—
							TV Sub	—	TV Sub	—	—
							TV Main	—	TV Sub	—	—
							Ind L	—	Ind R	—	—
	1 Mono Program	1 Stereo Program	TV	—	Ind L	Ind R	TV	—	TV	—	—
							Ind L	—	Ind R	—	—
	—	1 Stereo Program	—	—	Ind L	Ind R	Ind L	—	Ind R	—	—
	3-1 Stereo	—	TV L	TV R	TV C	TV S	TV L	TV C	TV R	TV S	TV S
	2-2 Stereo	—	TV L	TV R	TV L_S	TV R_S	TV L	—	TV R	TV L_S	TV R_S
B-Mode	**TV Audio**										
	1 Stereo Program		TV L	TV R	—	—	TV L	—	TV R	—	—
	1 Mono Program		TV	—	—	—	TV	—	TV	—	—
	2 Mono Programs		TV Main	TV Sub	—	—	TV Main	—	TV Main	—	—
							TV Sub	—	TV Sub	—	—
							TV Main	—	TV Sub	—	—

Key **C** Center, **L** Left, **L_S** Left Surround, **R** Right, **R_S** Right Surround, **S** (Mono) Surround, **Sub** Secondary Audio Program

Multiple output assignments, where shown for a single audio channel mode, can be switched between using the front panel TV/ADD and DUAL buttons, or the corresponding RCU commands. The front-panel indicator lights will illuminate as appropriate.

The MUSE standard actually calls out 28 different audio channel modes (including two with no audio at all), but the only ones known to exist on disc are A-Mode 3-1 Stereo and B-Mode Stereo.