JPEG Video Streaming System
Technical Manual

Model 2480 | Rev.1.0.3 | March 2011

SENSORAY | embedded electronics

Designed and manufactured in the U.S.A.

SENSORAY | p. 503.684.8005 | email: info@SENSORAY.com | www.SENSORAY.com

7313 SW Tech Center Drive | Portland, OR 97223

Limited Warranty

Sensoray Company, Incorporated (Sensoray) warrants the hardware to be free from defects in material and workmanship and perform to applicable published Sensoray specifications for two years from the date of shipment to purchaser. Sensoray will, at its option, repair or replace equipment that proves to be defective during the warranty period. This warranty includes parts and labor.

The warranty provided herein does not cover equipment subjected to abuse, misuse, accident, alteration, neglect, or unauthorized repair or installation. Sensoray shall have the right of final determination as to the existence and cause of defect.

As for items repaired or replaced under warranty, the warranty shall continue in effect for the remainder of the original warranty period, or for ninety days following date of shipment by Sensoray of the repaired or replaced part, whichever period is longer.

A Return Material Authorization (RMA) number must be obtained from the factory and clearly marked on the outside of the package before any equipment will be accepted for warranty work. Sensoray will pay the shipping costs of returning to the owner parts that are covered by warranty. A restocking charge of 25% of the product purchase price will be charged for returning a product to stock.

Sensoray believes that the information in this manual is accurate. The document has been carefully reviewed for technical accuracy. In the event that technical or typographical errors exist, Sensoray reserves the right to make changes to subsequent editions of this document without prior notice to holders of this edition.

The reader should consult Sensoray if errors are suspected. In no event shall Sensoray be liable for any damages arising out of or related to this document or the information contained in it.

EXCEPT AS SPECIFIED HEREIN, SENSORAY MAKES NO WARRANTIES, EXPRESS OR IMPLIED, AND SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. CUSTOMER'S RIGHT TO RECOVER DAMAGES CAUSED BY FAULT OR NEGLIGENCE ON THE PART OF SENSORAY SHALL BE LIMITED TO THE AMOUNT THERETOFORE PAID BY THE CUSTOMER. SENSORAY WILL NOT BE LIABLE FOR DAMAGES RESULTING FROM LOSS OF DATA, PROFITS, USE OF PRODUCTS, OR INCIDENTAL OR CONSEQUENTIAL DAMAGES, EVEN IF ADVISED OF THE POSSIBILITY THEREOF.

Third party brands, names and trademarks are the property of their respective owners.

Introduction

Sensoray's Model 2480 is an Ethernet based video capture system that simultaneously processes up to 16 analog video inputs. The system is capable of capturing JPEG-compressed images from all 16 channels in real time at full NTSC or PAL frame rates. Each video input signal is converted to Motion JPEG (MJPEG) and then streamed out over Ethernet. A 16x4 crosspoint switch enables any input signal to be routed to any of four video outputs.

The unit communicates with one or more network clients by means of standard network protocols. Configuration settings and system operation can be managed through the module's HTTP server, enabling manual control and diagnostics access from any web browser. A telnet server enables the system to be controlled by a custom, client-side automation application.

Standard BNC connectors are provided for connecting the unit to analog video signals. The system is housed in a 1U, 19-inch rackmount enclosure and is powered from 120VAC.

2.1 Video Inputs

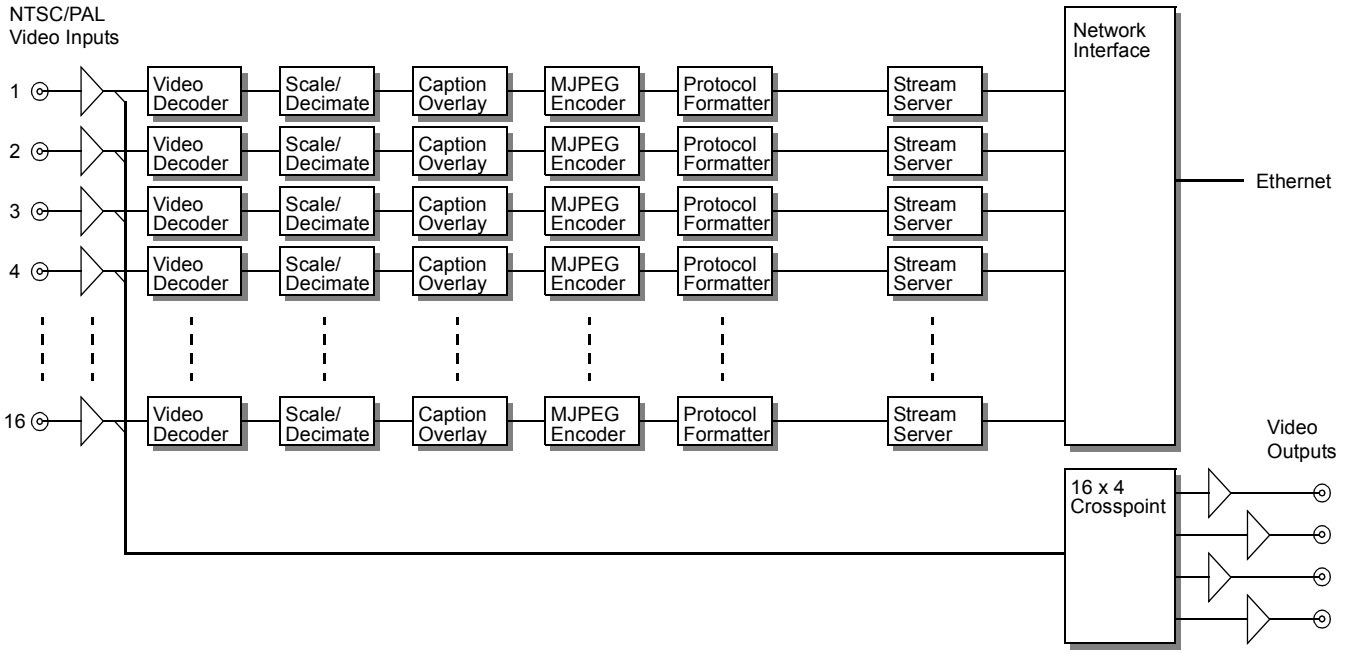
Capture parameters can be set independently for each video input channel. For example, each input channel can be individually configured to accept NTSC or PAL.

Each analog video input is first converted to uncompressed digital video. The resulting digital video frames are optionally scaled and frame rate decimated. A single-line text caption of up to 80 characters may be overlaid onto the scaled images for on screen display (OSD). The resulting composite images are compressed to MJPEG. After encoding, the elementary video stream is framed and encapsulated as required by the target network streaming protocol.

2.2 Video Outputs

A 16x4 analog crosspoint video switch can be used to route any combination of four input channels to external video monitors. Each of the four video outputs can be individually turned on or off to enable multiple outputs, or even multiple 2480s, to share output connections to a common monitor.

Figure 1: Block Diagram



Installation and Configuration

3.1 Overview

The 2480 must be installed and configured for operation before use. Basic configuration encompasses network settings and video attributes such as frame rate and size.

After the basic configuration is complete, runtime settings may be changed as needed. For example, OSD captions, streaming, and output mapping of the crosspoint video switch may be changed on the fly as required.

3.2 Installation

The module can be mounted in a standard 19-inch rack enclosure or left unmounted. In either case, it is important to ensure that the unit has adequate ventilation and cooling.

Cables should be connected to the module after it has been mounted. All cable connectors are located on the module's back panel:

- **Power** is brought into the unit's IEC power receptacle from a 120VAC source.
- **Ethernet**. Connect a Cat-6 Ethernet patch cable from the unit's RJ-45 jack to your LAN. The other end of the cable can connect to a switch or hub via a standard patch cable, or directly to a client (e.g., a PC) via a crossover cable.
- **Video**. Connect video inputs and outputs to the module's BNC connectors as required. Unused video inputs and outputs may be left unconnected.

3.3 Starting the System

Turn on the power switch on the back panel and wait for the module to boot. This takes approximately 30 seconds. The unit can be pinged, if desired, to test its online status.

Configuration settings are retained when the 2480 is powered down. When the module is powered up, it will restore the retained settings and begin operating with those settings in effect. When powered up for the first time, the 2480 will restore factory programmed settings.

3.4 Network Configuration

The module's HTTP server becomes active when the unit finishes booting. Once the server is online, the module can be configured through its internal website from a remote web browser.

As shipped from the factory, the module's IP address is set to `10.135.24.80` with netmask `255.0.0.0`.

If the default address is reachable from the web client, the 2480's web site can be accessed through its default URL, `http://10.135.24.80/`, and configuration and control can be managed through the web interface. If the default IP address is not reachable, however, there are two ways to access the unit:

- Reconfigure the client's network settings so that it resides on the same subnet as the 2480. This method can be used only if the 2480's network settings are known and if the user is authorized to change the client's network settings.
- Create a plaintext configuration file named `cfg2480.txt`. Edit the file so that it contains the desired 2480 network settings as three lines of text, in this order: IP address, netmask, and gateway address. Copy the file onto a USB mass storage device. After the module has booted, insert the device into the 2480's front panel USB socket. In response, the 2480 will read the configuration file and configure its network setting as specified in the file. Successful configuration will be indicated by two audible beeps. This method can be used to configure the 2480's network interface even if its current network settings are not known.

After the web client has successfully connected to the 2480's website, the module's network settings can be changed through its web interface. Note that your browser may lose its connection to the web server when the unit's IP address or other network settings are changed, thus making it necessary to enter a new browser URL in order to resume communication with the module.

3.5 Setting Date and Time

The system date and time can be programmed through the 2480's web interface. This should be done before streaming because video may be overlaid with the date, or time, or both if OSD is enabled.

3.6 Stream Configuration

In most cases, stream configuration will be done once during initial system setup and left unchanged thereafter. For example, settings such as NTSC vs. PAL, or image size, are typically left unchanged after initial setup, though this is not a requirement.

If a configuration setting is changed on a streaming channel, the channel will stop streaming momentarily and then start streaming again with the new settings in effect. Other channels will continue to stream while the affected channel is being reconfigured.

3.6.1 Image Format and Encoding

Various image format and encoding attributes must be configured for each input channel:

- **Input format**. The 2480 supports two analog video input formats: NTSC and PAL. One of these formats must be selected for each video input channel.

- **Frame size**. One of three possible frame sizes must be selected for each video input channel: 4CIF, 2CIF or 1CIF. The resolution of each of these sizes is detailed in the Specifications (see page 8).

3.6.2 JPEG Quality

The JPEG compression level can be set to values between 0 (lowest quality, smallest file size) and 100 (highest quality, largest file size). These are relative levels; the actual compression ratio will vary based on image complexity and other factors.

3.6.3 Stream Protocol

Stream protocols are used to convey stream data across a network. Three stream protocols are available on the 2480:

HTTP Streaming Video. This protocol enables a compatible web browser to display video directly in its client window. Not all browsers support this feature; some browsers have native support, while others require plug-ins or, in some cases, do not support this protocol. In general this is only recommended for viewing one stream at a time.

RTP-JPEG. This protocol, in which the MJPEG stream is encapsulated by RTP (Real-time Transfer Protocol) per RFC 2435, is compatible with Quicktime viewers.

RTP-TS. When this protocol is used, the compressed stream is encapsulated by RTP and then multiplexed into a transport stream.

Table 1: Comparison of stream protocols

Stream Protocol	Compatible Viewers
HTTP	Various web browsers
RTP-JPEG	Quicktime, VLC
RTP-TS	VLC

3.6.4 Stream Control Protocol

Stream control protocols are used to establish and control media sessions between endpoints, thus enabling clients to issue commands to facilitate real-time control of streams.

A stream control protocol is automatically selected for each video input channel, based on the streaming protocol used. Two stream control protocols are supported by the 2480:

HTTP. Hypertext Transfer Protocol. This protocol enables web-based stream control via a web browser, which interacts with the 2480's internal web server. It is used when streaming via HTTP.

RTSP. Real-Time Streaming Protocol is used to control streams delivered via RTP. RSTP is used by VLC and Quicktime clients.

Runtime Control

4.1 Overview

Runtime operation can be controlled through the 2480's web-based interface or its telnet interface, or both. This chapter discusses runtime control as it applies to both interfaces. Unless otherwise noted, descriptions apply to both interfaces.

4.2 Stream Viewing

The stream from each video input channel is accessible through a URL that has this general form:

```
protocol://address:port/
```

The `protocol`, which may be either `http` or `rtsp` as explained in Section 3.6.4, is followed by the 2480's IP `address`. The `port` number designates the video input channel as follows:

```
port = channel + 10000
```

For example, the stream from video input channel 3 might be viewed in VLC or Quicktime through a URL similar to this:

```
rtsp://10.135.24.80:10003/
```

4.2.1 Video Adjustments

Various adjustments can be made to the video decoder on the fly. These adjustments do not interrupt streaming, but the resulting visual changes will be reflected in the stream. These video attributes can be adjusted:

Attribute	Value	
	Range	Default
Brightness	0 to 255 (dark to light)	128
Contrast	0 to 255 (min to max)	128
Saturation	0 to 255 (no color to max color)	128
Hue	-128 to 127 (irrelevant in PAL mode)	0

4.3 OSD Caption Overlays

User-defined text may be overlaid onto the video frames of any video input channel, thus enabling on-screen display (OSD) of the text. One line of text, consisting of up to 80 characters, may be displayed at either the top or bottom of video frames.

The OSD text content, display location, and background color are individually programmable for each channel.

4.3.1 Caption Strings

OSD text content is determined by a user-defined caption string. OSD is enabled by default but can be disabled using web or telnet interface. Caption strings are persistent; once a caption string is defined, it will be displayed on subsequent video frames until it is changed.

Caption strings may contain any printable characters except the up arrow ("^"), which denotes the beginning of a special character sequence. The special two-character sequence "^t" inserts the current system time, and "^d" inserts the current system date. The format of the date and time strings can be modified using the web or telnet interface.

For example, this caption string will result in a display that contains both constant text and dynamic date and time stamps:

```
Reactor Core - ^d ^t
```

The resulting OSD will look similar to this:

```
Reactor Core - 11/14/2015 23:11:42
```

The OSD line length, including displayed time and date stamps, must not exceed 80 characters.

Caption strings cannot be manually updated at frame rates, and it is not possible to synchronize manual updates with particular video frames. However, automatically generated date and time stamps are updated at video frame rates.

4.3.2 Text and Background Colors

OSD captions are always displayed as white text. The text background may be configured to be either solid or transparent. When solid mode is selected, a solid black background appears behind the white text, whereas the transparent mode uses live video as the text background.

The solid background optimizes text contrast, but it obscures video that would be visible in the transparent mode.

4.4 Video Output Switching

The 2480 features a 16x4 analog video crosspoint switch that is capable of routing any combination of four input channels to external video monitors. Each video output channel may be connected, through the crosspoint switch, to any of the 16 video input channels.

When configuring an output channel, any video input channel may be selected as the video source or, in lieu of selecting an input channel, the output driver may be disabled by turning it off.

Automation API

5.1 Overview

The 2480's embedded web interface is suitable for manual control, but it is not well suited to automated control nor is it recommended for use in automated client applications. Instead, automation clients should communicate with the 2480 through its telnet server and command line API.

5.2 Telnet Server

The 2480's embedded telnet server provides the principal means for controlling the 2480 from automated client applications. Because it is based on plaintext messages, telnet can also serve as an alternative to HTTP for manually controlling the module.

The server supports concurrent telnet sessions, each with a private, dedicated shell. Each shell, in turn, provides access to a variety of shell commands. Network clients interact with the module's video subsystems by issuing shell commands, and receiving associated replies, over telnet. In most cases, a client will open a telnet session and leave it open until it has finished communicating with the 2480 (e.g., when the client application closes).

Applications may have any number of open telnet sessions on a module, up to the maximum number supported by the module. This is a flexible arrangement that makes possible a wide range of configurations. For example:

- A host computer could use a telnet session for automated control while, at the same time, a laptop computer employs another session for diagnostic monitoring.
- Multiple host computers—each responsible for managing specific resources on a 2480 (e.g., 16x4 crosspoint switch, or a specific video input channel)—can concurrently communicate with the module over separate telnet sessions.
- Telnet clients need not reside on different host computers; a single host may run multiple threads or processes, each of which has a private telnet session for controlling its assigned resources on the 2480.

Each telnet session maintains a communication timer. If no communications are received within the time-out interval, the server will automatically close the session. If a client terminates a telnet session in an "ungraceful" way (e.g., application crash) then the server will time-out the session, thus freeing its resources.

5.3 Commands

Commands must be all lower case, while arguments are case insensitive and may be upper case, lower case, or any combination thereof.

Some commands return information while others do not. In most cases, commands will return an error message if the command function cannot be executed, or if illegal arguments were specified in the command string. Unless otherwise described, commands return only error messages.

Channel numbers used by the API match those printed on the module's back panel. Video input channel numbers range from 1 to 16, and output channel numbers range from 1 to 4.

Angled brackets are used to denote symbolic names of arguments that are supplied to commands. For example, an argument such as "`<chan>`" is intended to be replaced with a numeric channel number.

Square brackets are used to denote optional values. For example, "`[<caption>]`" indicates that the `caption` argument is not required.

5.3.1 Configure Video Input

Function Configure a video input channel.

Command `vicfg <ichan> <vstd> <size> <fps> <comp> <proto>`

Argument	Description
`ichan`	Video input channel: `1-16`
`vstd`	Video standard: `NTSC` or `PAL`
`size`	Frame size: `4CIF`, `2CIF`, or `1CIF`
`fps`	Frame rate: `FULL`, `20`, or `10`

`stream`	Stream protocol:
	`HTTP`
	`RTP-JPEG`
	`RTP-TS`
	`OFF`

Notes This configures a channel prior to streaming. `FULL` frame rate is 30 fps for NTSC and 25 fps for PAL. Refer to Specifications (page 8) for details of frame sizes.

Example `vin 1 NTSC 4CIF FULL RTP-TS`

5.3.2 Adjust Video Input

Function Set visual attributes for a video input channel.

Command `viadj <ichan> <b> <c> <s> <h>`

Argument	Description
`ichan`	Video input channel: `1-16`.
`b`	Brightness: `0-255`.
`c`	Contrast: `0-255`.

Argument	Description
s	Saturation: 0-255.
h	Hue: -128 to 127.

Notes See Section 4.2.1 for details.

Example `viadj 128 128 128 0`

5.3.3 Configure Video Output

Function Configure a video output channel.

Command `vout <ochan> <ichan>`

Argument	Description
ochan	Video output channel: 1-4
ichan	Video input channel: 1-16, or OFF to disable video output

Notes This routes a video input to the specified output via the 4x16 video crosspoint switch. In lieu of an input channel, the command may specify OFF to disable the output.

Example `vout 2 14`

5.3.4 Set OSD Caption String

Function Set On Screen Display caption.

Command `osdcap <ichan> <caption>`

Argument	Description
ichan	Video input channel: 1-16
caption	Caption string (see Section 4.3.1)

Notes This defines the OSD caption for the specified video input channel.

Example `osd 1 "date:^d4 time:^t1"`

5.3.5 Configure OSD

Function Configure On Screen Display caption.

Command `osd <ichan> <enbl> <loc> <mode> <dtfmt> <yrfmt> <fsec>`

Argument	Description
ichan	Video input channel: 1-16
enbl	Enable: ON OFF
loc	Location of caption on image: TOP BOTTOM
mode	Overlay Mode: TRANSPARENT SOLID
dtfmt	Date Format, day first or month first: DDMM MMDD
yrfmt	Year Format, 2 or 4 digits: YEAR2 YEAR4
fsec	Number of digits to diplay for fractional seconds: FRACTION0 FRACTION1 FRACTION2

Notes Configures OSD caption display options for the specified video input channel.

Example `osd 1 ON TOP TRANSPARENT MMDD YEAR2 FRACTION0`

Specifications

Network	Physical layer		Auto-switching 100BaseTx/1000BaseT Ethernet	
	Connector type		RJ-45	
	Isolation		1500Vrms	
	Streaming control protocols		RTSP, HTTP	
	Stream protocols		HTTP RTP (RFC 2435) RTP-TS (RFC 2250)	
Video inputs	Channels		16 analog composite	
	Input impedance		75 ohms	
	Connector type		BNC	
	Formats		NTSC, PAL	
Video capture	A/D resolution		8 bit luminance, 8 bit chrominance	
			NTSC	**PAL**
	Image size (pixels)	4CIF	640 x 480	704 x 576
		2CIF	640 x 240	704 x 288
		1CIF	320 x 240	352 x 288
	Frame rate (aggregate, maximum)		480 fps	400 fps
	Frame rate (fps, per channel)		30, 20, 10	25, 20, 10
Video compression	Format		MJPEG (ITU-T T.81 | ISO/IEC 10918-1)	
	Quality		JPEG: 0 to 100	
Video outputs	Channels		4 analog composite with individual on/off capability	
	Output impedance		75 ohms	
	Connector type		BNC	
	Crosspoint switch		16x4 analog video	
Temperature	Operating range		0 to 50°C (with convection cooling)	
Power	Supply voltage		120VAC	
	Power consumption		28W (nominal)	
	Connector type		IEC/C14	
Mechanical	Dimensions		1U, 19-inch rack mountable module	