

Ocean ProHD

Undersea HDTV

From the Ocean Bottom to the Desktop

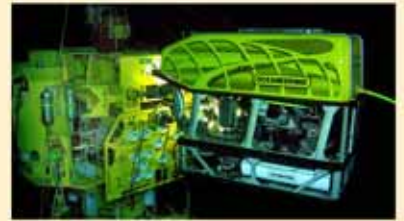
— Technical Overview —



OCEANEERING[®]



Ocean ProHD



**From the
ocean bottom
to the
desktop**



HDTV Technology Overview 5

HDTV technology provides the viewer with high resolution color video and digital sound in a wide screen format.

- 1080 x 1920 image resolution
- Two megapixel still image capture
- Improved sound and color quality
- 30 frames per second frame rate
- Wide 16:9 aspect ratio



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Ocean ProHD Undersea HDTV combines high quality precision optics with the latest in HDTV technology and a fiber-optic communications link.

- Miniaturized surface controlled camera and converter
- Choice of a 3.8x or 10x super wide angle zoom lens
- Optical domed view port with light baffle
- Remotely controlled camera functions
- Optical conversion and transmission of HD-SDI video
- Real-time viewing of true HDTV images and image capture
- Image overlay of operator entered information and CTAG data
- Video recording and playback with Oceaneering CODEC



System Components and Software 9

The components of Ocean ProHD Undersea HDTV are grouped into two separately available systems.

- Ocean ProHD TV Camera System
- Ocean ProHD TV Recording and Overlay System



Component Specifications 14

Ocean ProHD Undersea HDTV meets all of the electrical, operational and environmental specifications for installation on ROVs.

- Ocean ProHD Camera
- Fiber-Optics Transmitter/Converter
- Surface Control Unit
- Camera Controller
- Overlay Unit
- Recording Computer
- LCD Video Monitor



Ocean ProHD Undersea HDTV provides the means to acquire and to record stunning high definition television (HDTV) video images at water depths up to 4000 meters for direct delivery to customers on affordable, readily available digital media which can be easily played back on virtually any desktop or laptop computer. From the deep ocean bottom to the customer's desktop, Ocean ProHD provides the best, the most advanced and the most complete solution to HDTV undersea video imaging possible today.



Actual Ocean ProHD Image

Without needing to use costly and continually evolving media technologies that require specialized playback equipment for viewing and editing video, Oceaneering customers can now view, edit and capture digital stills from HDTV underwater video that has been prerecorded, with or without a mission data overlay and voice component, on removable 1-TB hard drives using their own computers. With Windows Media Player, or any other digital media player capable of playing AVI files, and with Oceaneering supplied video decompression software, the prerecorded HDTV video can be viewed in full 16:9 high

definition format on any 1920 x 1080 pixels or higher computer monitor.* Furthermore, with the video recordings saved as AVI files, post production editing by the customer is made easier, as many PC based video editing systems are available for creating a finished video program. The files can also be easily transferred to and from .ftp sites for viewing over the internet. Ocean ProHD makes all this possible by providing the most advanced HDTV image capture, video data transmission and recording components available, along with custom designed software, in ready to install surface and subsea systems.

* The HDTV video can also be viewed on lower resolution monitors; however, the image quality is reduced.

HDTV Technology Overview

When compared to standard definition television (SDTV), the performance of HDTV exhibits two very big advantages which are ideally suited to the imaging requirements of many underwater tasks, including detailed inspections and complex manipulator operations. First, both the vertical and horizontal resolutions of HDTV are more than twice that of SDTV, and second, HDTV uses a 16:9 aspect ratio which provides a wider field of view. Furthermore, because HDTV is all digital, both the sound and the color quality are much improved over that of analog based SDTV.

High Vertical and Horizontal Resolution

HDTV provides 1080 pixels of vertical resolution and 1920 pixels of horizontal resolution in the video image. By comparison SDTV provides only 480 pixels of vertical resolution and 640 pixels of horizontal resolution. Therefore, for HDTV, every

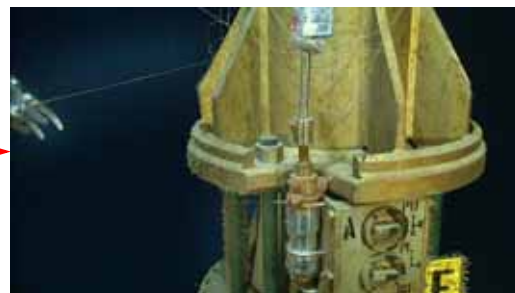
per frame, or 1/30th of a second (twice the time) to alternately scan both the A and B fields for each frame. This scanning rate translates to a frame rate of 30 frames per second. Similarly, for Europe's PAL TV system, the scanning rate for a field is 1/50th of a second per frame or 1/25th of a second per frame for both fields for a frame rate of 25 frames per second.

SDTV



640 x 480 Pixels with 4:3 Aspect Ratio

HDTV



1920 x 1080 Pixels with 16:9 Aspect Ratio

image frame contains over two million pixels which results in stunning picture detail and enables the capture of high quality digital still images from real-time or recorded video.

Although the resolutions are different for HDTV and SDTV, the frame rates are the same. Ocean ProHD uses the interlaced format where alternating horizontal scans of two separate fields ("A" and "B") are used to create each frame of video. For the NTSC TV system used in the USA, the scanning rate for a field is 1/60th of a second

Wide Aspect Ratio

The wide 16:9 aspect ratio of HDTV, as compared to the 4:3 box type format of SDTV, enables a wider viewing angle. A wide viewing angle requires less camera motion which reduces operator fatigue. To take full advantage of the wide screen format, Ocean ProHD is available with either of two high quality optics systems that provide very wide angle fields of view and high powered zooms.

About Ocean ProHD Undersea HDTV

Ocean ProHD Undersea HDTV is designed to meet a wide range of underwater imaging applications, including commercial, military, entertainment, science, and oil and gas. It delivers true real-time HDTV video from the ocean bottom directly to the viewer by combining high quality precision optics with the latest in HDTV technology in a single miniaturized surface controlled camera and converter, and transmitting the uncompressed video images to the surface over a fiber-optic communications link. The images are viewed on a monitor in real time and can be recorded with an overlay of operator entered information and CTAG (Oceaneering Computer Telemetry and Graphics) data from any Oceaneering CTAG Pilot Computer. Voice audio can also be recorded with the video.

Ocean ProHD Optics

The dramatic, high resolution imaging capability of HDTV can only be fully realized with high quality optics. And for most undersea applications, these optics must also provide both a wide horizontal field of view for situational awareness and a high powered zoom for detailed inspection. To meet these requirements an extensive effort went into the design of the optics for Ocean ProHD. The work was based on years of experience in designing lenses for underwater inspection and broadcast television applications. With the aid of a

The optics system includes either a 3.8x zoom lens for a 100° wide to 27° zoom in-water field of view or a 10x zoom lens that provides an 80° wide to 8° zoom range. Both lenses, when matched with an optical domed view port, are fully rectilinear—exhibiting no "pincushion" or "barrel" distortion—over the full zoom range. For the 3.8x zoom lens, objects remain sharply focused from a distance of just 2 inches to infinity at full wide and from 14 inches to infinity at full zoom. For the 10x zoom, objects remain in focus from 0 inches to infinity at full wide and from 18 inches to infinity at full zoom.

Full wide



80° Field of View

Full Zoom (10x)



8° Field of View

world class optics design and manufacturing company, Oceaneering applied its experience to the development of this unique, proprietary optics system which is unmatched in performance by any other small HDTV camera available today.

The optical domed view port is of 0.2-inch thick polished BK-7 glass that is optically ground on the inner and outer surfaces and includes an adjustable, removable light baffle. This domed view port design is well proven and is used in 35 and 70-mm film applications.

Miniaturized HDTV Camera and Converter

The HDTV video images are acquired with the **Ocean ProHD TV Camera** and are output to a remotely mounted **Fiber-Optics Transmitter/Converter**. The converter transmits the HDTV video signals in digital format to a **Surface Control Unit** over a fiber-optic communications link. Measuring only 4.4 inches in diameter and 9.6 inches long, and weighing only 2.5 pounds in water, the camera can be easily mounted on the

pan and tilt unit of an ROV. A single oil filled cable, up to 30 feet in length, connects from the camera to the converter which can be mounted most anywhere on the ROV. The converter measures 5.25 inches in diameter and 10.25 inches long, and weighs 5.5 pounds in water. The camera is controlled from a **Camera Controller** at the surface and the video is viewed on an **LCD Video Monitor**. The camera controls include, focus, zoom, exposure, iris, and white balance adjustments.



Ocean ProHD Camera on an Oceaneering Hydra[®] Maxximum ROV

Transmission of True HDTV Video Signals

HDTV requires a high bandwidth medium to transmit the true HDTV video signals. True HDTV signals are uncompressed and contain over six times the information of SDTV. For undersea applications they must also be transmitted over long cable lengths. Therefore Ocean ProHD first converts the analog HDTV video signals to a High Definition Serial Digital Interface (HD-SDI) video data stream at 1.5 GB/sec in accordance with the SMPTE 292M standard for broadcast quality video and then transmits these digital signals over a fiber-optic communications link from the ROV to the surface. The use of a high power laser

transmitter and highly sensitive optical receiver ensures that the signals are received completely noise free and contain no signal dropouts.

Transmission of true HDTV video ensures that there is no significant processing delay between image capture and viewing by the operator which would otherwise be present for compressed video signals. The operator views the images in real time, a critical requirement for most ROV operations. At the surface the HDTV video signals are available as outputs in HD-SDI format and are downconverted to standard definition analog video signals and made available as NTSC or PAL composite outputs.

Video Compression, Recording and Playback

Recording of HDTV video requires that the true HDTV signals be first compressed, and when playing back the recorded video, decompressed. To perform this function a compression/decompression (CODEC) algorithm is required. Without compression the recording of even just a few hours of HDTV would require considerable storage capacity. Ocean ProHD includes Oceaneering CODEC, an advanced, essentially lossless CODEC method specifically designed for Oceaneering to greatly reduce the required file size when recording video. In addition, unlike other CODECs that limit post production editing to specific frames, Oceaneering CODEC files can be edited, frame by frame, by many PC based software programs, making advanced post production work easier. To compress and record true HDTV video, Ocean ProHD includes a **Recording Computer**. The Recording Computer inputs true HDTV video in HD-SDI format, compresses the video using Oceaneering CODEC, and saves the compressed video as AVI

files on removable 1-TB hard drives which are delivered directly to the customer. As much as 24 continuous hours of HDTV video can be recorded on a single drive. The customer can play back the AVI files on any computer that has Oceaneering CODEC and Windows Media Player installed.

Video Overlay

The Recording Computer also inputs operator entered information and CTAG (Oceaneering Computer Telemetry and Graphics) data for overlaying on the video images which are displayed on a second **LCD Video Monitor**. The operator entered information includes client data, job location, job title, job number, and other information. The CTAG data includes real-time ROV data, such as pitch, roll, depth, date, time, location, and other parameters. All this information is output from the Recording Computer to an **Overlay Unit** to be combined with the true HDTV video. The Overlay Unit outputs the combined video and overlay to the Recording Computer for compression and recording.



Actual Ocean ProHD Image with Overlay

System Components and Software

Ocean ProHD Undersea HDTV includes all of the components and software programs required to acquire and to record unlimited hours of HDTV video for playback on virtually any desktop or laptop PC. The components are grouped into two separately available systems: the **Ocean ProHD TV Camera System** and the **Ocean ProHD TV Recording and Overlay System**. The Ocean ProHD TV Camera System acquires and transmits the HDTV video, and the Ocean ProHD TV Recording and Overlay System records the video, along with an overlay of operator entered information and CTAG data from any Oceaneering CTAG Pilot Computer. Voice audio can also be recorded with the video. Together these two systems require a dedicated optical fiber to transmit the HDTV video signals from the ROV to the surface and a single RS-232 channel of the fiber-optics data multiplexers installed in Oceaneering's Surface Consoles and ROVs.

Ocean ProHD Camera System

The Ocean ProHD Camera System includes the following components:

- **Ocean ProHD TV Camera**
- **Fiber-Optics Transmitter/Converter**
- **Surface Control Unit**
- **Camera Controller**
- **LCD Video Monitor**

The Ocean ProHD TV Camera and the Fiber-Optics Transmitter Converter are installed on the ROV. The Surface Control Unit, the Camera Controller and the LCD Video Monitor are installed on deck with the Surface Console.

Ocean ProHD TV Camera. The Ocean ProHD TV Camera captures broadcast quality HDTV color video at 1920 x 1080 pixels of resolution with a 16:9 aspect ratio and outputs true HDTV video signals to the Fiber-Optics Transmitter/Converter. The camera includes a 3:8x or 10x zoom lens and an RS-232 serial interface for remote control of all the camera functions. Tri-state inputs are also included for remote control of the camera focus and zoom.



Fiber-Optics Transmitter/Converter.

The Fiber-Optics Transmitter/Converter inputs the video signals from the Ocean ProHD TV Camera and converts them to a 1.5 GB/sec HD-SDI video data stream which is output directly to the Surface Control Unit over a dedicated optical fiber. The Fiber-Optics Transmitter/Converter also inputs and isolates the RS-232 serial interface connections from the Camera Controller and the tri-state inputs from the Surface Console. The Camera Controller and tri-state inputs are provided over separate RS-232 channels of the ROV and Surface Console fiber-optics data multiplexers and are routed to the camera.



Surface Control Unit.

The Surface Control Unit provides fiber-optic to electrical conversion of the HD-SDI video from the Fiber-Optics Transmitter/Converter and includes two HD-SDI video outputs which connect to the LCD Video Monitor and to the Overlay Unit of the Ocean ProHD Recording and Overlay System. The Surface Control Unit also routes the Camera Controller RS-232 serial interface connections to the Surface Console fiber-optics data multiplexer and provides SDTV outputs in either NTSC or PAL.





Camera Contoller. The Camera Controller connects to the Surface Control Unit with a 15-foot cable and provides remote control of the Ocean



ProHD TV Camera over an RS-232 serial interface, including zoom; automatic, manual and instant focus; automatic and iris preferred exposure; and automatic and user set white balance. An LCD display is included which displays the camera settings. When the Camera Controller is not connected, the camera focus and zoom can be controlled using the tri-state controls provided by the Surface Console.

LCD Video Monitor. The LCD Video Monitor connects to an HD-SDI output of the Surface Control Unit and displays real-time HDTV video from the Ocean ProHD TV Camera.



Overlay Unit. The Overlay Unit inputs HD-SDI video from the Surface Control Unit of the Ocean ProHD TV Camera System, overlays graphics and text onto the video and outputs HD-SDI video with overlay to the Recording Computer. The overlay graphics and text, which include operator entered information and CTAG data, are input from the Recording Computer on a USB port.



Recording Computer.

The Recording Computer inputs HD-SDI video with overlay from the Overlay Unit and records the video on a RAID (redundant array of independent disks) consisting of four 1-TB hard drives. The recorded video can then be copied to a fifth, removable 1-TB drive for delivery to the customer. A DVD drive is also included which enables recording of up to four minutes of video on a DVD.



Ocean ProHD Recording and Overlay System

The Ocean ProHD Recording and Overlay System includes the following components:

- **Overlay Unit**
- **Recording Computer**
- **Accessories and Audio Kit**
- **LCD Video Monitor**
- **Media Kit**
- **Playback Kit**

The Overlay Unit, the Recording Computer and the LCD Video Monitor, along with components of the Accessories and Audio Kit, are installed on deck with the Surface Console.

The Recording Computer also includes the following installed Oceaneering software:

- CTAG for Windows Server
- Ocean ProHD Overlay
- Oceaneering Capture

The CTAG for Windows Server inputs CTAG information from any CTAG Pilot Computer over an



RS-232 serial interface. Or for installations where the CTAG for Windows Server runs on a remote computer, the CTAG information is input to the Recording Computer over an Ethernet port.

Ocean ProHD Overlay, which is a client to the CTAG for Windows Server, generates the overlay graphics and text



from operator entered information and CTAG data. The operator entered information is displayed on a Splash screen, which can also display both Oceaneering and customer logos, and the CTAG data are displayed on an Operations screen. The overlay can be turned on or off, and when on, it is recorded with the video. Ocean ProHD Overlay also enables capture of still images from the real-time video. The images can be saved to the RAID, with or without the overlay included, in compressed (JPG) or uncompressed (BMP) format.

Oceaneering Capture compresses the real-time video from the Overlay Unit, with or without the overlay, using the Oceaneering CODEC compression algorithm and then records the video to the RAID. The video is displayed on the LCD Video Monitor and recording can be started or stopped at any time using the Recorder Start/Stop Switch which is included with the Accessories and Audio Kit. Real-time video can also be displayed on a computer monitor and on a second LCD Video Monitor, both of which are optionally supplied.



In addition to recording video and overlay information, the Recording Computer provides an audio input for recording voice with the video. The audio is input from a microphone and preamplifier which are included with the Accessories and Audio Kit. Oceaneering Capture includes a VU

meter which indicates the output level of the preamplifier. The level can be easily adjusted with front panel controls.

Accessories and Audio Kit. The Accessories and Audio Kit is supplied with the Recording Computer and includes the following items which are used in the installation and operation of the Ocean ProHD Recording and Overlay System:

- Keyboard and trackball
- Preamplifier with cables and power supply
- Microphone with holder and mount
- Recorder Start/Stop Switch with USB Switch Interface
- USB Drive Enclosure with power supply and accessories
- DB9-to-DB25 serial cable
- DVI-to-VGA cable
- Breakout cable
- BNC cables



LCD Video Monitor. The LCD Video Monitor connects to an HD-SDI output of the Recording Computer and displays real-time HDTV video with or without the overlay.



Media Kit. The Media Kit is a consumable that includes eight preformatted 1-TB hard drives packed in a transportable case. The drives are inserted into the removable drive bay of the



Recording Computer, and the video files are copied to them from the RAID. Once copying is complete, the drives can be delivered to the customer as part of a Playback Kit.

Playback Kit. The Playback Kit is the deliverable to the customer. It includes a transportable case packed with the following items:



- Up to three 1-TB hard drives with recorded HDTV video
- USB Drive Enclosure with power supply and accessories
- Oceaneering CODEC CD

To play back the video recordings on a desktop or laptop PC, the customer must first install Oceaneering CODEC on the PC from the CD, connect the USB Drive Enclosure to a USB port of the PC and insert a 1-TB hard drive into the drive enclosure. Then the video recordings can be played back in Windows Media Player by simply double-clicking the AVI file of the recording on the hard drive.

Component Specifications

Ocean ProHD TV Camera

Size:	24.4 cm (9.6 in.) long 11.2 cm (4.4 in.) dia
Image sensor:	1/3 type 2-megapixel HD
Effective number of pixels:	2 million (approx)
Resolution:	1080i/59.4 and 1080i/50
Video screen format:	16:9
Minimum illumination:	4 lux reflected scene illumination for a usable, clear picture
Optimum illumination:	100 to 100,000 lux for broadcast quality images
Signal to noise ratio:	Greater than 50 dB
Lens:	3.8x or 10x zoom with auto iris and remote control of zoom, focus and iris
Focus control:	Auto and manual over RS-232 interface and the tri-state connections
Zoom control:	Manual over RS-232 interface and the tri-state connections
Exposure control:	Auto and manual over RS-232 interface
White balance control:	Auto and manual over RS-232 interface
In-water horizontal field of view:	100° (wide) to 27° (full zoom), or 80° (wide) to 8° (full zoom)
In- water minimum subject distance:	5.1 cm (2 in.) at full wide 35.6 cm (14 in.) at full zoom
Housing construction:	6061-T6 hard coat anodized aluminum
Weight in water:	1.1 kg (2.5 lb)

Weight in air:	2.8 kg (6.2 lb)
Storage temperature:	-4°F to 140°F (-20°C to 60°C)
Operating temperature:	32°F to 113°F (0°C to 45°C)
Depth rating:	4000 m (13,000 ft)
Optical port:	0.2-in. thick polished BK-7 glass dome
Connector:	Impulse MSJ-10-BCR
Camera cable:	0.75-in. diameter oil filled PBOF polyurethane tube with MSJ-10-CCP connectors each end
Camera cable length:	4.6 m (15 ft) standard; up to 9.1 m (30 ft) optional

Fiber-Optics Transmitter/ Converter

Size:	26.0 cm (10.25 in.) long 13.3 cm (5.25 in.) dia
Power requirements:	18–32 VDC; 0.6 A @ 24 VDC
Video output:	Optical HD-SDI digital video (SMPTE 292M), broadcast quality
Optical source:	Laser diode
Optical wavelength:	1310 nm
Optical transmitter output:	-2 dBm, ±1 dBm typical
Fiber type:	Singlemode
Control link:	RS-232 @ 38400 baud, fully isolated tri-state for focus and zoom, fully isolated
Housing construction:	6061-T6 hard coat anodized aluminum
Weight in water:	2.5 kg (5.5 lb)

Weight in air:	4.6 kg (10.2 lb)
Storage temperature:	-4°F to 140°F (-20°C to 60°C)
Operating temperature:	26°F to 120°F (-3.3°C to 50°C)
Depth rating:	4000 m (13,000 ft)
PWR/CONN. connector:	Seacon Global CS-MSAJ-9-BCR
CAM HEAD connector:	Seacon Global CS-MSAK-10-BCR
F.O. OUT connector:	Seacon Global OPHD-PP-90

Surface Control Unit

Size:	48.5 cm (19.1 in.) wide 20.6 cm (8.1 in.) deep 4.5 cm (1.76 in.) high
Weight:	5.5 kg (12 lb)
Power requirements:	100–240 VAC, 47–60 Hz, 250 watts
Video output:	Two HD-SDI digital video (SMPTE 292M), broadcast quality; one composite NTSC or PAL
Optical wavelength:	1310 nm
Optical detector:	PIN-TIA diode
Optical receiver sensitivity:	-22 dBm (signal off)
Optical receiver indicators:	DC power; optical power from 0 dBm to -20 dBm in -5-dBm increments
RS-232 connector:	DB-9F
FO INPUT connector:	ST style singlemode; mates with ST style singlemode connector
HD-SDI OUTPUT connectors:	BNC; mates with BNC cables included
CAMERA R/C connector:	Amp CPC receptacle

NTSC/PAL OUTPUT connector:	BNC
POWER IN connector:	CEE-type AC; mates with AC power cable included

Camera Controller

Size:	11.9 cm (4.7 in.) wide 18.8 cm (7.4 in.) long 5.6 cm (2.2 in.) high
Cable connector:	Amp CPC plug
Cable length:	4.6 m (15 ft)
Weight:	1 kg (2.3 lb)
Power requirements:	12 VDC from Surface Control Unit
External interface:	RS-232 @ 38400 baud to ROV interface through Surface Control Unit
Operator controls:	Focus Zoom Exposure White balance Display brightness 59.94/50 frame rate Zoom limit

Overlay Unit

Size:	48.3 cm (19.0 in.) wide 30.8 cm (12.125 in.) 4.4 cm (1.75 in.) high
Weight:	2.3 kg (5.0 lb)
I/O ports:	(1) SD/HD-SDI input (1) SD/HD-SDI output (2) Composite video input (1) Composite video output (2) S-Video input (1) S-Video output (1) Microphone input (1) Stereo left input (1) Stereo right input (1) Digital I/O (1) DVI (1) USB
Power requirements:	100–240 VAC, 50/60 Hz

Recording Computer

Size:	48.3 cm (19.0 in.) wide 66.0 cm (26 in.) deep 8.9 cm (3.5 in.) high
Weight:	27.3 kg (60 lb)
Non-removable SATA bays:	(6)
Removable SATA bay:	(1) Wiebetech RTX100-INT
Data storage:	(5) 500GB 7200RPM SATA2 (1) 1.44MB floppy (1) DVD-R+R/-RW+RW/DL+R/CDR/CDRW
Processor:	Intel Dual Xeon Quad-Core E5335 2.0GHz, 1333MHz 8MB cache
Memory:	4GB RAM
Operating system:	Windows XP Professional
Software:	CTAG for Windows Server Ocean ProHD Overlay Oceaneering Capture
RAID controller:	Integrated Intel ESB2 SATA2
Audio:	Integrated ALC 833 HD 7.1 channel
Graphics processor:	Leadtek PX8500 GT, 256MB, 128-bit GDDR2 PCI Express
Video encoder:	Black Magic Design DeckLink HD Extreme
I/O ports:	(4) USB 2.0 (1) RS-232 (1) Parallel (2) PS2 (2) Ethernet 100/1000BaseT (1) HD-SDI input (2) HD-SDI output (1) Octopus (HD/audio/RS-422) (1) DVI (1) HDMI (1) Composite video
Power supply:	650 watt
Power requirements:	100–240 VAC, 50/60 Hz

LCD Video Monitor

Size:	48.3 cm (19.0 in.) wide 5.3 cm (2.1 in.) deep 31.1 cm (12.25 in.) high
Weight:	5.7 kg (12.5 lb)
Screen size:	50.8 cm (20.0 in.) diagonal
Aspect ratio:	16:9
Pixels:	1366 x 768
Color depth:	24-bit (16,777,216 colors)
Power requirements:	100–240 VAC, 50/60 Hz



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