



Confidential

White Paper

for DVI extension cable

FIBER **DVI**

ver. 1.13

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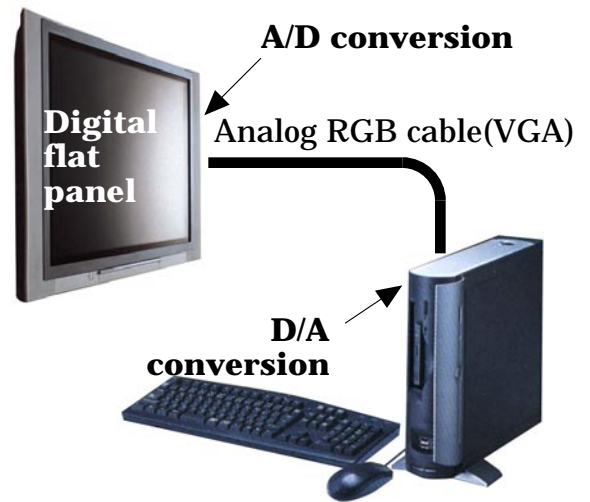
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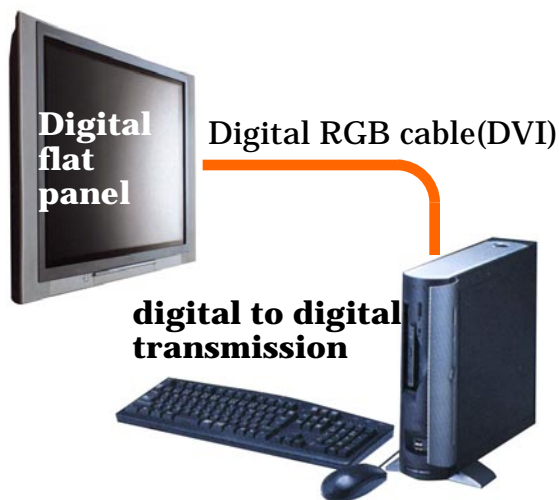
1. Outline of DVI

Most of the computers on the market today generate digital video, which is then converted to analog by the video graphics card and transmitted to an analog CRT monitor. In the case of digital displays such as Plasma, LCD flat panel monitors, DLP and LCD projectors, that analog signal has to be converted back to digital before it can be displayed, a process that can add unnecessary cost and complexity to some products. Additionally the digital to analog (D/A) and analog to digital (A/D) conversion of the video signal can introduce sampling errors, which can reduce image quality and require the addition of controls to help correct the errors introduced in the process.



Legend technology to transmit video

With the increase in popularity of digital flat panel monitors, the need for a digital graphics connection became apparent. The challenge was to develop a simple, cost effective digital connection to send high bandwidth digital RGB signals across a reasonable cable length. Silicon Image's Transition Minimized Differential Signaling (TMDS) technology were explored. A number of competing standards for digital interfacing soon emerged. VESA introduced the Plug and Display (P&D) standard, Compaq Corporation led a consortium of manufacturers to introduce the Digital Flat Panel (DFP) interface standard and the Digital Display Working Group (DDWG) introduced the Digital Visual Interface (DVI) standard. All three standards were based around Silicon Image's TMDS technology.



Advanced technology to transmit video

The Digital Visual Interface (DVI) was designed to provide the industry with a single universal digital interface. Its primary focus was to provide a digital connection between a PC and a display device. It quickly gained widespread market acceptance and is now the industry standard.

DVI offers the right combination of versatility and functionality, which is why it has become the industry standard. Market research indicates that in just a few years, sales of digital display devices will surpass sales of analog display devices. DVI is poised to replace the analog VGA connector to become the single universal display interface.

2. What FiberDVI offers?

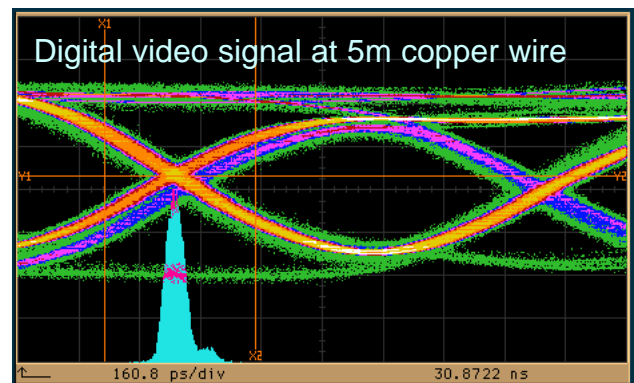
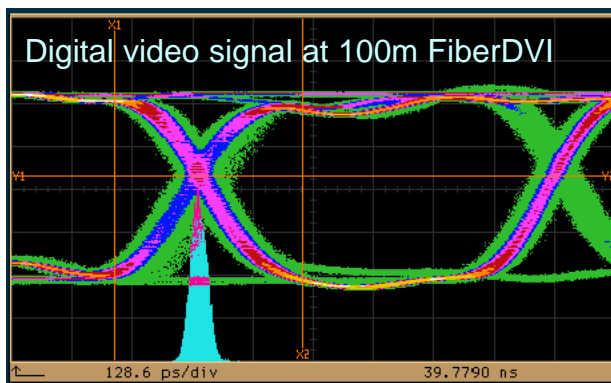
Stretch the Standard

One major disadvantage of digital to digital transmission for a video signal is the limitation of cable length because of the attenuation of high bandwidth signal transmitted through copper wire. Optical data transmission could be one of a solution to overcome this disadvantage, but legend technology for optical data transmission still has required inconvenience of an extra bulky box which includes E/O, O/E converter and an extra power supply for the box.

Sumitomo Electric has developed an ultra-small form integrated circuit that changes electric signals to optical signals, and a system that runs off the electric current from the computer it is connected to, allowing Sumitomo Electric to make the connectors for FiberDVI equal to copper DVI connectors as shown in a picture on the right. The FiberDVI can **stretch the standard** cable length over 332 feet (100m) versus the listed copper DVI standard of 15 feet.



Fiber Optic Clarity



Optical fiber can transmit the video signal with less attenuation in comparison with copper wire. As you can see from the eye diagrams pictured above, digital video signals transmitted through FiberDVI is less distorted than the signal through copper DVI cable. This feature presents a clear and vivid vision on larger size and high resolution displays which are suitable for professional or high end use.

3.Applications

Wall Panel

Large scale flat panel screens become popular for displaying map, chart or video on a large wall of a control room, dealing room or operation room. This kind of screen is constructed with multiple flat panels like 4x4 or 6x2, etc. A contractor or a system integrator of the screen will have difficulty while installing and adjusting such panels because it takes time and cost to calibrate color of each panel.

FiberDVI, which has advantages of less electromagnetic susceptibility(EMS) and less distortion to legend analog RGB cable, will solve such difficulty.



Home Theater

Recently, price of Plasma Display Panels, LC or DLP projectors are going down and they are spreading into the home to have fun by watching DVD, Satellite TV, CATV or other digital content. Long cable lengths of FiberDVI gives flexible layout of audio-visual equipment.

Medical Equipment

LC displays with high resolution are taking the place of photograph or CRT displays for viewing X-Ray or MRI pictures. It becomes absolutely necessary to avoid electromagnetic interference(EMI) which is radiated from the electric wire cable of the display. FiberDVI transmits high speed digital video signal through optical fibers, which do not affect these instruments.



Active Screen

LC projectors (beamers) or Plasma Display Panels are useful media for dynamic and attractive advertisements. FiberDVI expands applications for advertising with features as follows: Long cable lengths permit host machines for visual images to be placed behind the wall to hide from the view of the guests; Less electromagnetic susceptibility (EMS) provides clear and precise picture on large screens or panels.



LED Signs

Large scale sign board system usually shows multimedia contents like TV, Video and PC. The system is constructed with several special equipment which would share each function of the system to compose, to convert, or to retouch the original contents. FiberDVI connects this equipment one after another without any distortion or deterioration.



Video Conference Rooms

Demand for video conferences within and between companies or individuals for distant communications to save time and expense is expanding exponentially. FiberDVI transmits high quality image over several hundred feet in large conference rooms or presentation rooms, and provides flexible layout of host PC and display.



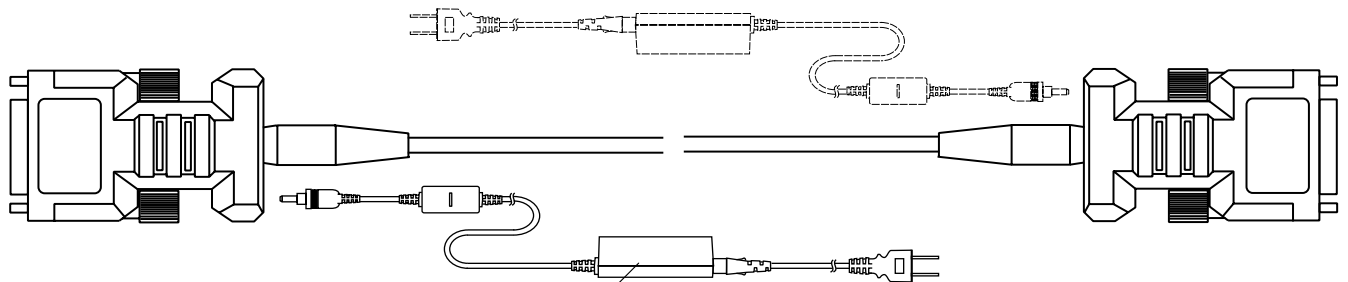
4. Products Offered

Plug & Play

A basic model of FiberDVI is called Plug&Play. This model supports full function of DVI 1.0 standard including following features.

- (1) Conforms to UXGA(1600 x 1200 dots) resolution at 60Hz refresh rate.
- (2) TMDS graphic data is transmitted by optical fibers. DDC data and electrical power are transmitted by copper wires.
- (3) Supports VESA DDC2B function.
- (4) Supports HDCP copy guard protocol.

This model offers 2 individual types based on application, **internal power supply** models and **external power supply** models. FiberDVI which has a built-in laser transmitter, photo diode receiver and a convertor IC within its connector will require electrical power supply to drive such components. The internal power supply model basically works with a PCI graphic card, conformed to DVI 1.0 standard, which has enough capacity of power supply. The external power supply type should be used with a PCI graphic card which has insufficient power capacity (such as typically available on most DVD players). Please refer to section **6.Operation with Power Supply** for further information.



AC/DC power adaptor :
 should be attached to a port either in a transmitter or a receiver for external power supply type.

Ordering information for Plug & Play

Product Name	Model	Supporting resolution
FiberDVI M1-7TH-***-i	internal power supply	upto SXGA, 75Hz
FiberDVI M1-7TH-***-e	external power supply	upto SXGA, 75Hz
FiberDVI M1-7UX-***-i	internal power supply	upto UXGA, 60Hz
FiberDVI M1-7UX-***-e	external power supply	upto UXGA, 60Hz

*** indicates cable length in meter, i.e. 010,020,030,050,070, and 100.

4. Products Offered

Field Installable Version (under development)

Another model of FiberDVI offers a unique solution for field installation of long cable. The cable is divided into three parts, i.e. transmitter part, intermediate cable part and receiver part which are then combined to each other by multi-core optical connectors. We also offer 2 types of product in this version. **FiberDVI Light** is applicable to PC application, and the home entertainment application typically requires **FiberDVI Pro**.

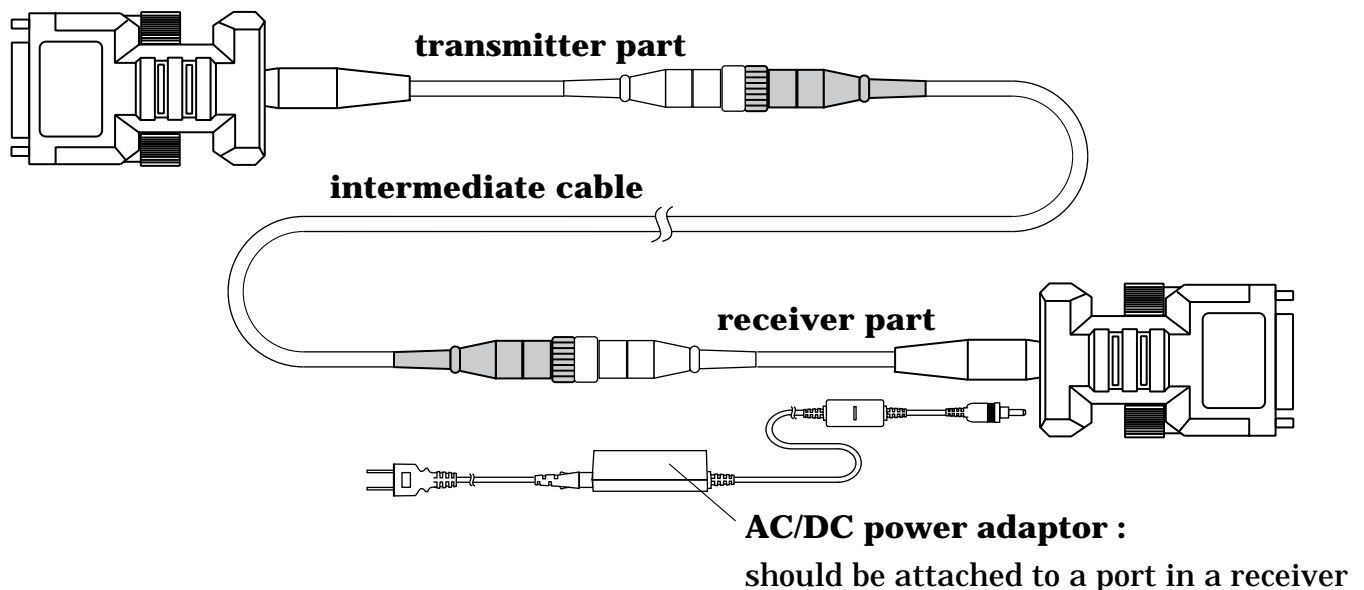
FiberDVI Light for PC application (under development)

The connectors attached to intermediate cable which are composed of **crimp(not to glue) & cleave(not to polish)** technology could be terminated on-site after the cable is installed through a conduit. This model has the following features.

- (1) Conforms to UXGA(1600 x 1200 pixels) resolution at 60Hz.
- (2) TMDS graphic data is transmitted by optical fibers.
- (3) AC/DC power adaptor required in the receiver part.
- (4) The intermediate cable meets UL910 plenum grade flammability.
- (5) Does not support DDC2B function and hot plug detection.*



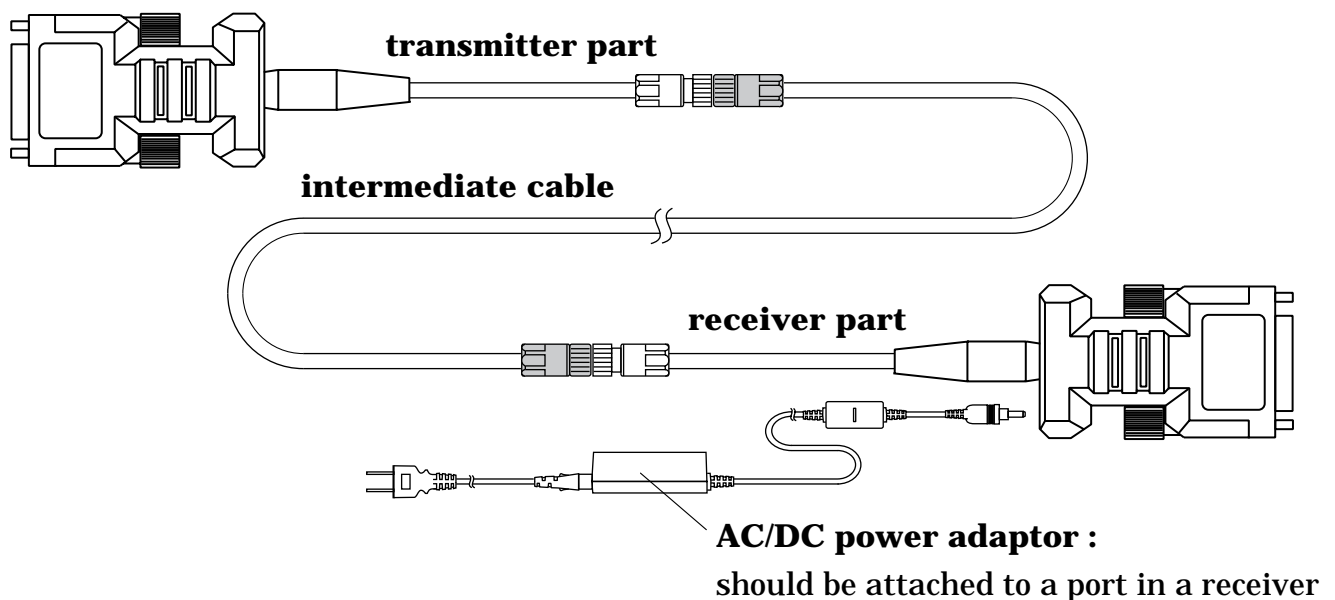
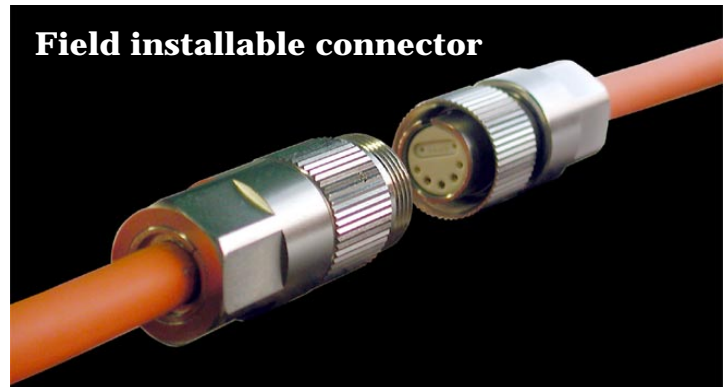
* : Display identification data such as maximum resolution of LCDs or LC projectors is not transferred to host computer. In case a display is changed to others and the PC is rebooted, setting up for resolution should be adjusted suitable for the new display before changing the display.



FiberDVI Pro for home entertainment (under development)

The connectors attached to the intermediate cable are pre-terminated in Sumitomo Electric's factory. The outer diameter of the connector is approximately 17.5mm(0.69in), so that the connector part could be installable through o.d.=22mm(0.87in) conduit. This model has the following features.

- (1) Conforms to UXGA(1600 x 1200 pixels) resolution at 60Hz.
- (2) TMDS graphic data is transmitted by optical fibers. DDC data and electrical power are transmitted by copper wires.
- (3) AC/DC power adaptor required in the receiver part.
- (4) Supports VESA DDC2B function.
- (5) Supports HDCP copy guard protocol.
- (6) The intermediate cable meets UL1666 riser grade flammability.



Ordering information for Field Installable Version

FiberDVI Light Series

Product Name	Model	Supporting resolution
FiberDVI Light M1-4UJ-TX	transmitter part	to UXGA, 60Hz
FiberDVI Light M1-4UJ-RX	receiver part	to UXGA, 60Hz
OFNP 4-IB-V	intermediate cable	-
Fiber DVI Light M1-4UJ-P	crimp&cleave connector	-
CAK-M1-4UJ	termination tool kit	-

Note : Maximun length of the intermideate cable to be installed should be 300m.

FiberDVI Pro Series

Product Name	Model	Supporting resolution
FiberDVI Pro M1-7UJ-TX	tansmitter part	to UXGA, 60Hz
FiberDVI Pro M1-7UJ-RX	receiver part	to UXGA, 60Hz
FiberDVI Pro M1-7UJ-***	intermediate cable	to UXGA, 60Hz

*** indicates cable length in meter, i.e. 010,020,030,050,070,and 100.

5.Instructions

Plug & Play

SYSTEM REQUIREMENTS FOR SETUP

Hardware Requirements

You have to have a DVI graphic controller or card having a DVI port in your PC, SUN or Mac systems. It should support the maximum graphic resolution feature of displays to be connected. No special memory size, CPU speed and/or chip sets required, if you have already properly installed your DVI graphic controllers of cards.

Software Requirements

No special restrictions, if you've already properly installed your DVI graphic controller in your operating software.

AC/DC Power Adapter Technical Advisory

The **internal power supply type** is designed for internal power (+5V) to be supplied through a DVI pin (#14) from the graphic card. However, the **external power supply type** requires one external +5V AC/DC power adaptor to drive the Tx/Rx modules. To plug the power into either one of two end modules, permits the other to be power supplied through the hybrid cable.

INSTALLATION

Please refer to **Installation instructions** in page 16.

CONNECTION

Important : Please use the connection procedure below. Improper, or no operation may result if the start-up sequence is not correctly followed.

Step 1 Connect an AC/DC adapter to either of the Tx/Rx module of **external power supply type**. **Internal power supply type** does not require any power adaptor.

Note : **Internal power supply type** uses only the power +5V supplied through a DVI pin (#14) from the graphic cards. After completing the installation instruction, if the system does not work properly, you have to make sure your hardware graphic card has the power capable to supply more than 500mA.

Step 2 Plug directly the Tx module (marked as "to COMPUTER") of FiberDVI in the DVI receptacle of PC.

Step 3 Plug directly the Rx module (marked as "to MONITOR") of FiberDVI in the DVI receptacle of display.

Step 4 Power on the PC and display.

5.Instructions

Field Installable Version(under development)

FiberDVI Light

SYSTEM REQUIREMENTS FOR SETUP

T.B.D.

INSTALLATION

Please refer to **Installation instructions** in page 16.

CONNECTION

T.B.D.

FiberDVI Pro

SYSTEM REQUIREMENTS FOR SETUP

T.B.D.

INSTALLATION

Please refer to **Installation instructions** in page 16.

CONNECTION

T.B.D.

6. Inter operability

Operation with Power Supply

FiberDVI which has a built-in laser diode transmitter, photo diode receiver and convertor IC in its connector part requires electrical power supply to drive such components. Method to supply electrical power for each type of the products is described in a table below.

<u>Model</u>	<u>Type</u>	<u>Method for power supply</u>
Plug&play	Internal power supply (Denoted as "I")	Supplied from PCs.
	External power supply (Denoted as "E")	AC/DC adaptor attached to a port either in the transmitter or the receiver.
Field installable	-	AC/DC adaptor is to be attached to a port in the receiver side only.

Maximum value of consumption current of the FiberDVI is 350mA at 5V. PCI graphic cards installed on a PC with the internal power supply type is connected and should have capability to supply current at least 350mA to 500mA.

Most PCI graphic cards will operate with our FiberDVI product. The occasional exception are typically related to Apple computer products.

DDC Signal Transmission

Inter operability for DDC signal transmission is as described in a table below.

<u>Model</u>	<u>Type</u>	<u>Compatibility for DDC</u>
Plug&play	Internal power supply	Fully compatible.
	External power supply	Fully compatible.
Field installable	FiberDVI Light	Not supported.
	FiberDVI Pro	Fully compatible.

Note : In case of Fiber DVI Light, display identification data such as maximum resolution of LCDs or LC projectors is not transferred to host computer. In case a display is changed to others and the PC is rebooted, setting up for resolution should be adjusted suitable for the new display before changing the display.

List of Applicable PCI Graphic Boards

T.B.D.

HDCP Signal Transmission

Inter operability for **H**igh-bandwidth **D**igital **C**ontents **P**rotection signal which is transmitted through DDC data line is as described in a table below.

<u>Model</u>	<u>Type</u>	<u>Compatibility for HDCP</u>
Plug&play	Internal power supply	Fully compatible.
	External power supply	Fully compatible.
Field installable	FiberDVI Light	Not supported.
	FiberDVI Pro	Fully compatible.

Graphic Resolutions

FiberDVI supports various graphic resolutions as listed below.

<u>Name</u>	<u>Resolutions</u>	<u>Pixel clock rate</u>	<u>Product to be used</u>			
			M1-7TH-	M1-7UX-	M1-4UJ-	M1-7UJ
DVD progressive	720x480p	27.0MHz	o	o	n/a	o
VGA, 75Hz	640x480	31.5MHz	o	o	*	o
SVGA, 75Hz	800x600	49.5MHz	o	o	*	o
HDTV 1080i	1920x1080	74.25MHz	o	o	n/a	o
XGA, 85Hz	1024x768	94.5MHz	o	o	*	o
SXGA, 75Hz	1280x1024	136.6MHz	o	o	*	o
HDTV 1080p	1920x1080	148.5MHz	n/a	o	n/a	o
UXGA, 60Hz	1600x1200	162.0MHz	n/a	o	*	o

The mark "o" indicates "fully compatible".

The mark "*" indicates "compatible but does not support DDC and Hot plug".

The mark "n/a" indicates "not available" because it does not support HDCP .

7. Other Information

Permissible Ratings

The permissible rating of the product shall be in accordance with tables below.

for Plug & Play

<u>Item</u>	<u>Min.</u>	<u>Max.</u>	<u>Unit</u>	<u>Condition</u>	
Storage temperature	-30	70	°C	packed	
Operating temperature	0	50	°C	-	
Operating humidity	-	85	%RH	-	
Tensile load	Cable	-	196	N	short term
	Cable/connector	-	49	N	short term
	Cable	see installation instructions			long term
Bending radius	Cable	25	-	mm	short term
	Cable	50	-	mm	long term
Lateral pressure	-	980	N/50mm	short term	
	see installation instructions			long term	

for FiberDVI Pro(under development)

<u>Item</u>	<u>Min.</u>	<u>Max.</u>	<u>Unit</u>	<u>Condition</u>	
Storage temperature	-30	70	°C	packed	
Operating temperature	0	50	°C	-	
Operating humidity	-	85	%RH	-	
Tensile load	Cable	-	196	N	for Tx/Rx part, short term
		-	490	N	for intermediate part, short term
	Cable/connector	-	49	N	for Tx/Rx part, short term
		-	49	N	for intermediate part, short term
Cable	see installation instructions			long term	
Bending radius	Cable	25	-	mm	short term
	Cable	50	-	mm	long term
Lateral pressure	-	980	N/50mm	short term	
	see installation instructions			long term	

for FiberDVI Light(under development)

<u>Item</u>	<u>Min.</u>	<u>Max.</u>	<u>Unit</u>	<u>Condition</u>	
Storage temperature	-30	70	°C	packed	
Operating temperature	0	50	°C	-	
Operating humidity	-	85	%RH	-	
Tensile load	Cable	-	196	N	for Tx/Rx part,short term
		-	490	N	for intermediate part, short term
	Cable/connector	-	49	N	for Tx/Rx part,short term
		-	49	N	for intermediate part, short term
Cable	see installation instructions			long term	
Bending radius	Cable	25	-	mm	short term
	Cable	50	-	mm	long term
Lateral pressure		-	980	N/50mm	short term
		see installation instructions			long term

*****Caution*****

This product is intended for use with ordinary electronic goods (computers, personal electronic equipment, office equipment, measuring instruments, industrial robots, household electrical appliances, etc.). It is neither intended nor guaranteed for use with equipment where especially high levels of quality or reliability are required and where faults or malfunctions will be a direct threat to life or property or there is a risk of causing bodily harm (e.g., nuclear power control equipment, aerospace equipment, transportation instruments, traffic signal equipment, combustion control, medical equipment for life support, safety equipment, etc.). Any use of this product for such special applications is entirely at the risk and responsibility of the user.

*****Caution*****

- Please connect the plug of the AC/DC adapter firmly. It can become the cause of heat generation leading to a fire.
- Do not connect Tx and Rx module inversely. It can become the cause of heat generation leading to a fire..

*****Attention*****

- Don't leave this product in high temperatures or humid environment for a long time.
- Don't give a shock to this product.
- Keep this product dry.
- Don't break up this product.
- Be sure not to pull tightly at connector part of this product while installing.
- Observe the permitted bend radius.
- Please refer to permissible rating of this product.

*****Installation instructions*****

Observe the permitted tensile force.

If tension is applied to the cable sheath or if the maximum permitted tensile force is exceeded during cable handling, the optical fibers may break due to mechanical stress and the optical characteristics of the cable may be impaired. Even where the optical fibers do not break and there is no immediate loss of optical performance, such handling can have adverse long-term effects. When laying the cable, avoid situations where longitudinal tension is permanently applied to the cable.

Observe the permitted bend radius.

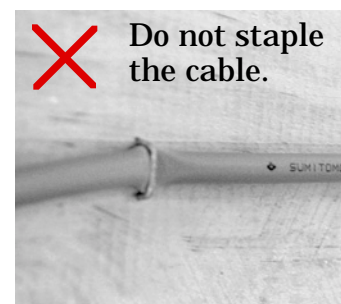
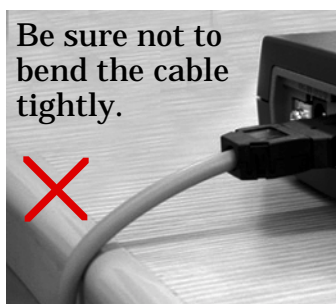
Bending optical cable in a radius smaller than the minimum permitted bend radius may break the optical fibers and impair the optical characteristics of the cable. Even where the optical fibers do not break and there is no immediate loss of optical performance, such handling can have adverse long-term effects. Take particular care to avoid bending the cable sharply at the neck of the optical connector. When paying out the cable, suitably raise the reel so that it can turn freely and ensure that no twists or kinks occur. Where there are bends in the cable laying route, pull the cable out of the hand hole and lay in a figure 8 shape, then pull the cable progressively into the next section.

Observe the permitted lateral pressure.

If the cable is handled such that the lateral pressure applied to it exceeds the permitted maximum, the optical fibers may break and the optical characteristics of the cable may be impaired. Even where the optical fibers do not break and there is no immediate loss of optical performance, such handling can have adverse long-term effects. In particular, take care to avoid conditions where lateral pressure is permanently applied to the optical cable, caused by actions such as binding the cable strongly, laying other cables on the cable or placing the trough cover directly on top of the cable.

Take care not to twist the cable.

Twisting the cable until kinks occur can result in the cable bending at a radius smaller than the minimum permitted bend radius so that the optical fibers break and the optical characteristics of the cable are impaired. Twisting may be concentrated at the point where the cable meets the connector and cause breakage in the optical fibers. When paying out the cable, suitably raise the reel so that it can turn freely and ensure that no twists or kinks occur. Where there are bends in the cable laying route, pull the cable out of the hand hole and lay in a figure 8 shape, then pull the cable progressively into the next section.

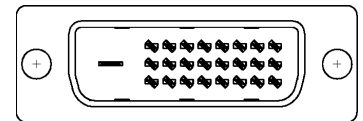


8. Glossary

DDC : An abbreviation for Display Data Channel. A general term of data channel between the display and the host (PC). FiberDVI transmits DDC signal through copper wires .

DDC2B : A bidirectional data channel between the display and the host (PC). The data includes **EDID** data.

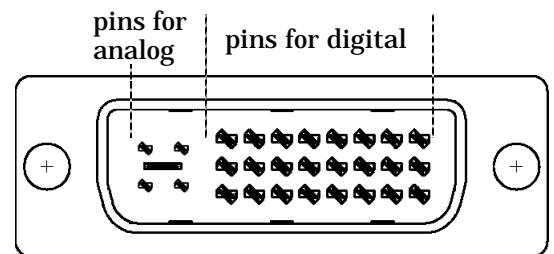
Dual Link : A pair of RGB graphic signals and one clock signal are transmitted. Capacity of graphic data is as twice as **Single Link**. 24-pin plug is used for Dual link.



24-pin plug for DVI-D Dual link

DVI-D : DVI connector which supports only digital RGB graphic signal. 24- or 18-pin plug is used.

DVI-I : DVI connector which supports digital and analog RGB graphic signal. 29- or 23-pin plug is used.



29-pin plug for DVI-I dual link

EDID : An abbreviation for Extended Display Identification Data. Data structure containing the display identity and the basic display specifications, i.e. name of manufacturer and practical graphic resolutions etc.

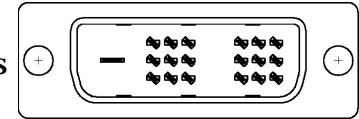
EEPROM : An abbreviation for Electronic Erasable Read Only Memory. An IC chip which is installed in the display and provides **EDID** data.

HDCP : An abbreviation for High-bandwidth Digital Contents Protection. A protocol for copy guard of high density digital contents, i.e. DVD movie or **HDTV**. HDCP is exchanged between the host(player) and the display through **DDC** line.

HDTV : An abbreviation for High Definition Television which is a standard of next generation digital TV. Another meaning is one of variations of graphic resolution which corresponds 1920x1080 pixels.

QXGA : One of variations of graphic resolution which corresponds 2048x1536 pixels.

Single Link : One RGB graphic signals and one clock signal are transmitted. Capacity of graphic data is as half as **Dual link**. 18-pin plug is used for Single link.



18-pin plug for DVI-D Single link

SVGA : One of variations of graphic resolution which corresponds 800x600 pixels.

SXGA : One of variations of graphic resolution which corresponds 1280x1024 pixels.

TMDS : An abbreviation for Transition Minimized Differential Signaling. A style of signal transmission introduced by Silicon Image used for RGB digital video image transmission.

UXGA : One of variations of graphic resolution which corresponds 1600x1200 pixels.

VESA : An abbreviation for Video Electronics Standard Association. Variations of normal graphic resolutions regulated by VESA is as shown in a table below.

<u>Name</u>	<u>Resolutions</u>	<u>Pixel clock rate</u>
DVD progressive	720x480p	27.0MHz
VGA, 75Hz	640x480	31.5MHz
SVGA, 75Hz	800x600	49.5MHz
HDTV 1080i	1920x1080	74.25MHz
XGA, 85Hz	1024x768	94.5MHz
SXGA, 75Hz	1280x1024	136.6MHz
HDTV 1080p	1920x1080	148.5MHz
UXGA, 60Hz	1600x1200	162.0MHz

VGA : Basically, an abbreviation for Video Graphics Array, which is a name of standard graphic card installed in IBM PC/AT personal computers or a familiar name for analog RGB video connector composed with 15 pins. Another meaning is one of variations of graphic resolution which corresponds 640x480 pixels.

WXGA : One of variations of graphic resolution which corresponds 1280x768 pixels.

XGA : One of variations of graphic resolution which corresponds 1024x768 pixels.