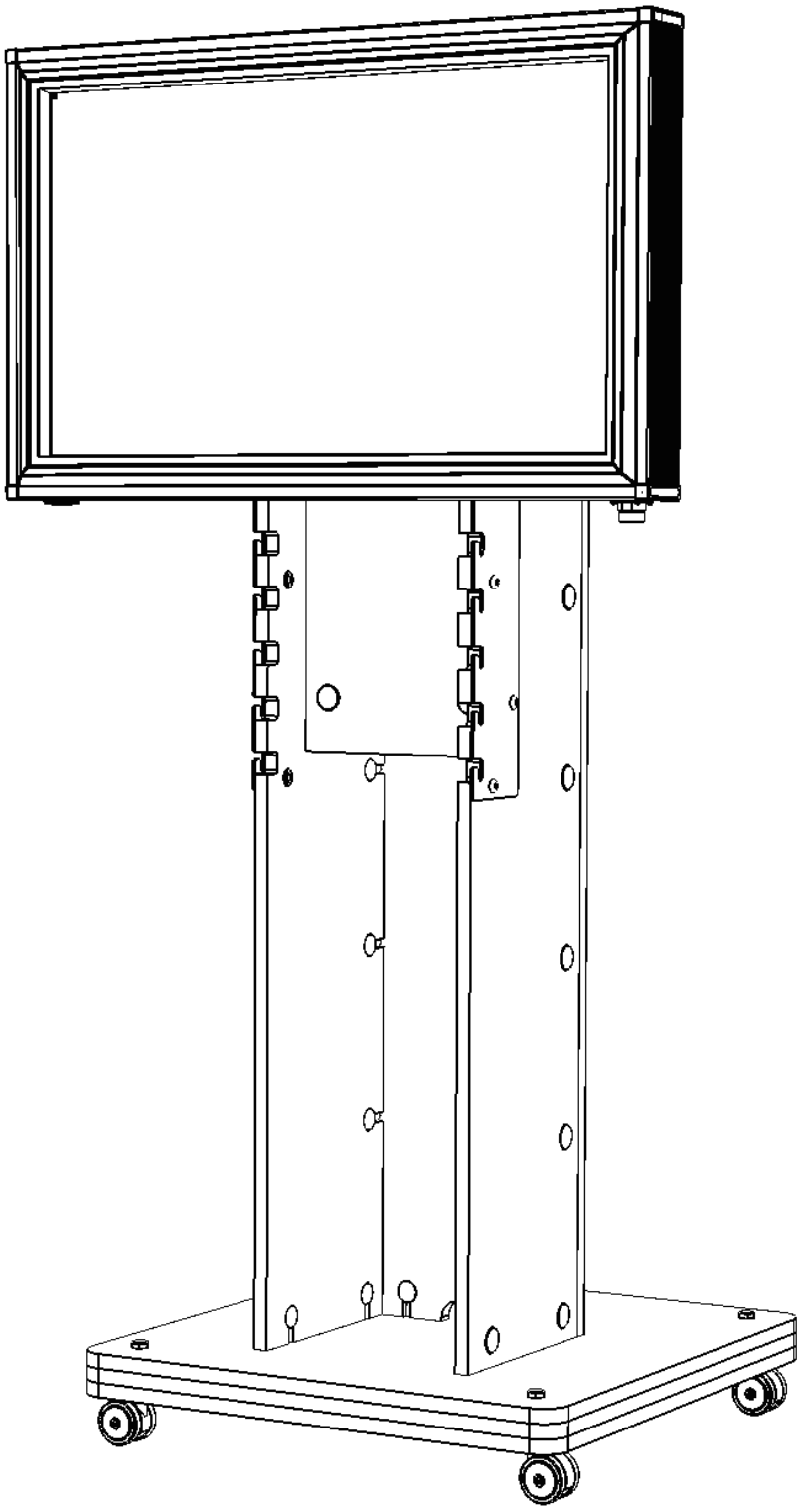
BOLDscreen 32 user manual



Intended Use

BOLDscreen 32 is an MRI-safe HD 32” LCD monitor with LED backlight intended to display visual stimuli for fMRI experiments. It's safe to install in the scanner magnet room, and the crisp, precision adjustable images can be viewed using standard head coil mounted mirrors. It is designed for scanners of any field strength and has currently been tested up to 7 Tesla.

BOLDscreen 32 Monitor

BOLDScreen 32’s 1920x1080 IPS LCD is edge illuminated by an array of SuperBright LEDs and is DC driven. The luminance of the monitor is stabilised by a built in sensor circuit. The display is natively 10 bit per colour gun, extended to 16 bit by dithering. A 4096 entry gamma correction lookup (8192 when in Bits# mode) is provided for calibration and linearization purposes. The display spatial uniformity is corrected by a real-time 5^{th} order polynomial.

The aluminium and stainless steel enclosure provides MRI-compatible shielding and passive cooling. The monitor is MR safe.

Video is supplied to the monitor via either a duplex LC fibre optic cable or “ODVA” rugged fibre optic cable (both are MR Safe). A detachable fibre transmitter (MR unsafe, control room only) plugs into a DVI socket of the video source in the control room. Video input depths up to 12 bits per gun are supported.

Power is supplied to the monitor via a MR Safe multicore triple shielded DC cable at SELV levels. Power entry to the magnet room is via a filter and voltage converter fitted into the penetration panel. The actual mains power supply is located outside of the magnet room.

There are no controls on the monitor, configuration is via a XML file on the memory card inserted in the rear of the monitor.

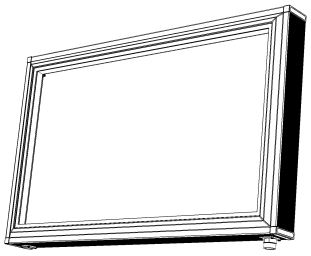
PLEASE READ THE SAFETY WARNINGS BEFORE INSTALLING OR USING BOLDscreen 32

System Components

Safety labelling of the items is as follows:

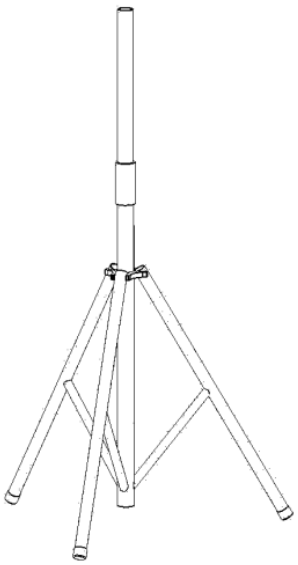
	MR-SAFE. These items can go into the magnet room. No displacement with any field strength of any MRI scanner.
	MR-CONDITIONAL: These items must only go into the magnet room **if specified installation and usage instructions are followed.**
	MR-UNSAFE: Never take these items into the magnet room. **A SERIOUS DANGER FROM THE MAGNETIC FIELD EXISTS WITH THESE ITEMS.**

- BOLDScreen 32 1920x1080 MRI compatible monitor



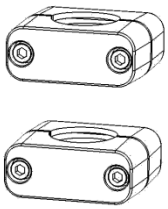
- 4mm Titanium Hex key

- Aluminium Stand or Trolley



- Four plastic clamps with four M6 stainless attachment bolts

MR



- Dust cover

MR

- Fibre optic DVI cable (either duplex LC to LC, or duplex LC to SC, to suit fibre transmitter).

MR

- Voltage converter unit and adaptor cable

*This item **must** be installed in the penetration panel.*

- Shielded DC supply cable

MR

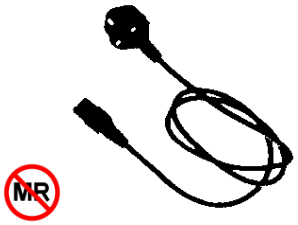
- Video transmitter (this may differ from the model shown).

MR

- Mains PSU

MR

- Mains lead



- *This will vary depending upon the territory in which the unit is sold.*

Packaging materials

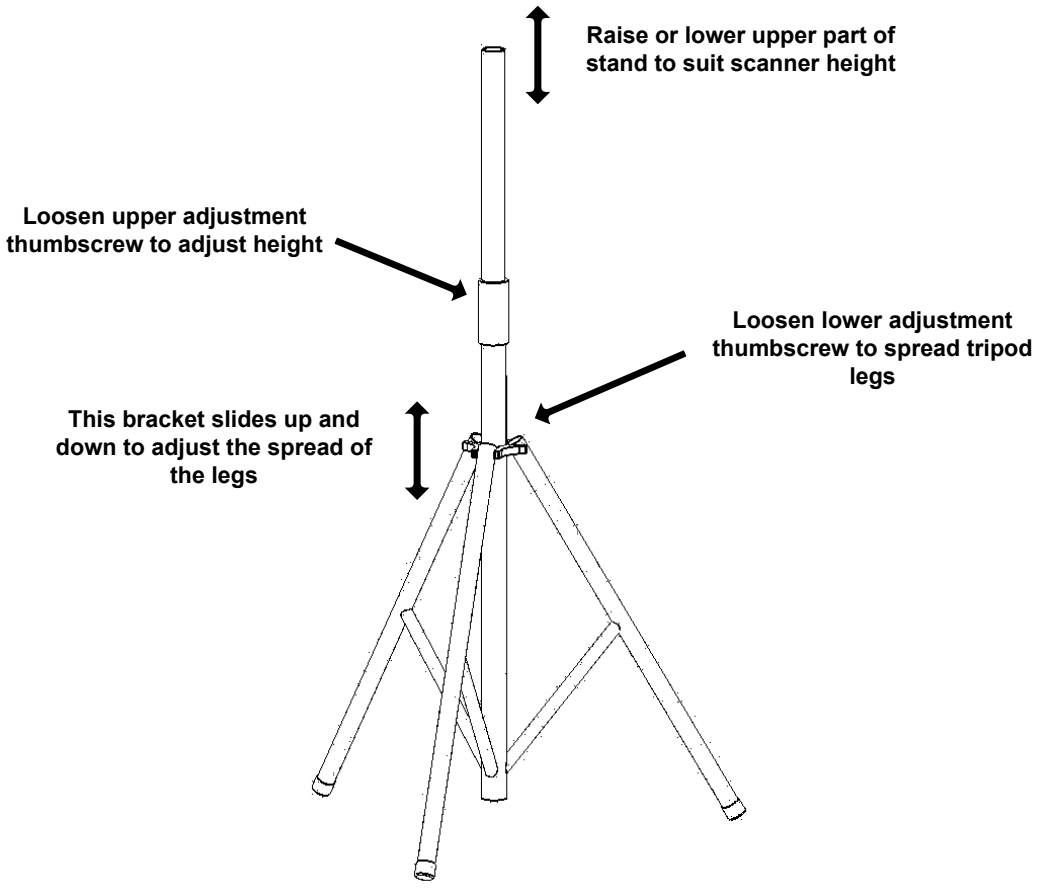
You may wish to retain the packaging for future use.

Mounting Options

Permanent or temporary installation of BOLDscreen 32 is possible. It can also be mounted either way up, depending on your viewing optics. The normal orientation is with the connectors facing downwards which will produce a right way up image. This is normally correct when BOLDscreen 32 is located at the subjects head end of the magnet bore. It would be normal in this case to enable left right reversal of the image to compensate for the mirror that is used to view BOLDscreen 32 (this is set using the configuration xml file located on the SDcard of the monitor, see Section on *"The SDcard"* and *"Config.xml"*).

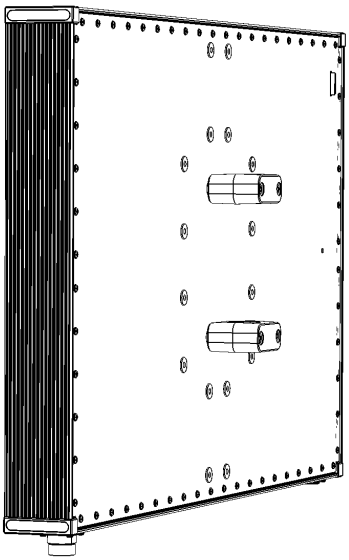
It is also possible to set your computer to produce a rotated image rather than physically rotating BOLDscreen 32.

Mounting on the stand via the clamps provided



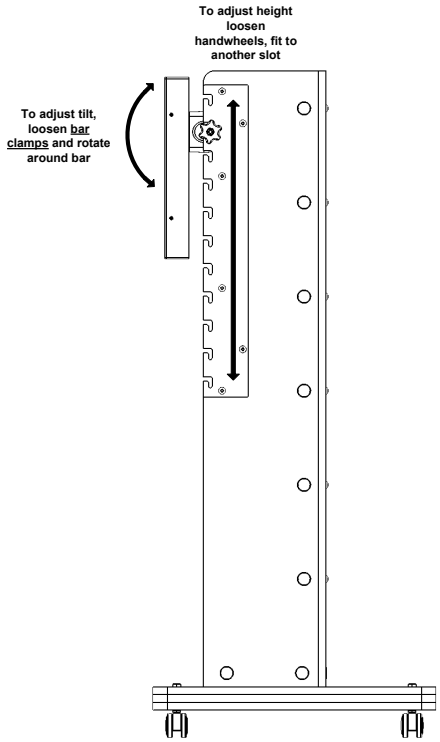
LOCK <u>BOTH</u> THUMBSCREWS ONCE ADJUSTMENTS ARE COMPLETE

- To fit to the stand, first loosen the lower locking collar and spread the legs of the tripod stand, then retighten the locking thumbscrew.
- Then loosen the upper locking collar, and extend the upper telescoping part of the stand. Retighten the locking thumbscrew.
- Before then attempting to attach the monitor, the clamps should be attached to the mounting holes on the back of BOLDscreen 32 (see diagram below) . Non-magnetic stainless screws are supplied for this. Do not fully tighten the screws yet.
- The clamps then slide over the upper telescoping part of the stand and should be gently tightened using the provided MRI-Safe hex-key. A few centimetres of stand should protrude from the upper clamp.
- Any further adjustment should be carried out using the adjustment screw on the side of the stand. Be careful to not trap your fingers when adjusting the stand. Adjustment should only be carried out by 2 people (one person should support the weight of the monitor while the other loosens and retightens the adjustment screw).



Trolley with adjustable height and tilt

This uses a horizontal mounting bar and larger clamps (both supplied with the trolley) to provide tilt adjustment for the monitor

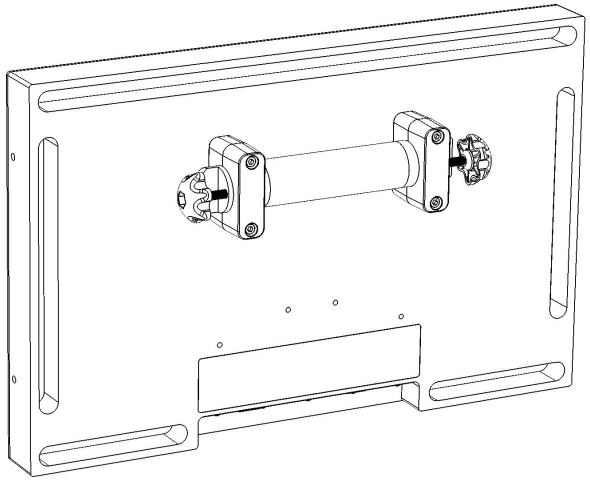


The castors wheels on the trolley enable it to be easily moved out of the way for other uses of the MRI scanner.

Optimising the height and tilt of BOLDscreen 32 needs to be done in the magnet room, with a subject in the scanner, viewing the screen through the mirror above the headcoil. BOLDscreen 32 needs to be correctly positioned at the head end of the magnet bore. This should be a once only task for a given scanner setup.

Be sure to only use the titanium allen key when making adjustments in the magnet room.

Firstly fit the mounting bar to BOLDscreen 32 (see illustration):



Then with a helper, decide on the slots (and hence the height) most appropriate for your scanner model to maximise the field of view as viewed by the subject. Once decided, make sure the mounting bar is properly located in the bottom of a pair of slots in the trolley column, then tighten the two handwheels to lock the bar in place.

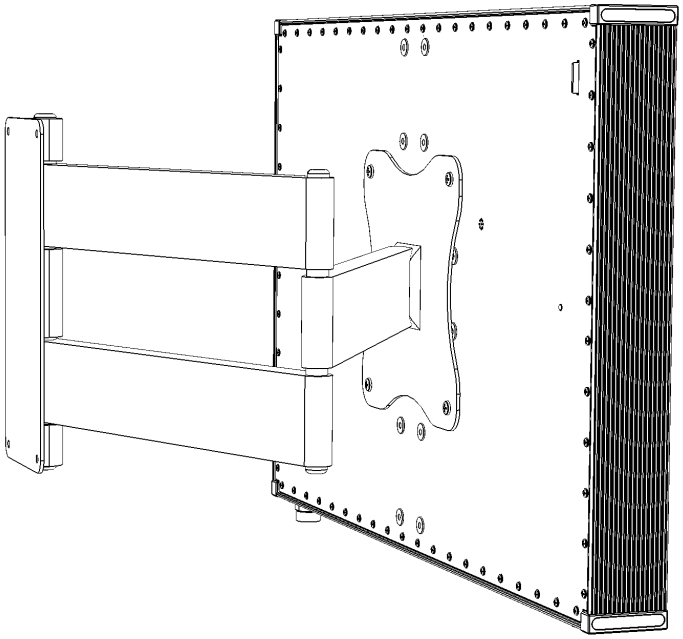
Check the field of view is correct, then adjust the tilt of the monitor. You will need to slightly loosen the clamps holding BOLDscreen 32 to the bar to adjust the tilt (no more than ½ a turn for each mounting of the 4 clamp screws).

Once the tilt has been optimised, be sure to re-tighten all four screws for the clamps.

Mounting on the VESA standard mount (200mm x 200mm M6)

BOLDscreen 32 can in principle be used with any standard VESA mount (MRI compatibility of the mount MUST be established by the installer). The 4 mounting holes are on a 200mm x 200mm spacing and take M6 screws. The screws are not supplied as this depends on the mount used. The screws should engage by between 5 to 8mm into the monitor. We recommend that either stainless steel A4 grade, or titanium screws are used.

This mounting method is designed for installations where the screen is permanently installed in the magnet room. Consult your MRI installer about this mounting option. **The mount should be strong enough to resist forces on the monitor due to eddy currents during a magnet quench.**



Installing Voltage Converter Unit in penetration panel

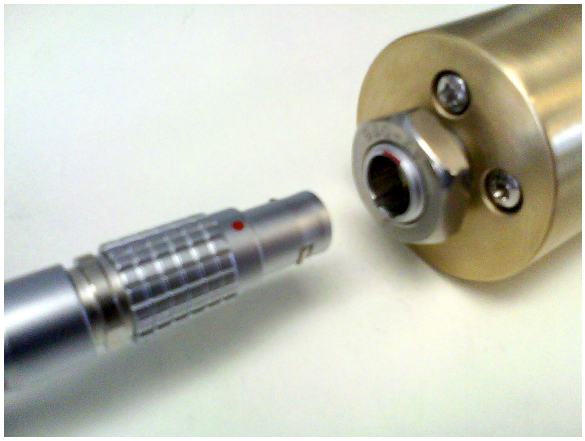
These instructions relate to the latest version of VCU with a connector in both ends.

The voltage converter unit must be installed into a 12mm or 0.5” hole in the penetration panel. The brass body of the unit is 39mm diameter and is located on the magnet room side of the panel. A single nut secures the unit from the control room side. DO NOT OVERTIGHTEN THE SECURING NUT (7Nm max).

Here is a picture of the VCU and adaptor cable:

Assembly of the VCU into the penetration panel either requires an assistant, or requires temporary removal of the penetration panel. The round body of the VCU was sized to replace an existing BNC filter module (if a spare filter exists), but check that the hole is at least 12mm diameter. Make sure your site MRI safety protocols are followed for the installation (particularly if a hole needs to be drilled or enlarged in the penetration panel, or if the penetration panel is temporarily removed). Once a suitable sized hole has been made in the penetration panel, proceed as follows:

1) From the magnet room side, insert the small connector of the VCU into the hole in the penetration panel.
2) From the control room side, get your assistant to carefully fit the supplied nut onto the threaded outer portion of the socket. **DON'T USE A SPANNER YET.** Be careful they do not "cross thread" the nut. It should be possible to do up the nut easily with just your fingers
3) Using a 19mm or ¾" AF spanner (not supplied), lightly tighten the nut. The maximum torque is 7 Nm. Obviously; **never take the spanner into the magnet room.**
4) Plug the short adaptor cable into the VCU socket. There is a small red alignment dot on the plug and on the socket. It only fits one way around. See picture (penetration panel not shown for clarity):



5) Plug the mains power supply into the free end of the adaptor cable, but **DON'T PLUG INTO THE MAINS JUST YET.**

6) See section on attaching the DC cable in the magnet room.

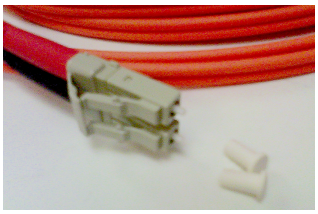
Connecting a Video Source to BOLDscreen 32

The photographs in the description that follows mainly refer to the Opticis fibre optic transmitter. Later production features a Ophit fibre transmitter. This is functionally equivalent except utilising an SC fibre connector at the transmitter end. The appropriate fibre cabling is supplied with your BOLDscreen 32.

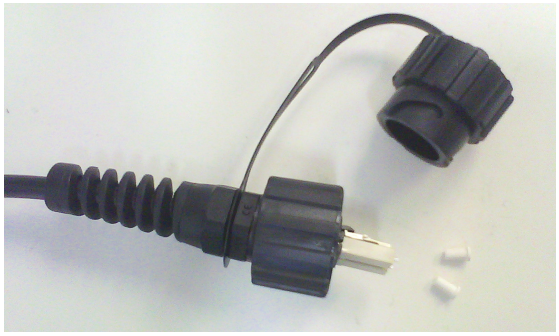
The video source should be connected to BOLDScreen 32 via the passive fibre-optic cable provided. The cable should be routed via the waveguide port from the control room into the magnet room. Do not plug the transmitter into the computer until after the fibre connections have been made.

The cable contains glass fibre optics and can be damaged by rough handling. DO NOT KINK OR STAND ON THE FIBRE CABLE OR IT WILL BE DAMAGED. Damage is less likely if the optional ODVA rugged cable is used:

The standard duplex LC fibre optic cable has removable protective covers over the fibre optic ends, which must be removed before use. Avoid then touching the ends of the fibres because fingerprints degrade the light transfer, which may lead to video problems.

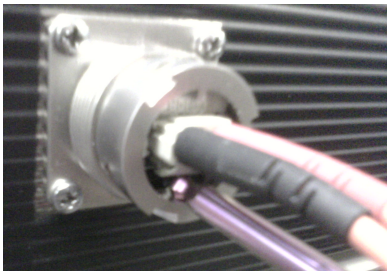


The ODVA cables additionally have a protective cap on the ends (twist to remove). Keep the cap on unless the fibres are connected.

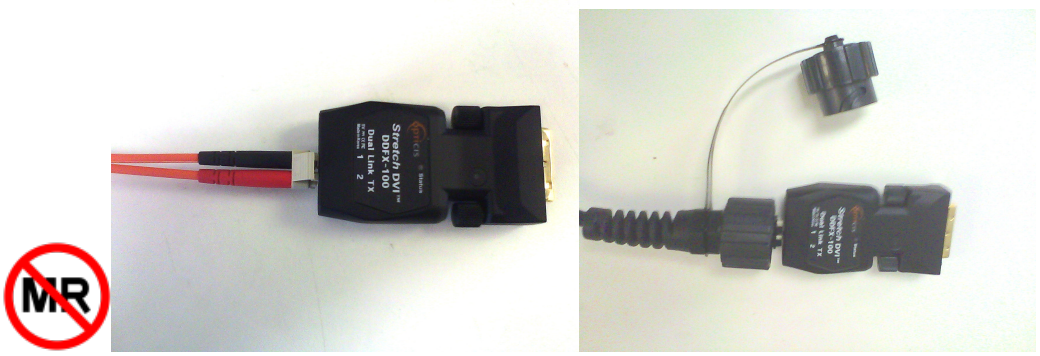


The monitor has dust caps inside the ODVA socket, which must be removed before first use. See below for pictures with and without the dust caps inside the socket:

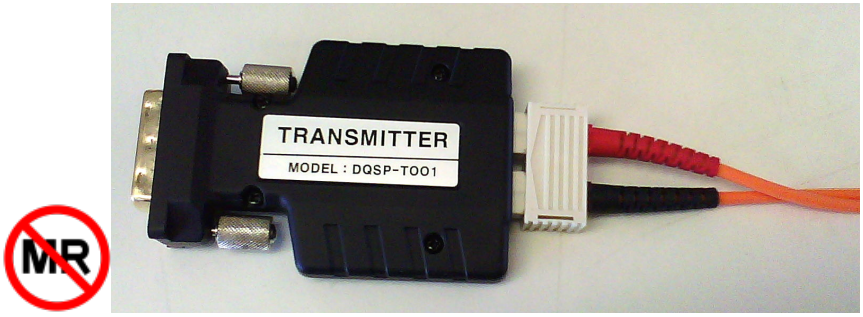
Both fibre types are based on the LC fibre standard and only connect one way around. The ODVA cables twist the locking cap to lock in place, whereas the LC cable “clicks” into place. To remove the LC fibre you will need to press the locking tang with the ball end of the supplied titanium hex key, as the LC fibres sit recessed in the ODVA connector on the monitor.



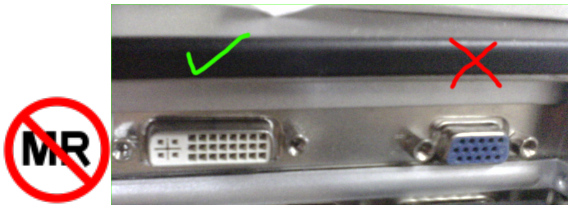
Route the fibre through a waveguide to the control room. The other end of the fibre connects to the video transmitter, but **DO NOT TAKE THE FIBRE TRANSMITTER INTO THE MAGNET ROOM.** Here are pictures of the fibres connected to the transmitter. Like the monitor end the fibres only fit one way around. The standard LC fibres click into place, whereas the ODVA fibres are a friction fit.



Note: If the Ophit fibre receiver is used with the ODVA cabling, then an ODVA bulkhead connector must be used in the penetration panel. A short standard LC to SC duplex fibre cable is then used in the control room to route from the penetration panel top the fibre transmitter:



The fibre transmitter should then be plugged into a DVI socket on the host computer in the control room **(under no circumstances should the host computer be located in the magnet room):**

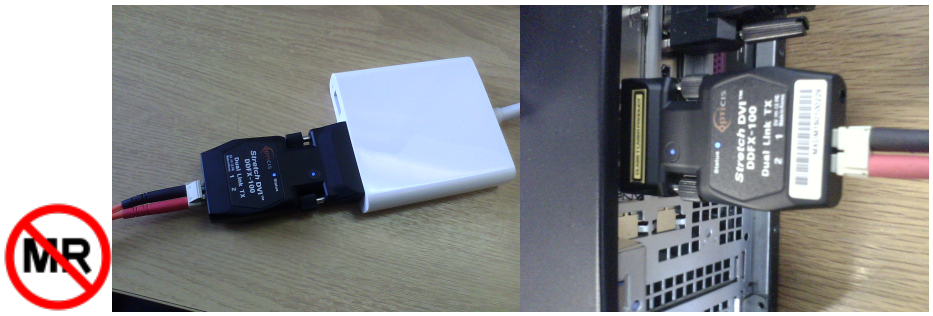


The video transmitter has blue LEDs which illuminate when powered. It is powered by the computer's graphics card. If the transmitter LED does not light up when the computer is switched on, it is possible that the graphics card is not supplying sufficient power.

It is important that the computer has a DVI connector; analogue "VGA" HD15 connectors are not suitable as BOLDscreen 32 requires a source of digital video (see picture above for identification).

For optimium performance the BOLDscreen 32 requires a source of dual-link DVI, as this provides higher pixel bandwidth.

It is also possible to use Displayport connectors with a Displayport to dual link DVI adaptor:



Do not use a DVI splitter because signal degradation can happen, and this also causes complication with compatible video timings (both monitors would be driven with the same video timing). If you need a mimic display of the BOLDscreen 32, then another output of the host computer should be used, with the operating system set to clone, or “mirror” as it often called, the BOLDscreen output.

For mechanical reasons, the use of HDMI to DVI adaptors is not recommended (because of the weight of the fibre transmitter). If your computer only has HDMI outputs then use a short HDMI to DVI (female) cable instead.

The monitor can be driven with a resolution of 1920x1080 (HD) at 100 or 120Hz. The HD resolutions require a source of dual link DVI. A resolution with a 4:3 aspect ratio of 1440x1080 at 100Hz is also possible, which only requires single link DVI. If less than 1920 horizontal pixels are provided then the image will be automatically padded with black bars at the left and right of the display. However, **do not drive with less than 1080 lines** or the panel may be damaged. The resolution options available depend on the graphics card and operating system.

The direct correspondence between input pixels and displayed pixels was deliberate to avoid an extra one frame of latency that would be incurred if a rescaler was fitted.

Your computer graphics card may offer other resolutions which are rescaled to fit the fixed 1920 x 1080 resolution of BOLDscreen 32. This conversely does not normally incur extra latency.

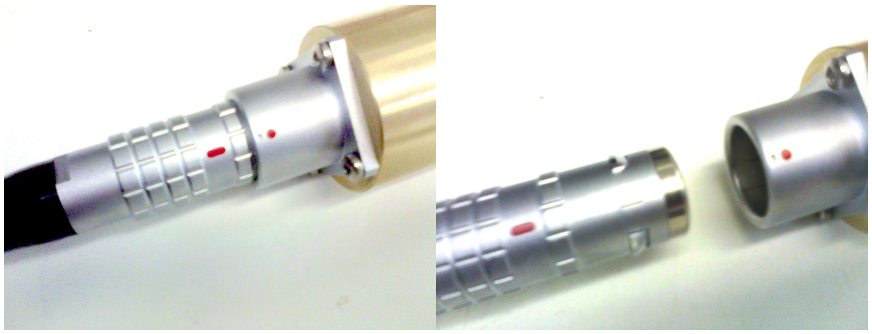
Attaching the DC cables

BOLDscreen 32 is supplied with a triple shielded DC supply cable. This is fitted with Lemo connectors at either end and is fitted between the voltage converter unit in the penetration panel, and the power in connector in the lower left corner of the monitor.

<u>Always</u> switch off the mains power before attaching or removing the DC cable.

The DC lead has a male connector at the VCU end and a female connector at the monitor end. The connectors are also provided with a red alignment dot. To plug in the connectors first check you have the correct end of the cable, then find the alignment dots and line them up. The connectors lock in place with a click

To release the connectors, hold the knurled release sleeve and slide it back to release the plug.

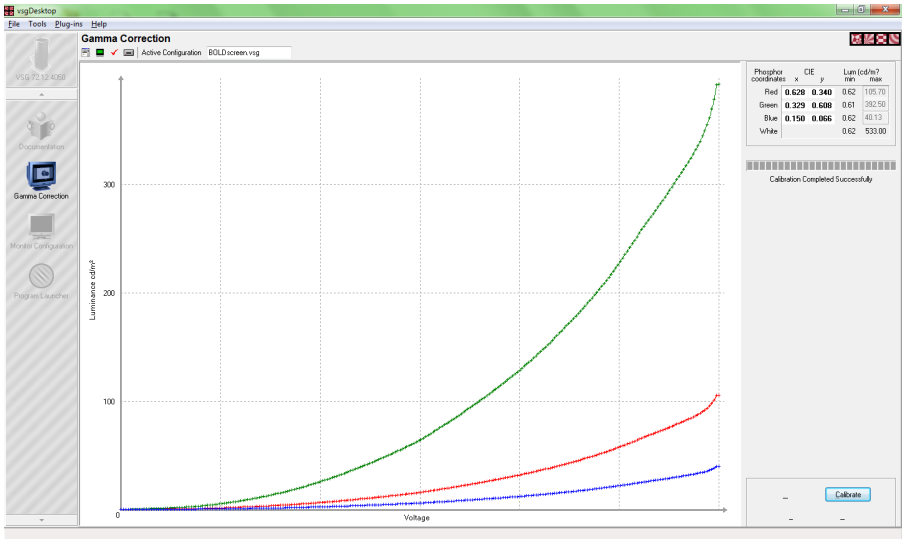


Calibration

BOLDscreen 32 has a nominal 2.2 gamma characteristic. However, for best performance, a gamma correction should be performed. Cambridge Research Systems can supply their ColorCal colorimeter for this purpose.

The calibration will have to be performed with BOLDscreen 32 located outside of the magnet room. BOLDscreen 32 should be allowed to thoroughly warm up for at least 1 hour before a calibration is attempted. This allows the LCD panel to thermally stabilise. The status display on BOLDscreen 32 gives the current temperature of the LED backlight.

For the ultimate performance a 256 reading calibration should be performed with a linear interpolation curve fit.



Once a calibration file has been created it can be saved in the gamma subdirectory. By default a linear correction file is loaded, hence you get the native 2.2 gamma of the LCD panel. However this can be changed with the enableGammaCorrection setting in the Config.xml file (see next section), to load in a different file.

It is also possible to change the RGB values of the displayed patch under the built in luminance sensor, which is useful if a different white point is used (the luminance scaling would otherwise require re-calibration). Set the patch to RGB values corresponding to the highest entry in the calibration file. The patch values are specified as unsigned 16 bit integers (0 to 65535).

Note that the video input to BOLDscreen 32 is a maximum of 12 bits per gun when in “monitor mode”. The table is therefore 4096 entries long. Your computer may or may not support the full 12 bit per gun colour resolution depending upon operating system and graphics hardware.

Conversely when operating in Bits# mode, the input is a more conventional 8 bits per gun. The Bits video modes expand this to up to 16 bits per gun. The gamma table when in Bits# mode is twice as long (13 bits or 8192 entries).

Spatial uniformity correction.

The BOLDscreen 32 supports spatial uniformity correction by applying a 5^{th} order polynomial correction to the incoming video. This is a factory calibration and requires no intervention by the user.

The SDcard

For convenience BOLDscreen 32 contains a removable SDcard that contains the files necessary for the device operation. This can be removed from the monitor to enable changes to be performed without removing the screen from the magnet room. **Do not take laptop computers or similar into the magnet room.**

It is suggested that users keep a backup of the contents of the SDcard, in case the files accidentally get deleted.

Please note that BOLDscreen 32 WILL NOT WORK WITHOUT THE SDcard INSERTED. Be careful not to delete any of the files from the card or change the directory structure. BOLDscreen 32 requires the SDcard to be formatted with the FAT filesystem, other formats will not function.

Documentation subdirectory

Contains a pdf version of this manual.

Gamma subdirectory

Contains display calibration files.

EDID subdirectory

The BOLDscreen 32 places a copy of the display identification data in this directory, which is required for device operation.

Firmware subdirectory

This directory contains files essential for operation of the BOLDscreen 32.

Changes to BOLDscreen 32 only take effect if the device is powered off then back on again. If a firmware update is performed this may take about a minute before the screen illuminates again. This is normal AND THE POWER SHOULD BE INTERRUPTED AGAIN UNTIL THE FIRMWARE UPDATE HAS COMPLETED. The status LED will flash red during a firmware update.

Config.xml file

The backlight level and left right reversal of the screen are controlled by the “config.xml” file located in the “firmware” subdirectory of the SDcard. The monitor can also be set to emulate the video modes of a Bits# stimulus device (see separate Bits# manual).

The file can be edited with any XML aware text editor (e.g. “Notepad” on Windows or “Xcode” on Apple computers). If this file is missing or corrupt (or entries are missing), then defaults for some or all entries will be used instead. Beware that some editors by default substitute the double quotes character when the file is saved (Textedit on OSX for example). This can prevent entries from being interpreted.

```
<?xml version="1.0"?>
<BITS_SHARP_CFG>
    #device mode is either "MONITOR" or "BITS#"
    <Entry DeviceMode="BITS#" />

    #Enable left right reversal of the video (but not the status screen)
    #this compensates for the viewing mirror.
    <Entry mirrorMode="OFF"/>

    #show temperature on status screen
    <Entry TempDebug="ON" />

    #set only one video mode enabled at a time
    #or set all off for Tlock based video mode changing
    <Entry monoPlusPlus="OFF" />
    <Entry colourPlusPlus="OFF" />
    <Entry BitsPlusPlus="ON" />

    #enable backlight luminance control
    <Entry LuminanceEnable="ON" />

    #enable display of the backlight luminance control status
    <Entry LuminanceDebug="ON" />

    #required luminance of the display in cd/m^2
    <Entry LuminanceSetPoint="120" />

    #RGB values of the patch under the luminance sensor
    <Entry LuminancePatchR="0xFFFF" />
    <Entry LuminancePatchG="0xFFFF" />
    <Entry LuminancePatchB="0xFFFF" />

    #internal settings for the luminance digital filter
    <Entry LuminanceLowLimit="256" />
    <Entry LuminanceHighLimit="500" />
    <Entry LuminanceErrDiv="1000" />
    <Entry LuminanceCounts="4096" />
    <Entry LuminanceControlMode="ISTR" />
    <Entry LuminanceScalingFactor="945" />

    #Gamma correction file to load for native light output
    #the 12 bit table is for monitor mode:
    <Entry enableGammaCorrection="12bitLinearLUT.txt" />
    #When in Bits rather than monitor mode, use the 13 bit table:
    #<Entry enableGammaCorrection="13bitLinearLUT.txt" />

    #enable temporal dithering to increase output depth
    <Entry TemporalDithering="ON" />

     #power to internal fibre receiver. Must be on.
     <Entry FibrePower="ON" />
</BITS_SHARP_CFG>
```

Status LED

This is located on the back panel. It indicates the status of the BOLDscreen 32 system:

LED colour / behaviour	Interpretation
Blue	BOLDscreen 32 is working normally and is displaying its video input.
Flashing blue.	*Not currently assigned*
Green	BOLDscreen 32 is working, but no video input is present. Check stimulus source and fibre cable. Can also occur if fibre power setting is turned off.
Flashing green	*Not currently assigned*
Flashing red	BOLDscreen 32 is updating firmware or persistent configuration information. Do not interrupt the power while the LED is flashing.
Solid red	A problem has been detected and BOLDscreen 32 cannot start. This usually occurs if the SDcard is missing or not inserted correctly.
Orange	BOLDscreen 32 main firmware is absent. This usually is because a bootloader update has been performed. Perform main firmware update to restore operation.
Flashing Orange	*Not applicable in BOLDscreen 32.*
Flashing Purple	Error in config.xml file.
Solid Purple	Internal backlight communication problem, consult Cambridge Research Systems.

Technical Data:

System Environmental Conditions

Indoor use only.
Operating Temperature: 0 °C to +40°C
Cooling : Convection-cooled
Operating (or Storage Humidity up to 40°C) : 10-90% RH, non-condensing
Storage Temperature: -20 °C to +60 °C, 40% RH.

Monitor Characteristics

- Screen size: 31.55" diagonal (active area 698.4mm x. 392.9mm, 0.36375mm pixel pitch).
- Screen resolution: 1920 x 1080 pixels (Note: a small area about 16 x 16 pixels in the top left corner is masked for the built in luminance sensor).
- Brightness: factory set to 120cd m^{-2}.
- Automatic compensation of brightness for temperature and ageing (factory set to maintain 120cd m^{-2}).
- Grey-to-Grey Response time: 5ms typical
- 1920x1080 pixels, dual link DVI, 120Hz, 24 bit.
- 1920x1080 pixels, dual link DVI, 100Hz, 24 bit.
- 1440x1080 pixels, single link DVI, 100Hz, 24 bit.
- RF emissions: No effect observed on functional and structural MRI scans at 1.5, 3T and 7T with screen located at exit of scanner bore. No effect on displayed image whilst scanning.
- Type B equipment in accordance with EN60601 for devices in the patient environment. Provides 2 x MOPPs (means of patient protection).

Monitor Dimensions

Dimensions (monitor only): 797 x 491 x 78mm
Weight (monitor only): 19kg

Voltage Converter Unit: diameter 39mm, length 200mm plus connectors.

Stand Dimensions

Height adjustable: 1000 – 1800mm
Weight: 2.5kg

Power Supply

Mains Input: 100 to 240Vac nominal, 50 or 60Hz, 180w, Class II
Output: 15Vdc.
Dimensions: 200 x 80 x 41mm
Weight: 0.5 kg

EMC

Emissions:	EN55011 class B conducted & radiated
Harmonic Currents :	EN61000-3-2 class A
Voltage Flicker	EN61000-3-3
ESD Immunity:	EN61000-4-2, level 3 contact, Perf Criteria A
Radiated Immunity:	EN61000-4-3, level 3, Perf Criteria A
EFT/Burst:	EN61000-4-4, level 3, Perf Criteria A
Surge:	EN61000-4-5, installation class 3,Perf Criteria A
Conducted Immunity:	EN61000-4-6, level 3, Perf Criteria A
Magnetic Field (limit applies to PSU only):	EN61000-4-8, 3 A/m, Perf Criteria A
Dips & Interruptions :	EN61000-4-11
	EN60601-1-2

Safety Conformance

EN60601-1 Ed 3
Type B Equipment
Class 1

Cables

Optical Fibre Length: 15m
DC Power Cable Length: 10m
Mains power lead: IEC 320-C8 with plug to suit territory.

MR safety rationale

BOLDscreen 32 (together with supplied stand, fibre optic cable and DC connecting cable) is categorised as MR safe in accordance with the labelling requirements of ASTM F2503-08 (“an item that poses no known hazards in all MR environments”).

The penetration panel mounted “voltage converter module” is categorised MR conditional (“an item that has been demonstrated to pose no known hazards in a specified MR environment with specified conditions of use”).

The mains PSU (located outside of the magnet room is categorised as MR unsafe, as this would pose a missile hazard if it was placed in a high magnetic field gradient.

Image artefacts are not covered by the labelling MR safe or MR conditional, as ASTM F2503-08 does not consider these to be safety related.

The Monitor

BOLDscreen 32 is constructed mostly from aluminium, 316 stainless steel, glass and plastic. These materials are non-magnetic. There is a very small amount of ferro-magnetic content due mainly to nickel plating on some miniature electronic components, and some tiny ferrite components. This content if of the order of a few grammes in a total monitor mass of about 19kg.

ASTM standard (F2052) gives the test of pull in the magnetic field gradient verses weight. For the BOLDscreen 32 the pull is negligible compared to the weight hence we easily pass. It is not conceivable that there will ever be a high enough field gradient that this is not true. THERE IS ABSOLUTELY NO MISSILE HAZARD WITH THE BOLDSCREEN 32 MONITOR.

The BOLDscreen 32 enclosure is conductive to act as a EMI "Faraday cage" for the electronics within. Due to the heavy aluminium construction considerable eddy currents can be induced in the enclosure. It is likely that BOLDscreen 32 would be subject to a displacement force in the event of a magnet quench (theory dictates it will try to follow the collapsing field). Quench related displacement is not covered by any standard, but even so, no hazard exists with BOLDscreen 32 located against the scanner bore as per the instructions (as it has no further to go). BOLDscreen 32 is securely mounted to a tripod or large trolley and is too big to enter a standard 60cm bore.

The BOLDscreen 32 monitor is typically located at the "head end" of the scanner bore, and is therefore out of reach of the subject. The DC supply lead does not pass over the subject. There is therefore no RF burns hazard from either the conductive enclosure or the DC lead.

The BOLDscreen 32 electronics have been designed to work in the high magnetic field (it is not just a normal monitor in a box). There is therefore no electrical hazard from operating BOLDscreen 32 in the magnetic field of any field strength.

The Power Supply and voltage converter module

The voltage converter module is "MR conditional". It is designed to be permanently fixed into the penetration panel and away from the high magnetic field. It is located in the magnetic room rather than outside, because the DC supply lead would otherwise conduct interference from outside the shielded room. The voltage converter module contains some limited ferromagnetic content and should be kept away from the high magnetic field gradient.

The mains power supply is located in the control room (other side of the penetration panel). This unit contains significant ferro-magnetic content and is therefore MR unsafe. Under no circumstances must the mains power supply be taken into the magnet room.

The power supply is low leakage EN60601 approved, and the current limited DC output is less than the 60v limit for low voltage equipment (no additional "means of protection" are therefore required against electrical hazards).

Connecting Leads

The fibre optic and DC leads used in the magnet room are MR safe as they have no ferromagnetic content. However, both leads must be routed away from the subject to avoid entanglement or to avoid impeding an emergency exit (for example due to a scanner quench or a medical emergency). The DC lead could also present a radio-frequency burns hazard during scanning and therefore must not be in contact with the subject.

Safety Warnings

The MRI scanner should only be used by suitable qualified personnel aware of the risks involved. National regulations and guidelines should be followed. Follow all safety instructions from the MRI scanner manufacturer.

Life support applications

BOLDscreen 32 should NOT be used in situations where failure of the device would constitute a hazard. It is designed for visual stimulus of research applications only, and like any other regular electronic device the display could fail at any time, without warning.

Photo Sensitive Epilepsy

Any system capable of creating flashing images can potentially induce photo sensitive epilepsy in susceptible individuals. The confines of the MRI environment exacerbate the risk should a seizure occur. Experiment design should take this risk into account.

http://www.hardingfpa.co.uk/resources/photosensitive-epilepsy-pse/

Monitor

The monitor poses no missile hazard in an MRI environment. However, any adjustments made to the mounting clamps should be carried out ONLY using the purple Allen key provided. It is made out of titanium and is MRI Safe.

DO NOT UNDER ANY CIRCUMSTANCES TAKE STANDARD STEEL ALLEN KEYS INTO THE MAGNET ROOM. DO NOT SUBSTITUTE STEEL MOUNTING SCREWS FOR THE NON-MAGNETIC STAINLESS SCREWS SUPPLIED.

It is recommended that a helper is used when mounting BOLDscreen 32 in the magnet room due to the weight of the unit. Walk slowly into the magnet room with BOLDscreen 32. Due to the

conductive screened case considerable resistance to movement will be encountered in high field areas due to eddy currents. This is normal and don't try to force it to move quickly.

Always mount BOLDscreen 32 out of reach of the subject. The conductive case of BOLDscreen 32 could cause RF burns if touched whilst a scan is in progress.

During a magnet quench BOLDscreen 32 is likely to be displaced (it will be forced against the magnet as it will follow the collapsing field). Satisfy yourself that this will not cause any additional hazard with your experimental setup. If BOLDscreen 32 is placed hard against the magnet, this should prevent it from falling over should a quench occur.

Servicing

DO NOT ATTEMPT TO DISMANTLE any part of the BOLDscreen 32 system. The BOLDscreen 32 monitor, voltage converter, fibre transmitter and mains PSU contain no user serviceable components, refer all servicing to Cambridge Research Systems.

Stand

The supplied BOLDscreen 32 stand is MR-Safe under all foreseeable conditions in MRI magnet rooms. THE STAND MUST BE OUT OF REACH OF THE SUBJECT WHEN SCANS ARE PERFORMED TO PREVENT R.F. BURNS.

BOLDscreen 32 should be attached and adjusted ONLY using the purple titanium Allen key using the supplied plastic clamps and stainless steel screws.

Make sure that all feet of the stand are resting on the floor once BOLDscreen 32 is attached. You may find it easier to attach BOLDscreen 32 to the stand in a lower field area then move the two items together to the final position.

If possible, locate BOLDscreen 32 in contact with the magnet to prevent further movement in the event of a magnet quench.

Voltage converter module

MRI Conditional; safe for use when installed in the magnet room of 1.5, 3T and 7T scanners, **but only when bolted into the penetration panel,** outside of the high magnetic field. Do not place the voltage converter module in high field gradient areas or the device may move (the device contains some ferromagnetic content within a heavy brass enclosure). We DO NOT recommend locating the voltage converter in the control room as interference will be conducted into the screened room via the DC cable.

Fibre optic and DC supply cables

The supplied BOLDscreen 32 fibre optic and DC supply cables are MR-safe under all foreseeable conditions in MRI magnet rooms.

Route all cables around the edge of the room and NOT across the doorway to prevent trip hazard and to avoid damage to them.

On no account must the DC supply cable route over the subject in the scanner as a serious RF burn hazard exists.

Disconnect mains power before attaching or removing the DC cable.

Cleaning

Clean external components of BOLDscreen 32 with a damp cloth only. Do NOT allow fluids to enter the monitor, voltage converter or PSU. Do not sterilise in an autoclave.

Mains PSU

The mains PSU contains SIGNIFICANT FERRO-MAGNETIC CONTENT. **DO NOT TAKE THE MAINS PSU INTO THE MAGNET ROOM.**

The power supply contains dangerous mains voltage and also has no user serviceable parts. Do not attempt to dismantle.

Optical hazard

The high powered LED backlight could present an eye hazard if viewed directly. Therefore do not attempt to operate BOLDscreen 32 if the LCD screen has been damaged or removed.

The infra-red laser diodes in the DVI video transmitter are class 1M. Do not view the output of the fibre transmitter, or end of the fibre cable, with optical instruments.

Contact

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