TeraCota Core Modules

User’s Guide

TeraView

TeraCota Core Modules
User's Guide

IMPORTANT: BEFORE YOU START

NOTE: The instrument should not be removed from its packaging by the customer. This is reserved for TeraView trained personnel. Your TeraCota will be removed from the shipping container and installed by a TeraView Service Engineer. The system should be left unopened in its transportation packaging until a TeraView Service engineer is on site to begin installation.

NOTE: Provision should be made by the customer to enable storage of the system in its transportation packaging, in an environment that protects all components from temperatures outside of 13 – 35 °C, and the storage humidity should be less than 70% (non-condensing).

NOTE: When the system is moved from storage to the installation environment it should be left, to acclimatise, for at least 24 hours prior to use.

NOTE: All packaging materials, including the wooden crate and pallet, should be retained by the customer or integrator at least for the duration of the warranty period or rental period.

Release History

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1. INTRODUCTION

1.1. About this User Guide

This manual describes the safe and effective use of the TeraCota Core Modules. These modules contain all of the core electronics and laser optics required to power, support and communicate with compatible TeraView sensor heads, for TeraCota 2000, TeraCota 3000, and TeraCota 3500 applications.

This manual contains information on unpacking and set up, the meanings of warning signs, an overview of the instrument functions, servicing and routine maintenance. TeraView recommends that all users read through the whole document thoroughly before commencing use of the instrument. The user guide is not a substitute for training, which will be provided by TeraView upon installation of the instrument.

1.2. Notes, cautions, and warnings

Three terms, in the following standard formats, are used in this user guide to highlight special circumstances and warnings.

NOTE: *A note indicates additional significant information that is provided with some procedures.*

CAUTION	*We use the term CAUTION to inform you about situations that could result in **serious damage to the instrument** or other equipment. Details about these circumstances are in a box like this one.*

WARNING	*We use the term WARNING to inform you about situations that could result in **personal injury** to yourself or other persons. Details about these circumstances are in a box like this one.*

2. WARNINGS AND SAFETY INFORMATION

2.1. Safety summary

The TeraCota family of modules and instruments has been designed to comply with a wide variety of international standards governing the safety of laboratory and industrial equipment. In routine use, the TeraCota instruments pose no risk to you. If you take some simple, common sense, precautions you can make sure that you maintain the continued safe operation of the instrument:

- DO make sure that the modules are properly connected to the electrical supply; in particular, make sure that the ground (earth) is securely connected.

- DO keep the TeraCota modules dry. Avoid spilling liquid into the instrument. Clean all external spills immediately. If anything is spilled that enters the main body of the TeraCota, switch off the power and contact a TeraView Service Engineer.

- DO NOT remove the instrument covers. The TeraCota instruments contains a high power, invisible (near-infrared) laser; momentary exposure to the direct or scattered beam could damage your eyes.

- DO NOT use a flammable gas with the TeraCota modules; a fire or explosion could result. Only use clean, dry, dust-free, and oil-free compressed air or nitrogen with the instrument.

- DO read the more detailed information on warnings and safety in the following pages to ensure the safe operation of the instrument.

2.2. General safety

The TeraCota Modules have been designed and tested in accordance with TeraView specifications and in accordance with the safety requirements of the International Electrotechnical Commission (IEC). The instrument conforms to IEC publication 61010-1 (‘Safety requirements for electrical equipment for measurement, control, and laboratory use’) as it applies to IEC Class 1 (earthed) appliances and therefore meets the requirements of EC low voltage Directive 2014/35/EU.

If any adjustment, maintenance, and repair of the opened, operating instrument is necessary, this must only be done by a TeraView Service Engineer. Whenever it is likely that the TeraCota module is unsafe, make it inoperative. The TeraCota may be unsafe if it shows visible damage; fails to perform the intended measurement; has been subjected to prolonged storage in unfavourable conditions; or has been subjected to severe transport stresses.

WARNING

Use of controls or performance of procedures other than those specified herein may result in hazardous radiation exposure.

If the equipment is used in a manner not specified herein the protection provided by the equipment may be impaired.

The TeraCota core modules have been designed to be safe under the following environmental conditions:

- Indoor use.
- Altitude up to 2000 m (9840′) above mean sea level.
- Ambient temperatures of 18 °C (64 °F) to 30 °C (86 °F) – for an air-conditioned cabinet, the ambient temperature specifies the controlled conditions inside the cabinet.
- Temperature changes should be less than 2 ^{0}C over an 8 hour period for best performance.
- Mains supply fluctuations not exceeding ±10% of the nominal voltage.

With open cabinets, to allow for adequate cooling, the TeraCota modules should not be sited near to room heating equipment, for example central heating radiators. During operation, there should be a minimum gap of:

- 15 cm (6 inches) between any surfaces and the instrument.
- 7 cm (3 inches) between the instrument and any adjacent equipment.

2.3. Electrical safety

Connect the TeraCota cabinet or Electronics Rack Assembly to a power supply line that includes a switch or other means of disconnection from the electricity supply. Only plug the TeraCota into an electricity-supply socket that is provided with a protective earth connection.

When fuses need replacing, use only those with the required current rating and of the specified type. Do not use makeshift fuses and do not short-circuit fuse holders.

When the TeraCota module is connected to its electricity supply, terminals may be live and the opening of covers or doors other than those that can be opened by hand is likely to expose live parts. Capacitors inside the TeraCota modules may still be charged even if the instrument has been disconnected from all voltage sources.

WARNING

Any interruption of the protective earth conductor inside or outside the TeraCota *or disconnection of the protective earth terminal can make the instrument dangerous.*

2.4. Laser safety

The TeraCota core instrument is a CDRH Class 1, BS EN 60825-1/IEC 60825-1 Class 1 laser product.

The enclosed optical system of the TeraCota Optics Rack Assembly contains a Class 3b ultrashort pulsed laser. Class 3b lasers can cause severe eye injuries. CDRH regulations state that Class 3b lasers are those for which intrabeam viewing and the viewing of specular reflections is hazardous, but the viewing of diffuse reflections is normally considered safe. A Class 3b laser is not normally a fire hazard.

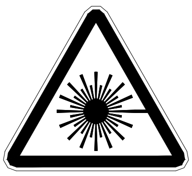
WARNING

Do not attempt to remove the covers from the enclosed optical system of the TeraCota*. The* TeraCota Optics Rack Assembly *contains a high power, invisible (near-infrared) laser; momentary exposure to the direct or scattered beam could damage your eyes.*

2.5. Warning signs on the instrument

At the appropriate locations on the instrument, there are warning signs to remind users of the various hazards. They have their standard meanings as follows:

Danger, risk of electric shock.



Danger, laser radiation hazard.

	*Caution (refer to accompanying documents).*

	When these labels are attached to an instrument, they mean *"Refer to the manual for a description of the possible hazard and how to avoid it".*

2.5.1. Locations of TeraCota module safety labels

Electrical safety labels are fixed to the rear of the TeraCota Electronics Rack Assembly, adjacent to the electrical inlet, as shown in Figure 1.

Figure 1: Electrical safety labels on the rear of the TeraCota core instrument

Laser safety labels are fixed to the rear of the TeraCota Optics Rack Assembly, as shown in Figure 2.

Figure 2: Laser safety labels on the rear of the TeraCota core instrument

Laser safety labels are fixed to access panels behind the front cover of the TeraCota core instrument (Figure 3).

Figure 3: Laser safety label behind the front cover

A product identification is attached to the TeraCota, with information about: the specific model and serial number; power requirements; and date of manufacture: an example is shown in Figure 4.

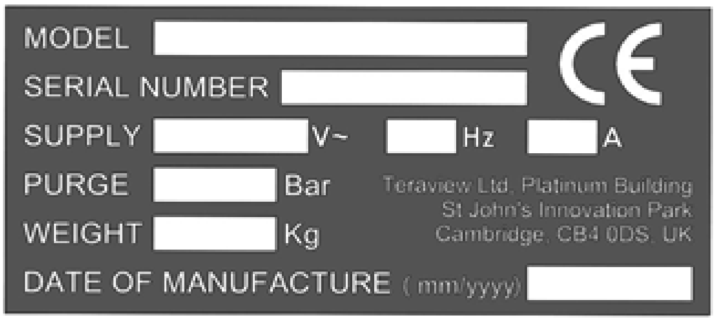


Figure 4: Example serial number plate

2.6. EMC compliance

The TeraCota Modules have been designed to meet the requirements of the EC Directive 2014/30/EU. The TeraCota complies with the EMC standard EN 61326-1 (EMC standard for electrical equipment for measurement, control, and laboratory use).

3. OVERVIEW OF THE TERACOTA FAMILY OF MODULES

A commissioned and complete TeraCota instrument consists of three principal components: the core instrument, an umbilical assembly, and a sensor head. The head is connected to the core by an umbilical containing electrical and fibre optic (laser) connections. The sensor head takes its low voltage power from the core instrument, and hence needs no independent power supply. There are a variety of sensor heads available with various optical designs and form factors. The sensor heads are detailed in a separate manual. The umbilical assembly consists of cables that are usually bespoke to the application, and may be made in a single section, or several, disconnectable, sections.

3.1. The TeraCota core instrument sub-modules

The TeraCota core instrument (Figure 5) is a terahertz spectrometer that always contains at least the following three core sub-modules:

- An integral PC, running Windows OS, for system control and monitoring.
- An enclosed optical system: the Optics Rack Assembly
- An enclosed electronics system based on a 16-bit digital signal processor and integrated processor: the Electronics Rack Assembly.

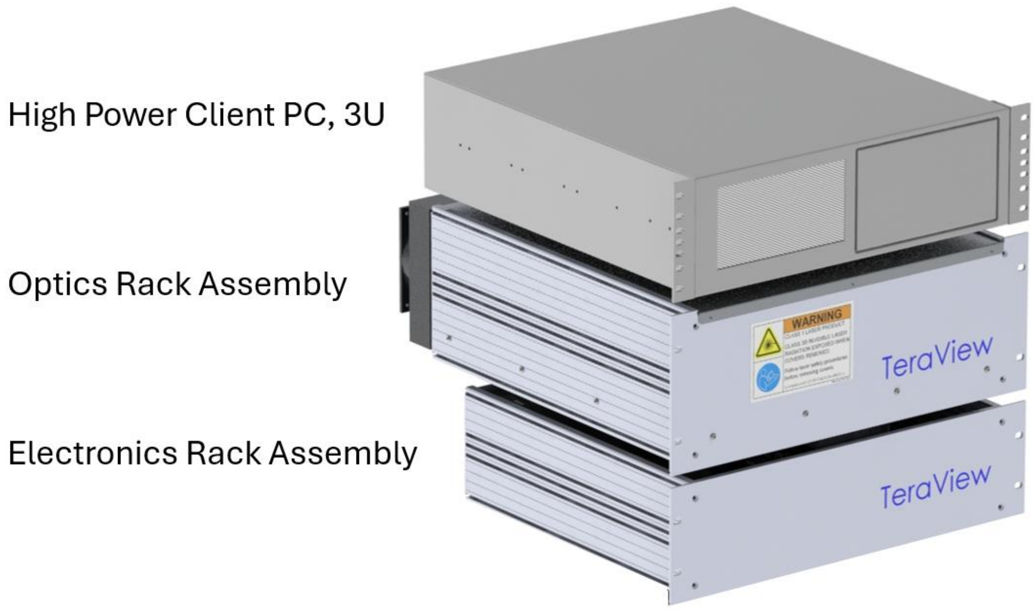


Figure 5: Overview of the three modules which comprise the TeraCota core system

3.2. The Optics Rack Assembly

The optical system of the TeraCota is associated with the bespoke chassis module into which the laser is mounted. All optical components are on kinematic mounts for alignment stability, ensuring the reliable operation of the instrument without any adjustment by the user. This is enclosed within the Optics Rack Assembly, which also contains the closed-loop water cooling system (underneath the laser) and radiator and cooling fan (on the rear panel).

Covers prevent access to the optical system and ensure safe and reliable operation of the TeraCota. The covers are screwed in place and can only be removed using tooled-release by a TeraView Service Engineer. Access to the system internals is gained by removing the covers. This should only be performed by trained Service Engineers.

WARNING	*Do not attempt to remove the covers from the Optics Rack Assembly of the* TeraCota*. The* TeraCota *contains a high power, invisible (near-infrared) laser; momentary exposure to the direct or scattered beam could damage your eyes.*

3.3. The Electronics Rack Assembly

The Electronics Rack Assembly contains the main power supply units for the modules, as well as a Data Acquisition Module (DAM) and embedded PC, which contains all software and firmware required for controlling and monitoring the hardware subsystems.

The AC power cable connector, and on/off switch is on the lower rear panel of the TeraCota Electronics Rack Assembly. The PC (server) and monitor may use their own separate line power supplies, and hence may be used even when the main core system is shut down.

The Electronics Rack Assembly contains components which operate at single phase mains (line) voltages (usually 110 V or 230 V). There are no user-serviceable components inside.

WARNING	*Do not attempt to remove the covers from the Electronics Rack Assembly of the* TeraCota*. The* TeraCota *contains mains voltages, which could cause electrocution injuries, if the user accidentally makes contact with live terminals.*

While the design of the core modules remains defined, the instrument can be assembled into a variety of configurations according to the scope of supply and the application type. These options are described below:

3.4. TeraCota 2000, 3000 and 3500

The TeraCota 2000 instrument is a configuration of TeraCota that is intended for applications measuring multiple coating layers, usually (but not necessarily) paint film builds, of up to six layers. The substrates can be plastic, metallic or carbon fibre. The TeraCota 2000 head is optimised for a large working distance (88 mm) to allow robotic positioning without risk of colliding with the measured surface. The TeraCota 2000 configuration is also compatible with the Head Alignment System (H.A.S.), which allows automated fine alignment of the sensor head to the measured surface, even on narrow (down to 1 inch or 2.5 cm) or curved surfaces.

The TeraCota 3000 instrument is a configuration of TeraCota that is intended for applications measuring single or multiple coatings (usually up to three, depending upon material and thickness) on free-standing films (e.g. on a roller). The PolyScan Self-Referencing (S.R.) head has 18 mm and 35 mm working distance options, and is compatible with a linear or 2D scanning gantry.

The TeraCota 3500 instrument is a configuration of TeraCota that is intended for applications measuring anode and cathode materials for battery manufacture. The PolyScan Self-Referencing (S.R.) head has 18 mm and 35 mm working distance options, and is compatible with a linear gantry. It is used to measure thickness of the active layer on a foil, as well as other metadata such as layer density, conductivity, or loading.

3.5. Single or Dual channel instrument

The default arrangement is a single module set, as shown in Figure 5, but it is also possible to pair up two sets of modules to a single control PC for a dual channel instrument with two sensor heads, synchronised to measure simultaneously and independently. Each sensor head requires its own dedicated Optics Rack Assembly, Electronics Rack Assembly and Umbilical Assembly, but these may be housed within a single cabinet if desired, and if the umbilical length permits.

3.6. Cabinet Options

The TeraCota cores may be purchased as stand-alone items, for a customer or integration partner to incorporate into a pre-existing or bespoke cabinet. In this case, TeraView can advise on design constraints, but there are some additional environmental requirements in terms of service access, vibration suppression and temperature control.

Alternatively, TeraView can provide the instruments pre-installed into a suitable cabinet, to be agreed at the point of order. The cabinet design will depend upon whether the instrument is a single or dual channel configuration, and whether cabinet-mounted air-conditioning is required. A non-cooled, vented cabinet is suitable for ambient temperatures if up to 30 °C (e.g. lab or temperature environment), but if the ambient temperature is likely to rise above this, or if the air is particularly humid or dusty, then a sealed air-conditioned cabinet is required.

The cabinet size (both footprint and height) is available as various options, but 9U, 16U and 20U cabinets are available as standard.

3.7. PC Options

The TeraCota control system can be provided by various PC configurations, depending upon the processing power required for the application. In general, more layers of measurement require more processing power. All control PCs run the Windows 11 Operating System, and can be connected to the LAN at customer sites if desired, for integration with factory or laboratory processes.

3.8. Fieldbus Options

The HMI interface provided with each TeraCota system, and pre-installed on the Windows PC is sufficient to control the instrument, and for basic acquisition. It is also possible to control the TeraCota instrument from an external (factory, customer or integrator supplied) PLC via a Fieldbus Gateway. This can be configured to operate on a variety of factory protocols, including ModBus TCP, Ethernet/IP or ProfiNet.

3.9. Umbilical Options

The sensor head is connected to the core instrument modules using an umbilical consisting of at least two electrical cables (one for 24 V or 48 V DC power, one for communication) and two optical fibres (one for the terahertz emitter, one for the terahertz receiver). The exact requirement depends on the configuration and the type of sensor head. The umbilical may be contained within a split conduit, fixed site conduit (e.g. overhead or underfloor trunking) or an energy chain (cat track).

4. GETTING STARTED

4.1. Unpacking the TeraCota System

On receipt at site it may be conveyed to its intended operation area using a pallet truck, forklift or similar. The system should not be removed from its packaging. This is reserved for TeraView trained personnel. Your TeraCota will be removed from the shipping container and installed by a TeraView Service Engineer.

The wooden packing crate and pallet are specifically designed for the safe transportation of the TeraCota instrument. TeraView requests that all packaging should be retained by the customer or integrator at least for the duration of the warranty period or rental period.

4.2. Installation requirements

NOTE: *Read the warnings and safety information at the start of this manual before you install the* TeraCota*. They contain important information.*

4.2.1. Electrical requirements

The TeraCota instrument can operate on electricity supplies of 50 Hz or 60 Hz and on a voltage range of 220 V to 240 V (EU) or a voltage range of 110 V to 120 V (USA). The nominal power consumption of the TeraCota is 250 W. Electrical power is provided by one single-phase mains socket, at the lower rear of the instrument. The supply is protected by a Residual Current Breaker (RCB) rated at 16 A (110 V) or 10 A (220 V).

WARNING	*Make sure to use the correct voltage for the correct country (220V to 240V for EU and 110V to 120V for USA). Check with service engineer.*

The line supply must be within 10% of the nominal voltage.

If possible, do not connect the TeraCota to circuits that have heavy duty equipment, such as large motors or other potential sources of electromagnetic interference, connected.

If possible, do not use photocopiers, discharge lamps, radio transmitters, and other equipment with large or frequent transient loads on the same supply circuits.

Use an uninterruptible power supply and/or line conditioner to reduce the likelihood of electrical supply interruptions or power surges to the TeraCota.

The supply line into the system is protected by circuit breakers mounted on the rear of the instrument. Individual components, such as the laser and PC, have their own fuses fitted internally.

4.2.2. Environmental requirements

The TeraCota does not require a controlled environment; however to obtain the best performance and long-term reliability of your TeraCota:

- Locate the TeraCota in an environment that is relatively dust free.
- Locate the TeraCota on a flat floor capable of supporting the instrument weight. If there is a risk of flooding, it may be advisable to raise the instrument onto a plinth.
- The floor should be rigid and free from the transmission of vibration. Elevated walkways are unlikely to be suitable.
- Make sure the area is free from mechanical shocks or extreme vibration.
- Do not position the TeraCota near to room heating equipment, for example central-heating radiators.
- Do not position the TeraCota in direct sunlight to avoid overheating.
- If the TeraCota is not contained within an air-conditioned cabinet, then leave at least 15 cm (6 inches) from any vertical obstacle to the rear of the TeraCota, to permit an adequate flow of cooling air.
- Make sure that there are no overhanging shelves, and no water pipes or faucets that could leak onto the TeraCota.

4.2.1. Temperature requirements

NOTE:

The TeraCota modules have been designed for indoor use and operate correctly under the following conditions:

Ambient temperature: 18 °C (64 °F) – 30 °C (86 °F)

To maintain system performance ambient temperature variations must not exceed 1 °C (0.8 °F) in a 1-hour period and 2 °C (1.5 °F) over an 8-hour period.

For core instruments mounted inside an air-conditioned cabinet, the ambient temperature specifies the controlled conditions inside the cabinet. For cabinets supplied by TeraView, the temperature control loop will usually be set to cycle the air-conditioner unit each time an internal temperature of 30 °C is reached.

If the air-conditioner and/or cabinet is supplied and integrated by the customer or site-integrator, then the specifications must be agreed with TeraView in advance, paying particular attention to the power loss metrics given below.

In each case, the laser set temperature will be tuned appropriately by the TeraView Service Engineer when the instrument is set up. This will ensure that the heat transfer requirements are within the capability of the cooling system, even at the highest projected ambient temperatures.

4.2.1. Vibration requirements

The Optics Rack Assembly in particular may be sensitive to vibration. Specifically, the optical components that align the laser beam inside the system may become misaligned if exposed to excessive vibration. Internal components within the system provide protection from external vibration, and as such, the system should be able to work satisfactorily within most environments, however some care should be taken to ensure that the TeraCota is not exposed to extreme levels of vibration during operation, transportation or storage.

Sources of vibration may be:

- The air-conditioning unit itself.
- Momentary shock due to passing personnel, vehicles or conveyor-mounted items.
- Other equipment operating in the installation vicinity.

The TeraCota should be sited on a stable/solid/rigid floor. Elevated walkways are rarely suitable. TeraView recommend vibration amplitude levels of no more than 100 µm per second RMS in the frequency range of 8 – 100 Hz.

4.3. Installation of the TeraCota modules

If the modules are not supplied pre-installed into a cabinet, then the installation may take place at a customer or integrator site. The above environmental requirements – particularly with respect to vibration and temperature - still apply.

For the purposes of service access, the Optics Rack assembly is usually mounted such that it can be slid out of the cabinet on telescopic rails, for laser alignment access, and to service the water-cooling components from underneath.

To allow easy access to the underside of the Optics Rack Assembly, **TeraView advises that the module is mounted above the Electronics Rack Assembly in the cabinet**.

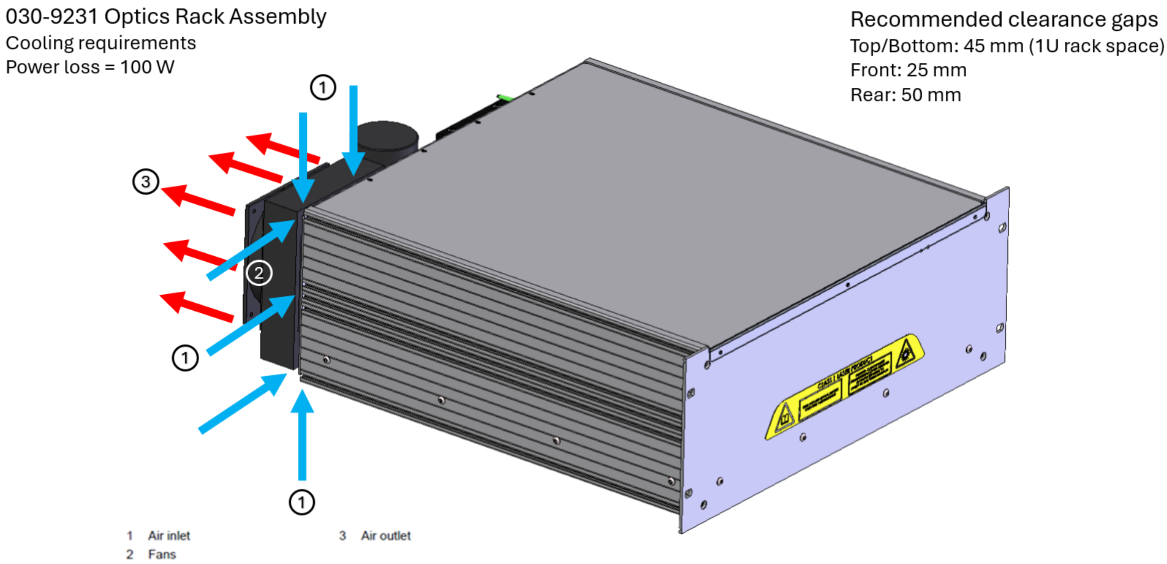


Figure 6: Clearance and cooling requirements for the Optics Rack Assembly

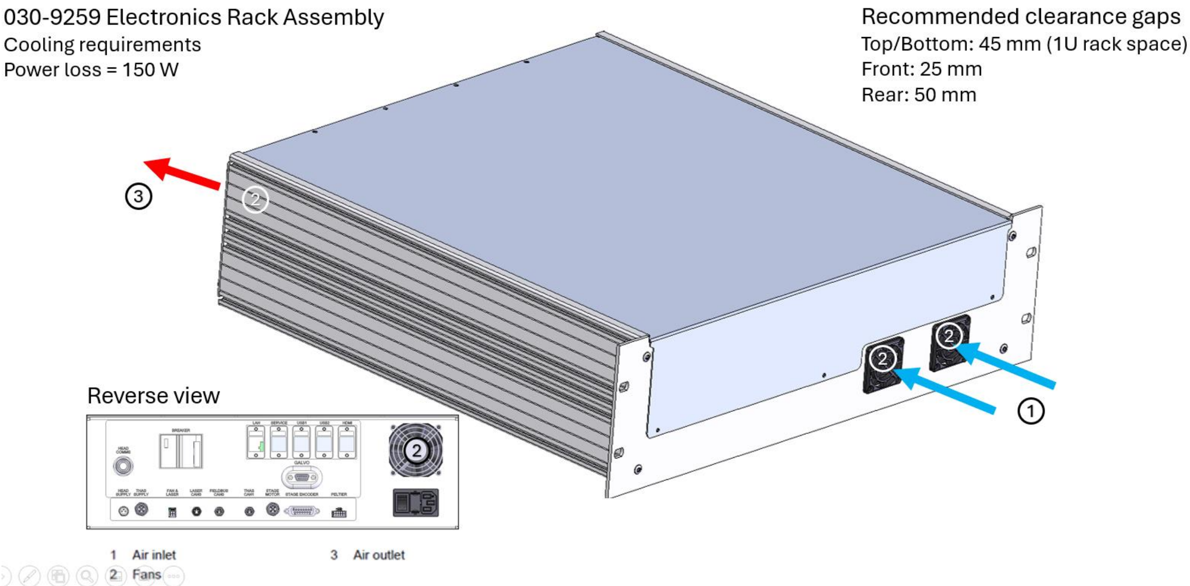


Figure 7: Clearance and cooling requirements for the Electronics Rack Assembly

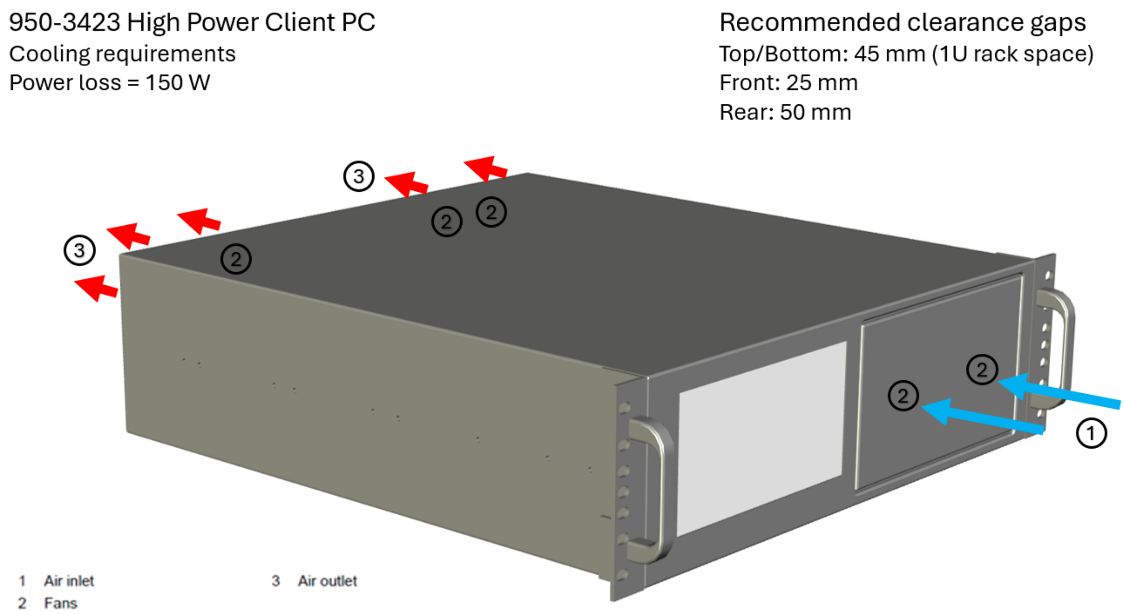


Figure 8: Clearance and cooling requirements for the Windows PC

4.4. Connecting up the TeraCota modules

4.4.1. Connecting the TeraCota to the electrical supply

The electrical power cable for the TeraCota plugs into the electrical supply C13/C14 inlet on the back or side of the unit. Do not switch on power until all other electrical connections have been made, see below.

WARNING

Do not connect the TeraCota *to an electrical supply voltage outside the 220-240 V (or 110-120 V for US) range without first consulting your local TeraView Service Engineer.*

The Electronics Rack Assembly contains an embedded PC running a Linux Operating environment, and it is factory configured to monitor and control all of the TeraCota core subsystem functions in real time. There is rarely any reason for the user to connect to, or interact directly with, this unit.

4.4.2. Other connectors

USB ports are located on the front of the PC, and network communication ports are located on the rear of the PC. Connection of the PC to an external network, for example for data transfer, is provided by inserting a suitable cable into the network port and configuring the PC.

Typically, the connection between the Windows PC, and the embedded controller within the Electronics Rack Assembly will be via a dedicated port on a fixed IP address. Changing this address may cause the instrument to cease to function.

No changes must be made to the USB and ethernet connections to the rear of the THz modules. They are pre-configured at the factory.

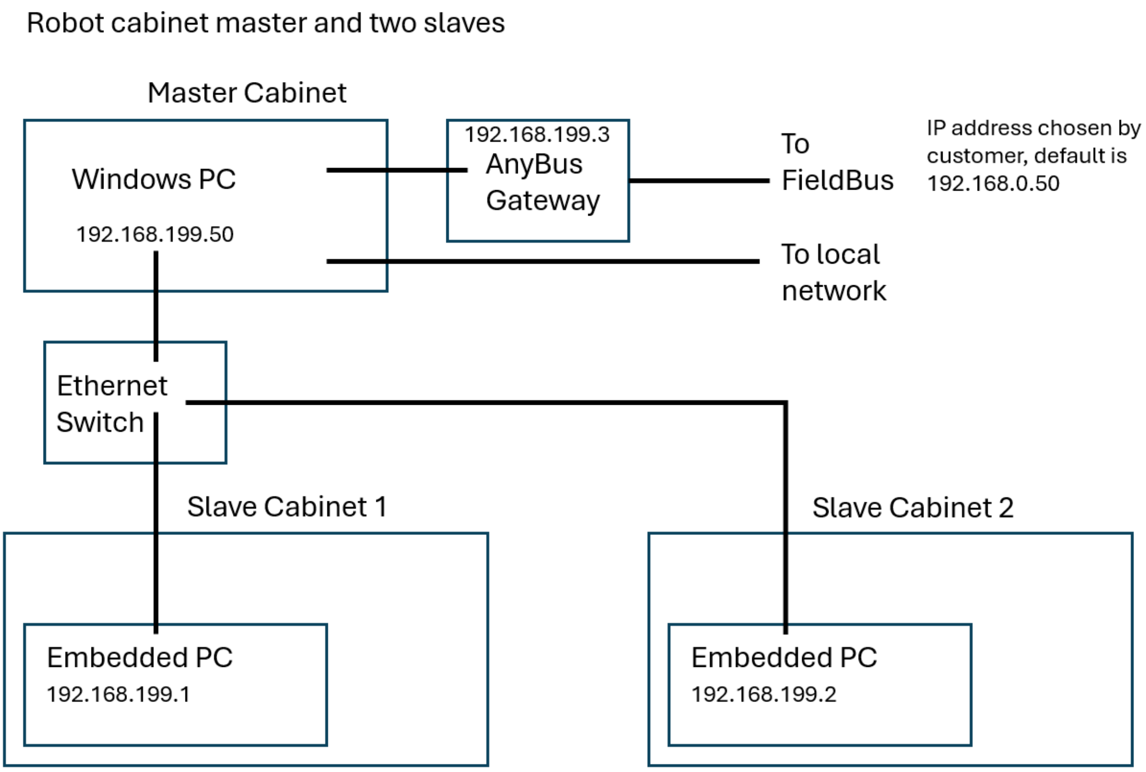


Figure 9: Example network diagram for a dual channel system housed in a master and two slave cabinets

CAUTION	*Do not unplug or swap cables for USB or Ethernet connections at the rear of the core instrument. To do so may result in the instrument not functioning, or in extreme cases, permanent damage may result.*

Figure 10: Front view of the Electronics Rack Assembly

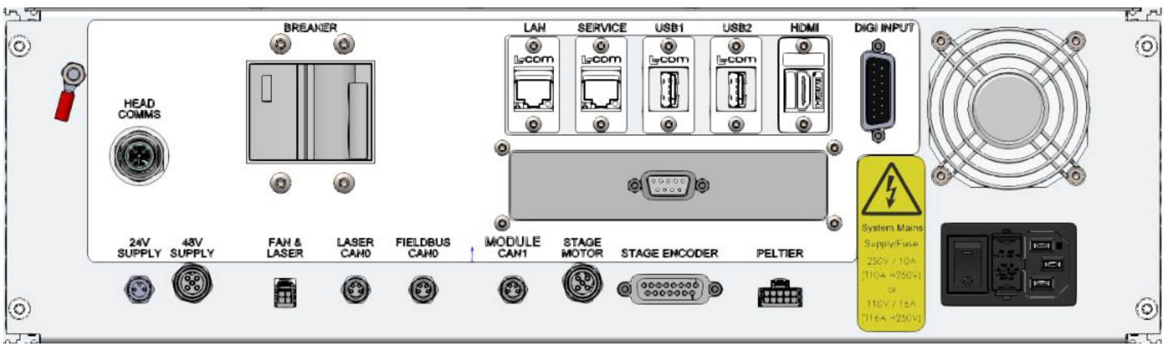


Figure 11: Rear view of the Electronics Rack Assembly, showing electrical connections

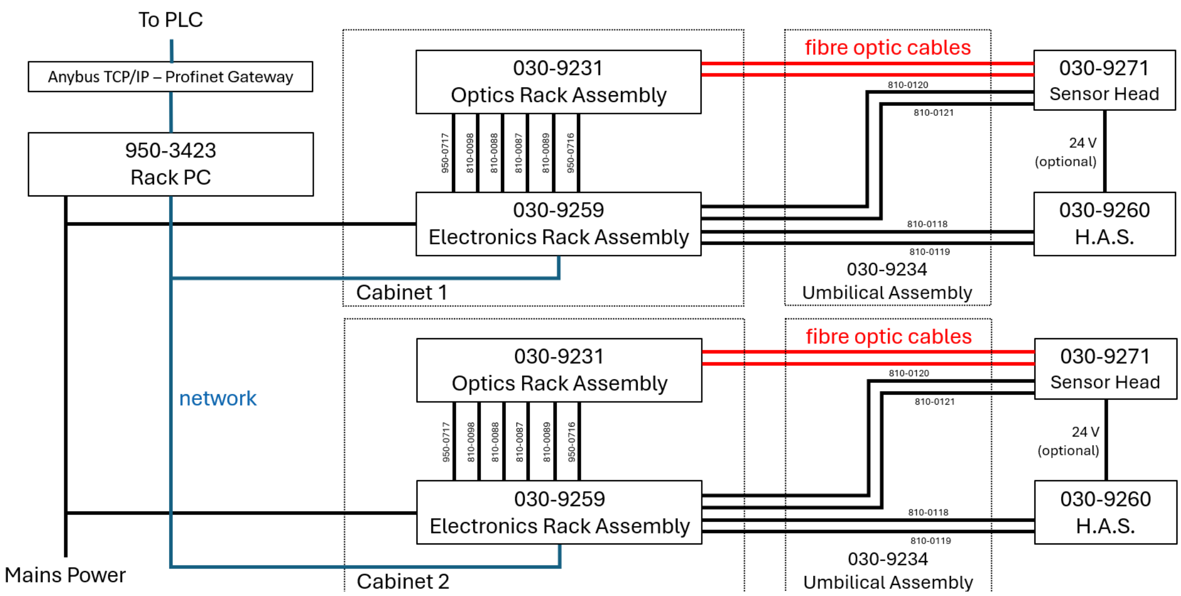


Figure 12: Example inter-module electrical schematic for a dual channel system with TeraCota 2000 sensor heads and H.A.S. units

4.5. Connecting cables into the Electronics Rack Assembly:

The electrical connections to the rear of the Electronics Rack Assembly are shown in Figure 11, and their function is as follows:

Fan and Laser: 24 V power supply to the cooling fan and laser modules. Power supply and control for the Peltier temperature control function. Always ensure that this cable is fully pushed in until it latches, and cannot easily become disconnected without depressing the release lock.

Laser CAN0: Communication with laser (Menlo Laser Types ONLY). Ensure the circular connector is correctly inserted in terms of rotational alignment, that the bezel turns freely, and is tightened to be finger-tight. Do NOT use a wrench.

USB 1: Communication with laser (Calmar Laser Types ONLY). Ensure the USB plug is firmly inserted, adding some form of strain relief if required.

FieldBus CAN0: Communication with external CANBus devices. Ensure the circular connector is correctly inserted in terms of rotational alignment, that the bezel turns freely, and is tightened to be finger-tight. Do NOT use a wrench.

Stage Motor: Power supply for the internal optical delay stage. Ensure the circular connector is correctly inserted in terms of rotational alignment, that the bezel turns freely, and is tightened to be finger-tight. Do NOT use a wrench.

Stage Encoder: Encoder communications from the internal optical delay stage. Push plug firmly into position and then ensure that both retaining screws are firmly tightened using a small flat blade screwdriver. Do not overtighten or damage the screw head.

Peltier: Power supply and control for the Peltier temperature control function. Always ensure that this cable is fully pushed in until it latches, and cannot easily become disconnected without depressing the release lock.

Galvo: Motor supply and control loop for the galvanometer (galvo) that operates the Rapid Scan Delay Line (RSDL). 9-way 'D' type socket. Push plug firmly into position and then ensure that both retaining screws are firmly tightened using a small flat blade screwdriver. Do not overtighten or damage the screw head.

4.6. Connections to the cables from the Sensor Head / Module:

Head Comms: M12 connection (cat 6a or cat 7 industrial ethernet cable preferred). Serial Link for sensor heads or terahertz modules. This connection is NOT an ethernet protocol and MUST NOT be connected to an ethernet network. Ensure the circular connector is correctly inserted in terms of rotational alignment, that the bezel turns freely, and is tightened to be finger-tight. Do NOT use a wrench.

24 V Supply: 24 V supply for modules (e.g. TeraCota 2000 sensor head, or FieldBus power supply). Ensure the circular connector is correctly inserted in terms of rotational alignment, that the bezel turns freely, and is tightened to be finger-tight. Do NOT use a wrench.

48 V Supply: 48 V supply for modules (e.g. Head Alignment System – H.A.S.). Ensure the circular connector is correctly inserted in terms of rotational alignment, that the bezel turns freely, and is tightened to be finger-tight. Do NOT use a wrench.

Module CAN 1: Communication with TeraView CANBus devices (e.g. Linear Stage controller or H.A.S.). Ensure the circular connector is correctly inserted in terms of rotational alignment, that the bezel turns freely, and is tightened to be finger-tight. Do NOT use a wrench.

4.7. Other Connections:

LAN (RJ45): This connection may be used to connect the embedded PC to a local network. Usually only for Service or diagnostic use. Insert RJ45 plug until it latches.

Service (RJ45): This connection is used to communicate with the Windows PC, via a dedicated internal I.P. address, which runs the internal TeraView services. Insert RJ45 plug until it latches.

USB 2: This connection may be used to connect the embedded PC to a keyboard, monitor or other USB device. Usually only for Service or diagnostic use. Ensure the USB plug is firmly inserted, adding some form of strain relief if required.

HDMI: This connection may be used to connect the embedded PC to a HDMI supported monitor. Usually only for Service or diagnostic use. Ensure the USB plug is firmly inserted, adding some form of strain relief if required.

Digi Input: This connection may be used to connect in a bespoke digital input signal, usually for synchronisation to an external stimulus. Push plug firmly into position and then ensure that both retaining screws are firmly tightened using a small flat blade screwdriver. Do not overtighten or damage the screw head.

4.8. Connections to the Optics Rack Assembly:

The electrical connections are hard-wired into the rear of the Optics Rack Assembly. The module takes all DC power from these connections: there is no mains power inlet.

The module connections into the rear of the Optics Rack Assembly are the fibre optic cables that connect laser power to the sensor head or module. These are not telecoms compatible fibre optics but specialised single-mode polarisation-maintaining (PM) fibres optimised for the laser light used in the TeraCota instrument. It is important to remember that the fibres function in an analogue manner, carrying relatively high-power pulses of laser light at a wavelength of approximately 780 nm (near infrared).

The composition of the optical fibres includes an optical core (which propagates the laser light) of only 5 μm in diameter. This is protected by a steel armour, overcoated with a PVC screen. When fibres cabled with armour cabling are coiled into small coils (less than about 30 cm or 12 inches in diameter), the fibre inside the armour cable gets compressed. This can damage the fibre inside, especially near either end of the fibre assembly.

CAUTION	To avoid compression damage, never coil armour cabled fibre assemblies to less than 30 cm (12 inches) diameter.

Coiling the armour cabled fibre assemblies to diameters equal to or larger than 30 cm (12 inches) will ensure that there is no excessive compression force on the fibre inside.

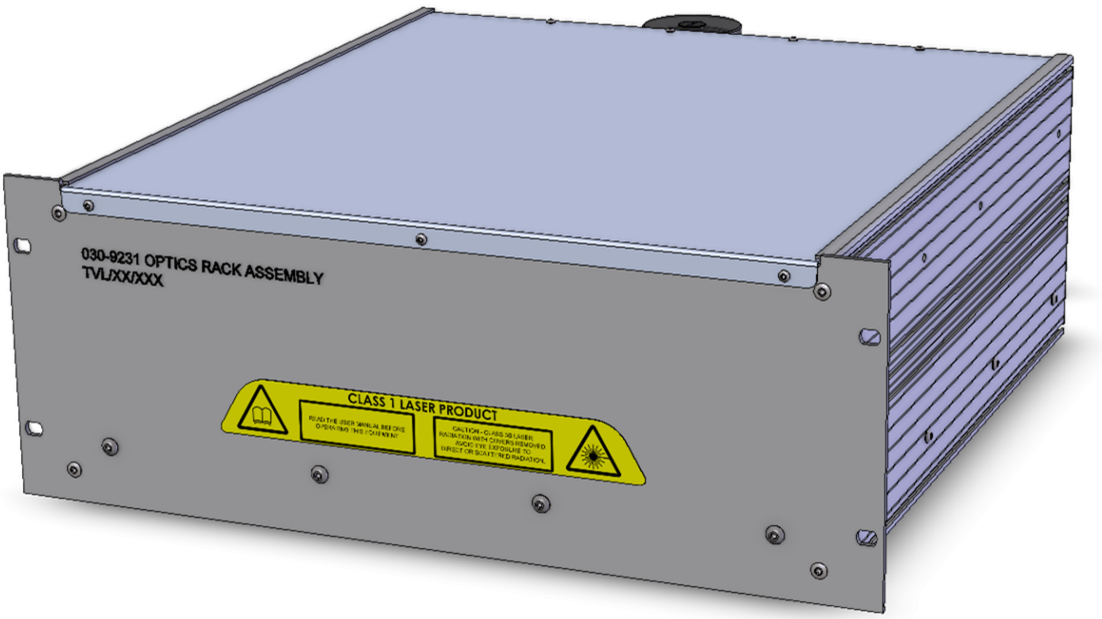


Figure 13: Front view of the Optics Rack Assembly

Figure 14: Rear view of the Optics Rack Assembly, showing cooling system reservoir and fan

There is one optical fibre to the terahertz emitter (source – usually coded red) and one optical fibre to the terahertz receiver (detector – usually coded blue). These are plugged into the laser connections for the Emitter (red) and Receiver (blue), respectively, as shown in Figure 14. These connections will be made by a qualified TeraView Service Engineer. Note that there are five different positions for the receiver fibre. This is module-dependent and will be supplied pre-configured.

4.9. Routing Optical Fibres

The fibre bundle will usually be provided with a black plastic 10 mm ID split conduit covering. The purpose of this is more than protection. The successful operation of the instrument depends critically upon measuring analogue metrics, such as the time-of-flight of the laser pulse from one end of the fibre to the other. Stress and strain on the fibre, caused by tensile, compressive or bending forces can affect the signals, interfering with the apparent stability and accuracy of the instrument.

Specifically, data can be adversely affected by differential strains on the two fibres, since the optical delay parameter is determined by the difference in the arrival time of two pulses travelling along the two fibres. If the fibres become separated (e.g. in an energy chain or robot dress pack) then bending motion can result in tensile forces on the outside of the bundle, with compressive forces on the inside. To minimise this and optimise the stability of the terahertz signal with respect to umbilical motion, TeraView recommends that the fibre conduit is retained.

Where fibres are routed through energy chains or cable management systems, care should be taken to avoid excessive torsional (twisting) forces or tensile strain. The cable should have some slack, preserved by appropriate strain relief. Sharp bends should be avoided, particularly where cable motion is expected. TeraView advise a maximum bend radius of 150 mm (6 inches) for armoured fibres, where possible.

4.10. Connecting Optical Fibres

The fibre optics supplied with the TeraCota instruments are all terminated with FC/PC connectors, using a 2.5 mm ceramic ferrule. When disconnected, always ensure that the dust cap is fitted, as shown in Figure 15. It is important to note that the polarisation is aligned using the key, which prevents incorrect rotational alignment. Always ensure that the keys are aligned with mating fibres, otherwise the ferrules will not be able to be inserted fully.

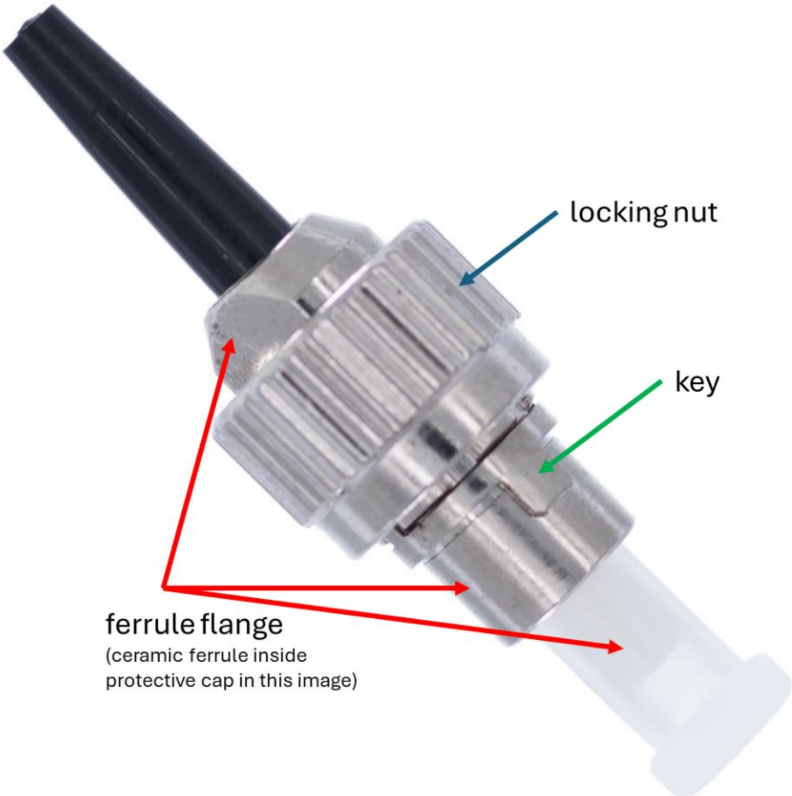


Figure 15: The FC/PC connector for polarisation-maintaining fibres

When coupling power from one fibre to another, it is important to remember that the two faces will be in physical contact with one another, and hence the cleanliness of the facets is absolutely vital. Since all FC/PC fibre terminations are ‘male’, it is necessary to use a ‘sleeve connector’ (a.k.a. mating sleeve, connector, joiner, uniter) to make the join, see Figure 16.

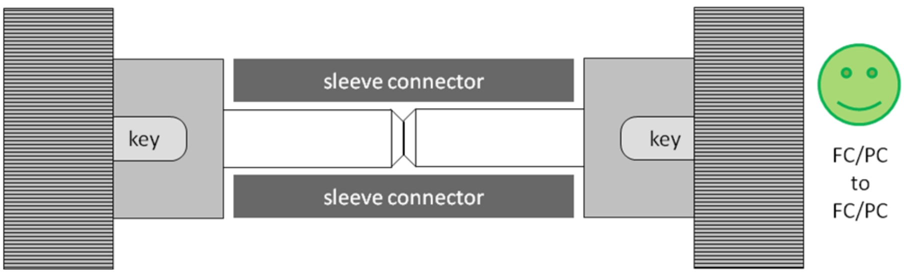


Figure 16: Cross section diagram of the fibre-fibre join using FC/PC connectors

- Examine both fibre tips to be connected, and clean ONLY if necessary.
- Ensure that the mating sleeve (connector, joiner, uniter) is clean by gently rubbing with a swab wet with a little propanol, then blow out any debris with the air duster.
- Insert the source fibre into the sleeve, being very very careful not to touch the metal face with the tip, and locate the alignment key into the notch on the sleeve. Tighten the housing thread finger tight.
- Insert the second fibre tip partially and rotate to align the key into the keyway on the mating sleeve. Then *gently but firmly* push the fibre fully into the sleeve: it will make contact and spring back a little. This is usually the state in which the best coupling is achieved.

It is important to inspect and clean the tip of the ferrules to ensure good coupling efficiency into the fibre. Use a handheld fibre microscope to view the fibre tip before using the fibre.

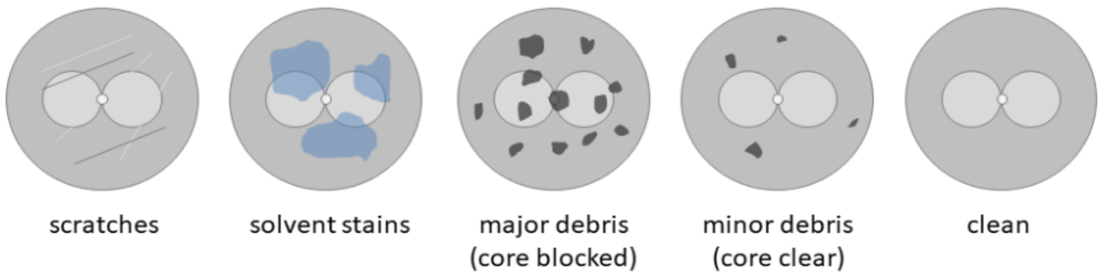


Figure 17: Examples of fibre tip cleanliness

If the Panda eyes are difficult to make out due to low contrast, then try rotating the ferrule back and forth as you observe – it is often easier to see a moving image than a static one.

With reference to Figure 17, the result could be:

Scratches: It is not possible to clean scratches from the tip without re-polishing the fibre (which cannot be done at site). Minor scratches outside of the core or panda eyes area will probably not do much harm. If the scratches are major, or cross the core, then consider rejecting the fibre. If in doubt, do NOT connect it face to face with another fibre, since the other face can be scratched by the first.

Solvent stains: These can be easily cleaned using the fibre cleaning cartridge, wetted with a little propanol, using very light pressure.

Major & minor debris: This can be either specks of dust / other debris on the surface, or pits and recesses in the tip. The former can be cleaned, the latter cannot. It is important to clean the tips for three reasons. First, the debris can block laser light, reducing the efficiency of coupling into the fibre. Second, it can absorb laser light and heat up, causing burnt-on damage that cannot subsequently be cleaned off. Thirdly, the damaged fibre may cause scratching or deposit debris onto any other fibre tip that it is brought into contact with. Cleaning should take place in the following order:

- A blast of air from the air duster.
- Dry wipe of fibre cleaning cartridge using light pressure.
- Wipe of fibre cleaning cartridge wetted with propanol using light pressure.
- Wipe of fibre cleaning cartridge wetted with propanol using heavier pressure.

Be aware that over-cleaning (or cleaning when not necessary) can often actually make the situation worse. Over time, lots of cleaning will tend to erode the tip of the fibre into a concave shape, leading to a significant loss of coupling efficiency. **Clean only when necessary, and as little as necessary**.

The best route to optimising fibre cleanliness is to plan work to make and break the fibre-fibre connections as few times as possible. Performance frequently begins to degrade after 3 or 4 mating cycles.

4.11. The water-cooling system

The TeraCota instrument is supplied with an integrated water-cooling system, to ensure stable operation even in fluctuating ambient temperatures. The system comprises of a Peltier heat transfer unit, managed by a temperature controller. Heat is removed using a closed cycle water cooling loop, via a radiator and reservoir. The radiator is air cooled using a fan.

The water reservoir will be pre-filled by TeraView. It contains distilled water, plus a very small quantity of approved corrosion inhibitor/antifungal additive (1% Accepta).

Before first switching the instrument on, and at monthly intervals thereafter, we recommended visually checking the water level in the reservoir at the rear of the instrument. The fill level is indicated on the reservoir body. Do not overfill the reservoir – there must be a visible air space at the top to allow for thermal expansion.

CAUTION	*Do not power up the core instrument if the reservoir is empty. Damage to the water-cooling equipment could result.* *ONLY use **distilled** water, to avoid risk of scaling.*

In the event of low water levels, first establish that there is no leak. Check the floor at the rear of the instrument for leaking water and visually inspect the drain tube for condensation. If a leak is suspected, report to a member of TeraView's Service team immediately.

For routine water top-up, use distilled water ONLY. Remove the top filler cap using a screwdriver. Add water slowly until the fill level is achieved, using either a wash bottle spout, or a small funnel. Finally, replace the filler cap and tighten gently. Clean up any spills immediately.

4.12. Switching on the TeraCota

The TeraCota should normally be powered up but with the laser system in standby mode when not in use. To power up the instrument from a cold start:

- Ensure all cables are connected to line power.

- Switch on the Windows PC by pressing the button on the front panel.
- Switch on the inlet switch at the bottom rear. This causes the internal computer to power on, and places all components in standby mode.

NOTE: *It can take the TeraCota up to 2 hours to stabilise after it has been switched on, depending upon the ambient temperature. The software will not allow the laser to switch on until the temperature is stable.*

4.13. Switching off TeraCota

TeraCota should normally be left powered up, but with the laser system in standby mode when not in use. If the instrument is not to be used for several days, then it can be powered down.

To power the system down:

- Using the "Instrument" pull-down menu at the top of the TeraCota application, select ***Instrument -> Shut Down Core System***.

- Close the TeraCota application window, and wait until the application has successfully closed, and for all disk activity to cease.

- Power down the unit by the inlet switch at the bottom rear of the unit. Shutting down the system while the TeraCota application is open may corrupt configuration files.

CAUTION	*Do not power down the core instrument until the embedded instrument in the core has been correctly shut down. Do not power down the core instrument if the TeraCota application is running on the PC (server). Wait until all windows have closed. Powering down while disk activity is taking place risks damage to embedded files.*

4.14. Automatic sleep mode

After a (configurable, but usually between 2 and 6 hours) period of inactivity, the instrument will automatically enter Standby Mode. The purpose of this mode is to increase the lifetime of the components (e.g. laser) which will typically last for 20,000 operating hours. It is needless to leave it on when the system is not in use (e.g. at weekends, or factory shut down periods).

The instrument can be woken (reinitialised) either by a PLC-induced Fieldbus command, or via the User Interface.

4.15. Feed-throughs for Air-Conditioned cabinets

Cable routing should make use of the purpose designed bulkheads and grommets for cable exits from the cabinet. With the exception of short-term testing during initial set up, do not run the air-conditioning system with the cabinet doors open.

The externally-accessible panel contains the universal C14 socket, which accepts the C13 plug on a country-specific power lead, along with a master switch. The panel is shown in Figure 18.

Figure 18: Bulkhead panel on the cabinet side

The panel also contains connection points for Ethernet and USB connections.

The USB connections, unless labelled otherwise, are provided for connections to the Windows PC, and are all functionally equivalent. They may be used for the connection of a keyboard, mouse, dongle, USB memory stick, or other permitted hardware.

The RJ45 (Ethernet) connections are usually dedicated to specific functions, as required by the configuration of the instrument (e.g. master-slave, Profinet etc). Any specific function will be labelled and the IP address of the corresponding port will be fixed. An example is shown in Figure 19.

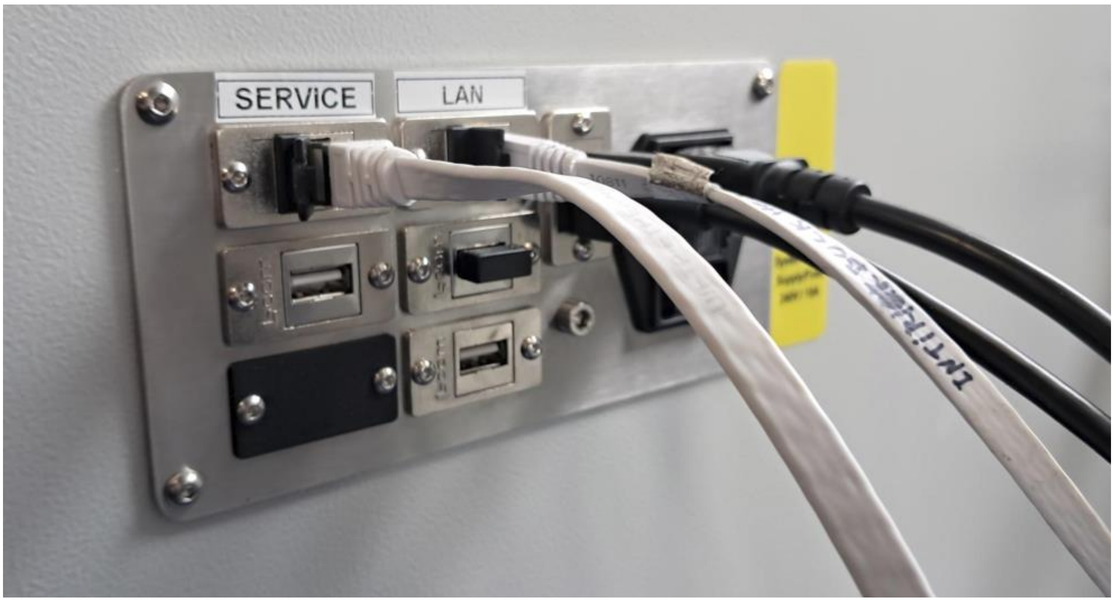


Figure 19: Bulkhead panel showing example RJ45 port labelling

Typical examples of connections with dedicated functions are:

LAN
Used for connection to a local area network hosted at the customer site. This may be used for data exchange (file transfer), internet access or a remote connection to the PC from outside of the organisation.

SERVICE
Usually, this indicates a connection to the embedded (Linux) PC, and should only be used by a TeraView Service Engineer for support, maintenance or diagnostic activities.

MASTER
For a two-cabinet dual-channel system, the cable connects to the Master cabinet.

SLAVE
For a two-cabinet dual-channel system, the cable connects to the Slave cabinet.

PROFINET
For connection to the factory PLC for Fieldbus control using a Profinet protocol.

ETHERNET/IP
For connection to the factory PLC for Fieldbus control using an Ethernet IP protocol.

5. SERVICING AND ROUTINE MAINTENANCE

TeraView recommends a 6-monthly or an annual service plan, which is offered when the instrument is purchased. An engineer will visit the site, and fine tune the instrument, as well as complete various service tasks.

There are no user-serviceable or configurable parts inside the instrument, hence there is very little regular maintenance for the user to complete. The few exceptions are detailed below.

WARNING	*There are no user serviceable parts inside the TeraCota. The user must not open the instrument as it risks exposure to the laser.*

WARNING	*Opening the TeraCota modules without authorisation by TeraView voids warranty.*

WARNING	*Do not use system if the covers are damaged. Switch-off system and contact TeraView for advice and repair.*

5.1. Water level in cooling system

TeraView recommends visually checking the water level in the reservoir at the rear of the instrument (Figure 20) at least monthly. The fill level is indicated on the reservoir body. Do not overfill the reservoir – there must be a visible air space at the top to allow for thermal expansion.

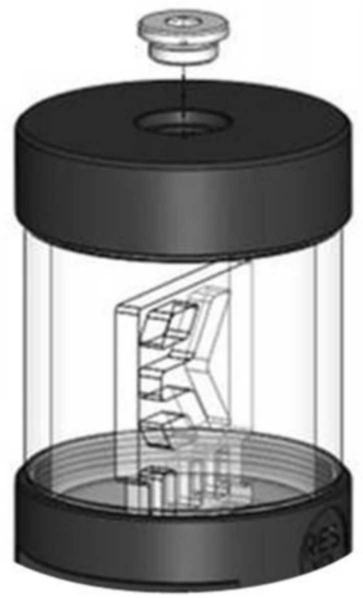


Figure 20: The water reservoir on the cooling system

For routine water top-up, use distilled water ONLY. Remove the top filler cap using a flat bladed screwdriver. Add water slowly until the fill level is achieved, using either a wash bottle spout, or a small funnel. Finally, replace the filler cap and tighten gently. Clean up any spills immediately.

5.2. Condensate Bottle

For the air-conditioned cabinets, during initial cooling, or in a high-humidity environment, the cooler unit mounted on top of the cabinet will produce condensation that must be removed. The cooler unit has condensate drain ports at the rear and side of the instrument. Usually one will be capped, and the other used for drainage. The active drain port can either be connected to a permanent drainpipe plumbed into a waste water drain system at the installation site, or connected to a collection bottle, as shown in Figure 21.

Periodically (TeraView suggests at least monthly) check the condensate bottle for accumulation of water. Empty if necessary, by removing the push-fit drainage pipe and removing the bottle from the friction clamp. Ensure that the drainage pipe is firmly pushed into the fitting when replacing the empty bottle (Figure 22).

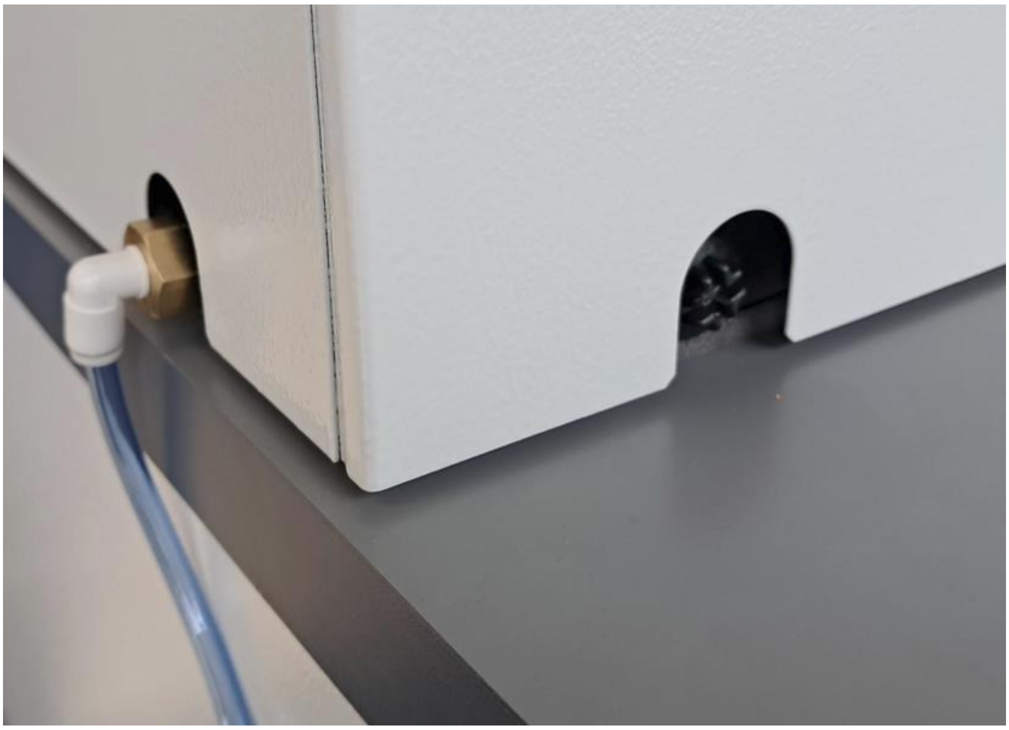


Figure 21: The condensate outlet ports on the air-conditioning unit

Figure 22: The condensate collection bottle for the air-conditioning unit