LASERMET LASER JAILER
ACTIVE LASER GUARDING SYSTEM

INSTRUCTION MANUAL

laser jailer
active laser guarding system

INSTALLATION, MAINTENANCE,
AND REPAIR MANUAL

Issue 2

LASERMET Laser Jailer
Instruction Manual

Contents

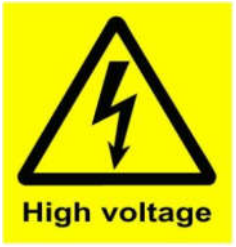
1 Safety Warnings

The technician attempting to repair a Laser Jailer system must familiarise himself with the following hazards.

The repair must not be attempted if the technician is unable to satisfy both himself and relevant site authorities that the work can be undertaken in a safe manner.

Site-specific safety instructions may cover some test and repair activities and must be observed as applicable.

The diagnosis and repair of the Laser Jailer system will very likely require access to the inside of the Interlock Controller in which the Monitor and Detection circuit board is fitted.



The Interlock Controller has mains voltages inside. Whilst these are generally touchproof to IP2X the technician must be aware that hazardous voltages are present and take appropriate precautions. This will include personal and site safety requirements. In some cases, this may require a cordon or other warning to others that exposed hazardous voltages may be present.

The Laser Jailer system operates on an earthed 24VDC supply produced by a power supply within the interlock controller. Technicians should be aware that the Monitor and Detection board generates up to 36V with respect to earth which may be felt on contact.

The technician must ensure that any laser that may be connected to the interlock system is disabled so that it cannot be operated despite the interlock controller being armed. Preferably this means isolating it from its power supply and ensuring that no one will reconnect it for the duration of work on the interlock controller. The work in this manual does not require the laser to be operated.

Approved means of access may be required for tiles that are out of reach from floor level. Site restrictions regarding working at height may be applicable. Personal protective equipment may be required for some activities.

This device is intended to be used as part of a safety system which may be used to protect personnel and equipment from possible injury, damage, or loss.

As such it must be installed and wired according to these instructions and tested by suitably qualified persons. No attempt may be made to tamper with the parts, open them, or use them outside of the parameters contained herein.

The units are only designed to be fixed to surfaces using their inbuilt fixing holes. They must not come into contact with each other or any other moving part when in use. The parts should never be subject to impact or mechanical strain.

Safety switches should never be defeated or bypassed. It is imperative that all steps are taken to ensure that any spare actuators are made unavailable, such that they cannot be used to defeat the switch or reduce the protection offered by the system in any way.

2 Concept

The Laser Jailer system uses laser detecting tiles which are available in a range of sizes and are fitted to the laser side of the enclosure. The tiles are electrically interconnected in series.

The tiles are wired to a monitoring and detection circuit board which is fitted inside a Interlock Control System (ICS).

The ICS forms the heart of a laser interlock and apart from monitoring the Laser Jailer tiles also monitors door contacts, emergency stop buttons etc. and provides control of illuminated signage, override facility, door locking and so on. The ICS is usually connected to the interlock connector on the laser, or to a beam shutter, so that the ICS can disable the laser beam if the enclosure is breached.

In the case of Laser Jailer, if a powerful laser beam misses its target and hits a detection tile on the enclosure wall, it is detected by the monitoring circuit, which in turn trips the ICS which disables the laser beam.

The monitoring and detection circuit memorises such an event and prevents the system from being re-armed, even if the power is cycled, until the damaged tile is replaced.

Lasermet provides a full range of laser interlock equipment including control systems, interlock switches, illuminated warning signs, laser shutters, door locks, external power supplies etc. which can be connected to provide a complete laser interlock system. Full support, design and installation is available from Lasermet, please contact us for any queries. Contact details are given at the end of this manual.

3 Installation

3.1 Laser Jailer Tile Description

The Laser Jailer tiles are made from a laminate material approximately 2mm thick.

Each tile has a two 300mm long interconnection leads attached. A rear view is shown below showing the interconnecting leads and mounting spacers.

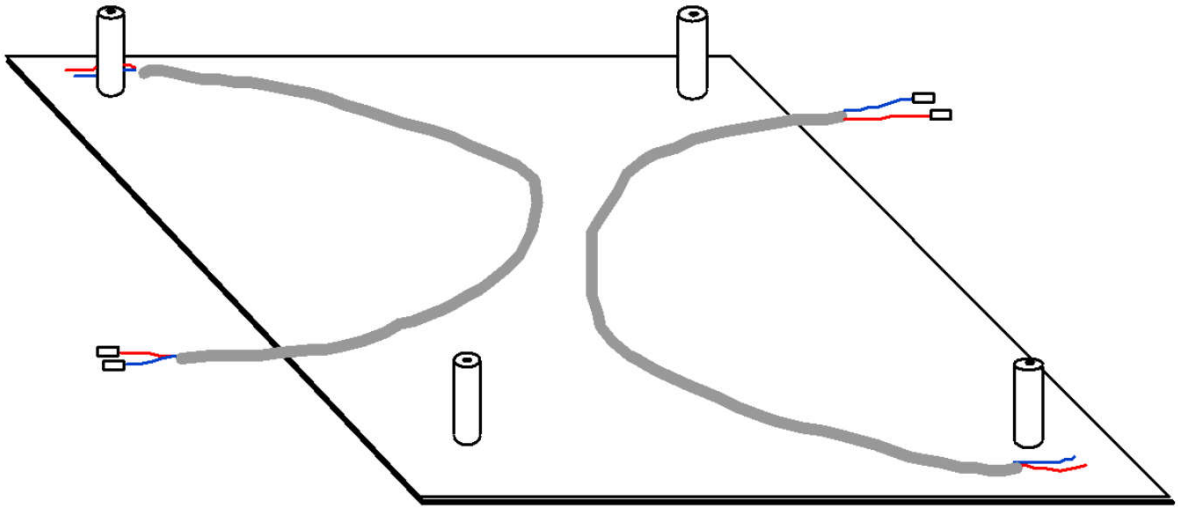


Figure 1. Tile showing Rear View

3.2 Laser Jailer Tile Fixing

The tiles are screwed to the mounting surface with M4 screws and 20mm tall spacers, the gap behind being used for the interconnection leads between the tiles.

The tiles should always be screwed into place. Adhesives and tapes should not be used as a tile which becomes detached may fall and cause injury. For small enclosures which may be made of sheet metal the spacers may be fitted directly into the enclosure wall. For larger enclosures where thicker wall material is used the tiles are often supplied in groups pre-assembled to larger panels which may be screwed to the wall.

When tiles are replaced it is usual to leave the spacers fitted to the structure.

4 Wiring

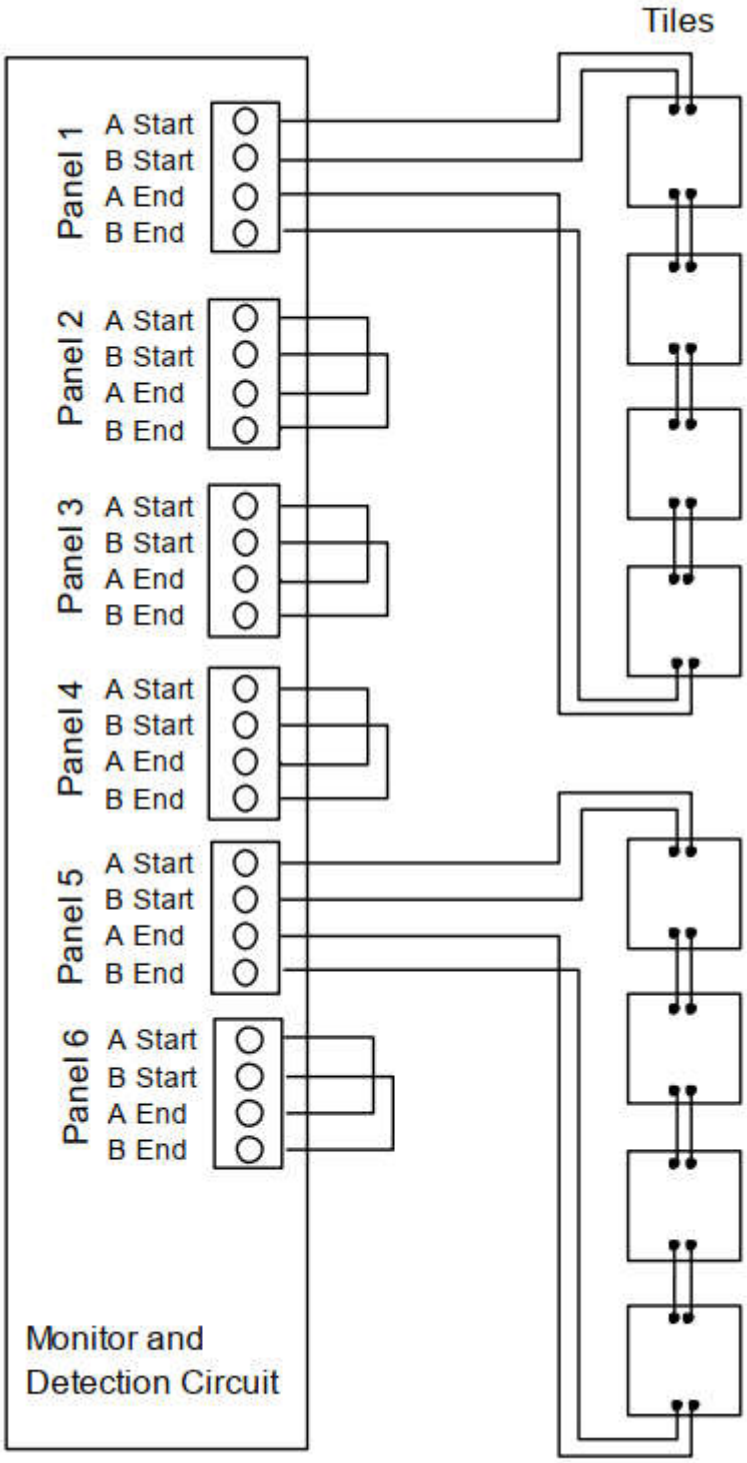


Figure 2.

Each tile has two 2-core flexible connecting leads. The tiles are connected in series so that the output of one tile is connected to the input of the next. The end leads of the group of tiles are extended to the monitoring and detection circuit inside the ICS.

The monitoring and detection circuit has sockets for up to six groups of tiles and it is usual to allocate one socket to each surface of the enclosure i.e. one socket for the roof, one for the floor, one for the left wall etc. Wire links are fitted across any unused connectors so that a complete circuit is formed.

The illustration on the left shows the wiring schematic for a simple installation with an enclosure which has two protected surfaces each having four tiles.

In practice it does not matter if the A and B channels are crossed over so long as A Start goes to either A or B End, and B Start goes to the other End.

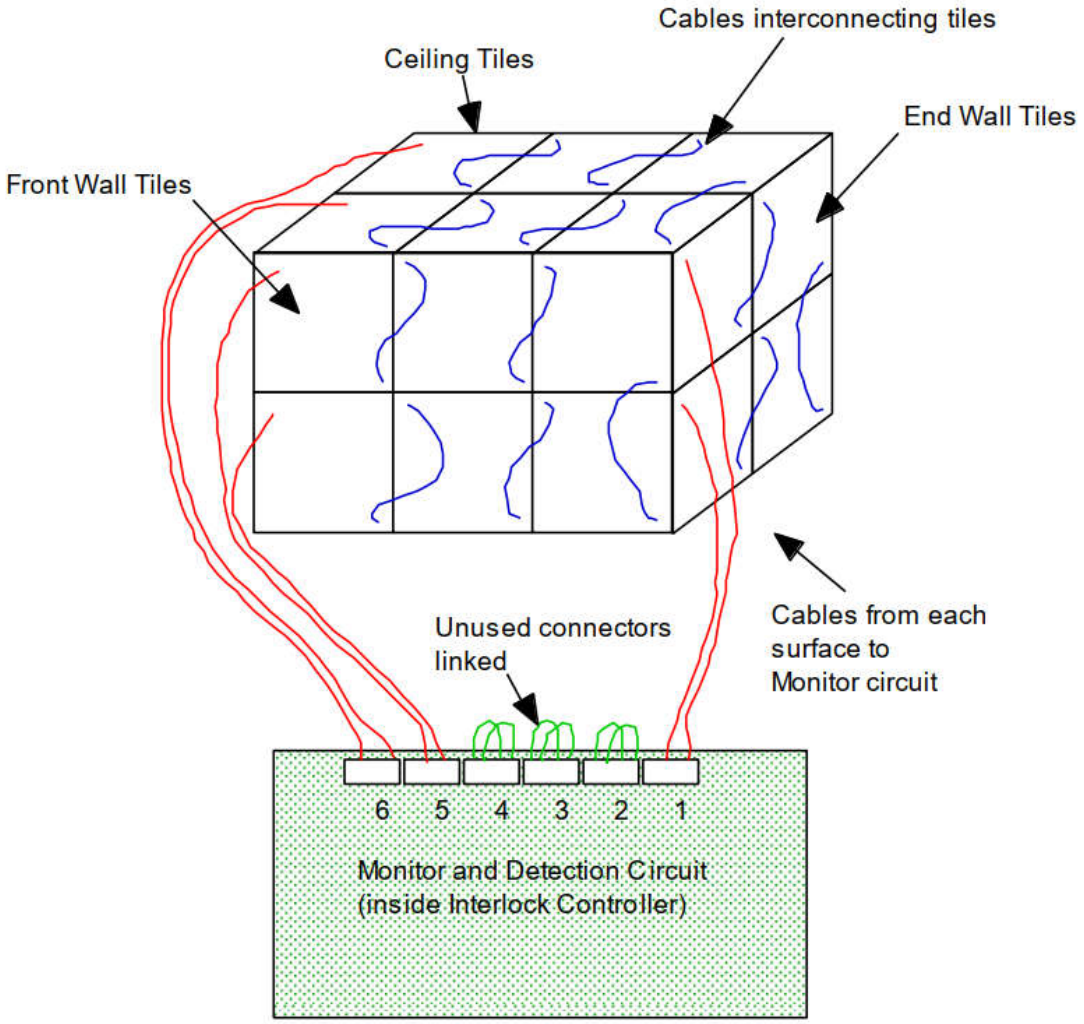


Figure 3. Example of Interconnecting Leads

Figure 3 shows one way that a three-sided enclosure may be physically wired. Each line in the diagram represents two cores. All the tiles on each surface are interconnected using two-core jumper cables (blue). The start and end points of each surface are fed to the Monitor and Detection circuit. In the above drawing a pair of 2-core cables are shown in red coming from each surface, but a single four-core cable may alternatively be used for convenience.

For very large enclosures patch panels are sometimes used which allow large surfaces to be sub-divided into smaller groups. Such enclosures may contain a thousand or more tiles. With so many tiles it may be hard to visually spot a damaged one, so by dividing the surfaces into smaller groups of tiles it is easier to locate a damaged tile electrically. Lasermet supply patch panels which enable multiple groups of tiles to be interconnected and fed back the Monitor and Detection circuit.

It is usual for a plan to be made when the system is installed showing the sequence in which the tiles are interconnected. This will be of great help in locating faults and will save having to remove tiles to work out the wiring.

5 Monitoring and Detection Circuit

5.1 General

Each tile contains two separate circuits. Once all the tiles have been connected and the cabling between them completed, two complete circuits are formed which pass through every tile. The Monitoring and Detection circuit passes a test current through the two circuits.

When the system is in order the two circuits are both complete and there is a very high electrical resistance between them.

If a laser damages a tile the resistance between the two circuits is reduced and this is detected and triggers a shutdown of the laser.

Sometimes one or both circuits may be broken due to laser damage and this is also detected. The same applies should a connection fail between tiles.

The circuit will also detect any electrical leakage to earth, which might be caused for example if the insulation on a cable becomes damaged or if water ingress occurs.

Prior to arming the interlock controller, the Monitor and Detection circuit is put into Test mode. In this mode a simulated leakage fault is applied which should be detected by the circuit. If the detector does not detect the simulated fault, the interlock controller will not arm. The picture below shows the normal indications on the Monitor and Detection board before the system is armed. The Leakage lights show that the simulated fault has been detected. This is not a genuine fault as the Fault Latched light is not lit.

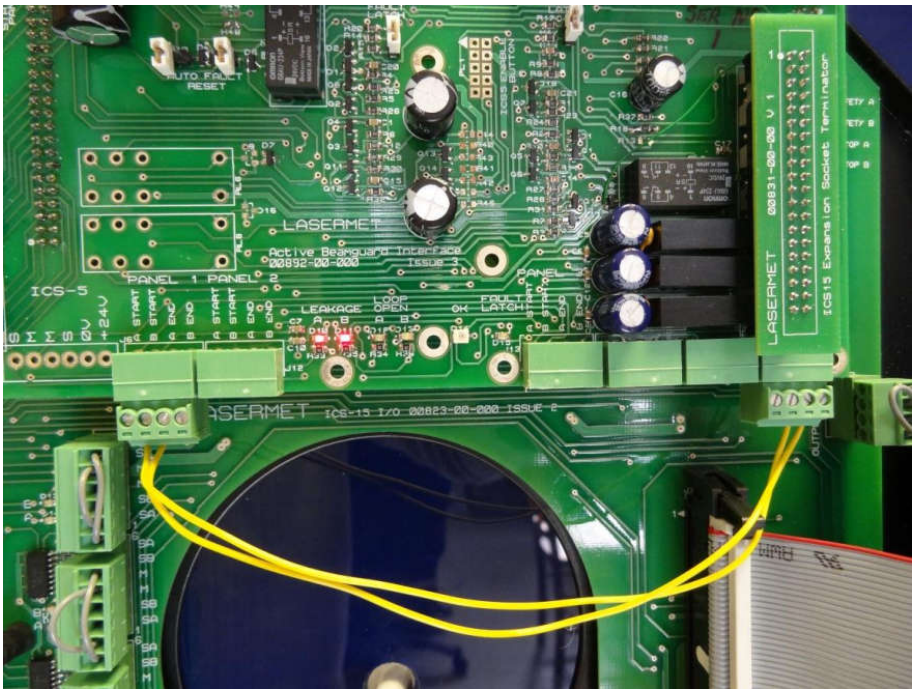


Figure 4. Normal Indications prior to arming Interlock Controller

When the system is armed the Leakage indications are extinguished and the ‘OK’ lamp lights as shown in Figure 5 below.

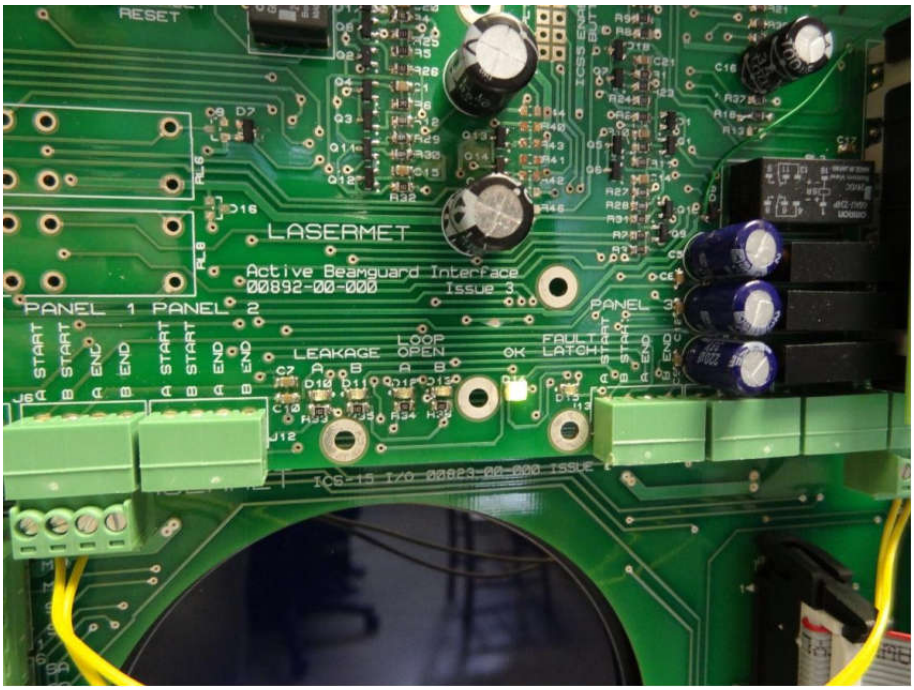


Figure 5. Normal Indications, system armed, ‘OK’ lit

5.2 Fault Latch

Should any fault occur a fault latch is set in the Monitoring and Detection circuit which keeps the laser interlock disabled. This is intended to encourage the system to be repaired before it can be re-used. For example, in some situations a user may attempt to electrically bypass a damaged tile in order to get the laser working again. However, this presents a hazard because a tile is now not monitored, so part of the enclosure is not protected. The fault latch keeps the interlock disabled if a tile is bypassed and (unless configured otherwise) even if the power to the system is cycled.

The activation of the Fault latch is indicated either by a red light on the Monitor and Detection circuit inside the interlock controller, or by a red ‘Fault’ light on the controller front panel.

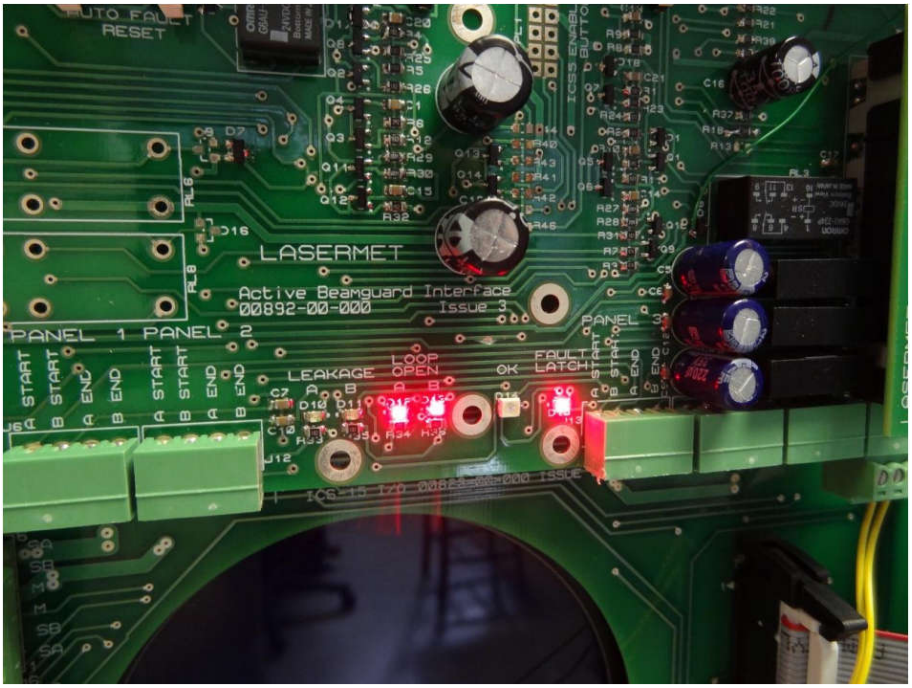


Figure 6. Loop Open and Fault Latched indications, ICS-5 and ICS-6

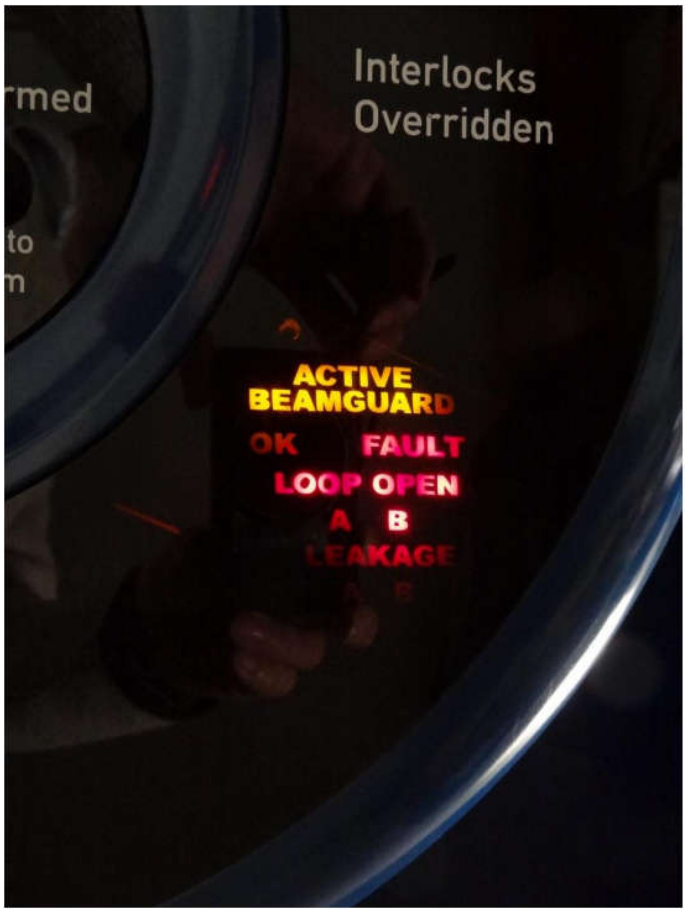


Figure 7. Loop Open Fault- ICS-15

Fault Latch Reset

In the event of a fault the system should be properly investigated and repaired (see 'Fault Location' below) before the fault latch is reset. Once the repair has been effected the fault latch may be reset by various means depending on system configuration. As this is a dual-channel system the fault latch controls are duplicated.

1. Turn the system power off for ten seconds, then back on again. This method offers the least resistance to abuse and is not generally recommended.

2. Internal reset. The ICS panel is opened and a pair of Fault Reset buttons on the Monitoring and Detection circuit are pressed.

3. Keyswitch reset. A key-operated switch may be provided to reset the fault latch.

Jumper links are provided on the Monitor and Detection board to configure the operation of the Fault latch as follows:

J8, J9 Enable Fault Latch. The latch is disabled if the links are removed.

J10, J11 Auto Fault Reset. If the links are fitted the latch can be reset by cycling the system power as described above.

If an external keyswitch or other control is provided to reset the latch it is connected in place of the jumpers on J10 and J11 and it should connect each pair of pins together momentarily to clear the latch.

5.3 Real Time Fault Indications

When a fault occurs and the Monitor and Detection board sets its Fault latch, the board is held in 'Run' mode and does not enter Test mode regardless of the state of the interlock controller. This is so that the indication lights on the board or on the front panel of the interlock controller may be used to show the status of the system in real time. When the Fault Latch is set, the interlock controller is disabled.

When both 'Leakage' and both 'Loop Open' lights are off the system should be OK. Any of these lights illuminated at the same time as the Laser Jailer Fault light shows that the fault is still present.

6 Fault Location

6.1 Self-Recovery

If the laser damage is insignificant the tile may recover allowing the fault latch to be reset and operation resumed. This is likely if the Fault light is on, but none of the four Leakage or Loop Open lights are lit. Try resetting the Fault Latch (see Fault Latch Reset above) to see if the system can then be armed.

If there are Leakage or Loop Open lights illuminated, or if the latch sets itself again, there is a non-recoverable fault which needs to be repaired.

6.2 Equipment

There are various methods that may be used to locate a fault in the tiles or interconnections. Sometimes the damaged tile will be obvious. Other times the damage might be difficult to see, or there may be some other fault which is stopping the system from working.

A multimeter will be very useful. Lasermet can also supply a handheld probe that can be used to locate faults.

A dummy tile can be made which is useful for substituting sections of tiles. This can be made as shown in Figure 8 from two four-way 3.5mm plug-in terminal blocks with two wire links fitted such that when one end is plugged in to the socket, 'Panel 1' on the Monitor and Detection board and the other end is plugged into 'Panel 6' it connects A START on Panel 1 to A END on Panel 6, and B START on 'Panel 1' to B END on 'Panel 6'.

A dummy tile can be seen in use in Figure 4 above.

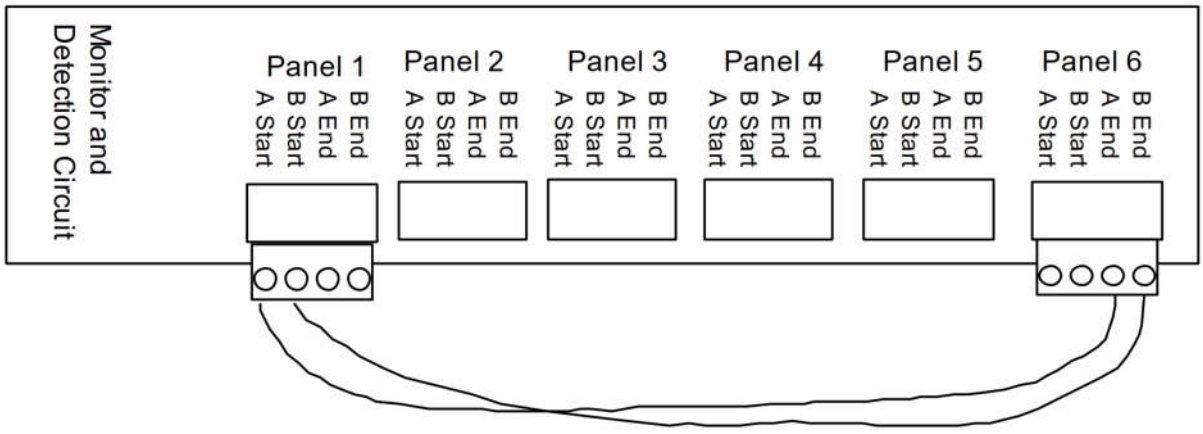


Figure 8. Dummy Tile

6.3 Narrowing Down the Faulty Section

The first step in fault location usually involves replacing sections of tiles with the dummy tile to see if the fault indications go out. For convenience this can be done with the power on, so that the monitor lights can be observed as different combinations are tried.

On the Monitor and Detection PCB there are six connectors for tiles. Remove all six cable plugs. Fit the dummy tile with the Start end to Panel 1 and the 'End' end to Panel 6 as shown in Figure 8.

If the board is working the 'Leakage' and 'Loop Open' lights should all be extinguished. It should then be possible to reset the Fault Latch as described in 'Fault Latch Reset' above and the green 'OK' light should come on, indicating that the board is working.

It is then possible to move the dummy lead from Panel 1 to Panel 2 and insert the original cable for Panel 1 and check the lights for Leakage or Loop Open. If one or more of these four lights is illuminated there is a fault in that section of tiles.

This can be repeated, progressively moving the test plug along one socket at a time and inserting the original cable socket by socket until the faulty section has been identified.

The plugs may be inserted in any order for test purposes. For example, the cables for panel 2 may be inserted into the panel 3 socket etc.

6.4 Identifying the Fault

Once the faulty cable has been located the actual faulty part needs to be found. Turn off the Interlock Controller. With the cable unplugged from the Monitor and Detection board set the multimeter to the resistance (Ω) setting and measure the resistance from A Start to A End. This should be about 33 ohms per tile, so if there are 16 tiles in the section there should be a reading of about 528 ohms. If the reading is much higher than this, or open circuit, refer to 'Open Circuit' below.

Repeat for the B circuit from B Start to B End.

If this seems OK measure the resistance between A Start and B Start. This should be at least 500kΩ and may be several MΩ or open circuit. If it is less than about 500kΩ there is a breakdown of insulation. Refer to 'Leakage' below.

If this also seems OK measure the resistance between A Start and earth. The ICS-6 and ICS-15 have an earth test point for this purpose. For ICS-5 the 0V terminal on the DC Power Out terminal block J10 is suitable. As before this should be at least 500kΩ and may be several MΩ or open circuit. If it is less than about 500kΩ there is a breakdown of insulation. Refer to 'Leakage' below.

Repeat for B start to earth.

Open Circuit

Lasermet supply a probe for locating open circuits. It comprises a signal source and a handheld 'wand'. The signal source is connected to the cable. The wand is offered close to each tile in turn following the order in which they are interconnected. A meter indicates whether or not the signal is present and in this way the point of open circuit can be located.

The wand can also be useful for confirming that none of the tiles have been bypassed or missed out.

The unit is supplied with operating instructions.

If the probe is not available, the circuit can be checked with the multimeter. One way is to remove a tile near the middle of the circuit and fit wires into the sockets of the remaining adjacent tiles such that the two pins are connected together. The meter, on resistance range, is then put across A Start and B Start. If the half circuit as far as the removed tile is OK a reading of less than 200kΩ should be seen. This is repeated for the other half circuit by measuring the resistance between A End and B End. Once the faulty half-circuit is found the tile is reconnected and replaced and a tile is removed near the middle of that half-circuit and the test repeated. In this way it is possible to progressively divide the circuit into smaller chunks until the fault is located.

Leakage

This technique can be used for faults between the two circuits, or between one circuit and earth.

If the failed resistance test indicates a low value (e.g. less than about 5kΩ) and the reading is steady there could be an actual short circuit and its position can be predicted based on the theory that each tile adds 66 ohms to the resistance. For example, if the reading was 594Ω from the start, one could predict that the fault is around the ninth tile from the start (594/66=9). As a check, the resistance at the end should be about 462Ω since the fault is 7 tiles from the end (462/66=7).

In other cases, it may be necessary to progressively remove tiles until the fault disappears. As in the open circuit testing above the easiest way may be to remove the middle tile and test each half circuit, then remove the middle tile of the affected half, and so on, repeatedly dividing the circuit in half until the fault has been located.

6.5 Repair and Test

Once the failure has been found it can be repaired. If the fault concerns wiring or connectors it can often be repaired in situ. If a tile has been damaged this may be visible in the form of burning. The tile should be replaced, and spares are available from Lasermet. You will need to advise the size of tile required when ordering.

Once the repair has been affected, the system should be restored to normal operation. With the power turned on, reset the fault latch as described in Fault Latch Reset above and confirm that the green Ready light is illuminated on the Monitor and Detection board or on the front panel of the interlock controller. Ensure any other interlocks (e.g. doors, covers etc.) are closed. Press the Arm Laser button and confirm that the interlock controller arms successfully.

7 Warranty

Lasermet provide a 12-month warranty for defects in materials and manufacture, from the date of installation or delivery. Installations completed by Lasermet are covered against defects in workmanship for 12 months.

Damage or defects caused by other factors are not covered. For example, industrial contamination, incorrect cleaning, storm damage. Consequential loss is not covered under warranty. Compensation for indirect or direct loss or damage is expressly excluded. Rectification of the defects or a replacement does not initiate a new warranty period.

For all deliveries, payments and other legal transactions, English law takes precedence for any litigation.

8 Contact Details

Lasermet provide a full range of laser interlock equipment including interlock switches, illuminated warning signs, laser shutters, entry keypads with built-in fail-safe override timer, door locks, external power supplies etc. which can be interconnected to provide a complete system. We also supply equipment and consultancy covering all aspects of laser safety. Full support, design, and installation is available from Lasermet, please contact us for any queries.

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