OPERATING & MAINTENANCE MANUAL MTT SLM125

PD-7900-1251-01

MTT SLM 125 - Laser Melting Machine

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PUBLICATION INFORMATION

MTT Technologies Limited.

This Operating Manual covers the SLM125

SUMMARY

The SLM-125 operates using the Selective Laser Melting (SLM) process to create homogeneous solid metal components from metal powder, using high powered laser energy to manufacture parts directly from 3D CAD data.

This manual covers basic machine operation and the relevant safety procedures for many commercially available materials. Users should be aware that certain materials require tightly controlled safety protocols to be adhered to. If in doubt about the particular requirements of the MTT SLM system for a specific material, please contact us for advice and guidance.

CONTENTS

SCOPE OF SUPPLY

The following section gives details of the equipment supplied with the machine, available as options, the warranty and spare parts available with the equipment

STANDARD EQUIPMENT

1. 1off MTT SLM-125 Selective Laser Melting Machine
2. 1 off chiller
3. Substrate plates (1 set)
4. Installation & Commissioning documentation
5. Operation & Maintenance Manual
6. Operator Training documentation
7. Starter kit
8. Control computer with installed software
9. File Preparation software MTT Autofab or Materialise Magics MTT Edition.

ACCESSORIES AND OPTIONS

1. Powder Handling System
2. Fire alarm and fire extinguishing system
3. Computer for offline file preparation
4. Metal powder

WARRANTY AND LIABILITY

Our equipment is sold subject to our "Standard Terms & Conditions" of sale. These are available at www.mtt-group.com

Warranty and maintenance claims will be void if they result from:

- improper use of the equipment or the system
- improper assembly, commissioning , operation of, or maintenance on the equipment or the system.
- operation of the equipment or the system with defective safety devices or improperly applied or non-functioning safety or protection equipment.
- failure to observe the instructions in the operating manual regarding transport, storage, assembly, commissioning, operation, maintenance and the use of unqualified operators or maintenance technicians.
- the use of metal powder not authorised by MTT Technologies Limited.
- any unauthorised structural modifications, in particular to the diameter of hoses, fittings, piping and tubing, connectors, choking coils and/or valves or factory settings for standard components as well as the installation of oversized valves and/or connectors.
- unauthorised modification to components, sub-assemblies or technical specifications (e.g. drive ratios, performance and motor speed as well as tools accessories, materials and consumables).
- improperly executed repairs.
- the specifications of the machine manufacturer MTT Technologies Limited must be adhered to at all times.

SPARE PARTS

All components and sub-assemblies are subject to rigorous quality control. Components purchased from sub suppliers, such as ball bearings, electric motors, hydraulic cylinders, are supplied in accordance with MTT Technologies Limited specifications. MTT will not honour any warranty claims where faults arise due to non-OEM replacement parts being fitted.

When ordering spare parts please quote the following

- Equipment Name and Model
- Serial number
- Year of manufacture
- Description of required spare part and part number if known

INTRODUCTION

The MTT SLM 125 is a complex piece of manufacturing equipment and must be used in the correct manner to ensure optimum performance. This manual has been written to allow the user to operate the machine in a controlled and efficient manner. The manual is straight forward, containing menus of work flow and many diagrammatic explanations. It should not be used by staff who have not been adequately trained either by MTT, our approved resellers or accredited instructors. All users should attend an MTT accredited training course before using the equipment.

STRUCTURE OF THE OPERATING INSTRUCTIONS

The MTT SLM 125 Operation & Maintenance Manual comprises this O & M Manual and the Operator Training Course Documentation.

DEFINITIONS

The following definitions are used throughout this manual

1. **The client or end user** is the company responsible for purchasing or using the equipment.
2. **The supervisor** is an individual or individuals who are ultimately responsible for ensuring the safe operation and maintenance of the equipment.
3. **The operator** is an individual or individuals working for the client or end user who is/are competent to operate, maintain and clean the equipment safely .This is because they have been formally trained and assessed in the individual tasks required.
4. **The technician** is an “operator” who is qualified to carry out a particular aspect of maintenance. This is because they have been formally trained and assessed in the individual tasks required.
5. **The equipment** is the scope of supply from MTT Technologies Limited that the client has purchased.
6. **Ancillary equipment** is any item which is required to complete the installation that is not included in the scope of supply .It also includes items which the operator requires to carry out tasks that are not included in scope of supply.
7. **Manufacture or manufacturing** is any process where the equipment is coHMIssioned, trialled, operated, maintained or cleaned.

TEXT STRUCTURE

The following structure has been used throughout this manual

1. The names of menus, buttons, options, icons, check boxes, functions, names of input fields and hot keys are written in bold.
2. Program windows, parameters, settings for controls, system messages, signals, paths, file names, software names, areas of the screen, and operating modes are written in italics.
3. Controls and function keys are written between <pointed brackets>
4. Wildcards for filenames are written in <*pointed brackets*> and in italics.

SAFETY WARNINGS IN THIS MANUAL

The following symbols are used within this manual to indicate locations where particular care in reading the manual must be taken

PROCEED WITH EXTREME CARE

Indicates possibility of serious and irreparable personal harm or death and possibility of substantial property damage.

CAUTION

Indicates possibility of minor personal harm, damage to the MTT SLM 125 SLM and problems related to component quality.

Warning - DANGER BY ELECTROCUTION

Warning – DANGER BY CRUSHING

INDICATION

Indicates important information that requires your attention

TRAINING

A minimum level of training required to operate the equipment safely is included in the scope of supply. Training is provided by MTT Technologies Limited. and persons authorised by MTT Technologies Limited. MTT Technologies Limited also offers extended training courses for operators. Please contact us for further details.

Topic	Key areas
INTRODUCTION TO THE MACHINE	• Commissioning/installation requirements • Starting and shutting down the machine • Understanding of machine mechanics
SAFETY	• Change of filters • Cleaning the machine • Safety equipment • Powder handling • Description of machine safety devices
ANCILLARIES	• Chiller maintenance operation & care • ATEX Vacuum cleaner operation & care • Sieving station • Safety equipment • Consumables & Spare parts
FILE PREPARATION	• Part Orientation • Hatching • Slicing • Support selection and positioning • Data transfer
PART MANUFACTURE	• Understanding the gas circuit • Setting wiper blade and substrate levels • Material preparation • Material processing • Part suppression • Support removal • Sieving the powder
BASIC MAINTENANCE	• Basic maintenance issues on a daily, weekly, monthly and annual basis.
FAULT DIAGNOSIS AND TROUBLE SHOOTING	• Common faults – what to look for and how to solve them

Operation of the MTT SLM 125 is only permitted by operators who have completed training from MTT Technologies Limited or persons authorised to carry out training by MTT Technologies Limited.

CONTACT NUMBERS

The following contact numbers should be used if any issue arises with the operation of this machine Please be prepared to provide the following information when calling the Hotline:

1. Machine type
2. Machine serial number
3. Software version number

Hotline	Hours of work: 0800 hrs – 1700 hrs GMT +44 (0)1785 815651
E-Mail	info@mtt-group.com
Service Address	**MTT Technologies Limited** **Whitebridge Park** **Stone** **Staffordshire** **England.** **ST15 8LQ**

MACHINE SAFETY

Relevant National legislation and internal company policies will dictate normal minimum requirements for health and safety. These legislations **must** be met. The system is provided with numerous safety interlocks and circuits. These must be kept in place at all times during the operation of the machines.

CLIENTS /END USER RESPONSIBILITIES

The client /end user must:

1. only allow persons to work on the MTT SLM 125 and the system who:
    a. are familiar with the basic requirements for work safety and accident prevention.
    b. are trained in the operation , maintenance and cleaning of the system.
    c. have read the safety chapter and the warning indications in this operating manual and who have signed a declaration stating that they have understood them.
    d. have been checked for safe working methodology at regular intervals, at least once a year or with change of the operator.
    e. are clearly competent with respect to assembly, start-up, operation, refitting, maintenance and cleaning.
2. ensure that personnel in training will operate the MTT SLM 125 with persons authorised to train by MTT Technologies present at all times

BASIC SAFETY MEASURES

Risk assessments for any foreseeable hazard must be carried out, prior to commencing manufacture. Proper risk assessment will reveal the requirement for COSHH assessment which will subsequently inform the provision of correct Personal Protective equipment.

Control of Substances Hazardous to Health (COSHH) data sheets for the metal powder and any other potentially hazardous materials must be available prior to commencing manufacture.

Where applicable ATEX Directives & DSEAR (Dangerous Substances & Explosive Atmospheres Regulations 2002) must be adhered to. They apply when either an explosive substance or atmosphere are present, either directly or indirectly, in the various stages of the handling, manufacturing, maintenance and cleaning processes.

A risk assessment of the level of Personnel Protection Equipment (PPE) required to limit exposure to hazards from dust, noise, vibration, heat or any other foreseeable hazard not specifically mentioned must have been carried out, prior to commencing manufacture. The PPE must be issued and any necessary training in its use carried out prior to commencing manufacture.

This operating manual contains the main requirements for safe operation of the equipment.

Most powder handling is executed under an inert atmosphere however there is a chance of exposure to small quantities of metal powders when cleaning the machine. Measures must be taken to minimise exposure to dust produced during the handling and processing of metal powder and any other potentially hazardous materials involved either directly or indirectly with the manufacturing operation by the use of the appropriate PPE as covered in the operator training programme.

Also any ancillary equipment must be designed and installed with due regard to minimising risk from dusty environments.

If ATEX & DSEAR is applicable to the processes involved .The end user must specify the correct type of ancillary equipment (i.e. used for operation, maintenance and/or cleaning) to be used in any hazardous areas. These types of equipment will be dictated by the area zone classifications determined by the end user. Only equipment which is stated to be suitable for the predetermined zone classification is to be used. For ancillary equipment the suppliers own O&M manual should be adhered to. Relevant training should be provided for operators using ancillary equipment.

SAFETY SIGNS

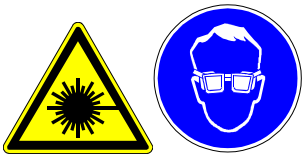
Various safety indicator signs are fixed to the equipment these are described in the table below.

Warning - DANGER BY ELECTROCUTION
Location - Sticker on inside of switch cabinet door

Warning - DANGER OF HOT SURFACES
Sticker on the process chamber
Sticker on cabinet door

Class 1 laser equipment (normal operation)
Sticker on process chamber

Classification
The MTT SLM 125 is classified according to the Standard "DIN EN 60825-1, edition:2001-11, Safety of Laser Equipment - Part 1: Equipment Classification, Requirements and User's Guide (IEC 60825-1:1993+A2: 2001); German Version EN 60825-1:1994 + A11: 1996 + A2: 2001"
Sticker on the process chamber



WARNING! IN NORMAL USE LASER OPERATION with process door open is strictly forbidden !
Class 4 laser equipment
During any adjustment or maintenance with the laser on and the chamber door open wear laser eyewear as specified in DIN EN 207 (DIN 58215) which provides protection against laser beams with wavelengths of 1000- 1100 nm. MUST BE WARN. Failure to do so may result in permanent irreparable eye damage.
Sticker on inside of cabinet door

BASIC SAFETY INSTRUCTIONS

Risk assessments have been carried out to ensure that the MTT SLM 125 operates in a safe manner under normal defined operating conditions.

The MTT SLM 125 is designed and constructed to comply with relevant European standards and legislation in force at the time that the equipment was produced with due regard to Health & Safety.

Although the equipment has been thoroughly developed to minimise the potential risk of hazards to personnel and property, it is the responsibility of the end user to ensure that it is operated and maintained in accordance with the manual.

WHAT TO DO IN AN EMERGENCY

In case of emergency, press the EMERGENCY-STOP button (arrowed) located on the front panel of the machine as shown in Figure 1 immediately

Figure 1 Emergency Stop Button Location on the front panel of the machine

OBSERVING THE OPERATING INSTRUCTIONS

This operating manual, and especially the safety requirements contained within, must be observed by all operators. The client/end user must make others who are not directly involved with the manufacturing processes of the equipment aware of any potential hazards within the vicinity of the equipment. This will be either by site induction, use of warning signs in the vicinity or restricting access to the equipment and/or the area of operation. PPE requirements must be displayed prior to entering an area of operation.

A copy of this operating manual must be kept with the equipment for reference. All operators must be aware of its location.

COSHH assessment for metal powder and any other hazardous substances used in the manufacturing process must be kept with the equipment for reference. All operators must be aware of their location.

All warning labels and operating signs on the equipment must be maintained in a legible condition. Damaged or illegible labels must be replaced immediately.

All warning labels and operating signs on any ancillary equipment must be maintained in a legible condition. Damaged or illegible labels must be replaced immediately.

Relevant National legislation and the end users internal company policies will dictate normal minimum requirements for health and safety.

REQUIREMENTS FOR OPERATORS - MTT RECOMMENDATIONS.

Before manufacturing, all operators of the equipment and any ancillary equipment must:-

1. be familiar with the basic requirements for work safety and accident prevention.
2. have had formal training in the operation, maintenance and cleaning of the equipment and ancillary equipment.
3. have read all of the safety chapter (Section 4) and the warning indications in this operating manual and signed a declaration stating that they have understood them.
4. have read the relevant risk assessments for the operation of the equipment ,metal powder and any other hazardous substances used in the manufacturing process and to have signed a declaration to the client stating that they have understood them.
5. be clearly competent with respect to assembly, start-up, operation, refitting, maintenance and cleaning.

For all assembly, maintenance and cleaning work, the equipment must be safely isolated before transporting or opening the machine. A safe isolation procedure must be in place and adhered to.

In addition the operator must comply with the following instructions:

1. The operator must be satisfied that no unauthorised persons have worked on the system.
2. The operator is required to carry out daily visual inspection of the equipment and ancillary equipment prior to use; any anomalies that may jeopardise the safe operation must be reported at once to the supervisor.
3. The operator is required to report any unauthorised modifications or “temporary repairs” which have been carried out on the equipment or ancillary equipment to his supervisor. MTT Technologies Limited will not be liable for any unauthorised modifications or temporary repairs which result in damage to persons or property.
4. After repairs or transport, the operator must be satisfied that all safety devices have been installed and that the system has been wired and secured in accordance with regulations prior to system start up, any anomalies should be reported to the supervisor.
5. It is imperative that no safety devices are removed or disabled during operation of the system.
6. System malfunctions must be handled carefully; in particular, vibrations and strain on components and items found in the system can result in unexpected damage to the machine and the equipment

NORMAL OPERATION

The MTT SLM 125 may only be started up from the area directly in front of the touch screen. Starting the machine from any other location is unsafe and is strictly forbidden..

During equipment and ancillary equipment operation, no safety devices may be removed or disabled.

The operating staff must ensure that no unauthorised persons enter the working area of the machine if it is unsafe to do so.

TRAINING

Training is included in the scope of supply of the MTT SLM 125 unless the user indicates that no training is required, for instance where a local MTT Technologies Group approved trainer already exists.

Operation of the MTT SLM 125 is only permitted by operators who have completed an MTT approved training programme

SAFE DISPOSAL OF WASTE PRODUCTS

All waste products must be disposed of in a safe and environmentally friendly manner.

The substances indicated below must be disposed of in a safe manner. They must not be allowed to contaminate the environment.

METAL POWDERS

Disposal of metal powder, whether new, used, or in the form of contaminated components and filters must be done in accordance with the relevant COSHH sheet and/or the local national requirements. Similarly metal powders should be handled with caution at all times and in some cases extreme caution due to their combustible nature in a normal atmosphere.

Wear protective eyewear, dust masks and protective clothing (protective suit and rubber/plastic gloves).

Do not allow the dust to form a cloud.

Do not eat, drink or smoke in the vicinity of the SLM system.

Wash hands thoroughly with water and soap after disposal.

Wash any contaminated clothing separately from other clothing.

GENERAL PRECAUTIONS FOR SAFE POWDER HANDLING PROCESS LIQUIDS

Lubricants must be disposed of in an area that has been designated for oil recycling and collection.

Refrigerants, coolants and coolant additives, chiller, and compressor oil are to be disposed of in accordance with the locally-applicable national requirements and the O&M manual for the chiller.

CORRECT USAGE

The MTT SLM 125 is solely intended for the construction of components from metal powder.

The maximum size of the components is limited by the size of the building envelope.

Acceptable metal powder is provided by MTT Technologies Limited or is approved for use with a particle size distribution of 15 – 60 µm. The use of other metal powders whilst not forbidden must be discussed in advance with MTT Technologies Limited to ensure safe processing and the appropriate processing parameters are used.

To ensure that the equipment is used correctly the following requirements must also be adhered to:

1. Operate the equipment in accordance with the operating manual
2. Carry out inspection and maintenance work in accordance with the operating manual
3. Refer to COSSH assessments for the metal powder in use and any other hazardous substances that are part of the manufacturing process
4. The equipment should be electrically installed in accordance with IEE standards by qualified electrical technicians as a minimum standard. Local requirements will take precedence.
5. The equipment is to be installed and coHMIssioned in by qualified technicians
6. There are no permissible modifications to the equipment.

IMPROPER USE

Anything that contravenes or is not specifically mentioned in this manual can be described as "Improper Use". In particular the following:

1. The use of non-permitted or toxic metal powders and other hazardous substances not approved by MTT.
2. The removal of machine components and/or the operation of machine components in a position other than the one prescribed for them.
3. Warning and safety instructions not properly maintained
4. Modifications to hardware components that have not been authorised by MTT Technologies Limited
5. Modifications to software elements that have not been authorised by MTT Technologies Limited
6. Operation without the Argon shielding blanket or with shielding gases that have not been authorised by MTT Technologies Limited
7. Disabling the safety devices

SAFE HANDLING OF METAL POWDERS

Some metal powders are reactive and spontaneously form a hard, protective oxide film on contact with oxygen. This oxygen may be in the form of a gas, air for instance, or in some other form, water for instance. This ability to rapidly oxidize imparts the need for careful handling as the potential for fire exists because the oxidation of the powders gives off heat and is therefore self sustaining. As a result, many metal powders, finely divided shavings (e.g., machining chips) and in certain situations, bulk structures, do have specific safety risks associated with them. Users of any metal powders need therefore to obtain, read and Risk Assess any powders by careful examination of the appropriate Material Safety Data Sheet (MSDS).

TOXICITY/PERSONNEL EXPOSURE

Metal Powders may be toxic this can only be ascertained by consulting the MSDS and once again going through the Risk Assessment procedure. In general metal powders create a family of hazards be they toxic or not, for example,

1. fine airborne solids can create a nuisance dust and prolonged exposure may cause lung irritation. Many powders have a maximum permissible exposure limit of #mg/m^3 this recommended exposure will be indicated on the MSDS for each respective powder.
2. Eye contact may cause irritation and burning; in the event of such exposure, the procedure indicated on the MSDS should be followed.
3. Similarly if skin is exposed the procedure indicated in the MSDS should be followed
4. Finally if large quantities of powder are inhaled then the procedure indicated in MSDS should be followed

REACTIVITY

Some metal powders may react violently with strong oxidizers, acids, or solvents in these reactions noxious or flammable gases may be given off. Some metals will only react if they are hot. Sometimes these reactions will take place with normally non reactive materials Titanium for instance will react with carbon dioxide, water, and nitrogen at elevated temperatures. Occasionally reactions will occur with other solid materials for example violent Thermite reactions can occur between Titanium and iron oxide (i.e., rust), as a result of heating, impact, or friction, are possible.

FLAMMABILITY

Metal powders burn rapidly and at elevated temperatures and can produce very noxious gasses. Metal powder in layers or in bulk may catch fire and burn if subject to a sufficiently energetic ignition source; airborne suspensions above limits indicated in MSDS pose a dust explosion hazard.

FIRE FIGHTING

In general, metal powder fires should be isolated and contained rather than extinguished. This can usually be accomplished by surrounding the fire with an inert material such as salt. After isolation, small fires can be put out by smothering them with free flowing salt, limestone, or a proprietary fire fighting powder such as MET-L-X®.

Moisture-sensitive fire-fighting powders such as salt should be kept dry to ensure that they will be usable in the event of a fire. While Type 'D' fire extinguishers can be used to extinguish some metal powder fires, care must be taken that the pressure from them does not disperse the powder into a dust cloud. If Type 'A', 'B', or 'C' fire extinguishers are required due to the presence of combustibles other than metal powder they should be clearly marked that they are not to be used on metal powder fires. Fires in airtight enclosures can be extinguished by flooding them with argon or helium. Use caution when cleaning up burned metal powder as re-ignition of unburned material is possible.

At all stages the fire fighting method must be appropriate for the material concerned and the MSDS should be consulted before assigning particular fire fighting measures to the material in question.

HANDLING AND PROCESSING

Contact of metal powders with potential ignition sources (e.g., flames, sparks, etc.) should be avoided. Spills of dry powder should be immediately cleaned up. Stagnation points should be minimised in equipment where powder is processed. Good housekeeping measures should be implemented to avoid build-up of powder layers in operating areas. For primary clean-up, gentle brushing with natural bristle brushes and non-sparking tools should be used. Residual material may

be removed with a properly grounded vacuum cleaner Ideally ATEX approved for use with combustible metal powders. Storage of combustible materials should be minimised or eliminated in locations where metal powder is handled and/or processed. Generating airborne dust clouds of metal powder should be avoided. This can be accomplished by minimising the height from which powder is poured and transferring powder at low flow rates. Under no circumstances should compressed air be used to remove deposits since this can result in formation of combustible dust clouds. Fugitive dust collection systems should be fabricated from non-combustible materials, be designed to minimise stagnation points, and be explosion-vented to a safe outside location. Where dust clouds are unavoidable potential dust explosions may be prevented by dilution of air with argon or helium or processing under vacuum. Static charging may result from flowing metal powder. It is therefore recommended that only grounded conductive equipment be used for handling and processing and that personnel handling metal powder be grounded.

The use of static dissipative footwear or inserts are recommended. Flame-resistant coveralls (e.g., Nomex®) without cuffs, pockets, laps, or pleats, which may accumulate powder, should be worn by personnel handling metal powder.

TRANSPORTATION

Methods of transport of metal powders is dependant on the type of material. Users should consult the MSDA or the powder manufacturer prior to shipping any powder material. Generally shipment is safe in the containers that the material was originally supplied however this should be checked with the manufacturer because the original containers may have been inert gas purged. All shipments need to quote a UN/US DOT classification and a proper shipping name.

STORAGE

Generally metal powder should be stored in a cool dry place in hermetically sealed non-flammable containers away from ignition sources. Bulk storage should be in accordance with local building and fire codes.

SPILLS

Avoid contact of spilled material with greases/oils/solvents/combustibles; do not walk through spilled material. Prior to clean-up ensure that potential ignition sources have been eliminated. Clean up the bulk of the spilled material by gentle sweeping with spark-proof tools and natural bristle brushes. Residual material may be removed by a vacuum cleaner approved for use with combustible metal dusts. Under no circumstances should compressed air be used for clean up of metal powder spills. Collected spill material should be collected in non-combustible metal containers; inert solids such as salt or sand may be added to reduce the risk of ignition. Do not mix the spill material with

other combustible materials. Collected solids should be disposed of in accordance with applicable local regulations.

METAL POWDER SAFETY CHECKLIST

1. Have you read and understood the metal powder's physical and chemical properties and the associated hazards from supplied MSDS and other product information?
2. Are you compliant with all national, regional, and local building and fire codes (e.g., NFPA/IBC/IFC) for the handling and storage of metal powder. Are there other materials stored in this area?
3. Is the metal powder stored under proper conditions and isolated from
    a. fuels
    b. strong oxidizing agents
    c. steam
    d. oils
    e. grease
    f. water
4. Are the metal powder storage area doors kept closed?
5. Does the metal powder storage area have limited access?
6. Is the metal powder inventory controlled?
7. Have you contacted the local fire protection agency to make them aware of the specific fire fighting procedures/equipment required in the event of a metal powder fire?
8. Have you supplied them with a copy of the MSDS?
9. Have area personnel been trained to handle small metal powder fires?
10. Do personnel know who to contact if they are unable to isolate and contain a metal powder fire?
11. Are emergency contact phone numbers posted?
12. Are correct metal powder firefighting materials readily available to isolate and handle small fires?
13. Does your business have written Standard Operating Procedures (SOP) for all aspects of metal powder handling and processing, including proper risk assessment, COSHH assessment and personal protection equipment (PPE) assessment?
14. Is there a written procedure in place or engineering controls present to address the reduction or elimination of metal powder dust formation during handling?
15. Are employees properly trained
16. Are written procedures in place which address safety issues to be considered during maintenance/repair activities in metal powder storage or processing areas?
17. Is there a written procedure for metal powder shipping that meets international standards?
18. Are correct shipping containers available?
19. Are there written procedures in place for spill cleanup and waste disposal for metal powder?

RESIDUAL DANGERS, MAINTENANCE AND PROTECTIVE MEASURES

Risk assessments have been carried out to ensure that the MTT SLM 125 operates in a safe manner under normal defined operating conditions. The MTT SLM 125 is designed and constructed to comply with relevant European standards and legislation in force at the time that the equipment was produced with due regard to Health & Safety.

ABNORMAL HAZARDS

Although the equipment has been thoroughly developed to minimise the potential risk of hazards to personnel and property, it will be the responsibility of the end user to ensure that it is operated and maintained in accordance with the manual. However, in the event of improper use, physical harm, and in extreme cases death of the operator and/or third-parties as well as damage to the equipment and other material assets, may occur. As a result the system may only be used for its intended purpose after all prescribed safety conditions have been met.

If possible operators should safely isolate the equipment and ancillary equipment then report any malfunctions immediately to a supervisor and then to MTT Technologies Limited using the contact details provided in this manual. Before commencing operators must have received the required amount of training to be sufficiently familiarised with:

1. control and operation components of the equipment and ancillary equipment.
2. safety devices fitted to the equipment and ancillary equipment.
3. assembly procedures for the equipment and ancillary equipment.
4. work methodology for the equipment and ancillary equipment.
5. working environment in which the equipment and ancillary equipment have been sited.
6. emergency procedures and resources available for use in an emergency.
7. use of the O&M manual for the equipment and ancillary equipment.
8. COSHH assessments for metal powder and any other hazardous materials used in manufacture.

SAFETY DURING MAINTENANCE

The following is intended as a general guide. However it may not be exhaustive. It is the responsibility of the end user to ensure that any maintenance work is conducted in a safe manner.

Maintenance work may only be carried out by qualified technicians who are trained to work on this or similar types of equipment. The scheduled maintenance work described in the operating manual calibration, cleaning, lubrication, maintenance, inspection, etc. must be performed periodically as required in the schedule.

If it is absolutely necessary to remove a safety device during repairs or maintenance work on the system, this must only be done after a full risk assessment has been carried out. The removed safety device must be reinstalled immediately after completion of the repair or maintenance activities and prior to reactivation.

Prior TO MAINTENANCE ensure that the following is undertaken:

1. Carry out risk assessment to determine what actions are necessary to complete the work safely before maintenance is begun.
2. Wear the correct PPE for the work being undertaken and restrict access to the working area.

3. Isolate at the mains power supply by turning main switch to the “0” or “OFF” position and lock off with a personal padlock .Attach a visible a warning sign to indicate that the panel is isolated. Carry out safe isolation procedure checks in accordance with IEE standards.
4. Isolate the supply of Argon. This is used to operate valves and to provide the gas shielding blanket.
5. Ensure that all equipment elements which become hot during operation have cooled down to room temperature.
6. Ensure that adequate hoisting devices and load bearing equipment are on hand for the replacement of larger equipment parts.
7. Cordon off access to the work area of the machine to restrict access.
8. Replace worn or damaged parts.
9. Only use original replacement parts.
10. Ensure sure that adequate provision has been made for all substances that are hazardous for ground water (oil, coolant, etc.)

FOLLOWING MAINTENANCE WORK ENSURE THAT THE FOLLOWING IS UNDERTAKEN:

1. Perform a final check to ensure that all screwed fasteners that had been loosened are now tightly secured.
2. Perform a final check to ensure that all electrical connections have been reinstated and are sound.
3. Perform a final check to ensure that all pipe connections have been reinstated and are sound.
4. Clear up the work area and ensure that tools have not been misplaced inside the equipment
5. Reinstate all covers & safety devices
6. Dispose of any waste materials and liquids in safe manner
7. Check that all safety devices operate correctly
8. Carry out functional checks to prove that the equipment operates in the prescribed manner

WORK ON ELECTRICAL EQUIPMENT

The following points must be observed when working on live electrical equipment

1. Work on electrical equipment must only be carried out by a qualified electrical technicians who is trained to work on this or similar types of equipment.
2. It is generally considered safe only to work on isolated equipment after carrying out a safe isolation procedure in accordance with IEE standards.
3. Check electrical equipment regularly: Retighten loose connections. Immediately replace any damaged cables or wires.
4. Always keep the switch cabinet and all power supply units closed. Access to these is only permitted for authorised persons with a key or special tool.
5. Live work is not recommended and if attempted then the end user must have his own risk and method statements in place.
6. Never clean electrical devices with water or similar liquids.

LIVE WORK COULD RESULT IN INJURY OR DEATH TO INDIVIDUALS AND THIRD PARTIES BY ELECTROCUTION.

WORK ON PNEUMATIC EQUIPMENT

The following points must be observed when working on pressurised pneumatic equipment

1. Work on pneumatic equipment must only be carried out by qualified technicians who are trained to work on this or similar types of equipment.
2. Depressurise all pneumatic systems/system components before beginning work.
3. Check the condition of all hoses and replace if necessary
4. Ensure that the replacement hoses are of an equivalent specification or superior to the hoses being replaced. If in doubt consult MTT Technologies Limited

PRESSURISED PNEUMATIC SYSTEMS CAN CAUSE INJURY

THERMAL HAZARDS

If scheduled maintenance work is to be undertaken then the equipment must be isolated and a period of time should be allowed for hot parts of the equipment to cool. Care must also be taken if unplanned maintenance is to be carried out. The equipment also must be isolated and a period of time should be allowed for hot parts of the equipment to cool.

HOT SURFACES CAN CAUSE INJURY

NOISE HAZARDS

Operator exposure to noise levels of 65 dB (A) will be common when using this equipment. Ancillary equipment may generate higher noise levels in the working area and needs to be assessed by risk assessment accordingly. Operators must not be exposed to high levels of noise. They must be issued with the correct PPE and instructed in its use. It should be noted that the use of ear defenders impairs communication with others and also renders the user vulnerable to traffic such as fork trucks. Care must be taken to site the equipment in areas where operators can work safely when wearing their PPE.

EXPOSURE TO HIGH NOISE LEVELS MAY RESULT IN DEAFNESS, LOSS OF BALANCE OR REDUCED ATTENTIVENESS.

HAZARDS DUE TO "LATENT" ENERGY SOURCES

Isolated equipment may still present hazards to maintenance technicians. Typical examples of "Latent "energy sources are

1. Heated components will remain hot. The period of time required to cool to a safe temperature (≤ 43°C) is dependant on the material of construction, the shape and the mass of the component.
2. Some components may continue in motion after a process has halted. The period of time required for the component become stationary is dependant on the shape and the mass of the component.
3. Some components may be stopped in positions which make them unsafe.
4. Sealed pneumatic lines will remain pressurised
5. Other Fluid lines may remain pressurised
6. Capacitors may remain charged in electrical circuits
7. Risk and Method Statements for maintenance work should identify any latent hazards and the steps required to nullify them.

HAZARDS DUE TO UNEXPECTED MALFUNCTIONS

Though the equipment has been rigorously tested .The danger of unexpected malfunctions cannot be entirely ruled out when working on the equipment. Malfunctions may occur as a result of:

1. failure of the control system
2. restoration of the power supply after a power failure
3. external influences on electrical equipment

SERIOUS INJURY MAY RESULT FROM UNEXPECTED MOVEMENT OF MACHINE PARTS.

HAZARDS DUE TO FIRE OR EXPLOSION

Metal powders may produce flammable or explosive events under certain conditions. All measures must be taken to ensure that the conditions required to cause such an event are understood by the operators so that the possibility does not arise. In order for a fire/explosion to occur the following basic elements must be present:

1. A combustible powder or inflammable substance
2. An oxygen source (Air)
3. An ignition source

An area zone classification will define the risk of an explosive event.

FIRE AND/OR EXPLOSIONS MAY CAUSE SERIOUS INJURY OR DEATH TO PERSONNEL AND DAMAGE TO PROPERTY.ATEX REGULATIONS & DSEAR REQUIRE THAT RISK ASSESSMENTS BE CARRIED OUT TO DETERMINE THE REQUIRED AREA ZONE CLASSIFICATION BEFORE PUTTING THE EQUIPMENT INTO USE

ZONE CLASSIFICATION

Any ancillary equipment such as materials handling units will require a risk assessment to be carried out in order determine what areas need zoning and the level of zoning that is required.

Risk assessments have been carried out for the MTT SLM125

The top chamber is to be classed as Zone 21 when combustible or explosive metal powders are used in the manufacturing process.

The bottom chamber is to be classed as Zone 22 when combustible or explosive metal powders are used in the manufacturing process.

The top and bottom chambers are purged with an Argon shielding blanket when the building process is in operation as part of the process. This also creates an inert atmosphere (i.e. the presence of air/oxygen has been displaced) inside the chambers. Under no circumstances should the equipment be operated without the Argon shielding blanket present

All other areas on or around the equipment are classified as safe areas, that is to say have no zone classification. Under no circumstances should the safe area be compromised by work practises or ancillary equipment that is intended for use in areas that require a zone classification.

Handling equipment supplied by MTT Technologies Limited as part of the equipment will need to be operated in a Zone 22 Area outside the safe area in which the MTT SLM 125 is operating

IDENTIFIABLE IGNITION SOURCES

Ignition by electrostatic discharge

Electrostatic discharge is recognised an initiator of fires or explosions when the correct amounts of combustible dust (i.e. metal powder)or any other hazardous substances and oxygen are also present.

All equipment and ancillary equipment must be at the same electrical potential as everything with in the area zone classification including the operators and any other personnel authorised to be in the area.

All earth continuity straps must be in place and maintained

All operators and any authorised personnel must wear anti static boots and clothing. Only tools and other items that are suitable for the zone classification must be used in that area.

ENVIRONMENTAL PROTECTION & DISPOSAL OF MATERIALS

Ensure that all waste materials and liquids are disposed of in a safe manner. Ensure that liquid substances such oil and coolants do not contaminate soil and ground water or enter the drainage system. Companies not adhering to this requirement may face substantial fines from their local environment health or water authorities.

TECHNICAL SPECIFICATIONS, SERVICES AND INSTALLATION REQUIREMENTS, MTT SLM 125

Technical specifications are liable to change from time to time. MTT Technologies Group reserve the right to change any technical specification at any time. The following table indicated the general technical specification of the SLM125. Any specification not listed in the table is available on request by using the contact details indicated earlier.

Table 1 SLM 125 Technical Specifications

Dimensions without accessories (L x W):	1350 x 800 mm
Height without accessories (H):	1900 mm
Height with accessories :	1900 mm
Weight :	1125 kg Gross
Size of build platform envelope (X x Y x Z):	125 x 125 x 125 mm
Working pressure in chambers (Vacuum):	950 mbarg
Working pressure in chambers (Overpressure):	10 mbarg
Power Connection:	CEE Plug 400V, 16A, 50 Or localised via transformer
Data Connections	Standard Internet
Chilled water connection	From Chiller
Gas supply connection	From Regulator
Argon consumption	~30 l/h Average
Argon quality	4.6 or better
Continuous noise pressure level	65 dB(A)
Maximum noise pressure level (temporary)	67 dB(A)

Details of the technical specifications of other ancillary equipment are beyond the scope of this manual. The technical specifications of, ancillary equipment such as the chiller and integrated products such a the laser or optical scanning module are provided in the OEM manuals supplied with the system. Various services and installation requirements are also required prior to the installation and running of an MTT SLM machine. These are detailed below

INSTALLATION REQUIREMENTS

Primarily the following needs to be considered when undertaking a successful installation programme.

1. Have a project plan in place and work to it.
2. Risk and Method statements need to be in place prior to any installation work being carried out.
3. Check that the plant used to lift and transport the equipment is suitable for the intended purpose. The equipment has a gross weight of 1125 kg.
4. Check that the access route to the installation site is of adequate size to allow the equipment and any transporting device to travel unhindered.
5. Check the floor condition and load bearing capacity along access route is smooth and adequate enough to support the weight of the equipment and any transporting device.
6. Ensure that the unhindered access is available along the prescribed route on the day the equipment is to be sited
7. The installation site has been prepared in advance to accept the installation.

The SLM system should be used and stored under the conditions detailed in Table 2

Table 2 SLM 125 Ambient conditions

Ambient temperature range	15 to 35°C Stable to ±2°C
Relative humidity	40 to 60%, dry air
Vibration	Vibration Free
EMC	Minimise interference

The SLM 125 has been tested to European standards to ensure EMC compliance however the use of devices that emit high-frequency radiation should not be operated in the vicinity of the MTT SLM system. Similarly the installation site must be free from extraneous electrical interference (i.e. from other ancillary equipment)

In order to guarantee reliable operation the equipment must be used and stored in the correct environment.

The MTT SLM 125 cabinet is supported on 4 castors which are adjustable for levelling purposes. The stability of the machine can only be guaranteed if the floor meets the required standard detailed in Table 3

Table 3 SLM 125 Floor Requirements

Minimum floor load	5 kN/m²
Permissible floor unevenness	3 mm/m²
Finish	Smooth and easy to clean
Resistance	Solvent resistant and waterproof
Static	Antistatic if possible. If not antistatic mats to be provided

It is recommended that the room into which the equipment is installed confirm to the following specification. A typical room configuration is shown below

Table 4 Recommended workspace specification

Minimum recommended room size (L x W)	≥ 4000 x 3000 mm
Minimum recommended height of the room	2300 mm
Minimum access to the front of the machine	1200mm
Minimum access to the rear and sides of the machine	600mm
Minimum access above the machine	300 mm
Work surface requirements	1500 x 700 mm
Chiller floor space(L x B x H)	800 x 600 x 1180
Minimum access for chiller	500 mm to all sides

The inlet and exhaust vents of the cooling unit must not be obstructed. There must always be a minimum distance of 500 mm from walls or other equipment.

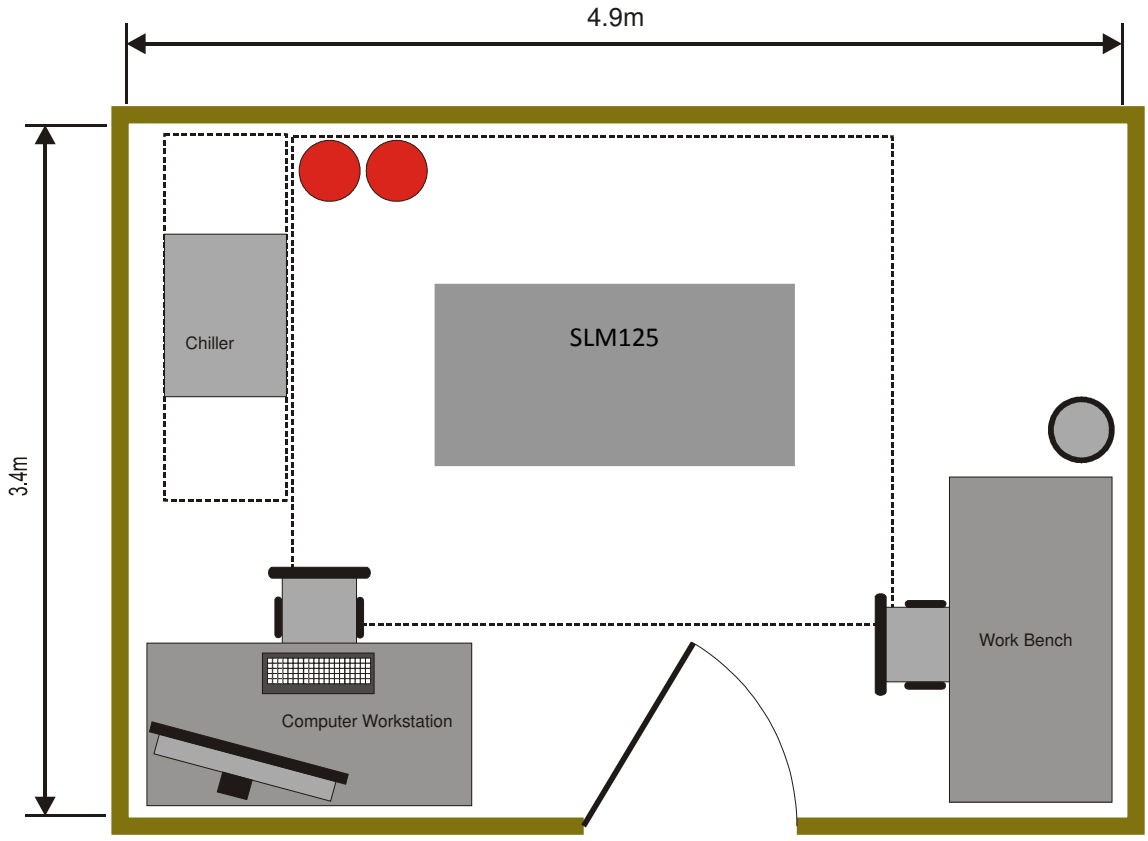


Figure 3 Typical Installation plan

Services must be installed prior to commencing installation work in accordance with the schedule of service requirements from MTT Technologies Limited

For the health and safety of operators and third parties; services must be planned in order to eliminate tripping hazards such as trailing leads and service pipes.

Table 4 Electrical connections - Chiller

Connection Localised to suit	CEE socket 400V/16 A other variations available on request
Voltage fluctuation	+ 6 - 10%
Frequency	50Hz
Fuse protection	3 ~ 16 A based on standard voltage
Connected load: approx	3.8 kW
Breaker	Earth leakage circuit breaker
Chiller floor space(L x B x H)	800 x 600 x 1180
Minimum access for chiller	800 mm to all sides

The MTT SLM 125 should be connected to a dedicated fused 3-phase circuit If additional heavy loads are supported by the same circuit, the supply voltage for the laser could be disrupted

INERT GAS ARGON

The SLM machine needs a supply of inert gas. It should be noted that the consumption of argon by this new system is much lower that the systems that it replaces however automatic changeover bottle systems are available as an optional extra from MTT Technologies Ltd

Table 5 Inert gas Connections

Consumption	~80 l/h average
Nominal pressure	8 bar
Minimum pressure	5 bar
Maximum pressure	10 bar
Quality	4.6 or better (material dependent)

0XYGEN LEVEL MONITORING WITHIN THE ROOM

The client must carry out risk assessments to establish whether or not there is a need for LOW LEVEL oxygen level monitoring within the room. Argon can be discharged into the room when the chamber doors are reopened.

ROOM AIR CONDITIONING REQUIREMENTS

There is no need for the room in which the equipment is sited to be temperature controlled however, safe working limits of 15°C up to an absolute maximum of 35°C must be observed. Target room temperature should be 20°C ±2°C.

Care must be taken to ensure that the room is sufficiently well ventilated and relative humidity around 60 to 65%. If condensation is detected as the dew point is reached the temperature of the room should be raised to reduce the relative humidity whilst remaining inside the temperature specifications detailed above. To achieve this some form of heating and an air extract system must be installed in the room with a volume flow rate of greater than 50 m^3/h.

Similar amounts of clean fresh air must also be available. It should be noted that care must be taken when designing extracts and ductwork to ensure that metal powders do not accumulate in the ducts and that any filter system is clearly marked and serviced all local legislation and standards must be met in this regard. More information on this can be obtained from consultation with an extraction expert or contacting MTT.

NETWORK CONNECTION

The MTT SLM 125 requires a network connection. The machine's network interface has the following specifications

Table 6 Network Connections

Network	Ethernet
Protocol	TCP/IP
Connection	10 Base T (BNC), AUI or TP

POWER CONNECTIONS FOR CLEANING AND MAINTENANCE WORK

Two separate socket outlets (230V/50Hz or local supply voltage) dedicated to cleaning and maintenance work must be provided close to the machine. The socket outlets should be RCD protected and within 2M working distance from the machine. It is very important to plan the layout of the room accordingly so that the customer can ensure smooth installation of the machine.

Two separate socket outlets (230V/50Hz or local supply voltage) dedicated to cleaning and maintenance work must be provided close to the machine

SAFETY PRECAUTIONS FOR END USERS AND OPERATORS

LASER SAFETY PRECAUTIONS

When using or maintaining laser equipment any local regulations or legislation take precedence over these instructions.

	Maintenance work on the laser system may only be carried out by employees of MTT Technology Ltd or by service personnel authorised by MTT Technology Ltd.

The machine will sometimes need to be operated by MTT Technology Limited personnel with the laser cover open.

When the MTT SLM 125 is operated with the laser cover open, the requirements of Laser Class 4 must be fulfilled, these include:

Secure the installation room.

It must be possible to lock all access doors to the installation room.

Ensure the following safety warning is fitted to all access doors to the installation room:

	Class 4 Laser in operation. No admittance.

Only personnel who have received instructions in laser safety are allowed in the hazard area, wearing complete personal protection equipment.

Personal protection equipment:

Laser goggles - Required type: Protection level L7 for D 1000-1100 nm according to DIN EN 207

EMC

Safety warning on all access doors to the installation room:

	Mobile phones prohibited. Do not operate any equipment near the MTT SLM 125, which emits high-frequency radiation. Switch off mobile phones before passing the access door to the installation room.

FIRE PRECAUTIONS

- Use only officially approved fire extinguishers of class D which are suitable for use in extinguishing fires caused by the type of metal powder being processed.
- Do not use water or liquid extinguisher. Nitrogen or carbon dioxide may be ineffective.
- Place the following safety warning on all access doors to the installation room:

	Fire, unshielded flames and smoking prohibited

ANTISTATIC EQUIPMENT

- Only antistatic equipment (e.g. vacuum cleaner) may be used.
- Only antistatic tools (e.g. screw drivers, brushes, etc.) may be used.
- Personnel may only wear antistatic boots
- Usage of earthed gloves is strongly recommended.

METAL POWDER

Protective gloves, breathing masks and safety goggles with side protection should always be used when exposed to metal powder

Always identify hazardous metal powders

- Some metal powders are combustible. The user must seek guidance from MTT Technologies Limited
- Combustible metal powders must be used , stored or disposed of in non-sparking or anti-static containers.
- Containers containing combustible metal powders must be labelled to identify a "Flammable Solid". Combustible metals powder must not be stored in plastic bags because of the possibility of electrostatic discharge.
- Always keep combustible metal powders away from any sources of ignition.
- When cleaning up spills of combustible metal powders ensure that the cleaning equipment is safe to use.
- Do not use compressed air to clean spills of combustible metal powder. This could cause an explosive cloud to form.
- Do not brush combustible metal powders for long distances. This could cause electrostatic charges to be formed
- We recommend the following safety equipment:

  Industrial vacuum cleaner ATEX approved, suitable for use with combustible metal powders

  Washbasin with eye washing station

  A safe waste container for metal powder residues

INERT GAS

	The concentration of inert gas in the ambient air needs to be monitored, and when necessary, indicated by a warning device!

A small amount of inert gas is emitted from the sieving station and SLM machine when in use.

The building chamber requires sufficient air ventilation (see chapter “Installation”)

SUBSTRATE PLATES

All plates should be indelibly marked (i.e. engraved or stamped) on the edge of the plate to indicate their material composition. The marking needs to be positioned on the centre of plate thickness.

Plates are to be cleaned up after used by either grinding milling or turning. The cleaned up plates should maintain the following tolerance of ±0.25µm for flatness and parallelism over their thickness (i.e. the build surface and clamped surfaces may both need machining). As a result a machine ground surface is desirable but plates can be faced in a lathe using a 4 jaw chuck or fly cut on a milling machine, providing a good surface finish is maintained allong with the stated tolerances for flatness and parallelism. The SLM machine is reasonably tolerant to substrate plate surface finish due to the soft re-coater blade.

After machining all cutting fluid residue must be removed using an appropriate cleaning medium. Normally ethanol is sufficient for cleaning most cutting fluids.

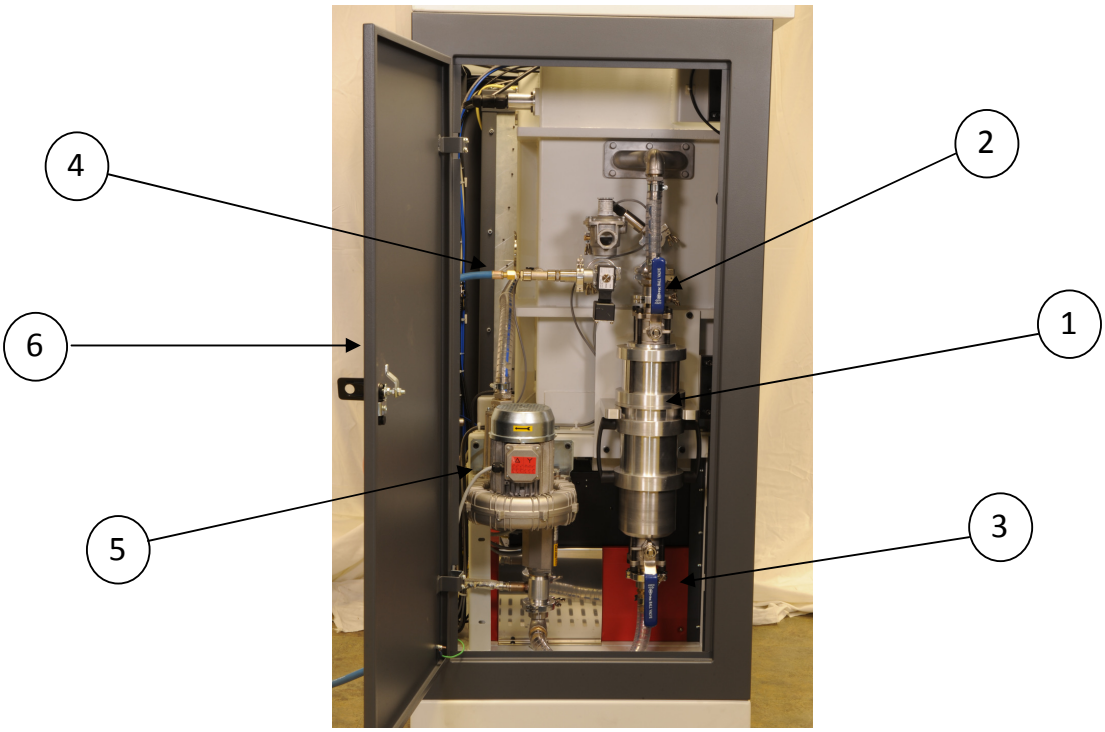
In particularly sensitive applications such as manufacturing medical implants or dental parts, both the cutting fluid and cleaning medium must carry FDA or other recognised approvals. The clients SOP’s (Standard Operating Procedures) and Validation procedures should clearly define the method for machining and proving that the plate is “clean”.

Plate thickness should be measured prior to final fixing onto the build table. Accurate measurement is essential to ensure that the correct reference datum is programmed into the SLM during the setting up operation. Failure to input the correct thickness value may result in damage to the machine.

STRUCTURE

FRONT

1. Process chamber door
2. Lower door (Housing laser & PC)
3. Emergency Stop button
4. Operstor touch screen interface
5. Reset button
6. Electrical panel access door
7. Powder overflow container
8. Powder castette with sight glass
9. Chamber access gloves
10. Main electrical isolator
11. Laser safe viewing window
12. Adjustable feet/castors



7. Removable safe change filter housing
8. Upper safe change filter isolation valve
9. Lower change filter isolation valve
10. Argon connection to machine circuit
11. Gas recirculation pump
12. Left hand access door for safe change filter.

FUNCTIONAL DESCRIPTION

The following describes the main components of the equipment

MAIN SWITCH AND EMERGENCY STOP BUTTON

To operate the system fit the Red 16A/3ph/N/E plug to a suitable power supply socket and switch on supply taking care to ensure that your machine is correctly configured for your local supply voltage or that a suitable transformer is used. For further information please contact MTT or your local machine supplier. The equipment main isolator switch is mounted on the right hand side of the SLM125 cabinet. Switch the main isolator to “ON” or “1”. The PLC and the main computer will then begin the start up routine.

Switch on the main regulator for the Argon gas located on top of the Argon cylinder connected to the equipment.

When the PLC and the main computer are booted the system is ready for operation.

To operate the equipment all safety devices must be in place and any alarm messages need to be cleared. Unlatch the Emergency Stop button situated below the PLC touch screen on the front of the SLM125 cabinet by rotating it clockwise. A safety relay hardwired into the electrical control system will only operate when the safety devices are made and alarm messages are cleared. To enable the safety relay press the blue RESET button situated below the PLC touch screen on the front of the SLM125.

The Process heating system is turned on via the appropriate page in touch screen interface and the Laser key switch to be switched on separately. This can be found by opening the lower door.

Pressing the Emergency Stop button at any point in the cycle will stop the manufacturing process. The Laser and mechanical components will be inoperable. The Main computer and PLC are available to the operator. However the functionality will be disabled until the Alarm messages have been cleared. Also the Argon atmosphere will remain in place to retain safe inert atmosphere inside the process chamber.

PLC TOUCH SCREEN (HMI) & PLC

The SLM build process is controlled from a man machine interface (HMI) on the front of the SLM-125 cabinet. It incorporates a user privilege access system. The level of access will depend on the individual Operators unique Log in code (Up to a maximum of 6 digits in alpha/numeric format). The PLC controls the machine operation , mechanical and monitoring functions of the equipment such as wiper assembly, table assembly, pumps and valves and the selection of the parts for building.

ARGON GAS FLOW VALVE

The flow of the Argon gas can be manually adjusted with this valve. For flooding of the top and bottom chambers and the recirculation circuit during the build process with inert gas in order to expel air (oxygen), approx. 3 l/min should be set.

MAIN COMPUTER & MONITOR

The build and process control software runs on this PC. It is located within the framework of SLM125 cabinet inside the lower door. In normal use there are no input or output devices for human intervention. The PC will be started and stopped from the PLC system using the PC on/off override buttons.

LASER

The laser provides the energy source for the SLM process. It is located within the framework of SLM-125 cabinet. A separate manual for the laser is supplied with every machine. Keep this safe as it has vital information for servicing such as ID passwords etc and safety and conformance information.

CHILLER

A chiller (supplied with the machine) maintains a stable temperature for the laser and optical system. It is imperative that the chiller is maintained in accordance with the manufacturer's instructions and that a suitable anti fungal inhibitor is used. This can be purchased from MTT and can be found in PD-7900-2506-01 Consumables, Spare Parts and Ancillaries list. The manual for the chiller is supplied with the SLM system documentation.

F – THETA LENS

The F-Theta lens focuses the laser beam on to the metal powder surface on the substrate plate housed in the top chamber. The lens should be cleaned using a lint free cloth or proprietary lens paper. The procedure is as follows.

The lens protection glass should be removed for cleaning. To do this, support the glass from below with a lint free cloth. Undo the ring of M6 cap screws using a 5mm hex key. Once removed the protection glass can be cleaned by using the lens paper in a single linear pass across the lens. Do not re-use the paper. If a second pass is needed either turn over the paper or use a new piece.

Follow the same procedure to clean the lens inside the machine taking great care never to use the same cloth or lens paper twice. A cleaning kit is available from MTT see PD-7900-2506-01 Consumables, Spare Parts and Ancillaries list.

METAL POWDER LOADING/ OVERSPILL BOTTTLES

Metal powder of the correct particle size should be loaded from the transport containers into Standard universal powder flasks using a mask, cloves and eye protection as detailed in the safety section of this manual.

When decanting reactive materials such as Titanium and Aluminium this should be done in an inert atmosphere in an argon glove box alternatively contact MTT for powder shipping container to KF40 adapters (PSC/KF40 Type#). The MTT powder flasks are sealed with a butterfly valve and can be used to load material into the machine. The overspill bottle is a large capacity vessel and is designed to collect excess powder. It is sited in the lower part of the main process chamber. To empty it connect it to a Standard Universal Powder flask to decant material. Only the Standard Universal Powder flasks part number 796531000 should be fitted to the sieving station following a build.

LOADING THE POWDER CASSETTE

The SLM125 features a sealed powder cassette inside the process chamber. Loading powder into the cassette can be done in two ways. One method is to simply remove the top of the powder cassette and then fill from the shipping containers inside an Argon glove box using the requisite safety equipment such as mask, gloves and goggles.

The preferred method is to remove the lid and use the KF40 lid adapter (SLM125/KF40 Cassette adapter) in place of the sealed lid for the purposes of filling the cassette, following this the fully sealed lid should be replaced prior to re-installing the cassette. Under no circumstances should the machine be operated without the fully sealed hopper lid securely in place.

Note that when the SLM125/KF40 Cassette adapter is fitted the hopper cannot be installed in the machine.

TOP CHAMBER (ZONE CLASSIFICATION 21)

The component building process occurs in the top chamber. It is sealed to atmosphere when the door located on the front of SLM125 cabinet is closed and the vent valve is shut off. It is not possible to open this door when the build process is taking place. The top chamber houses the following items:

1. Sight Glass Aperture for F- Theta Lens
2. Viewing window in door (laser class 1 in this application)
3. Cassette.
4. Recoater assembly
5. "Gas" knife inlet port and exhaust ports
6. Substrate plate (removable) bolted to table top surface.

SIGHT GLASS APERTURE FOR F- THETA LENS

The sight glass for the F-Theta lens is housed in the roof of the top chamber. It allows the laser beam to penetrate the top chamber while maintaining an inert atmosphere within the chamber It is important to clean any soot deposits formed during the build process from the internal surface of the sight glass before starting a new build process. Unattended soot residue may result in heating and failure of the sight glass and failed builds. The sight glass must be cleaned between each build.

VIEWING WINDOW

The viewing port is located in the door of the top chamber and in this application permits a Class 1 laser specification to be achieved for the SLM125. Details on the exact specification for Optical Density (OD) can be supplied on request. Please contact MTT for further information

CASSETTE

The cassette is situated inside the chamber and dispenses a dose of metal powder on to the base of the top chamber process plate. The variable dose configuration is achieved in the operation software on the machine. It should be set for the complete build and does not reset for subsequent builds without user intervention.

RECOATER ASSEMBLY

The recoater assembly comprises the recoater arm arm, pulleys and toothed belts .The assembly is driven by a stepper motor mounted externally onto the chamber structure. The pulleys and belts are fitted behind sheet metal covers. The recoater traverses the base of the top chamber, distributing a uniform layer of metal powder over the top of the substrate plate. Excess powder is discharged through front apertures in the process plate.

"GAS" KNIFE

The "gas" knife is situated on the right hand side of the top chamber. It creates a flow of gas directed across substrate plate. The finest metal powder & soot particles produced during the build process are collected and are directed to a port on the left hand side of the top chamber which is connected in turn to a Safe Change filter outside the chamber. The filter can be accessed through the left hand door, isolated and removed for replacement.

SUBSTRATE PLATE

The substrate plate is the surface upon which the build process takes place. It is covered by progressive layers of metal powder which are selectively melted and fused to the adjacent created layer in order to create a homogeneous solid component. It is bolted onto the top surface of the table housed in the bottom chamber using M6 cap screws.

BOTTOM CHAMBER (ZONE CLASSIFICATION 22)

The table assembly is located in the bottom chamber. It is sealed to atmosphere when the chamber door located on the front of the SLM-125 machine are closed.

1. It is not possible to open this door when the build process is taking place.
2. The bottom chamber houses the following items:
3. Table assembly
4. Heating /Temperature control
5. Metal powder overspill flask

TABLE ASSEMBLY

The table assembly comprises the table, a support plate, a stationary housing and the drive assembly. The table supports the substrate plate and progressive layers of powder. The table is lowered in its housing as additional layers of metal powder are added. The housing forms a peripheral boundary for the metal powder so that the re-coater can create a uniform layer.

HEATING/TEMPERATURE CONTROL

There are heaters built into the table which can be used to heat the substrate plate. The temperature can be set in degrees on the thermostat (250°C max).

SAFE CHANGE FILTER

The finest metal powder and soot entrained by the gas knife are expelled from the top chamber and captured in the top chamber filter housed in an an aluminium cylinder located on the left hand side of the SLM-125 cabinet. The filtered inert gas is then re-circulated through the machine to maintain an extremely low oxygen content. The filter housing can be isolated using the upper and lower valves and then removed by releasing the two KF40 flanges.

Following removal of the safe change filter housing it should be submerged prior to removing and replacing the filter element. Local regulations govern the disposal of the filter element.

Please seek advice from your local waste disposal provider; details of the contaminants for a range of materials can be provided by MTT.

OXYGEN MONITORING

The oxygen levels in the SLM125 chamber and the gas recirculation circuit are continuously monitored and tightly maintained. If the level of oxygen exceeds a maximum value the machine safety circuit is triggered and the machine defaults to safe mode until the oxygen level returns to the correct level. In practice oxygen levels are generally maintained well below 500ppm or 0.05%. The default setting is 1000ppm (0.1%) before build will commence.

SAFETY CONCEPT

The system is equipped with various safety-related components. A hardwired safety circuit controlled by a programmable safety relay. The Emergency Stop button and door interlocks form part of this circuit. The door release can only be operated if the internal pressure of the chamber is at atmosphere and the table has cooled to a safe level. (Note: Level 3 access overrides both pressure and temperature requirements.)

Other devices which affect the safe operation of this equipment are as follows:

1. Temperature sensors
2. Pressure sensors
3. Overpressure valve
4. Oxygen sensors
5. Personal gas safety detector
6. Fine particle filter
7. Fire suppression system
8. Fire extinguishing system (optional)

TRANSPORT & MACHINE RELOCATION

If your MTT SLM 125 is to be moved to an alternative production facility or resold, MTT is happy to assist and advise, with this in mind please inform us at your earliest convenience:

1. inform MTT Technologies Limited
2. advise the required schedule for moving the equipment
3. have the new site prepared in accordance with the requirements of this operating manual

	The transport of the MTT SLM 125 should only be carried out by following the advice and recommendations of MTT Technologies Limited or by service personnel authorised by MTT Technologies Limited. Failure to observe this advice may lead to machine damage.

IDENTIFICATION AND LABELLING OF METAL POWDER CONTAINERS

	Use MTT Technologies Limited approved Metal Powder bottles only!

Metal powder is supplied in containers from which is must be decanted.

For example the bottles are marked as follows for titanium:

Highly Inflammable

- R11
- chemical composition
- particle size

On delivery of the powder containers the correct labelling needs to be checked by the customer. Empty bottles are supplied with blank labels. The customer is obliged to label the bottles correctly when refilling these with powder either from the sieving unit or the building chamber. The metal powder bottles need to be stored correctly before using the next time. See the Risk Assessments on the powder materials for more information.

	Metal powders should never be mixed together. All containers should be dedicated to a particular product and labelled accordingly

DISPOSAL

	The substances indicated below must be disposed of in a safe manner. They must not be allowed to contaminate the environment!

METAL POWDERS

Disposal of metal powder, whether new, used, or in the form of contaminated components and filters must be done in accordance with the relevant COSHH sheet and/or the local national requirements.

	Wear protective eyewear, dust masks and protective clothing (protective suit and rubber/plastic gloves). Do not allow the dust to form a cloud. Do not eat, drink or smoke in the vicinity of the SLM system. Wash hands thoroughly with water and soap after disposal. Wash any contaminated clothing separately from other clothing.

Highly reactive pure titanium dust or respirator filters dust and detergents must be changed under a non-oxidising atmosphere and transferred to a controlled waste disposal in a hermetically sealed container, according to the safety datasheet or locally applied national regulations.

GENERAL PRECAUTIONS FOR SAFE POWDER HANDLING PROCESS LIQUIDS

Lubricants must be disposed of in an area that has been designated for oil recycling and collection. Refrigerants, coolants and coolant additives, chiller, and compressor oil are to be disposed of in accordance with the locally-applicable national requirements and the O&M manual for the chiller.

LUBRICANT

Dispose of lubricants for gears and guides at the recycling centre or by an approved contractor.

REFRIGERATING AGENT, COOLANT ADDITIVES

Dispose of refrigerating agents, coolants and their additives, as well as all components of the cooling unit and compressor oil, according to the locally applied national regulations and the instructions specified in the separate operating manual for the cooling unit.

COMISSIONING AND OPERATING

SWITCHING ON THE UNIT

- To operate the system fit the Red 16A/3ph/N/E plug to a suitable power supply socket and switch on supply, taking note of local conditions.

- Connect the Argon cylinder to the main regulator for the Argon shielding blanket and turn on the supply.

- The equipment main isolator switch is mounted on the right hand side of the SLM-125 cabinet .Switch the main isolator to “ON” or “1”. The PLC and the main computer will then begin the start up routine.

- The Chiller, Process heating system and Laser will also be turned on when the main isolator is switched.

- When the PLC and the main computer are booted the system is ready for operation. This is indicated by the welcome screen.

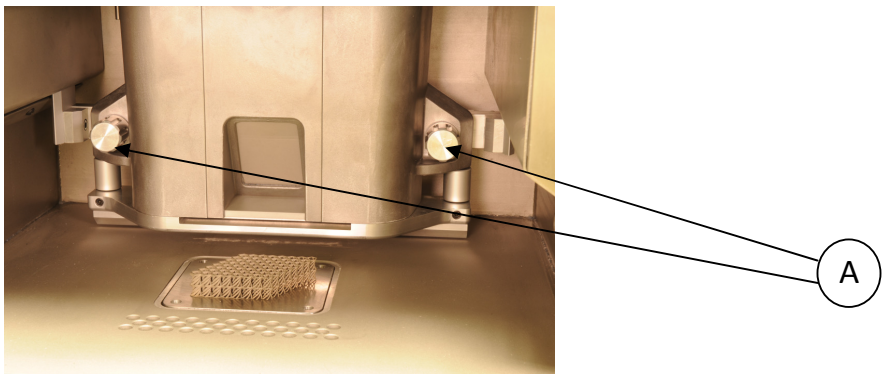
PREPARATORY OPERATIONS

- Measure and record the thickness of the substrate plate for reference.
- Cleaning operations must take place after every build.

METAL POWDER PREPARATION - CHARGING

Ensure that the correct type of metal powder is ready to use and has been correctly sieved if necessary i.e. if the powder has already been used.

The SLM125 features a sealed powder cassette inside the process chamber. Loading powder into the cassette can be done in two ways. First remove the powder cassette by unscrewing the two knobs (A) either side of the unit.



Following this the Cassette can be removed, taking care to allow for the weight of any unused powder..

METAL POWDER PREPARATION - CHARGING

The powder cassette is fitted with a removable lid, this is removed by unscrewing the M5 securing bolts using a 4mm hex key.

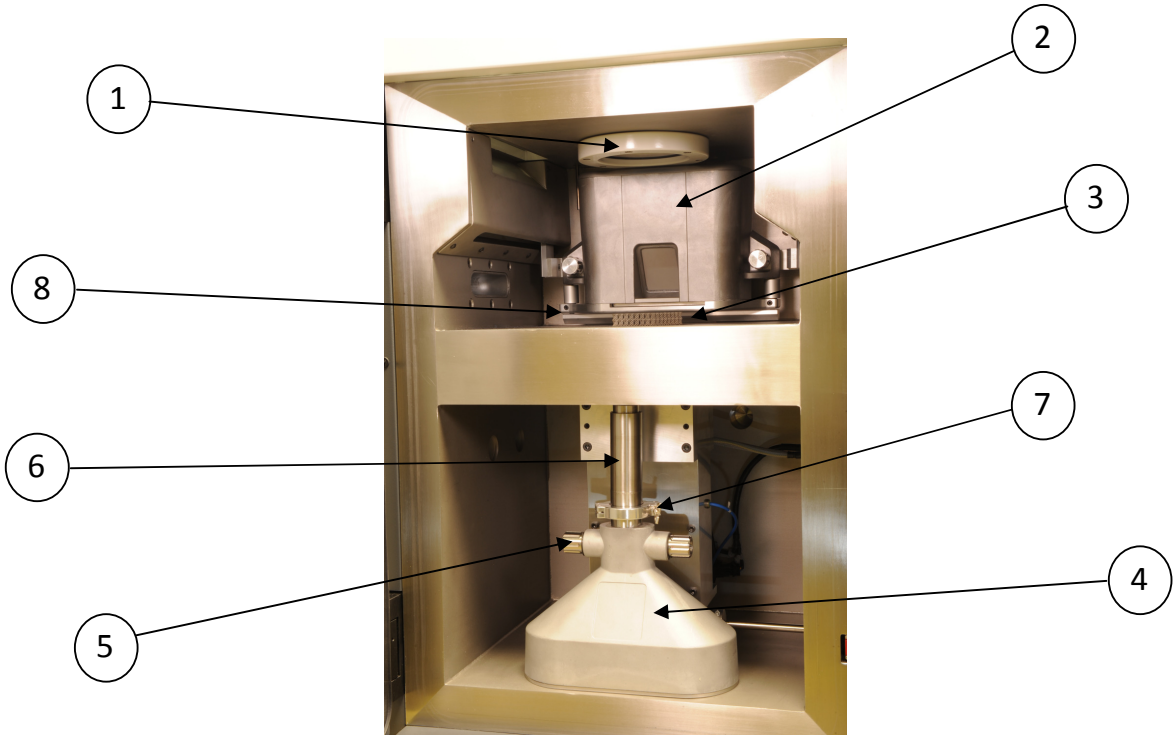
One method for refilling is to simply remove the top of the powder cassette and then fill from the shipping containers inside an Argon glove box using the requisite safety equipment such as mask, gloves and goggles.

The preferred method is to remove the lid and use the KF40 lid adapter (SLM125/KF40 Cassette adapter) in place of the sealed lid for the purposes of filling the cassette, following this the fully sealed lid should be replaced prior to re-installing the cassette. Under no circumstances should the machine be operated without the fully sealed hopper lid securely in place. Various adapters can be made available to connect between shipping containers and the powder cassette, contact MTT for further info.

Note that when the SLM125/KF40 Cassette adapter is fitted the hopper cannot be installed in the machine.

METAL POWDER PREPARATION - OVERFLOW

The powder overflow bottle should be fitted below the process plate as shown below. The tube that connects the overflow pipe to the bottle slides up to allow the KF fitting and the bottle to be removed from the machine. When refitting ensure that the KF40 sealing ring is in place prior to securing the KF40 clamp.



13. Lense cover – Clean every build
14. Powder cassette
15. Process plate
16. Powder overflow bottle
17. Rotarry overflow isolation valve
18. Sliding connection pipe

7. KF40 flange connection
8. Recoater Blade

Ensure the isolation valve is open on the overflow bottle before fitting the bottle to the machine prior to a build and ensure that the valve is closed before removal of bottle once the build has finished.

Remove the bottle.

Clean away any spillage with a moist, lint free cloth.

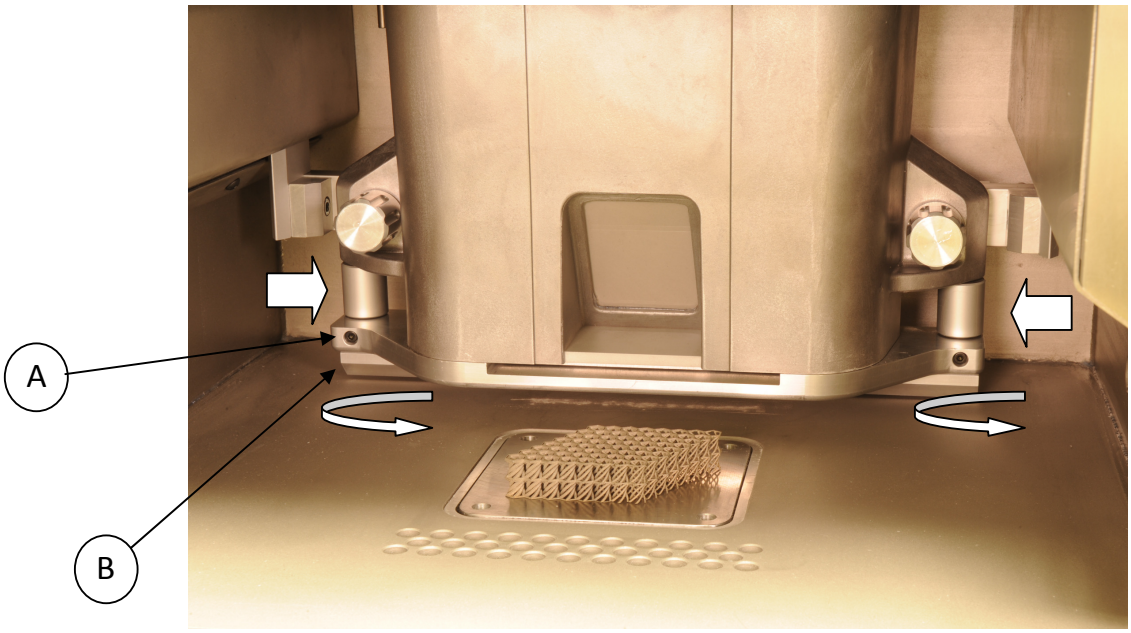
	The cleaning of the area around the computers, displays, control and electronics may be done with maximum care. Particularly no water may enter the housings.

SETTING AND REPLACING THE RECOATER BLADE

To replace the recoater blade insert first remove the powder cassette in the usual manner. Following this ensure that the cassette is empty of all powder. Once the cassette is out of the machine release the two clamp screws ‘A’ using a 5mm hex key to allow the two Knurled recoater blade adjusting nuts (arrowed) to be rotated in the direction shown, until the recoater housing ‘B’ is completely free and separate from the cassette.

The recoater housing ‘B’ is made from two pieces of aluminium and is secured together with M5 cap screws. Removing the cap screws along the entire length of the aluminium housing allows the old blade insert to be either rotated to a clean area prior to refitting the cap screws and tightening or replacing the recoater material if it is too badly damaged to continue. Replacement recoater insert is listed in PD-7900-2506-01 Consumables, Spare Parts and Ancillaries list, Part number 796770000.

To refit the recoater reverse the steps to reinstall. Following this the set up routine should be completed with the cassette refitted to the machine. The knurled adjusting nuts ‘B’ are used to set the recoater blade level. This is completed as part of the build set up routine prior to tightening the two clamp screws ‘A’ to lock the blade at the chosen height.



Conditions:

	Failure to accurately follow the filter change procedure and the best practice guidelines outlined in this section may result in personal harm or damage to the machine.

Fig FILTER 2 REMOVAL Note the valves in the closed position

Isolate and change the filter by shutting off both valves and removing the filter housing.

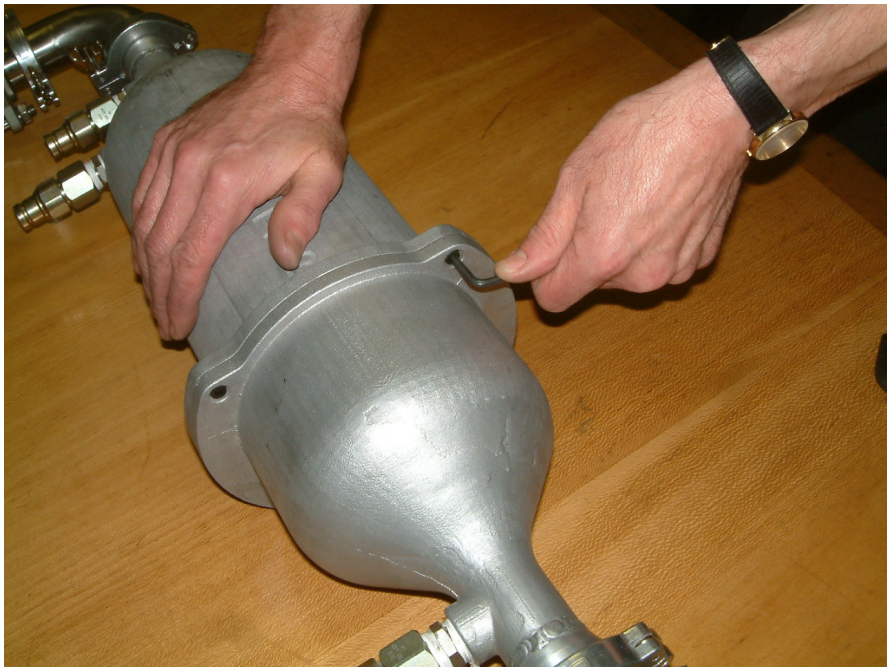


Fig FILTER 2 HOUSING DISMANTLING

It is good practice to submerge the filter housing in water with a small amount of detergent prior to removing the filter for all materials, however if using reactive metal powders such as Ti64, CpTi or Aluminium this procedure MUST be followed.

	Failure to submerge the filter as described, when Aluminium and Titanium builds have been completed, may result in fire.

Once the filter assembly has been removed from the machine, ensuring the valves are shut, submerge the whole assembly in a bath of water with a small amount of detergent. Once fully submerged both valves can be opened to let the water flood into the filter housing prior to dismantling. Once the filter assembly has been flooded it can be drained. To dismantle the filter housing remove the # cap screws using a 5mm Hex key taking care to retain the fixings and ensuring the seal remains in place. Filters can be ordered from PD-7900-2506-01 Consumables, Spare Parts and Ancillaries list, Part number 790730000.

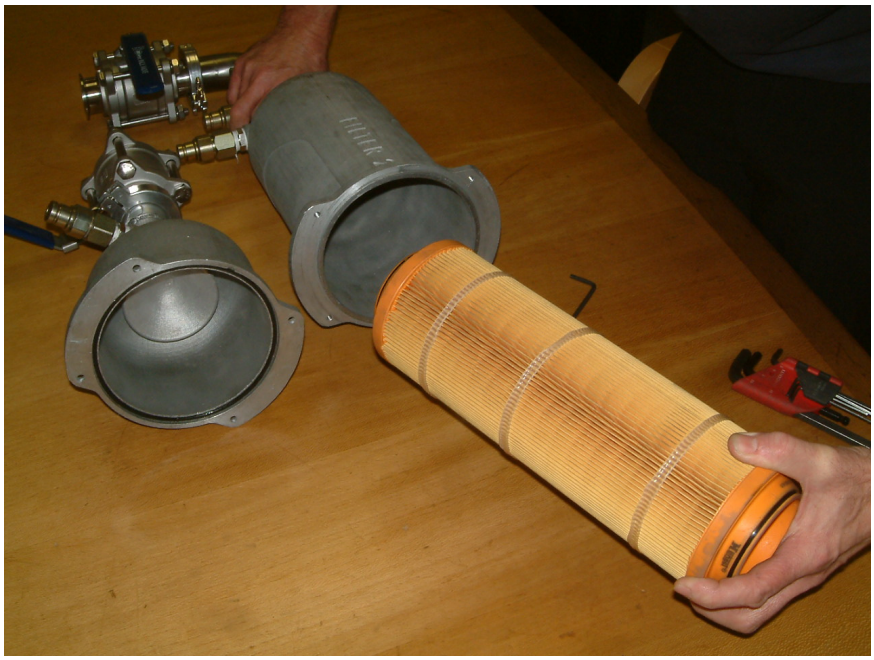


Fig FILTER 2 ELEMENT REMOVAL

Once the filter has been submerged and flooded the filter element can be safely removed and replaced. New filter elements can be ordered in quantities of 10 from MTT using the following part number; 790730000. It is also recommended that the seal is changed after between 10 & 20 cycles or if it has become damaged. A seal is included in the pack of 10 filters.

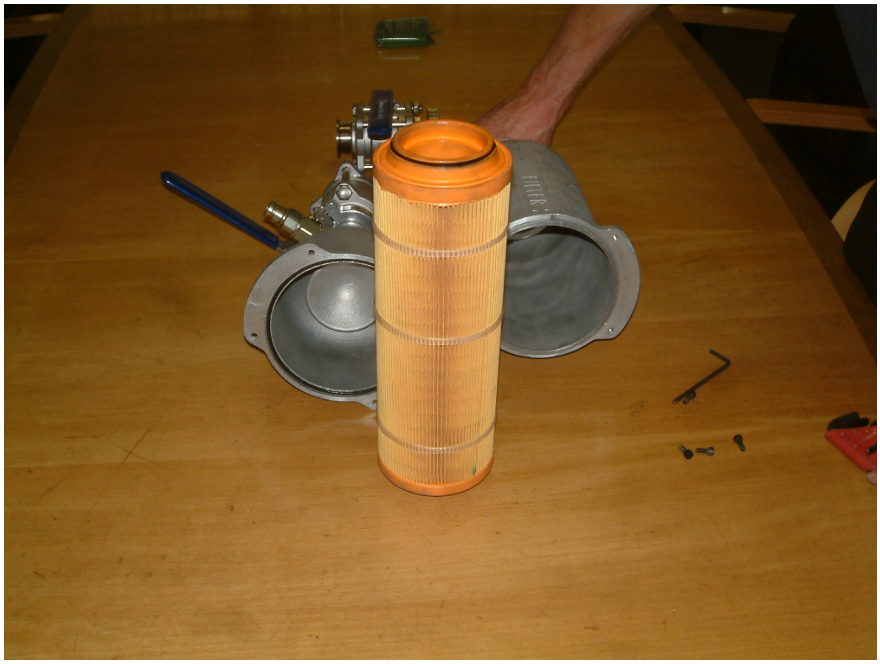


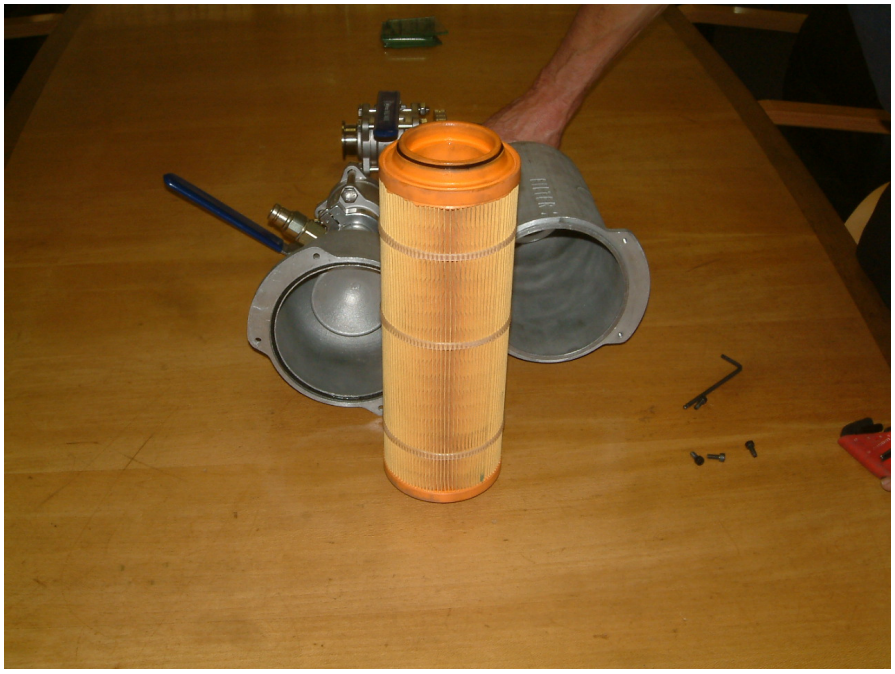
Fig FILTER 2 AND HOUSING

If using reactive metal powders such as Ti64, CpTi or Aluminium the filter MUST be changed every build without fail, the particulates collected in the filter when building in Ti & Al are combustible in a normal oxygen rich atmosphere. When the innerting process is initiated the machine goes through a cycle to remove Air from the build chamber by firstly creating a vacuum. While this is taking place air is drawn through the filter assembly and may cause the fine particles in a contaminated filter to combust. Once the vacuum process is complete the machine is then filled with high purity argon gas to create the necessary atmospheric conditions for successful parts to be safely manufactured.

Check the sealing ring in the filter housing for damage and exchange it if necessary.

	Use only filters authorised by MTT Technologies Ltd New filter elements can be ordered in quantities of 10 from MTT using the following part number; 790730000.

It is recommended that the seal is changed after between 10 & 20 cycles or if it has become damaged. A seal is included in each pack of 10 filters.



Before insertion of the new filter apply the enclosed special grease uniformly onto the sealing surface as shown.

Fig 2 FILTER ELEMENT REPLACEMENT

Insert the new filter with the sealing surface first and push it carefully in to the longest part of the filter housing as shown applying some pressure to ensure it is seated on sealing spigot. Once a definite ‘stop’ is felt the filter is seated, too much pressure may result in damage to the filter element.

Following this the filter assembly can be re-assembled ensuring the seal is in good condition with no obvious wear or damage, if in doubt replace the seal. Failure to ensure a good seal may cause increased argon usage or worst case failure to maintain a satisfactory atmosphere. Once re assembled the filter assembly can be re-fitted to the machine. Once re-fitted the valves can be opened as shown below.

BASIC MACHINE OPERATION

PAGES WHICH DO NOT REQUIRE USER TO LOG IN

In order to allow viewing of the machine status and modes several pages can be toggled without user log in. These are detailed in the following pages.

Fig MTT TECHNOLOGIES GROUP INFORMATION PAGE

log in. These are detailed in the following pages.

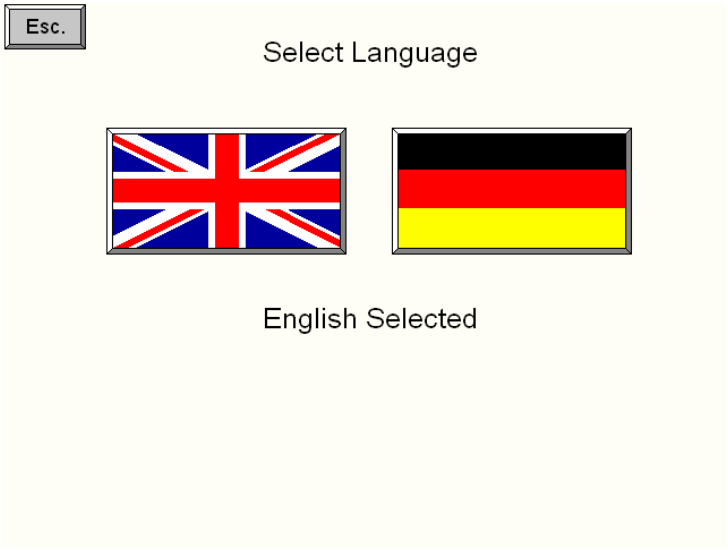


Fig LANGUAGE SELECTION PAGE (Optional depending on software install)

Following the start up page user languages can be selected by pressing the appropriate flag. If installed.

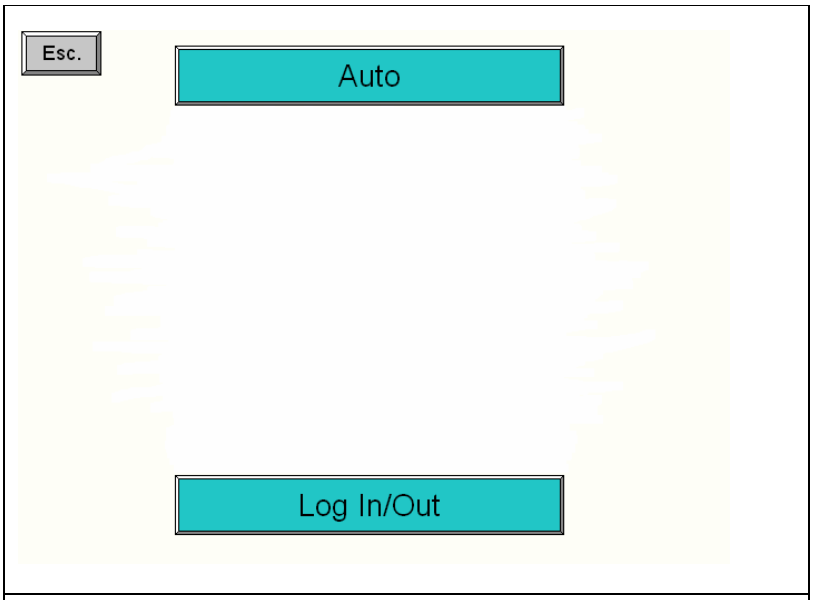


Fig MENU PAGE- INITIAL USER ENTRY

Select < ESC> to continue to previous page

Select <Auto> to view status pages or for log in select <Log In/Out>

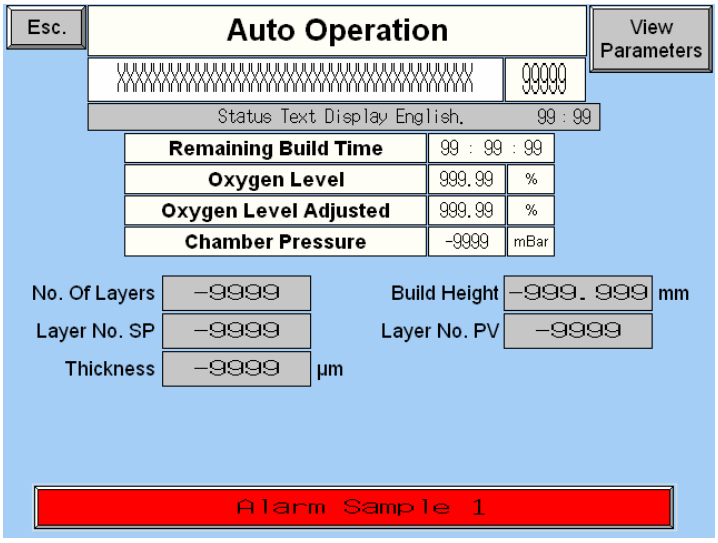


Fig AUTO OPERATION PAGE – NOT LOGGED ON

Select < ESC> to continue to previous page
Select <View Parameters> goes to machine status page

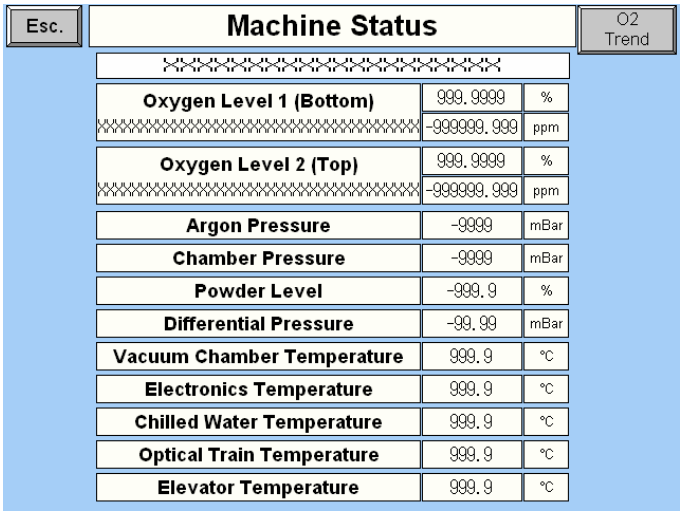


Fig MENU PAGE- MACHINE STATUS PAGE

Select < ESC> to continue to previous page

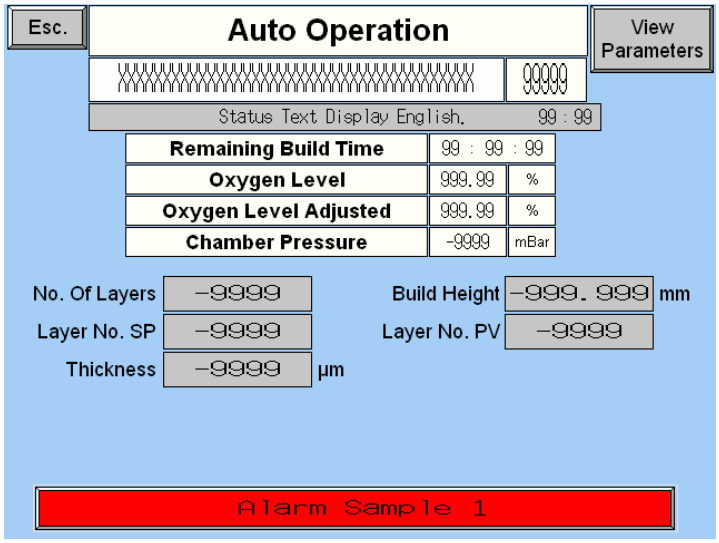


Fig AUTO OPERATION PAGE – NOT LOGGED ON

To access alarm messages select the <Alarms> red oblong key at the bottom of the page

Fig ALARMS PAGE-NOT LOGGED ON & LEVEL 1 USER

Select < ESC> to continue to previous page
Selecting < ▲> or <▼> allows the list to be scrolled incrementally.
Selecting <🡅> or <🡇> allows the list to move between pages of lists
Select <Alarm History>

Fig ALARMS HISTORY PAGE – NOT LOGGED ON & level 1 USER

Selecting < ▲> or <▼> allows the list to be scrolled incrementally.
Selecting <🡅> or <🡇> allows the list to move between pages of lists
Select < ESC> to continue to previous page

USER ACCESS LEVELS

There are 3 levels of user access which will depend on the operators user account

- Level 1 is the lowest available level and is intended for operators using the equipment on a daily basis. It allows for minimal user intervention such as starting builds.
- Level 2 is the supervisor level which enables all operational functions required to run the machine.
- Level 3 is intended as a maintenance only level for forcing drives and valves. Note that inappropriate use may result in damage to equipment. This privilege level is available to MTT trained service staff.

There is also a Level 4 access for user account & password control which is required for developer access. This is only available to approved MTT staff.

Note: If there is no operator input to the HMI within a 15 minute period, the system will automatically log the user out regardless of the state of operation of the equipment. This will not affect a build in progress.

OPERATOR LEVEL 1

The following user interface pages assume that all relevant cleaning operations and installation of consumables such as filters and re-coater blades, have taken place so that the equipment is ready to accept the next build.

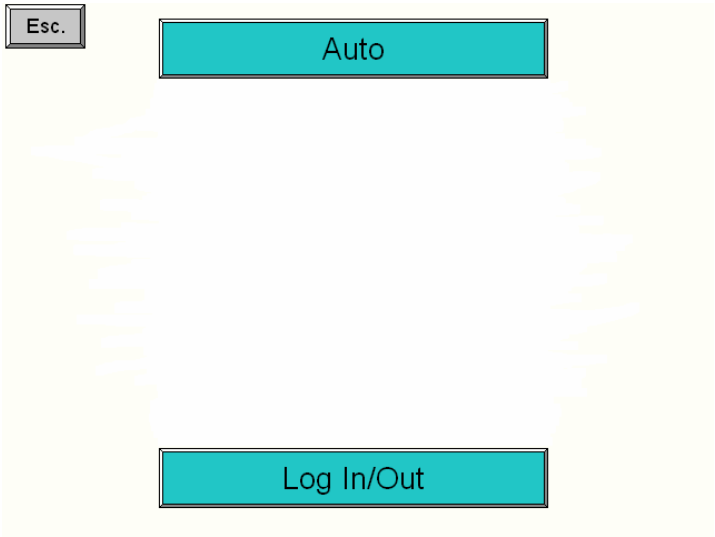


Fig MENU PAGE- INITIAL USER ENTRY

- Select <Log In/Out>

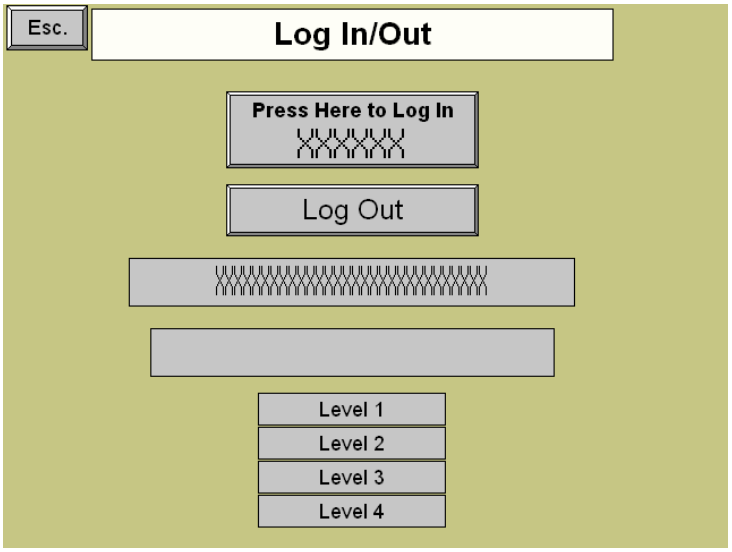


Fig USER ACCOUNT ACCESS PAGE

- Select < ESC> to continue to previous page
- Operator selects <Press here to Log In>
- Note before a new user can log in previous a previous user must be logged out unless the 15 minute time out has elapsed.

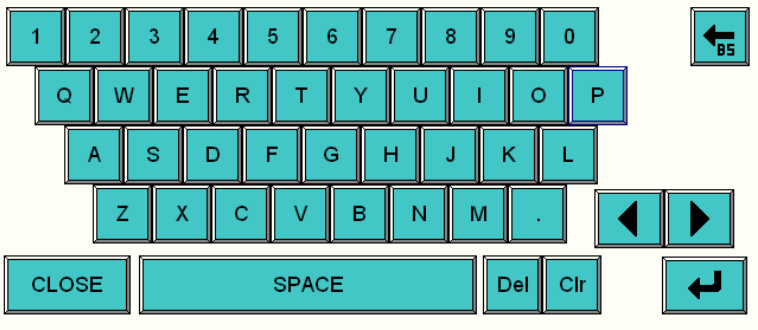


Fig ALPHA /NUMERIC KEYBOARD (OVERLAID ON USER ACCOUNT ACCESS PAGE)

- The keyboard is overlaid on the Log In/Out page
- Operator keys in his <six digit alpha/numeric code>
- Note that the display will show the entry as ****** to hide access codes
- Operator presses < ↵ > to confirm entry
- Keyboard disappears from page

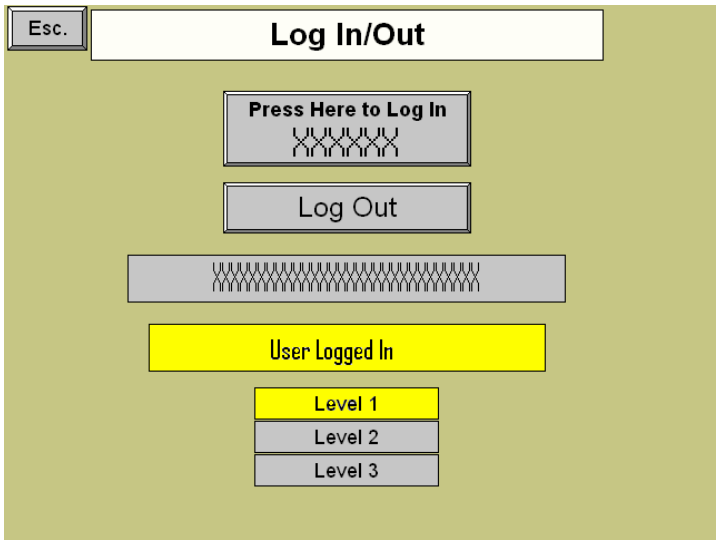


Fig LOG IN/OUT PAGE AFTER USER ACCOUNT IS OPENED (USER LEVEL 1)

- The user access level is defined by the individual user account. User account entry level is highlighted in yellow.
- All operations are carried out from the menu page. Once logged on:
- Select < ESC> to continue to previous page

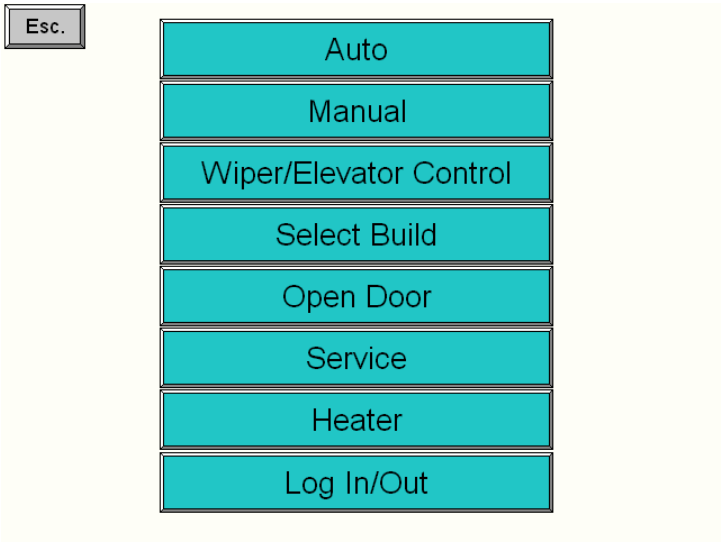


Fig MENU PAGE LEVEL 1

Select <Open Door>

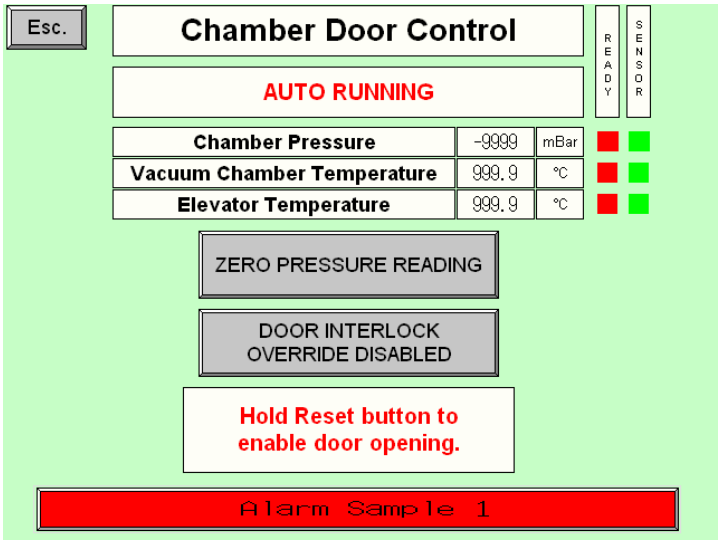


Fig CHAMBER DOOR CONTROL PAGE

Select <DOOR INTERLOCK OVERRIDE DISABLED>

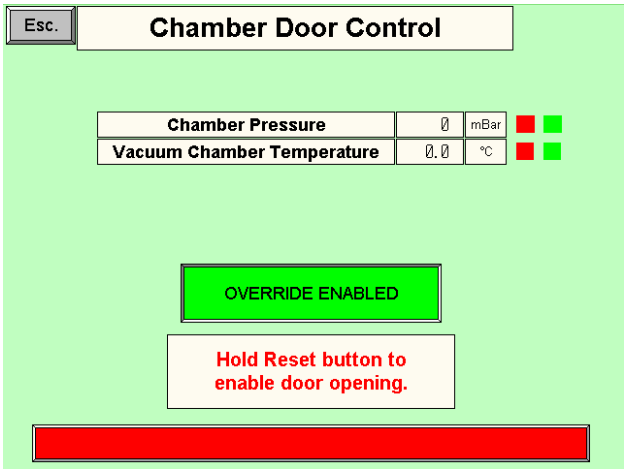


Fig CHAMBER DOOR CONTROL PAGE-INTERLOCK DISABLED

- The (Hold Reset button to enable door opening) instruction is displayed. The button text changes to (OVERIDE ENABLED) and background changes to green when complete.
- To enable opening of the chamber door depress and hold the blue RESET BUTTON situated below the HMI shown in the image on page 67.
- Open the top door (containing the viewing port) to access the top chamber.

Fig HMI,RESET BUTTON (BLUE) , EMERGENCY STOP BUTTON LOCATION

- Select a suitable substrate plate of the material type required for the build ensuring it is machined clean to a within a ~30µm surface roughness.
- Measure the thickness of the plate this figure will be required in setting up the zero position of the elevator
- Fix the substrate plate on the table after making a note of the thickness.
- Input the measured size in the input box in the wiper elevator control page.
- Once the table height is set the substrate thickness offset value can be entered.
- Ensure that any tools and fixings etc have not been left in either of the chambers .
- Close and secure the top and bottom chamber access doors.
- On Door control Page. Select <OVERRIDE ENABLED>
- Override button will become grey and change sense to read (DOOR INTERLOCK OVERRIDE DISABLED)
- To operate the equipment all safety devices must be in place and any Alarm messages need to be cleared. Unlatch the Emergency Stop button if depressed.
- A safety relay hardwired into the electrical control system will only operate when all the safety devices are made and Alarm messages are cleared. To enable the safety relay depress the blue RESET button for at least a second.
- Select < ESC> to continue to previous page

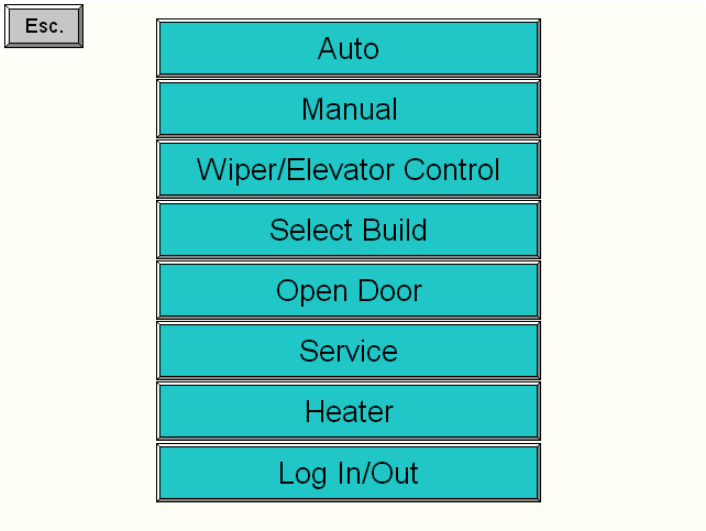


Fig MENU PAGE LEVEL 1

- If the build table is required to be heated as part of a particular build then
- Heating can be started when the E. Stop has been reset, the table is NOT over temperature and there is NO (ELEVATOR HEATER TEMP SENSOR ERROR!) alarm.
- Select < Heater>. (Note that the external housing surrounding the table relies on conduction from the table to bring it to temperature. Both components must be thoroughly soaked to allow for uniform expansion of the two components before attempting moving the table. An insufficient soak time will result in the table seizing or sticking in its housing.)

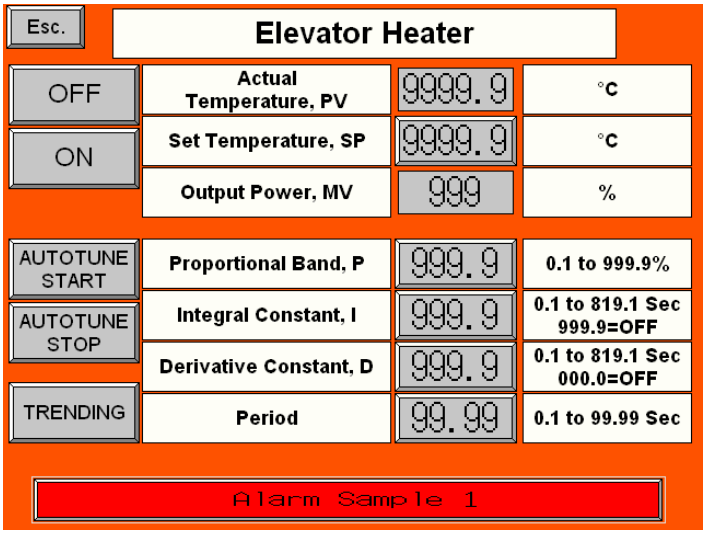


Fig TABLE HEATER CONTROL PAGE LEVEL 1

- Select Set Temperature, SP < 9999.9 >

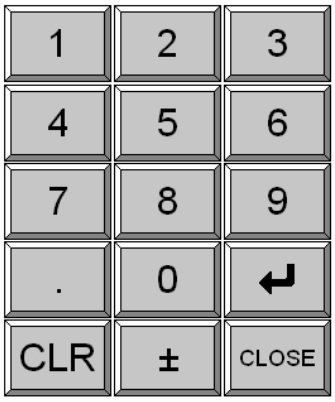


Fig NUMERICAL KEYBOARD OVERLAID ON TABLE HEATER CONTROL PAGE

- The keyboard is overlaid on the Table Heater page
- Operator keys in Set Temperature, SP < ###. ###> Temperature in °C (0 – 150°C)
- Select <↵ > to confirm entry

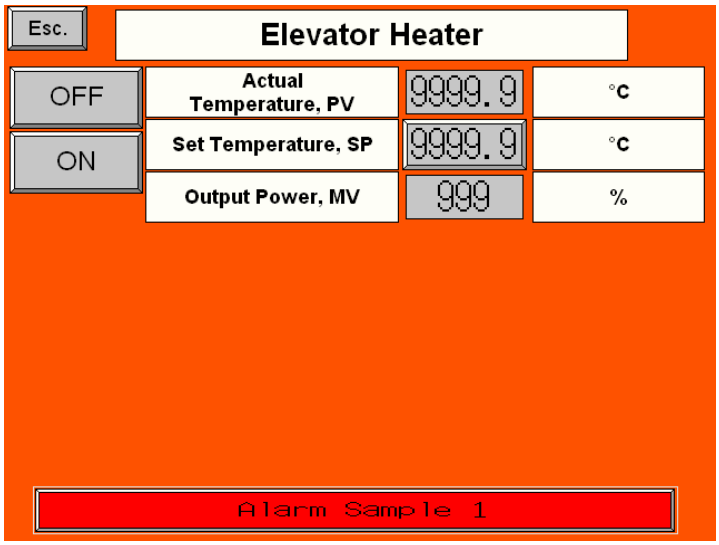


Fig TABLE HEATER CONTROL PAGE LEVEL 1

- (OFF) button is initially red after E.Stop is made healthy (reset).
- Select <ON> to run heater. (OFF) button changes to grey and (ON) button changes to green.
- Actual Temperature, PV is displayed (0 – 250 °C)
- Output Power, MV is displayed (0 – 100 %)
- Select < ESC> to continue to previous page.

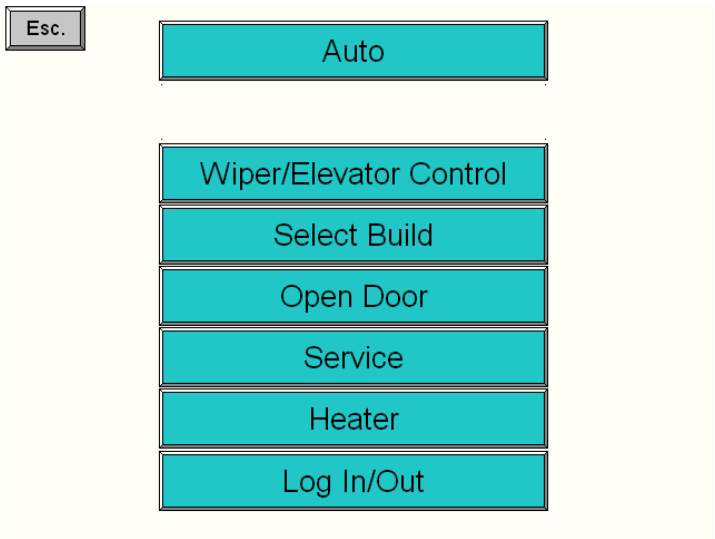
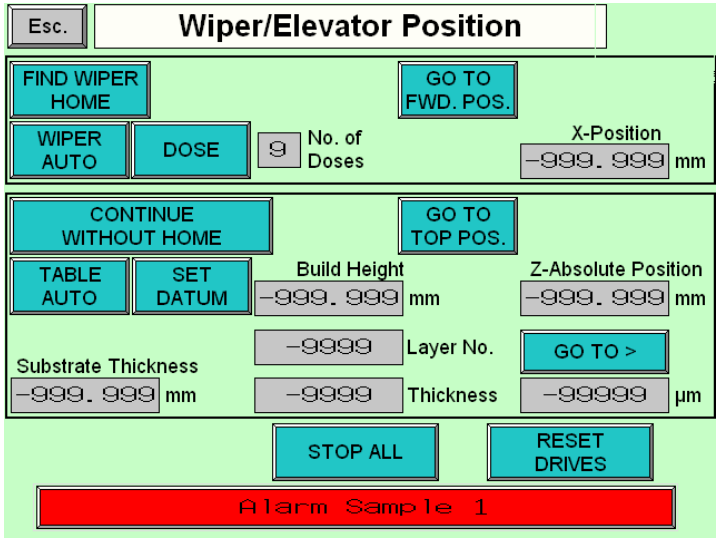


Fig MENU PAGE LEVEL 1

- For initial set up procedure

Select < Wiper/Table Control>

FUNCTION KEY DESCRIPTIONS IN LEVEL 1 SET UP PAGE



MACHINE SET UP PAGE - LEVEL 1

- Select < *STOP ALL* >.Stops any function during its cycle
- The (CONTINUE WITH OUT HOME) button is only displayed with the E-Stop operated. This gives the operator the option of continuing from the current table position after E-Stop has been operated. Note that the wiper will always have to find HOME following E-Stop operation.

MACHINE SET UP PAGE (FIND "HOME") - LEVEL 1

- The (FIND TABLE HOME) button becomes visible when the E-Stop is healthy.
- All function keys enclosed by the upper boarder relate to WIPER FUNCTION (X-Position movement)
- & DOSING of metal powder
- All function keys enclosed by the lower boarder relate to TABLE FUNCTION (Z-Position movement)
- The **wiper** must always be "Homed" on start up.
- (FIND WIPER HOME) will "flash" Red to indicate that the **wiper** needs to "find" the "Home" position .It will continue to "flash" until the **wiper** is "Homed".
- Select <FIND WIPER HOME >. This allows the **wiper** to find its "Home" sensor stop position datum on initial start up or after a fault such as power failure or Emergency Stop operation. The wiper home sequence is
- The **wiper** moves slowly towards the back of the chamber.
- The **wiper** stops when the home proximity switch detects the wiper.
- The **wiper** moves forward until the home proximity switch is clear again.
- The **wiper** stops.
- The home sequence is complete

- Select <Substrate Thickness >

Fig NUMERICAL KEYBOARD OVERLAID ON SET UP PAGE

- The keyboard is overlaid on the Wiper/Table Position page
- Operator keys in Substrate (Plate) < ###. ###> Thickness in mm
- Select < ↵ > to confirm entry
- The overlaid keyboard is deleted and the Wiper/Table Position page becomes active.
- The Substrate Thickness is displayed. (This is the thickness of the plate bolted to the table in mm)
- Select <GO TO TOP POS> .The **table** rises so that the substrate plate is flush with the floor of the top chamber. The button changes to red to indicate that the move is complete.
- Select <SET DATUM>. When the datum has been set the plate will be elevated such that there is minimal clearance between the wiper and the top of the substrate plate. NOTE If the substrate plate thickness values entered are incorrect then the wiper and drive mechanism may be damaged. On selection the key will turn from Blue to Red.
- Note that the user can reselect <SET DATUM> to unselect the datum .The key reverts to Blue.
- Select < *GO TO FWD* POSN >. This moves the wiper directly to the most forward X-Position towards the chamber door. Excess metal powder is discharged into the front discharge chute in the floor of the top chamber. The button changes to red to indicate that the move is complete.
- Select < *No. of Doses* >. The number of doses can be selected so that a thick layer of metal powder can be created by repetitive dosing .In instances where substrate plates are smaller than the table; a “moat” is formed around the substrate plate. A layer of powder needs to accumulate behind the substrate plate so that the “moat” is filled. It is not necessary to completely fill the “moat” sides and front sections.
- The keyboard is overlaid on the Wiper/Table Position page
- Operator keys in required number of doses < # > .Enter a value between 1 & 9
- Select < ↵ > to confirm entry
- The overlaid keyboard is deleted and the Wiper/Table Position page becomes active.
- The number of doses is displayed.

- Select < *DOSE* >. This automates the dosing procedure whereby the wiper moves to the load position. A dose of powder is discharged in front of the wiper blade .The metal powder is the pushed and spread to the home position. The cycle is repeated if the < *No. of Doses* > is greater than 1.When dosing is complete the (DOSE) button changes to red to indicate that the required number of cycles is complete.
- Select < *WIPER AUTO* >. This automates the dosing and spreading procedure whereby the wiper traverses the top chamber floor to the load position. A dose of powder is discharged in front of the wiper blade. The metal powder is the pushed and spread to the forward position. Excess metal powder is discharged into the front discharge chute in the floor of the to chamber. The wiper stops at the forward position. When the automatic sequence is complete the (WIPER AUTO) button changes to red to indicate that the sequence is concluded
- Once the set up conditions are correct the operator can move on to the automated build process.
- Select < ESC> to continue to previous page

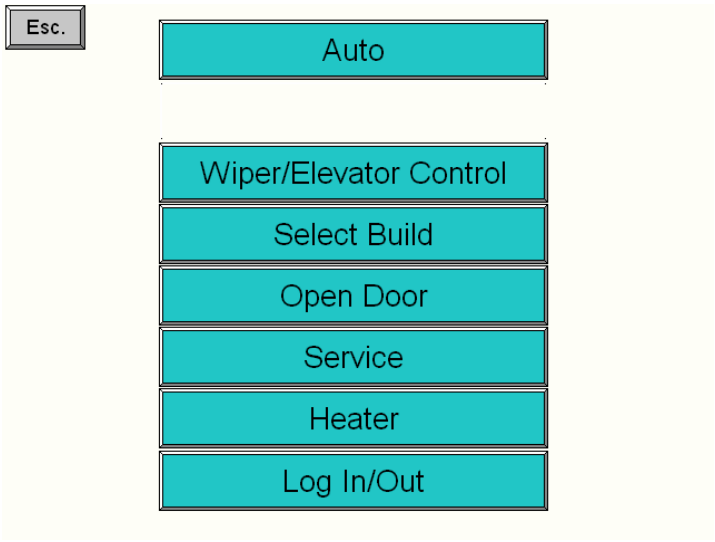


Fig MENU PAGE LEVEL 1

- Select <Select Build>

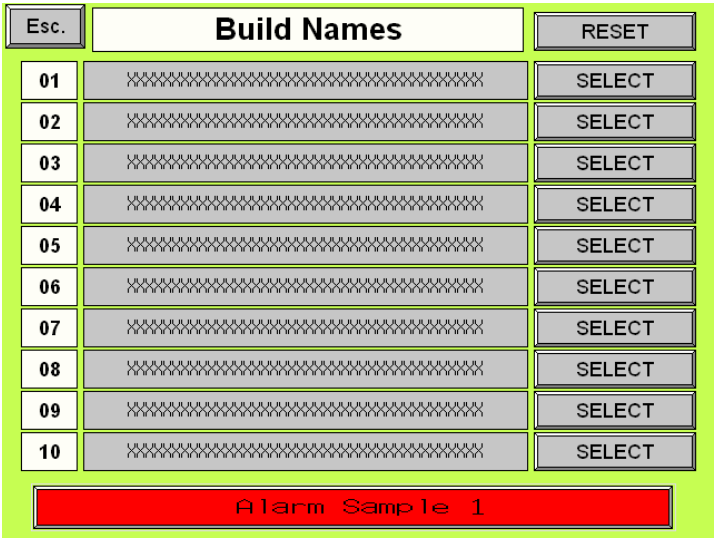


Fig BUILD MENU PAGE

- Select the required ## Build Name < SELECT> to choose the required component from the files in the shared folders
- Select < ESC> to continue to previous page

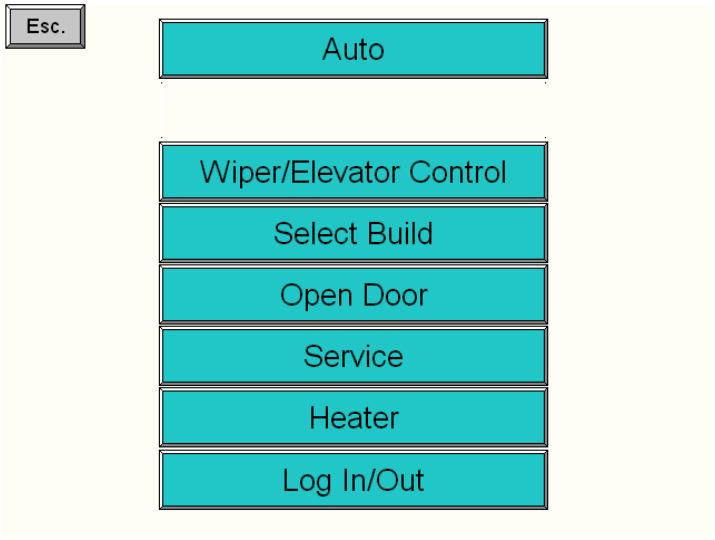


Fig MENU PAGE LEVEL 1

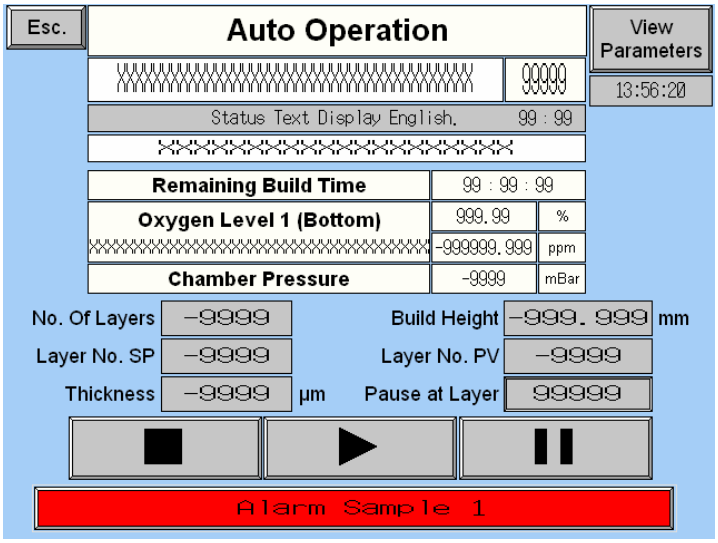
- Select < Auto> to go to automatic operation page
- Before the cycle starts a page prompt will be displayed to confirm “Filter valves opened and pressure zeroed”.

PROMPT PAGE- LEVEL 1

- The prompt page appears
- Manually open valves either side of the filter housed in the right hand side of the cabinet if not open

Fig SAFE CHANGE FILTER WITH ISOLATING VALVES SHOWN IN OPERATING CONDITION

- Return to operators screen and:
- Select <YES> .Automatic operation is displayed.



AUOTMATIC OPERATION PAGE- LEVEL 1

- Select < ■ >. Automatic cycle will stop (see later section)
- Select < ▶ >. Automatic cycle will commence .Button turns green and cycle starts
- Select < ❙❙ >. Automatic cycle will pause
- Select <View Parameters>.

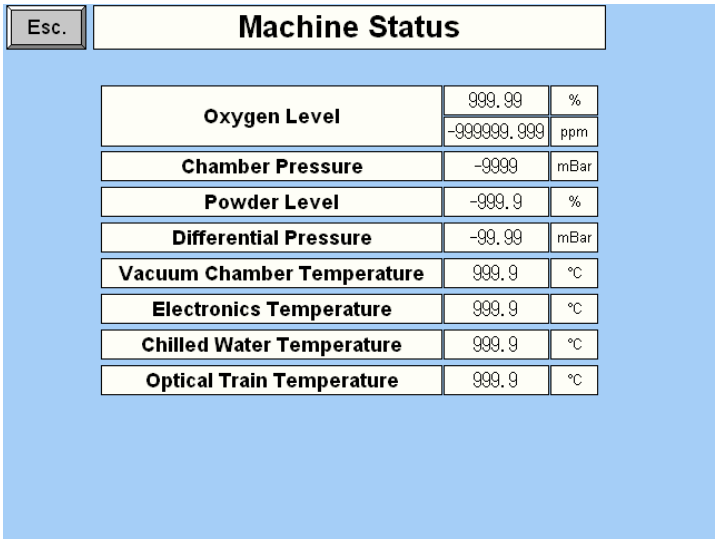


Fig MACHINE STATUS PAGE

- This page is for reference only during an operation cycle. No parameters can be changed.
- Select < ESC> to continue to previous page
- Note that these parameters can be viewed at any time during the cycle.

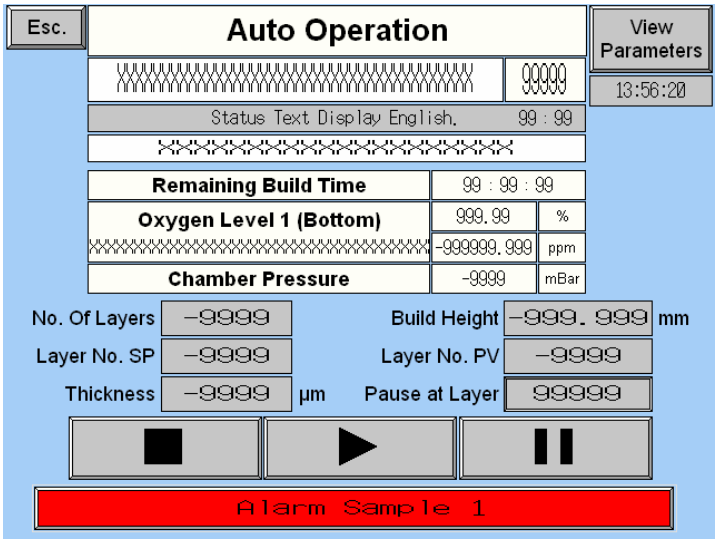


Fig AUOTMATIC OPERATION PAGE- LEVEL 1

- Select < ▶>. Automatic cycle will commence.
- (No. Of Layers) indicates the total number of layers required to complete build
- (Build Height) indicates the current height of the build in progress
- (Layer No. SP (*Set Point*)) indicates the layer stored in the memory
- (Layer No. PV (*Process Variable*)) indicates the current layer in build
- (Thickness)indicates the selected layer thickness in µm

CREATING & PROVING THE INERT ATMOSPHERE

The vacuum pump removes the air from the system, which is vented to atmosphere. A vacuum sensor will determine when the required vacuum has been reached. The system is then backfilled with Argon shielding gas until the system pressure has attained 10mbarg. Run the vacuum pump for XX seconds to evacuate the filter/exhaust chamber of air. The system is vented further by the addition of Argon Shielding gas which is maintained between 2-10mbarg. An Oxygen sensor will determine when the required maximum 0.1% Oxygen level has been attained so that venting can cease. The vacuum pump is reconfigured using automated valves which allow it to act as a circulation pump. Oxygen levels may rise as trapped Oxygen is freed from the system. Further venting and purging with Argon Shielding gas takes place takes place to achieve the maximum 0.1% Oxygen level. The inert atmosphere is then proved for a period of 5mins.Venting will cease. The system atmosphere is then maintained at 2-10mbarg through out the process.

BUILD START

The laser fires and the first layer is created. This fuses to the top of the substrate plate. The table is lowered automatically. The next layer of powder is added. The laser fires to create the next layer which is fused to the first layer. The process repeats until the build is complete.

BUILD CONCLUSION

Towards the end of the cycle a page prompt will be displayed to “Isolate safe Change Filter”.

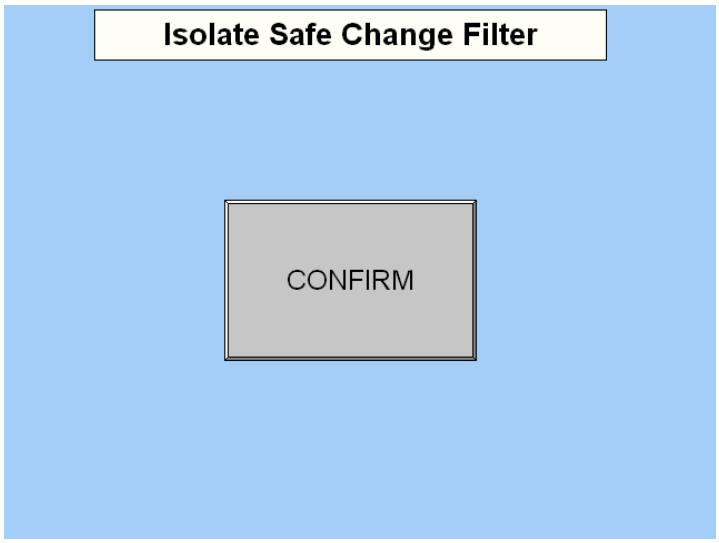


Fig SAFE CHANGE FILTER ISOLATION PAGE

Manually shut valves either side of the filter housed in the right hand side of the cabinet

Fig SAFE CHANGE FILTER WITH ISOLATING VALVES SHOWN IN CLOSED CONDITION

Return to operators screen and:

Select <CONFIRM>

Screen reverts to Auto Operation

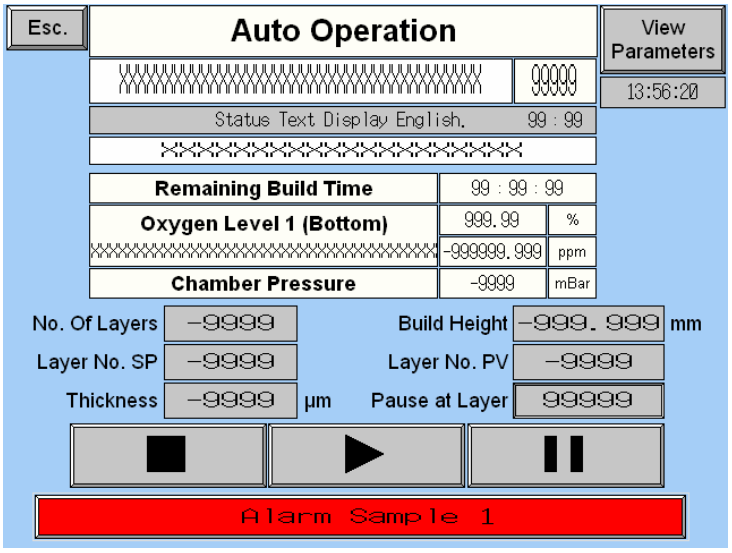


Fig AUOTMATIC OPERATION PAGE- LEVEL 1

Upon completion “Auto Cycle Complete” prompt page appears

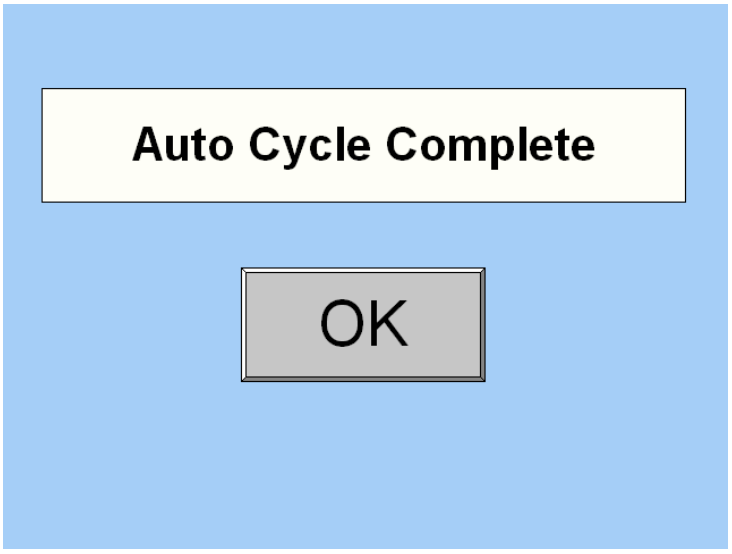


Fig CONFIRM AUTOMATIC CYCLE COMPLETE PAGE

Select <OK>

The process is complete. The chamber pressure is automatically equalised

Menu page is displayed

Follow door opening procedure to remove component and substrate plate

OTHER FEATURES AT LEVEL 1

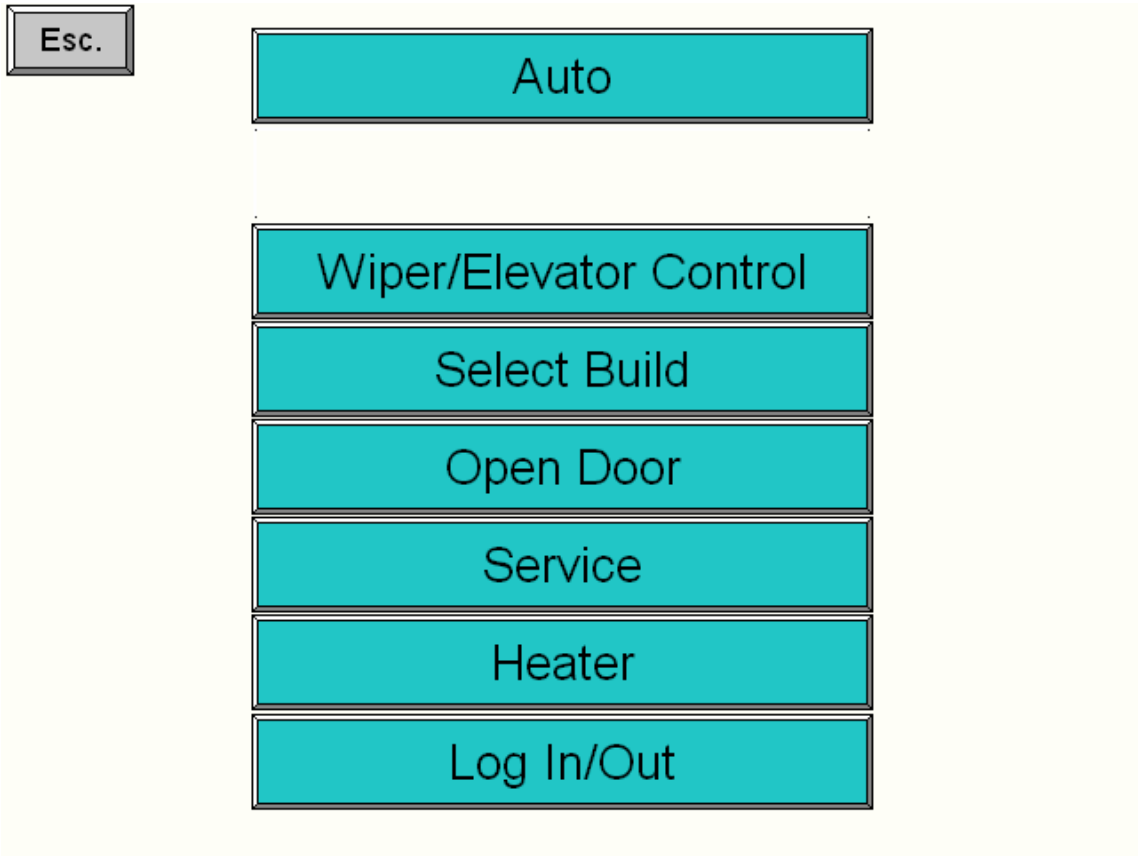


Fig MENU PAGE LEVEL 1

Select<Service>

SERVICE MENU

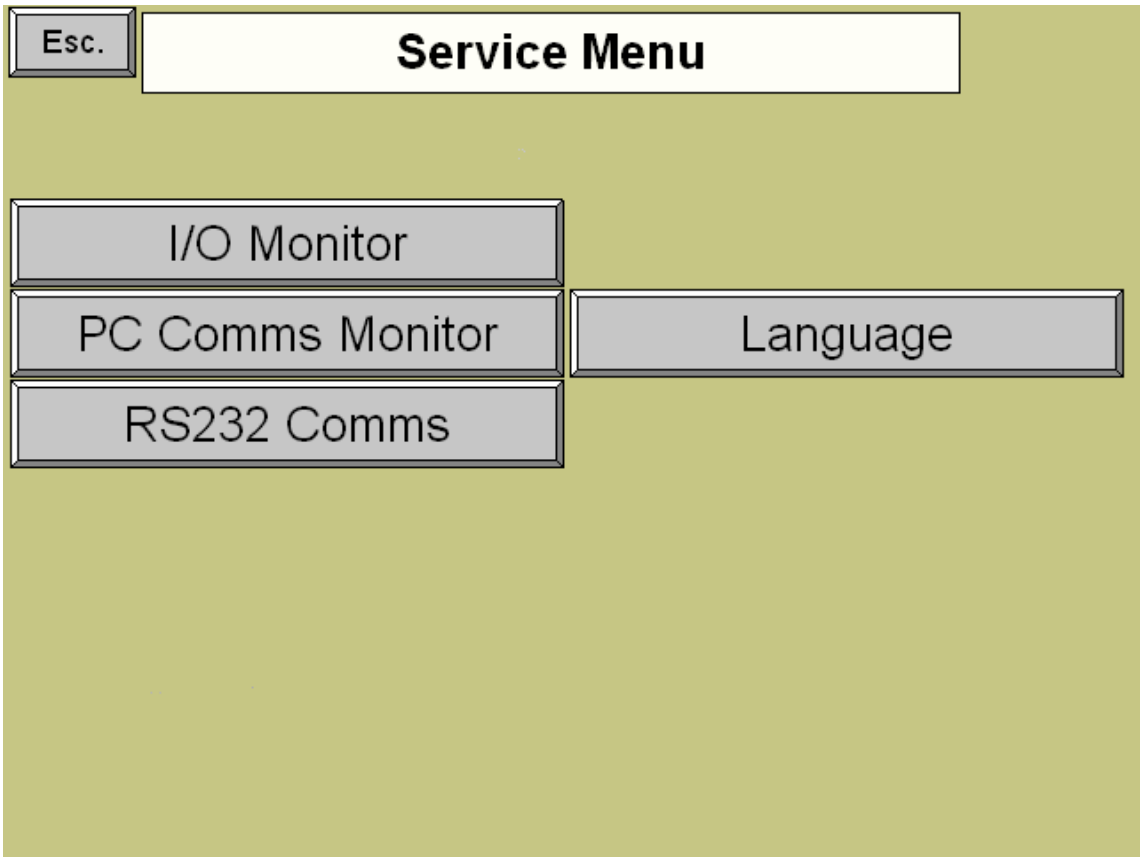


Fig SERVICE - LEVEL 1

See Descriptions at Level 3

USING AUTOMATIC CYCLE STOP

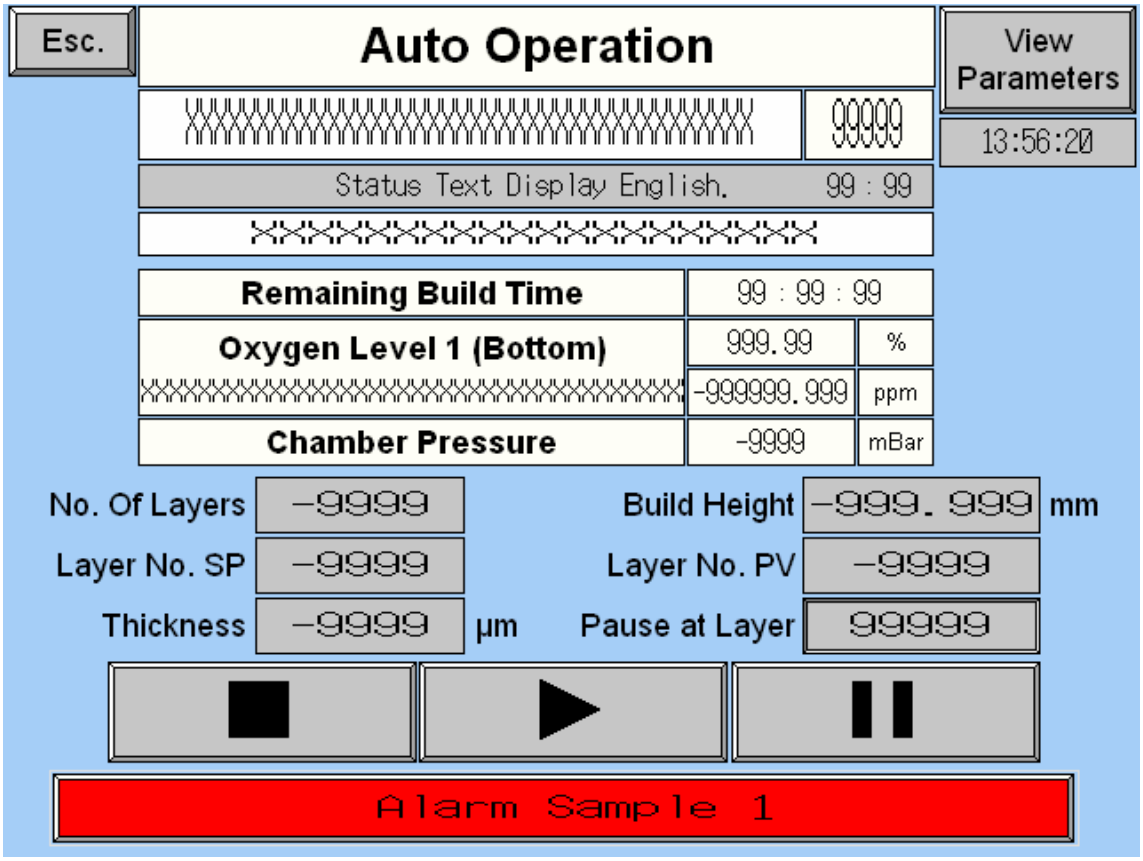


Fig AUOTMATIC OPERATION PAGE- LEVEL 1

Select < ■ >. Automatic cycle will stop

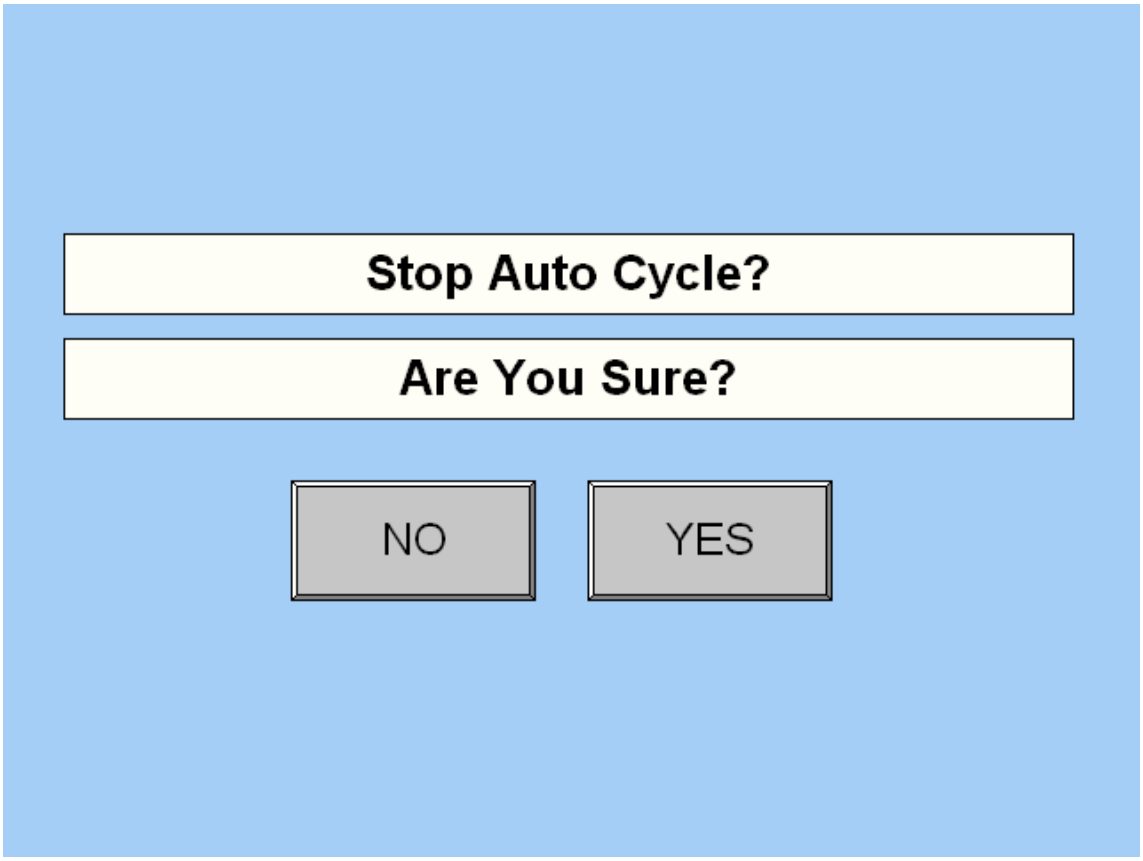


Fig CONFIRM STOP AUTOMATIC SEQUENCE PAGE

Prompt page appears:

Select <NO> to revert to Automatic Operation page

Select <YES> to discontinue the cycle. Note that the cycle cannot be recommenced once cycle stop has been confirmed

ADDITIONAL FUNCTIONS AVAILABLE AT LEVEL 2

At Level 2 access all Level 1 functions are available. However there are additional functions available

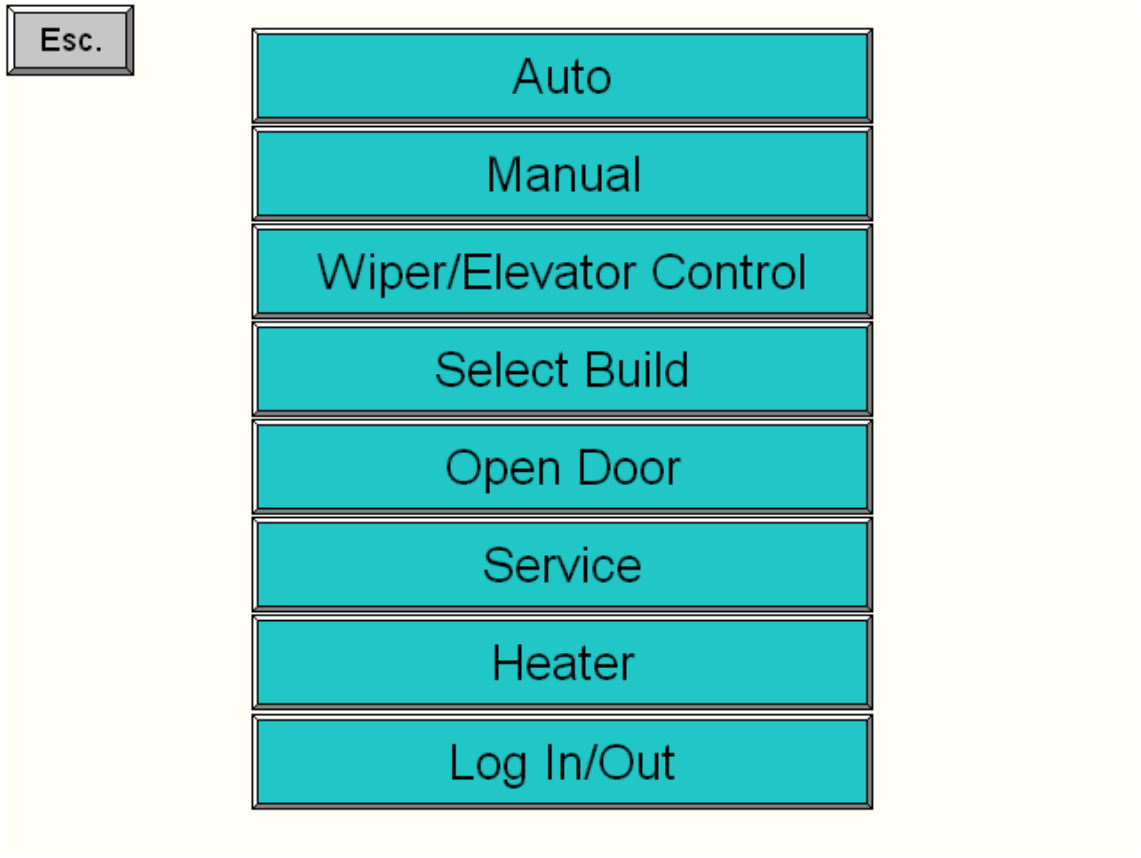


Fig AUOTMATIC OPERATION PAGE- LEVEL 2

Select<Auto>

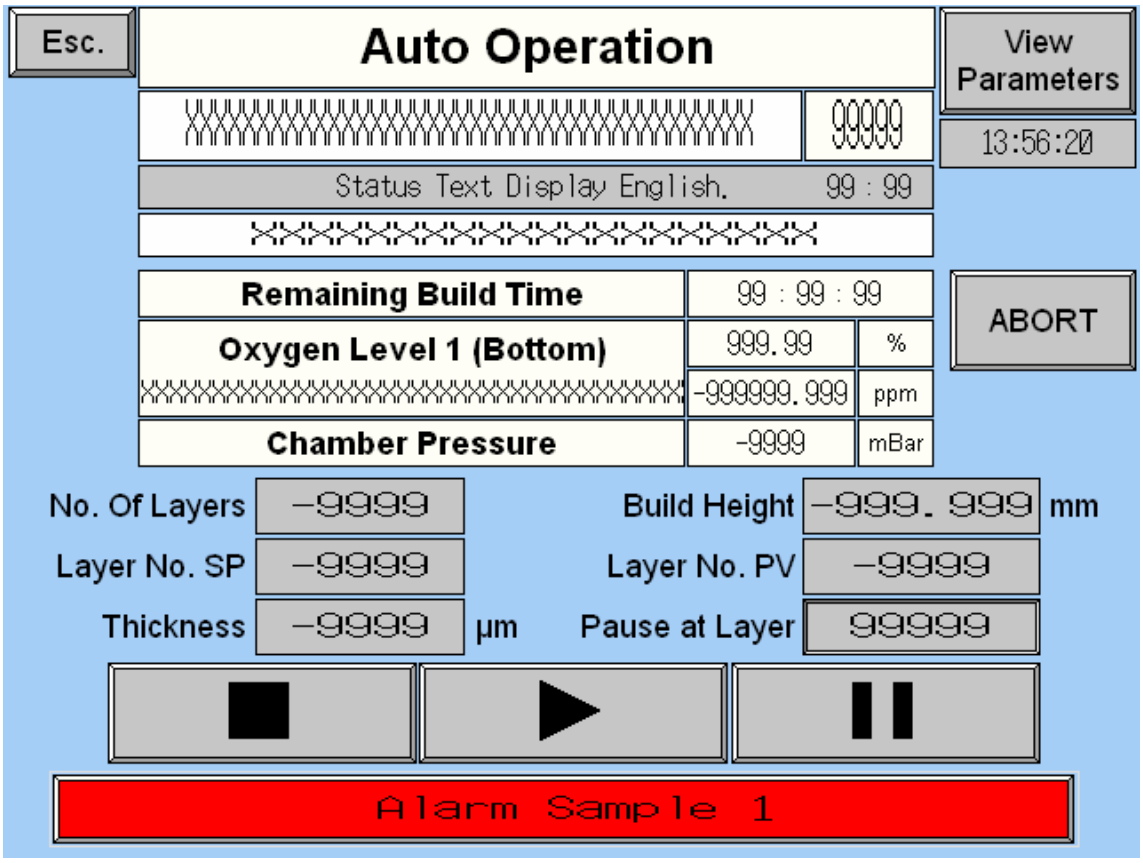


Fig AUOTMATIC OPERATION PAGE- LEVEL 2

From Auto Operation Page during the build

Select <Pause at Layer>.

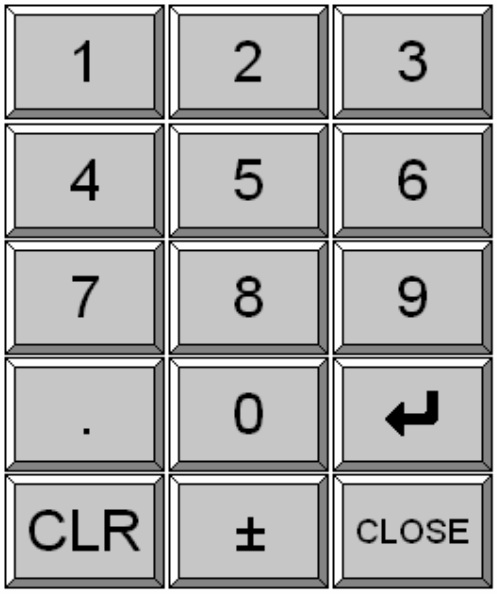


Fig NUMERICAL KEYBOARD OVERLAID ON AUTO OPERATION PAGE

The keyboard is overlaid on the Auto Operation page

Operator keys in Layer Number < ###> at which a pause is initiated

Select <↵ > to confirm entry.

The overlaid keyboard is deleted and the Auto Operation page becomes active.

The SLM will automatically reach the indicated layer and pause.

By reselecting <Pause at Layer> the user can either recommence the build by selecting a higher layer than previously selected or “switch off” the <Pause at Layer > function by selecting a value of Zero

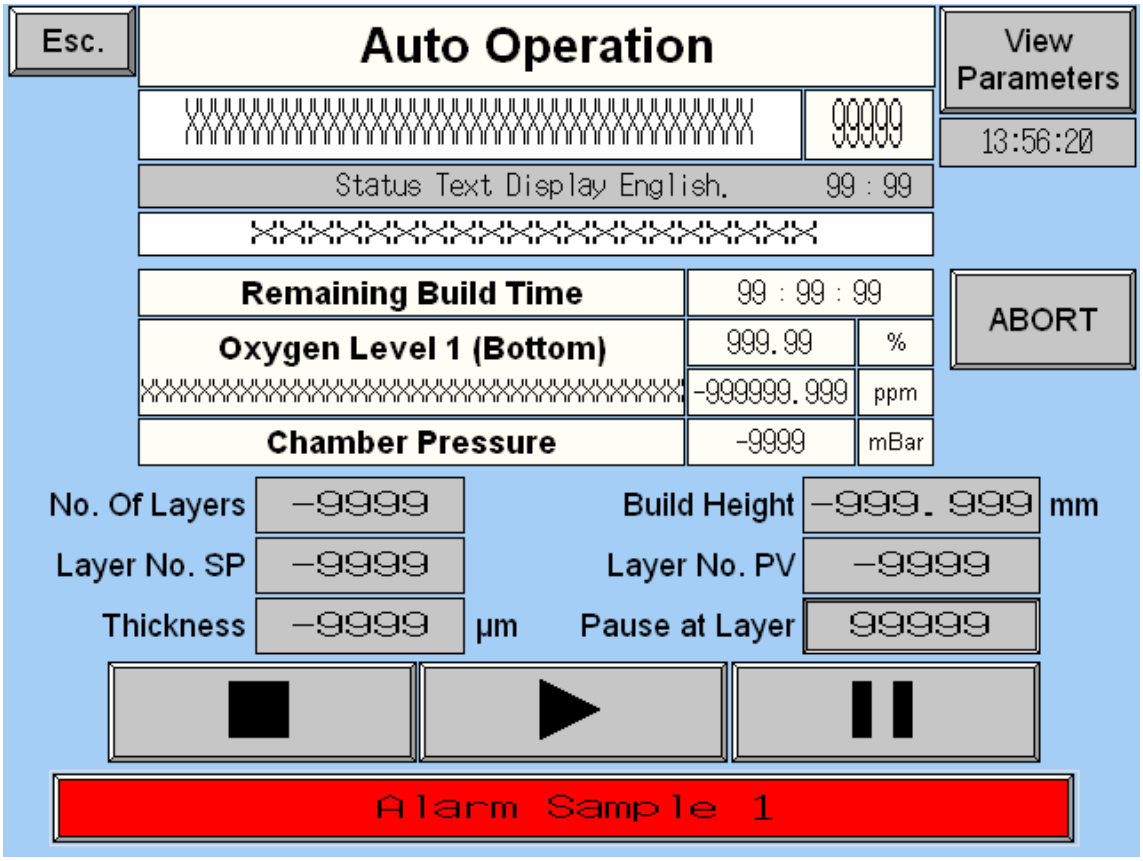


Fig AUTOMATIC OPERATION PAGE- LEVEL 2

From Auto Operation Page

If the E.Stop is healthy then the ABORT button becomes visible in Level 2

Select <ABORT>.

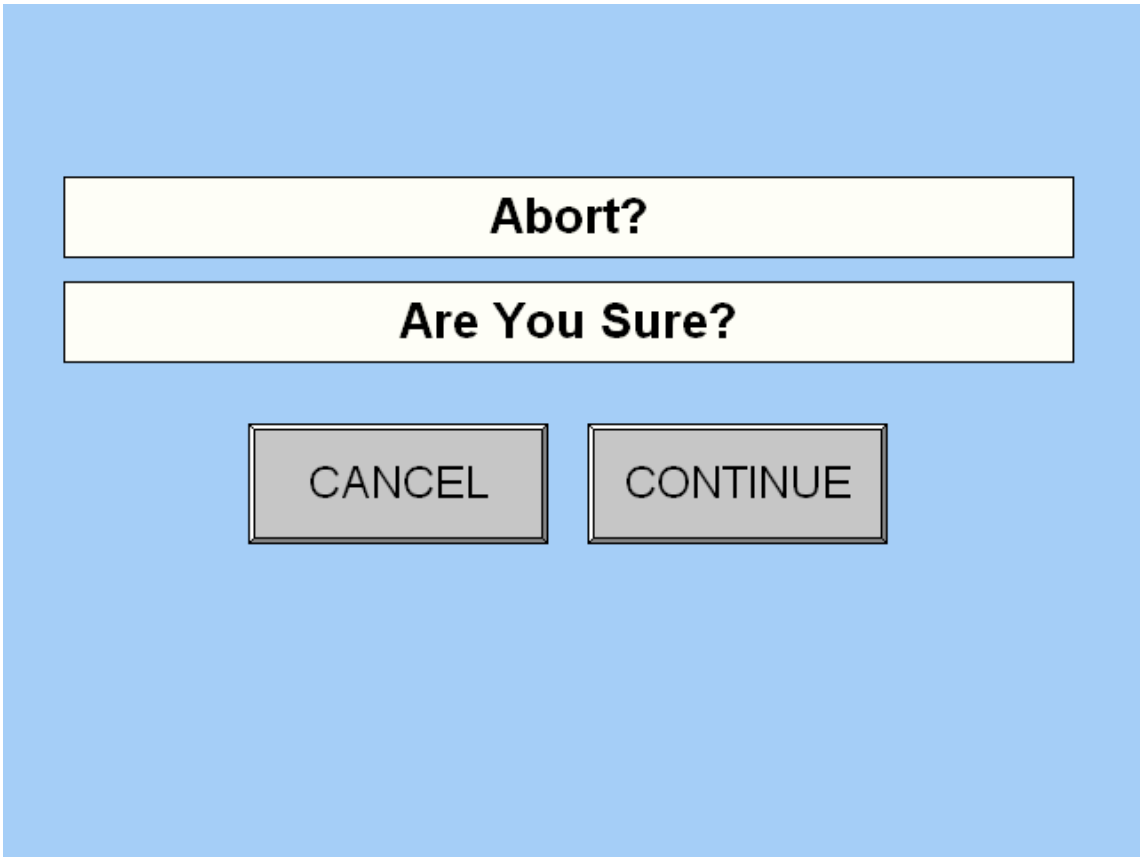


Fig ABORT PROMPT PAGE- LEVEL 2

Prompt page appears:

Select <CANCEL> to revert to Automatic Operation page

Select <CONTINUE> to abort the cycle. Menu page is automatically displayed

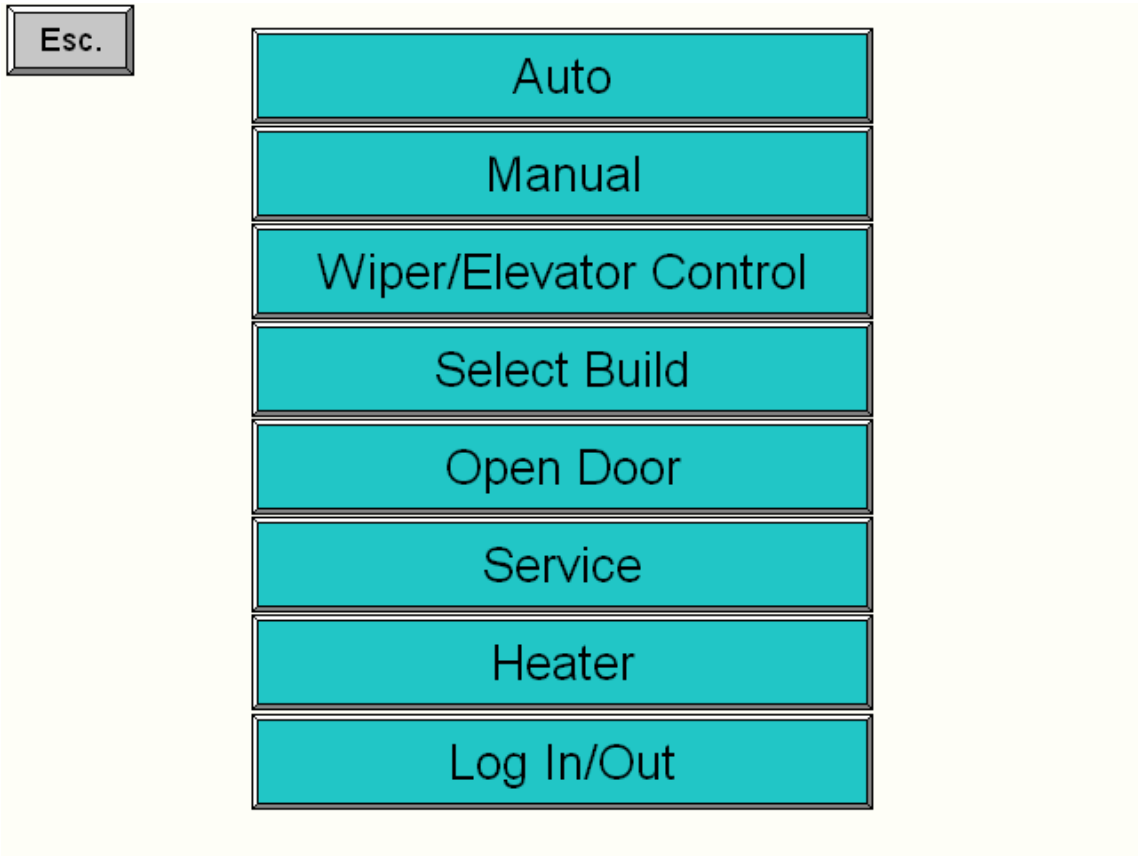


Fig MENU PAGE- LEVEL 2

Select<Auto>

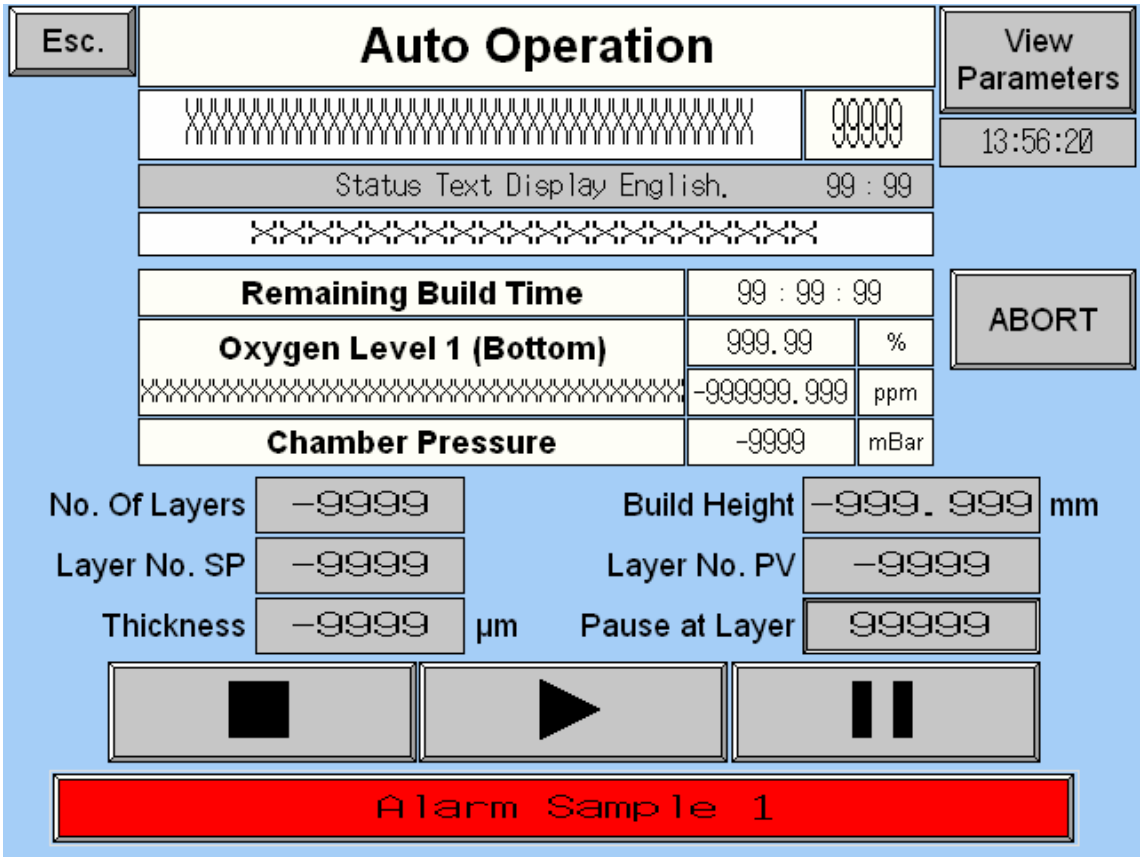


Fig AUOTMATIC OPERATION PAGE- LEVEL 2

To access alarm messages select the <Alarms> red oblong key at the bottom of the page

Fig ALARM MESSAGES PAGE- LEVEL 2 USER

Select < ESC> to continue to previous page

Select <Alarm History>

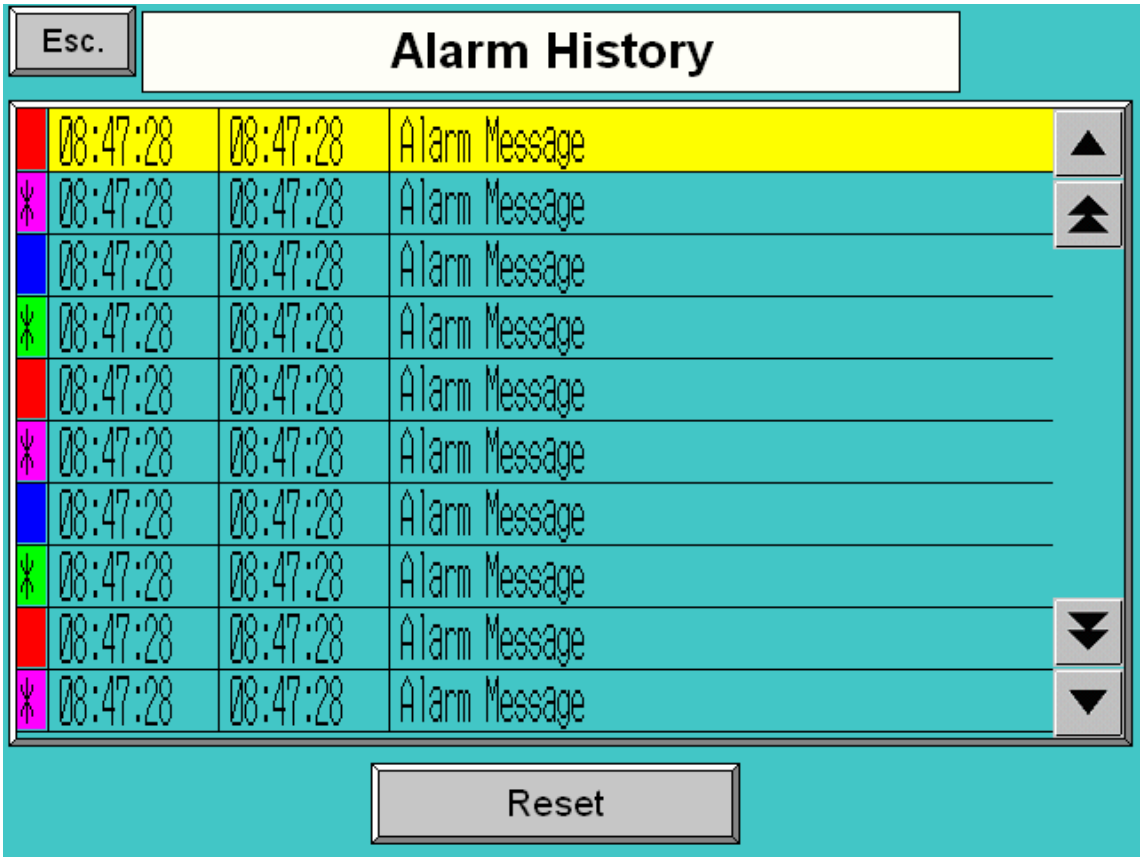


Fig ALARMS HISTORY PAGE & LEVEL 2 USER

Select < ESC> to continue to previous page

Before the system can be started alarm messages need to be resolved then reset

Select <Reset> button on either Alarms or Alarms History page

LIST OF AVAILABLE ALARM MESSAGES

Address	Label(English)Alarm Message	
SERIALA:00040.00	EMERGENCY STOP OPERATED!	1, Removes power from servo drives 2, Resets Home routines 3, Stops Pump
SERIALA:00040.01	PC COMMS ERROR!	Message Only
SERIALA:00040.02	CHAMBER TEMP SENSOR ERROR!	Message Only
SERIALA:00040.03	ELEVATOR HEATER TEMP SENSOR ERROR!	Message Only
SERIALA:00040.04	ELECTRONICS TEMP SENSOR ERROR!	Message Only
SERIALA:00040.05	CHILLED WATER TEMP SENSOR ERROR!	Message Only
SERIALA:00040.06	OPTICAL TRAIN TEMP SENSOR ERROR!	Message Only
SERIALA:00040.07	SPARE LOOP TEMP SENSOR ERROR!	Message Only
SERIALA:00040.08	O^2 SENSOR 1 ERROR!	Message Only
SERIALA:00040.09	O^2 SENSOR 2 ERROR!	Message Only (Not Fitted)
SERIALA:00040.10	CHAMBER PRESSURE SENSOR ERROR!	Message Only
SERIALA:00040.11	POWDER LEVEL SENSOR ERROR!	Message Only
SERIALA:00040.12	DIFF PRESSURE SENSOR ERROR!	Message Only
SERIALA:00040.13	ARGON FLOW RATE SENSOR ERROR!	Message Only
SERIALA:00040.14	PARTICLE SENSOR ERROR!	Message Only
SERIALA:00040.15	CHILLED WATER FLOW SENSOR ERROR!	Message Only
SERIALA:00041.00	WIPER SERVO NOT READY!	Wiper Servo Will Not operate
SERIALA:00041.01	TABLE SERVO NOT READY!	Table Servo Will Not operate
SERIALA:00041.02	WIPER SERVO ALARM!	Wiper Servo Will Not operate
SERIALA:00041.03	TABLE SERVO ALARM!	Table Servo Will Not operate
SERIALA:00041.04	LAYER NUMBER ERROR!	Message Only
SERIALA:00041.05	HIGH CHILLED WATER TEMP!	Chilled water must <248C Pause build if running Auto reset when temp is <248C Restart build is initiated by user
SERIALA:00041.06	Alarm23!	
SERIALA:00041.07	Alarm24!	
SERIALA:00041.08	Alarm25!	
SERIALA:00041.09	Alarm26!	
SERIALA:00041.10	Alarm27!	
SERIALA:00041.11	Alarm28!	
SERIALA:00041.12	Alarm29!	
SERIALA:00041.13	Alarm30!	
SERIALA:00041.14	Alarm31!	

ALARM MESSAGES LIST -ALL USER LEVELS

Address	Label(English)Alarm Message	
SERIALA:00041.15	Alarm32!	
SERIALA:00042.00	PLC BATTERY LOW!	Message Only
SERIALA:00042.01	HMI BATTERY LOW!	Message Only
SERIALA:00042.02	VACUUM CHAMBER OVERTEMPERATURE!	Message Only
SERIALA:00042.03	ELEVATOR OVERTEMPERATURE!	Message Only
SERIALA:00042.04	ELECTRONICS CABINET OVERTEMPERATURE!	Message Only
SERIALA:00042.05	CHILLED WATER OVERTEMPERATURE!	Message Only
SERIALA:00042.06	OPTICAL TRAIN OVERTEMPERATURE!	Message Only
SERIALA:00042.07	SPARE LOOP OVERTEMPERATURE!	Message Only
SERIALA:00042.08	Alarm41!	
SERIALA:00042.09	Alarm42!	
SERIALA:00042.10	Alarm43!	
SERIALA:00042.11	Alarm44!	
SERIALA:00042.12	Alarm45!	
SERIALA:00042.13	Alarm46!	
SERIALA:00042.14	Alarm47!	
SERIALA:00042.15	Alarm48!	
SERIALA:00043.00	Alarm49!	
SERIALA:00043.01	Alarm50!	
SERIALA:00043.02	Alarm51!	
SERIALA:00043.03	Alarm52!	
SERIALA:00043.04	Alarm53!	
SERIALA:00043.05	Alarm54!	
SERIALA:00043.06	Alarm55!	
SERIALA:00043.07	Alarm56!	
SERIALA:00043.08	Alarm57!	
SERIALA:00043.09	Alarm58!	
SERIALA:00043.10	Alarm59!	
SERIALA:00043.11	Alarm60!	
SERIALA:00043.12	Alarm61!	
SERIALA:00043.13	Alarm62!	
SERIALA:00043.14	Alarm63!	
SERIALA:00043.15	Alarm64!	

ALARM MESSAGES PAGE LIST CONTINUED -ALL USER LEVELS

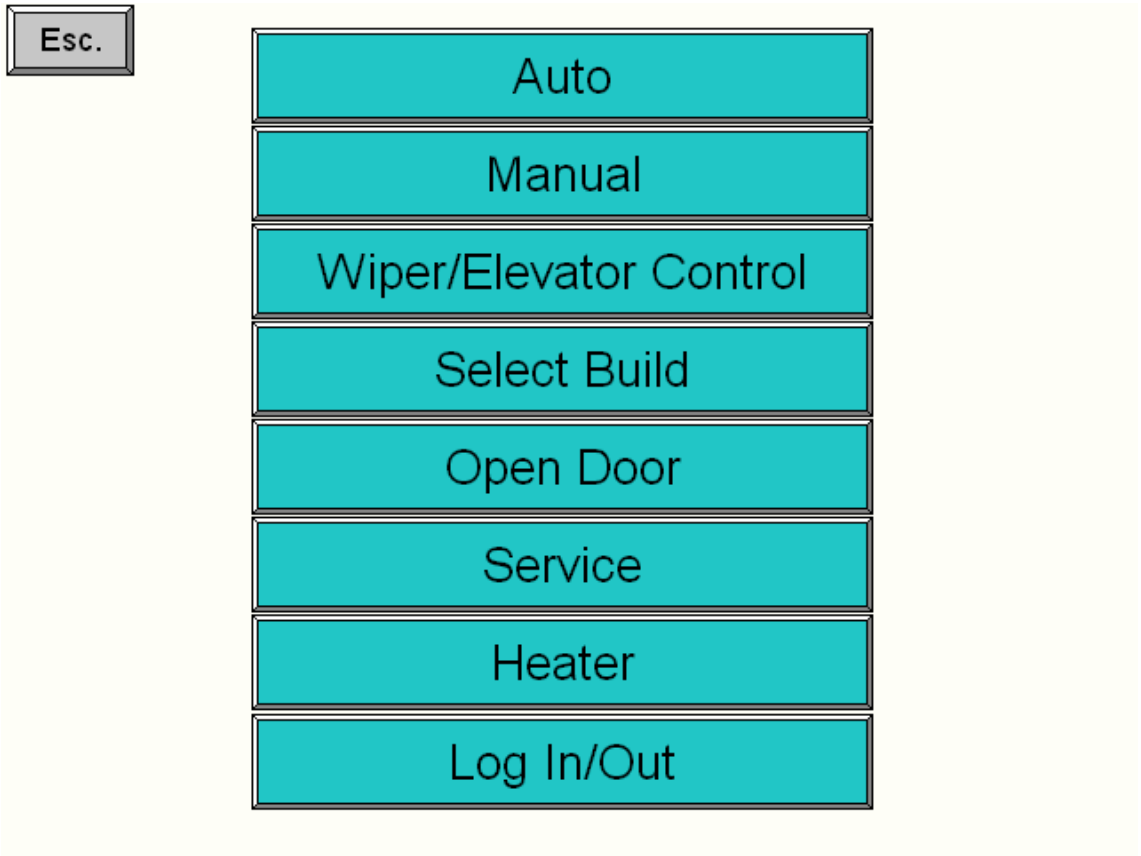


Fig MENU PAGE- LEVEL 2

Select<Manual>

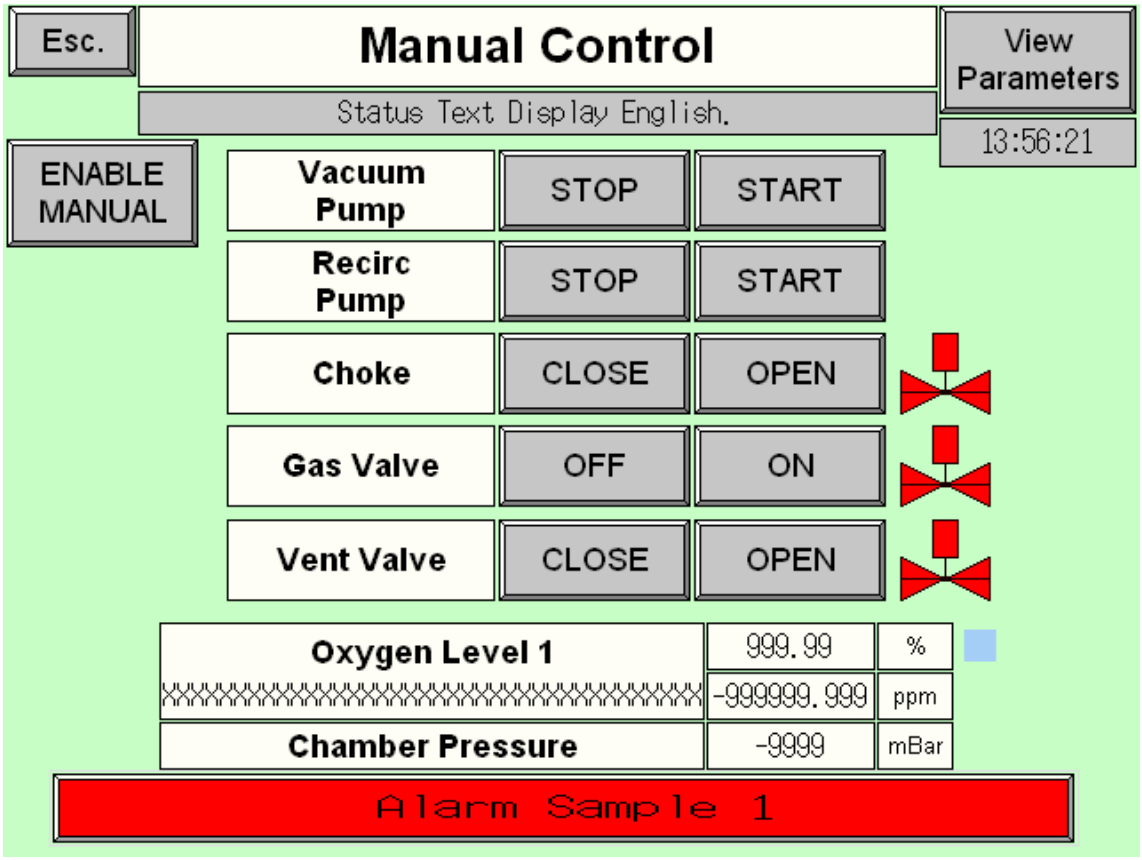


Fig MANUAL CONTROL PAGE- LEVEL 2

Select <ENABLE MANUAL> to allow the listed functions to be operated independently. Manual enable button changes from grey to green and button changes to (MANUAL ENABLED).

On screen buttons will become active and any listed item can be operated out of sequence. Note that using these screen buttons may inadvertently cause damage to the equipment depending on its state of operation.

ADDITIONAL FUNCTIONS AVAILABLE AT LEVEL 3

At Level 3 access all Level 2 functions are available. However there are additional functions available

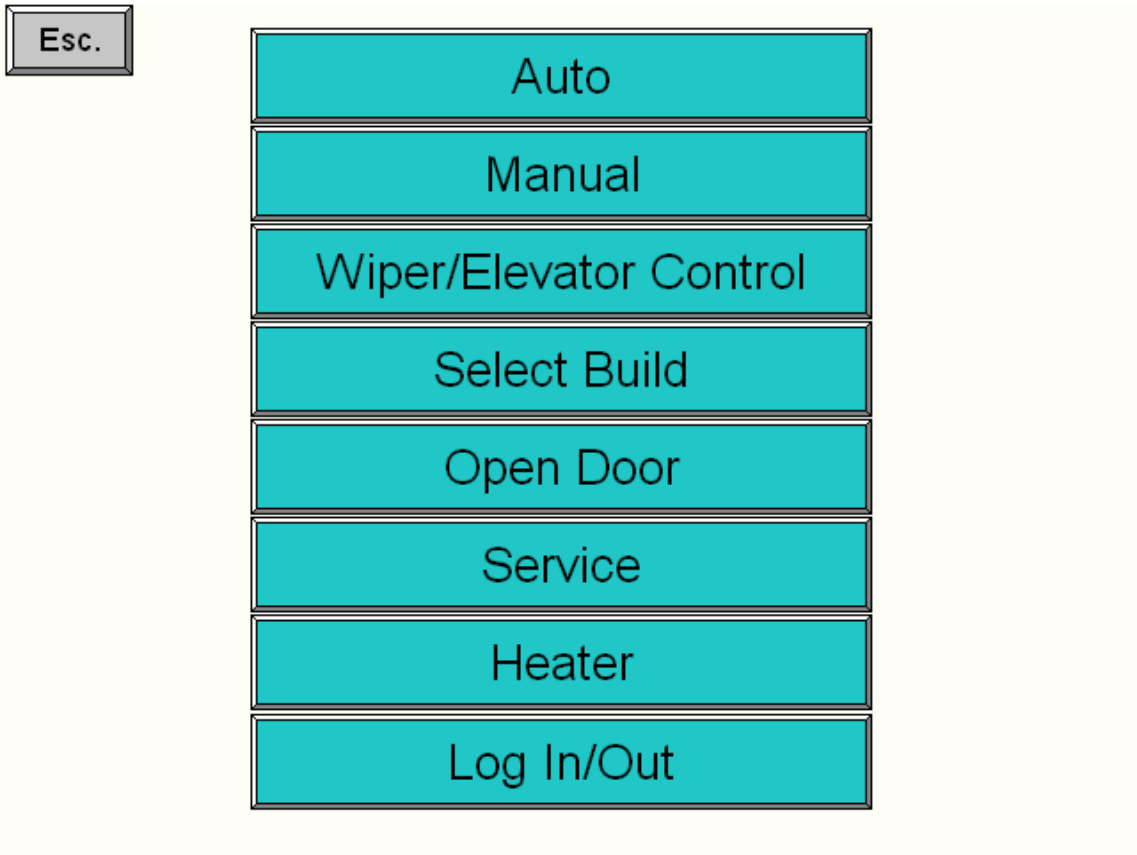


FIG MENU PAGE - LEVEL 3

From Menu Page select<Open Door>

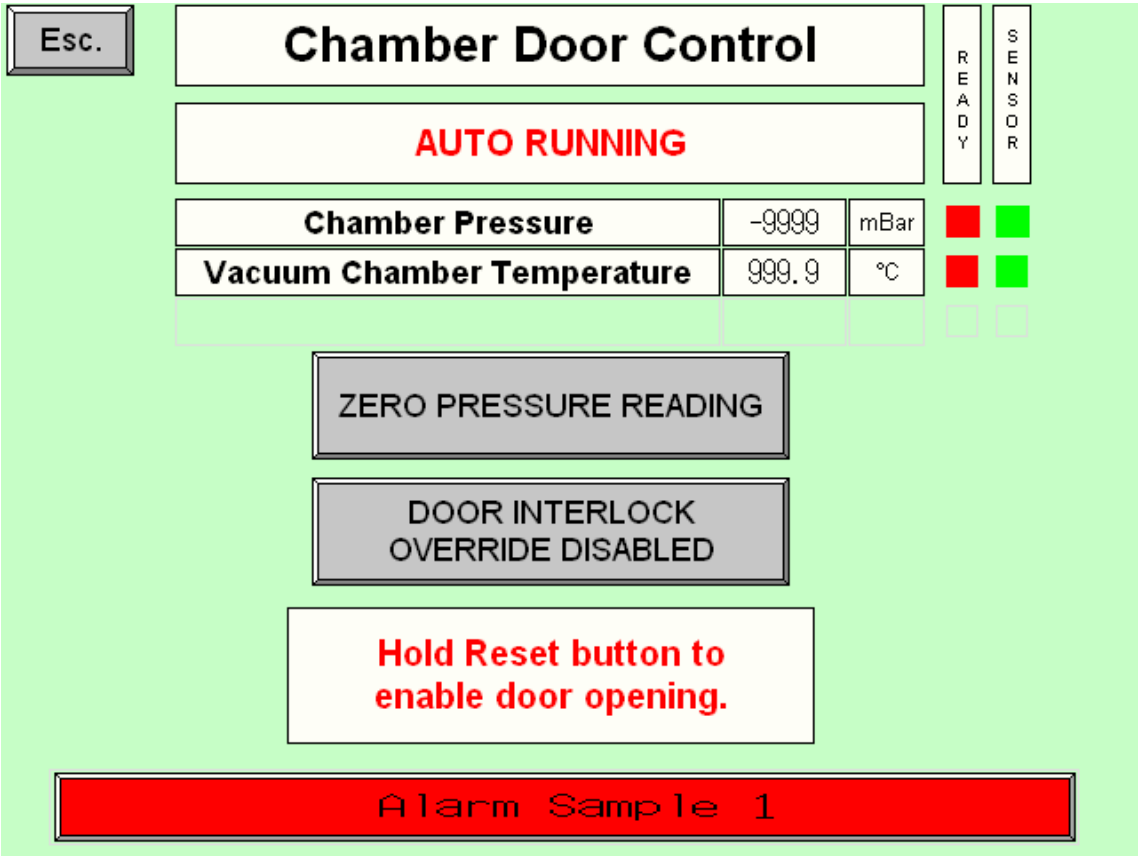


Fig CHAMBER DOOR CONTROL PAGE-INTERLOCK DISABLED LEVEL 3

The zero pressure button is displayed on the screen

Select <ZERO PRESSURE READING>

Prompt page appears “Set Pressure Reading to Zero”

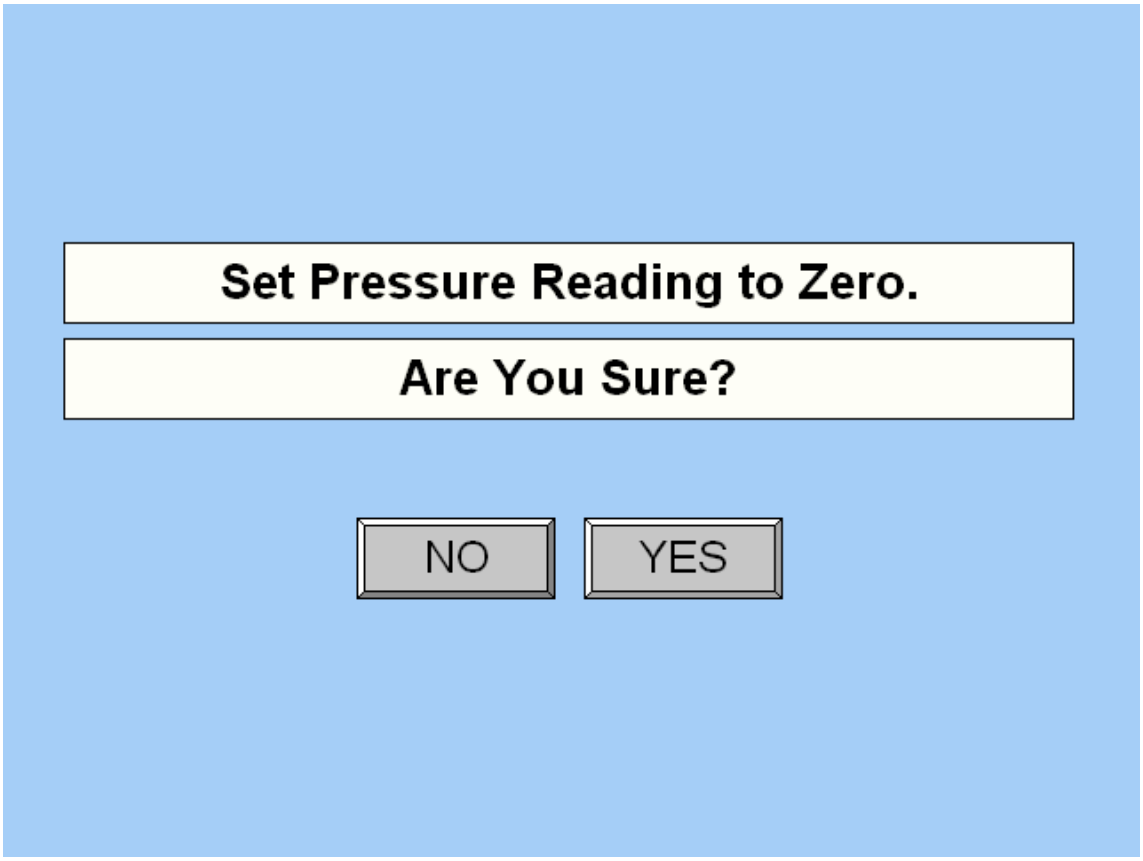


Fig CONFIRM RESET PRESSURE TO ZERO PAGE LEVEL 3

The sensor can be recalibrated to 0mbarg (Current ambient pressure conditions) only if the chamber doors are open.

Note if the Zero Pressure function key is operated when the chamber has been pressurised is would lose its reference point .This may lead to over pressurisation of the chamber.

Select <YES> to continue to return to Chamber Door Page Control Page

From Menu Page select <Heater>

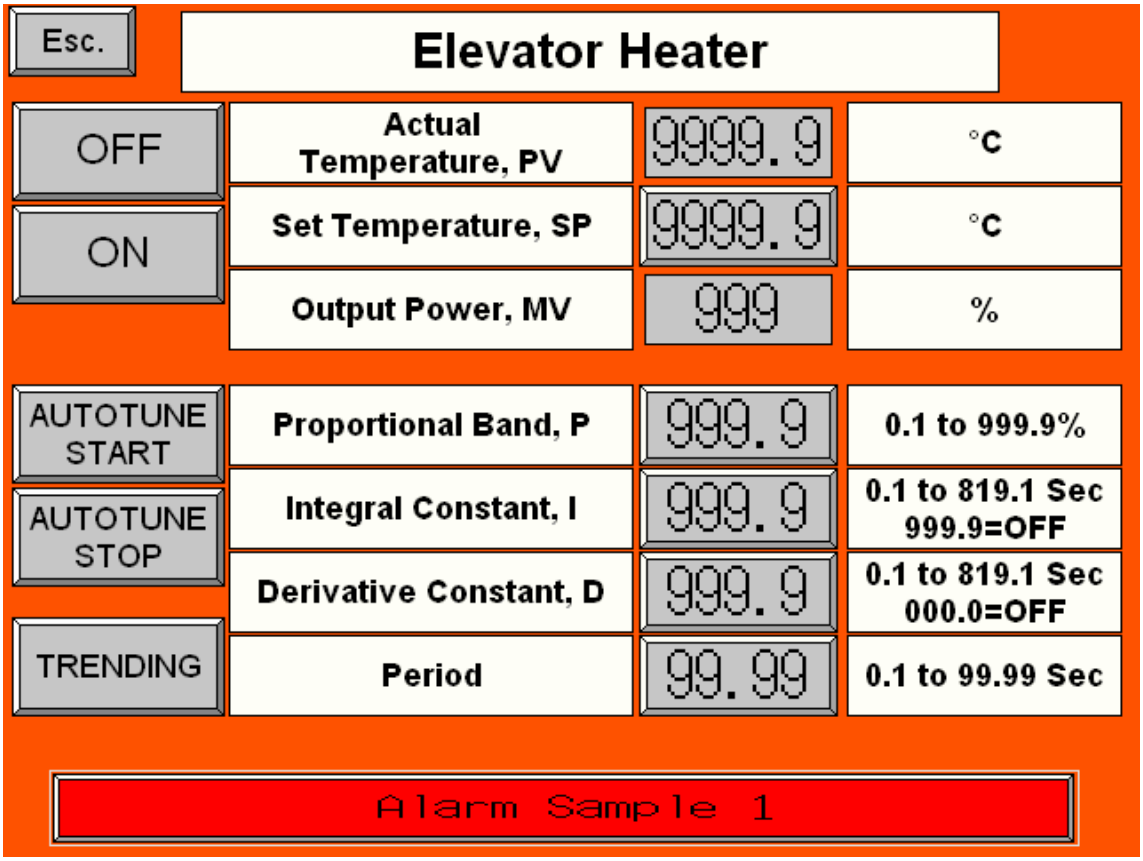


Fig TABLE HEATER CONTROL PAGE LEVEL 3

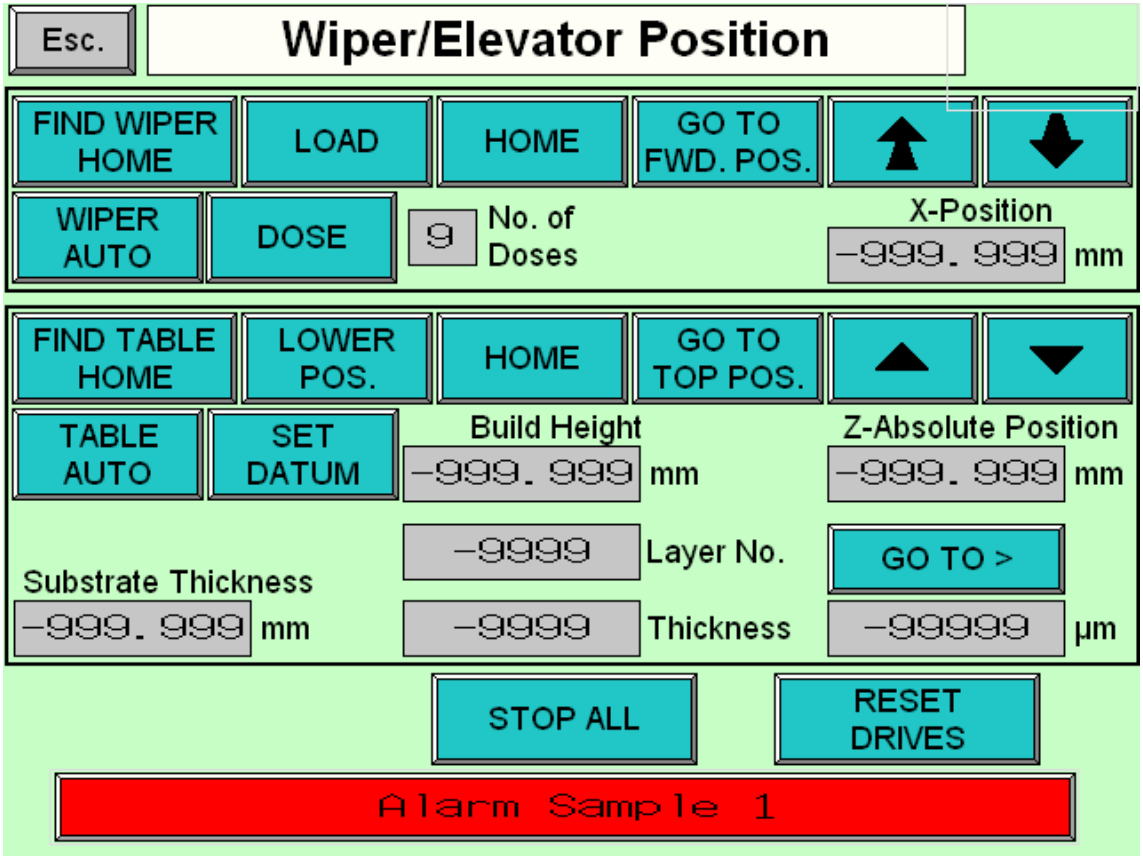


Fig MACHINE SET UP PAGE - LEVEL 3

(FIND WIPER HOME) reverts to constant Blue. <HOME> changes from Blue to Red h

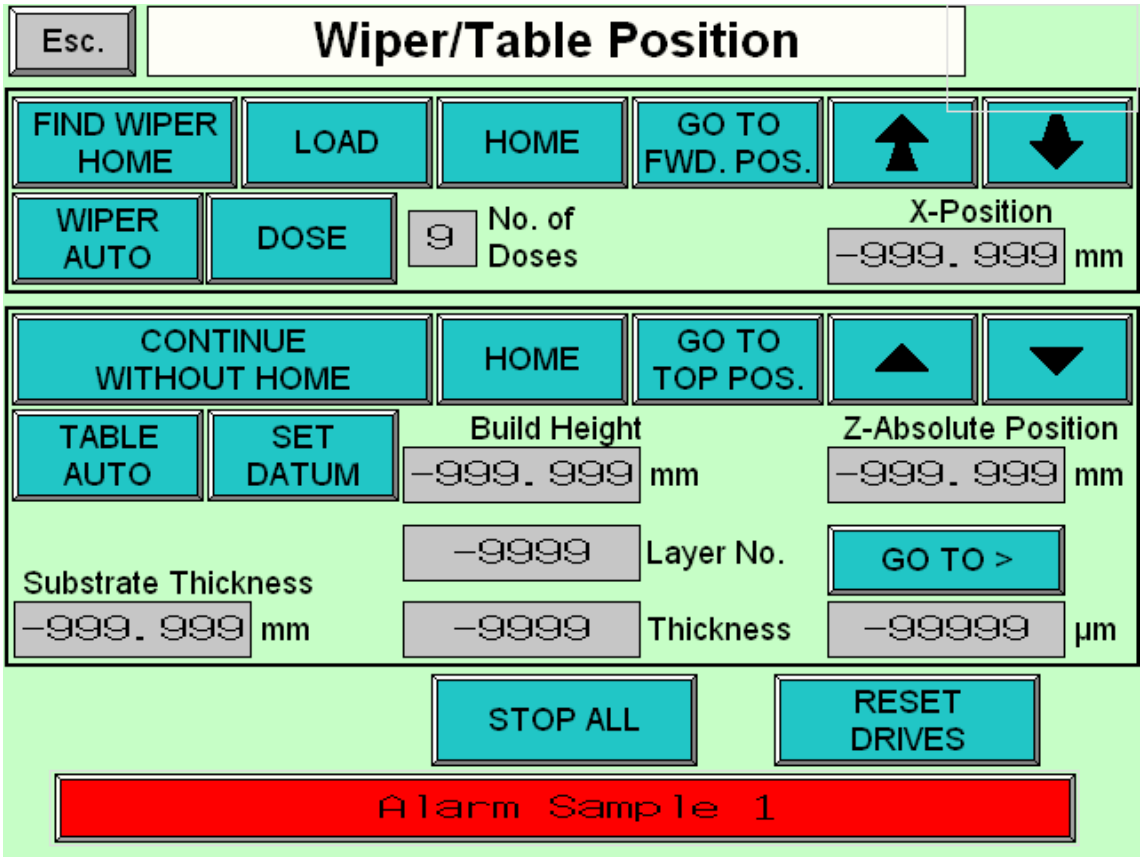


Fig SET UP PAGE LEVEL 3 USER

Select < (*GO TO*) HOME (POSN) >. This moves the wiper to Home position datum to X-Position 000.000.

Select < (*GO TO*) LOAD (POSN) >. This moves the wiper to X-Position -045.010 behind the cassette.

If Select < (*GO TO*) HOME (POSN) > is reselected. A dose of powder is discharged in front of the wiper blade .The wiper moves the wiper to Home position datum to X-Position 000.000 and pushes/spreads the metal powder in front of the wiper.

Select and Hold <🡅> to move the wiper forward to any position. Release to stop

Select and Hold <🡇> to move the wiper backwards to any position. Release to stop

Select and Hold <▲> to move the table upward to any position. Release to stop

Select and Hold <▼> to move the table downward to any position. Release to stop

SERVICE FUNCTIONS

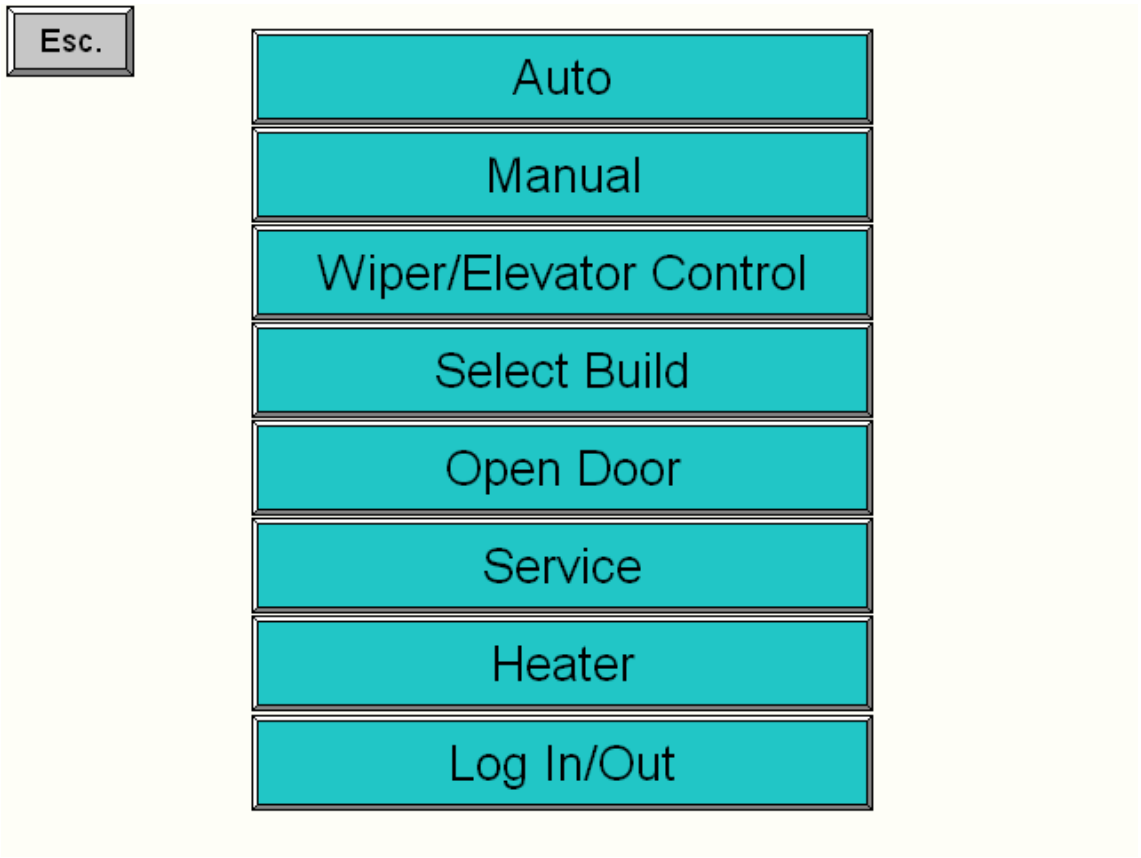


Fig MENU PAGE

Select <Service>

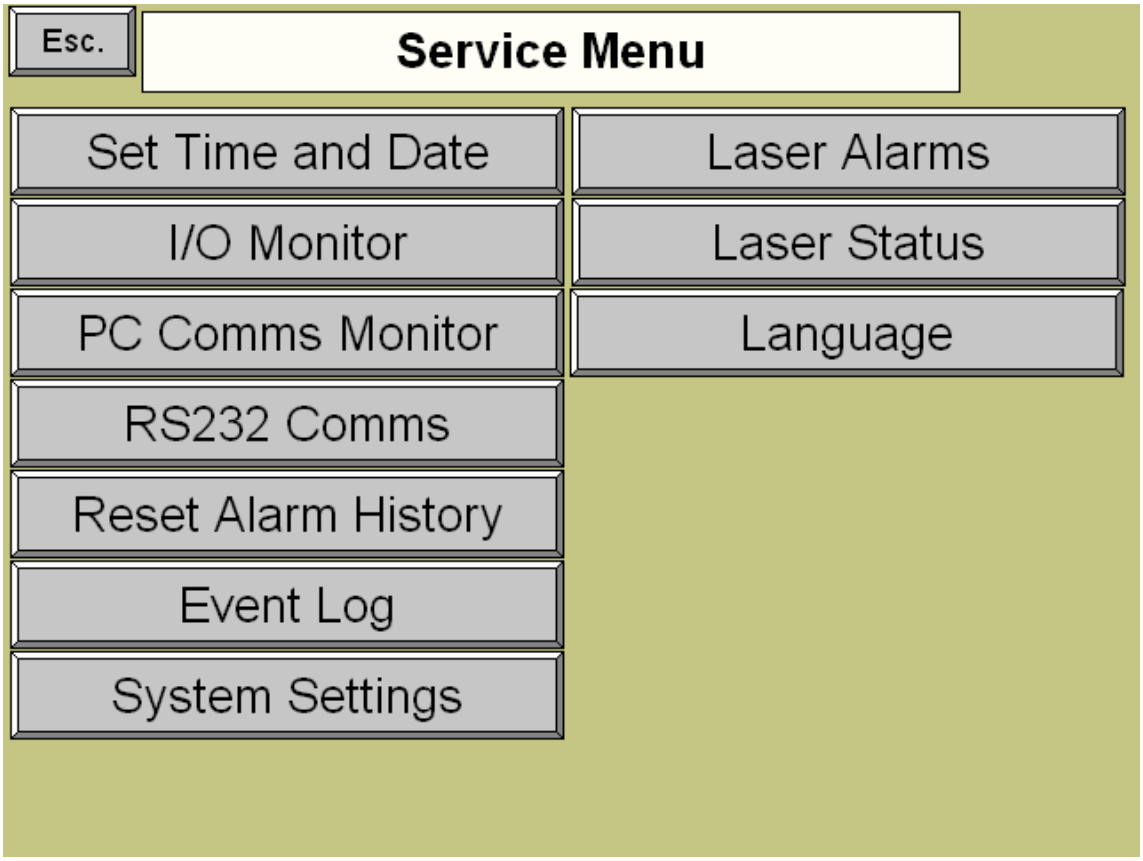
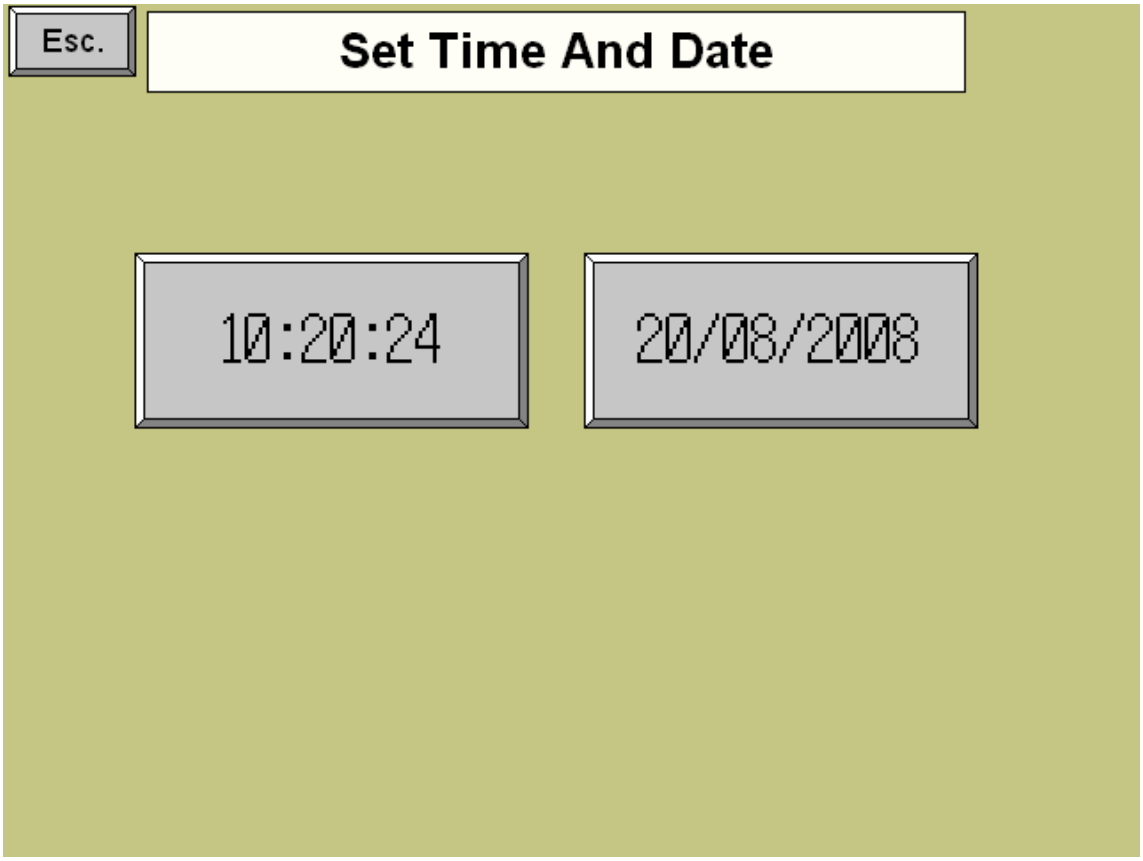


Fig SERVICE MENU LEVEL 3 USER

The service menu

Select <Set Time and Date>



TIME & DATE PAGE LEVEL 3 USER

Select <##:##:##> key to change time or date

Select <ESC> to return to Service Menu Page

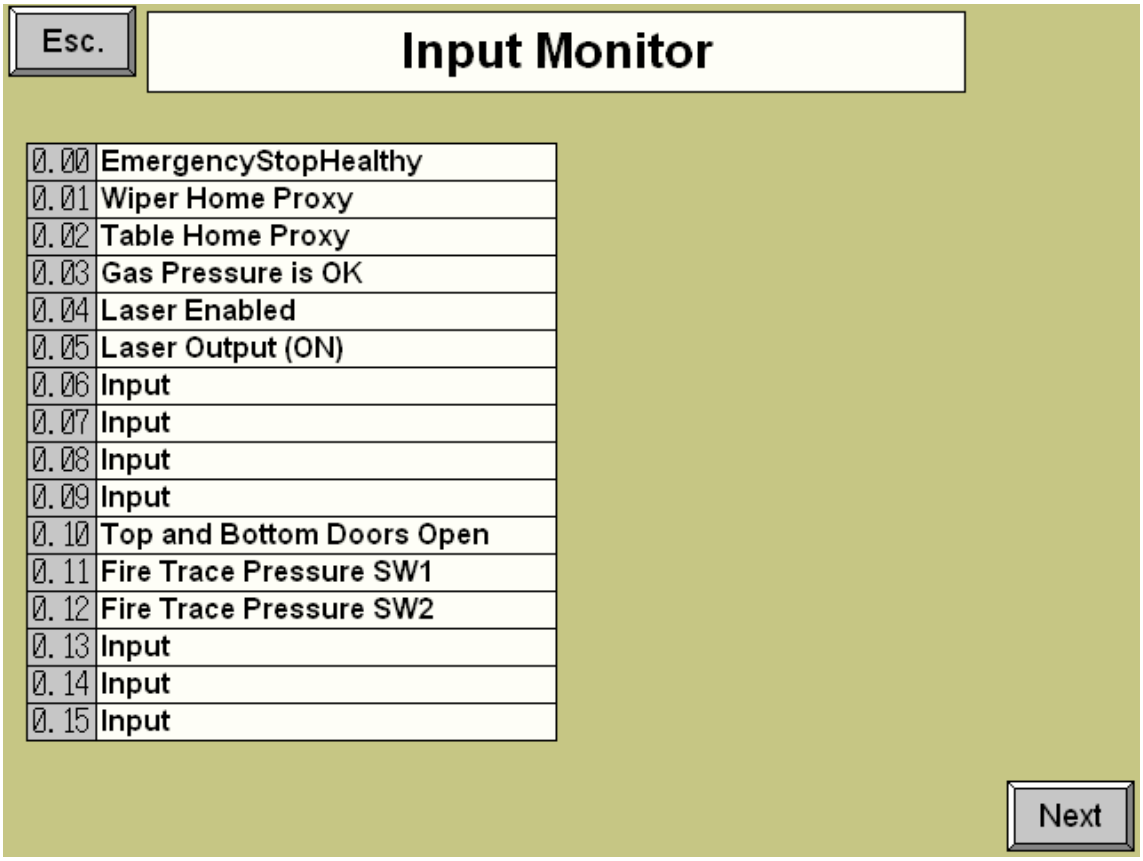


Fig PLC DIGITAL INPUT DATA PAGE

Select <ESC> to return to Service Menu Page

Select <Next> to go to PLC Output Data

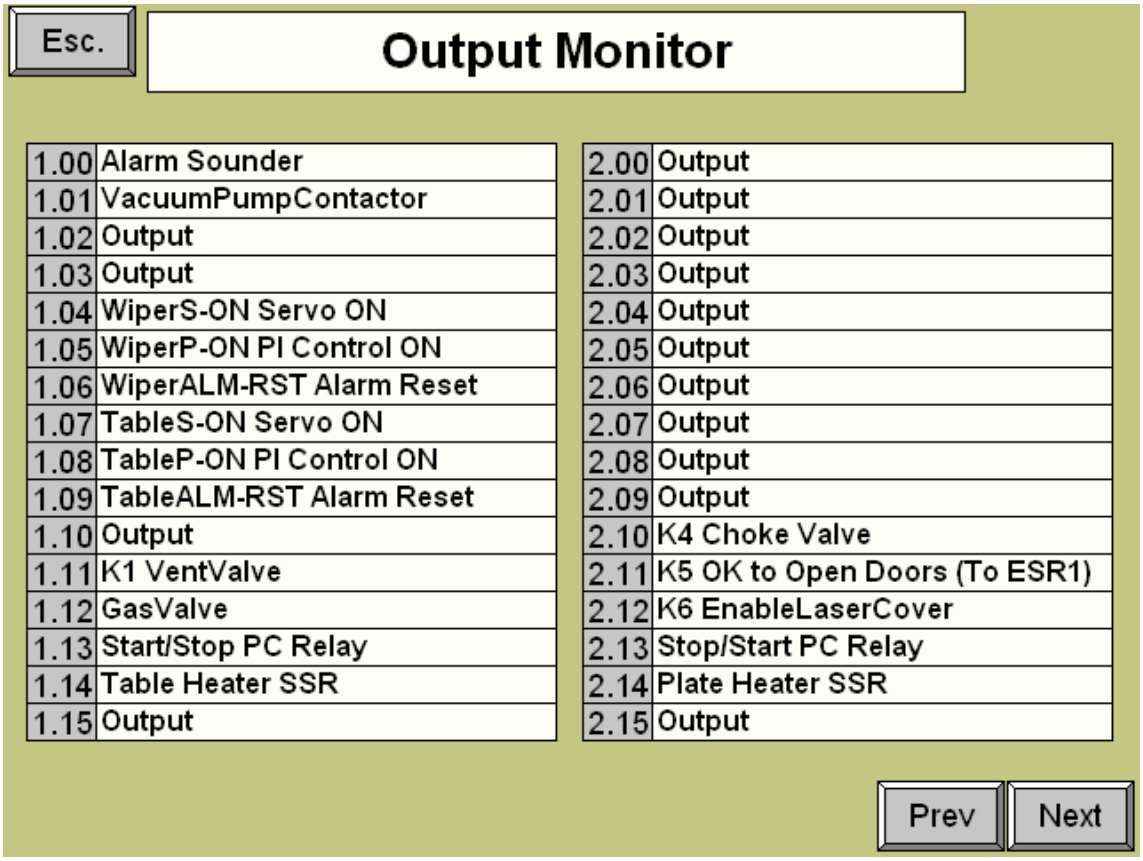


Fig PLC DIGITAL OUTPUT DATA

Select <ESC> to return to Service Menu Page

Select <Prev> to return to PLC Input Data

Select <Next> to go to Analogue I/O Page

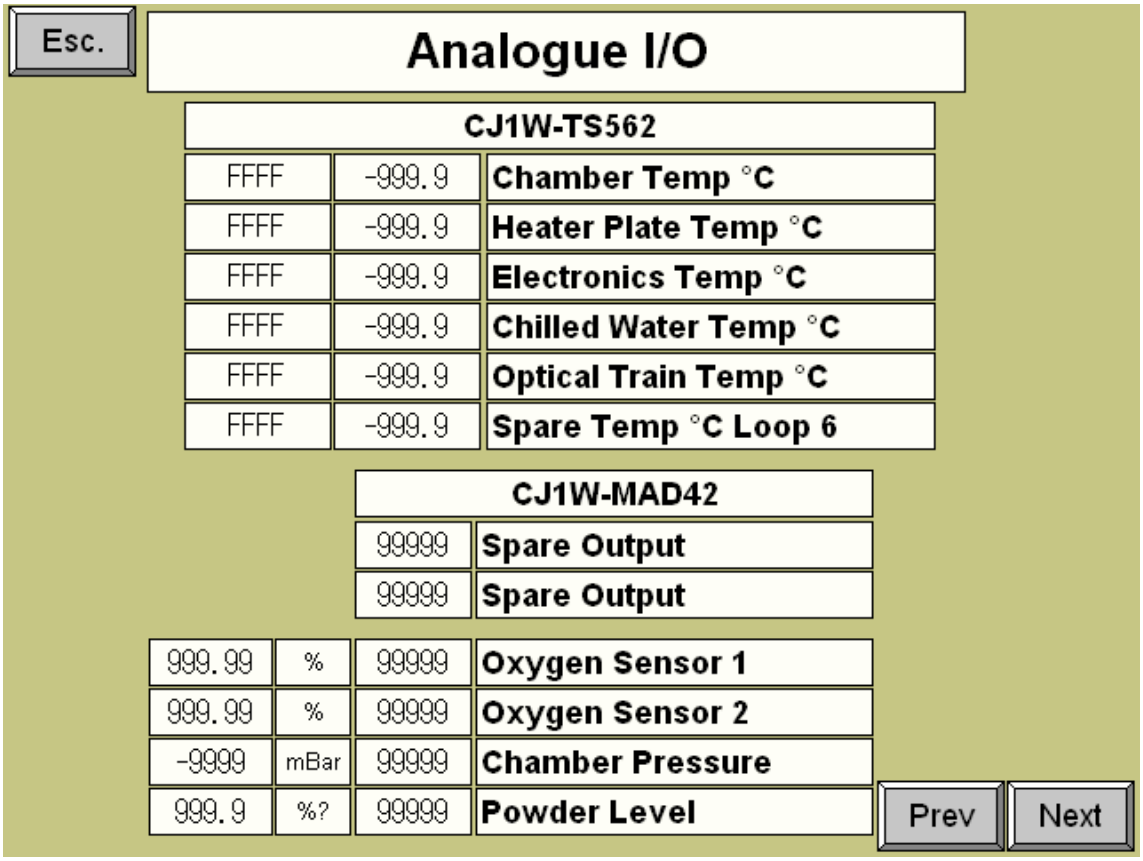


Fig PLC ANALOGUE I/O

Select <ESC> to return to Service Menu Page

Select <Prev> to return to PLC Output Data Page

Select <Next> to go to Analogue I/O Page

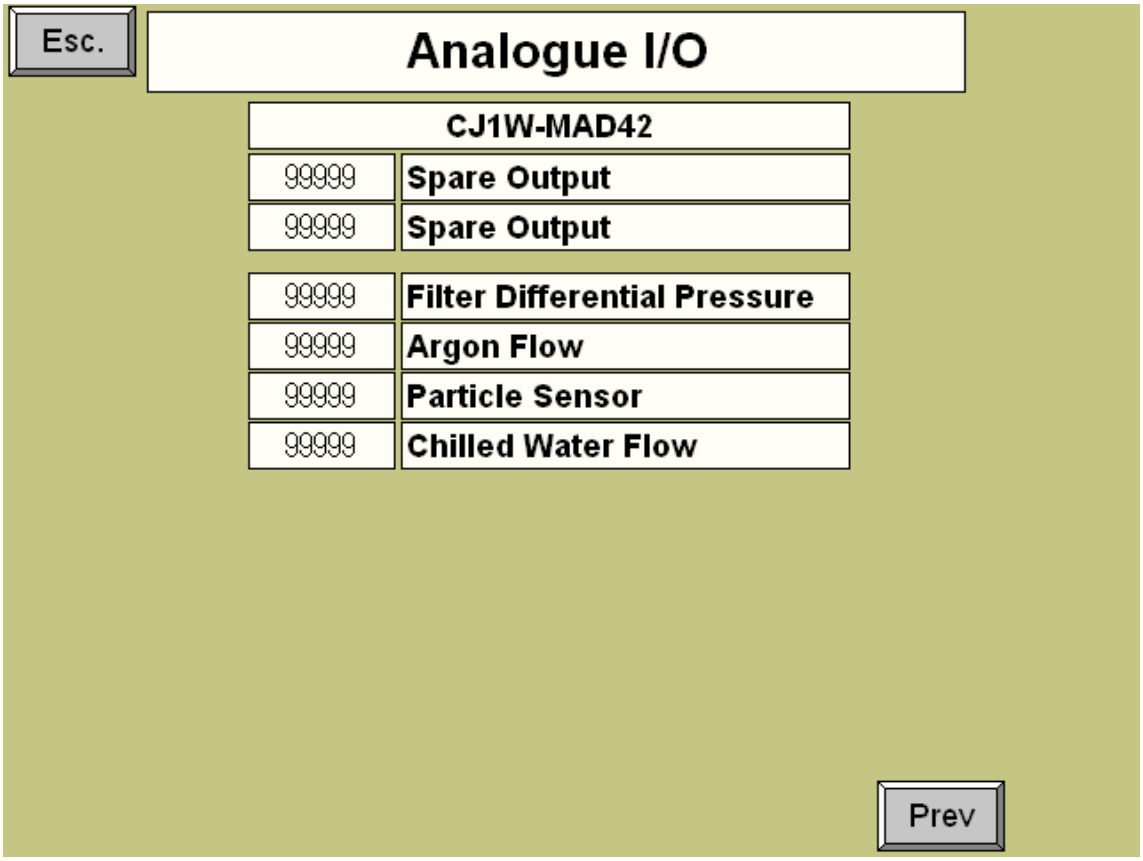


Fig PLC ANALOGUE I/O

Select <Prev> to return to Analogue I/O Page

Select <ESC> to return to Service Menu Page

From Service Menu Page

Select<PCCommsMonitor>

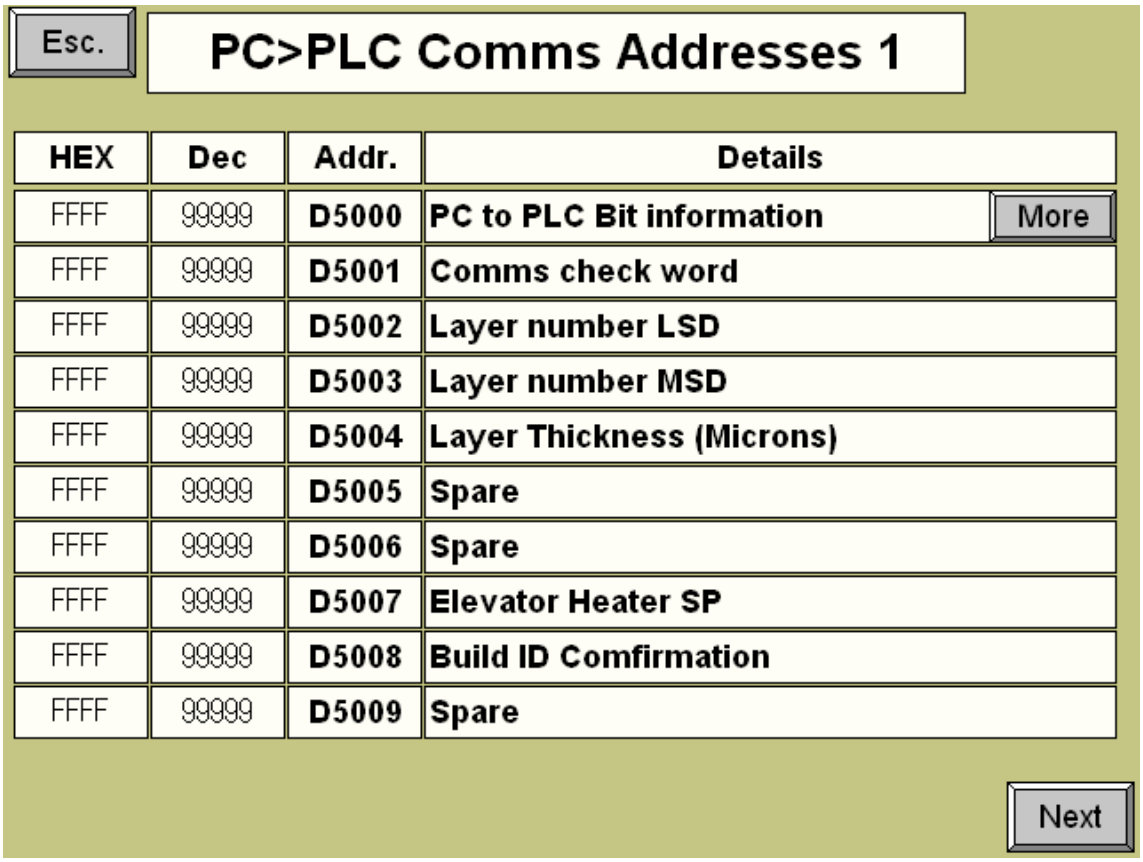
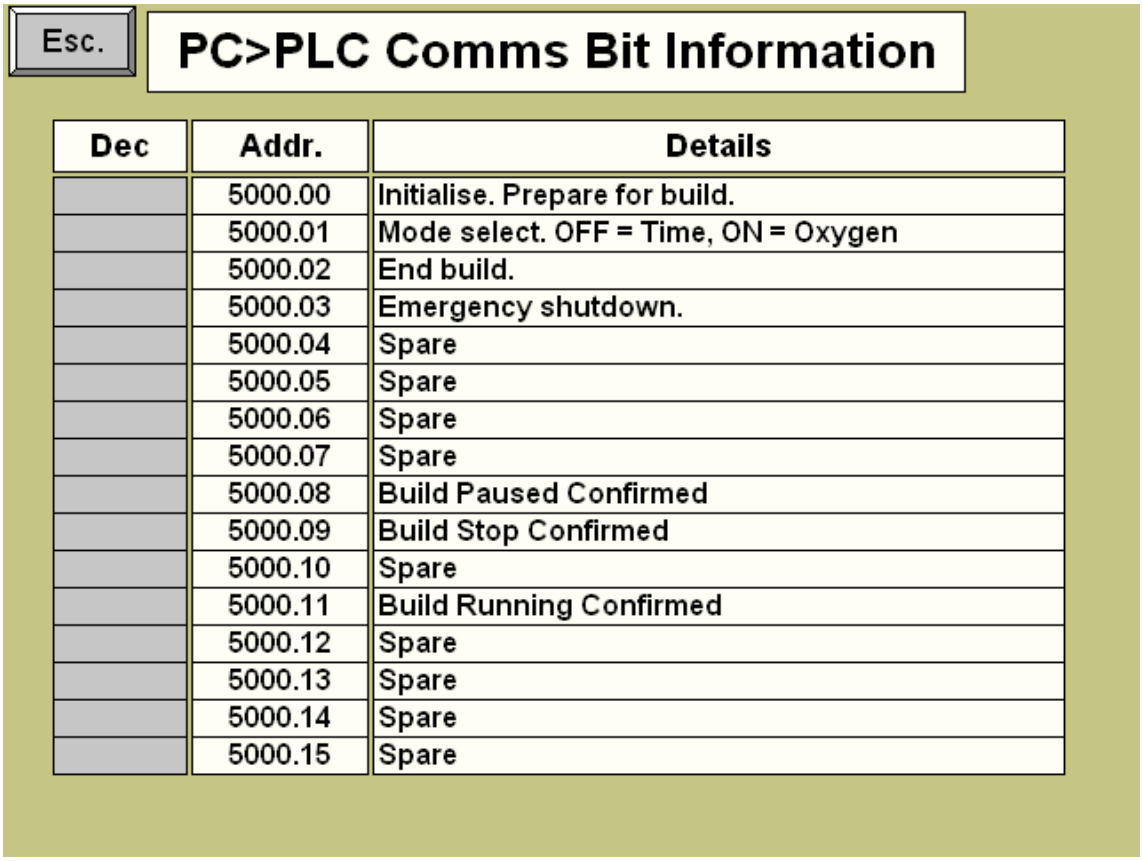


Fig PC>PLC COMMS ADDRESSES 1

Select <ESC> to return to Service Menu Page

Select <More> to go to PC>PLC Comms Bit Information



Dec	Addr.	Details
	5000.00	Initialise. Prepare for build.
	5000.01	Mode select. OFF = Time, ON = Oxygen
	5000.02	End build.
	5000.03	Emergency shutdown.
	5000.04	Spare
	5000.05	Spare
	5000.06	Spare
	5000.07	Spare
	5000.08	Build Paused Confirmed
	5000.09	Build Stop Confirmed
	5000.10	Spare
	5000.11	Build Running Confirmed
	5000.12	Spare
	5000.13	Spare
	5000.14	Spare
	5000.15	Spare

Fig PC>PLC COMMS BIT INFORMATION

Select <ESC> to return to PC>PLC Comms Addresses 1

Returns to PC>PLC Comms Addresses 1

From PC>PLC Comms Addresses 1

Select<Next>togotoPC>PLCCommsAddresses2

Esc.

PC>PLC Comms Addresses 2

HEX	Dec	Addr.	Details
FFFF	99999	D5010	Error Codes (Generated by PC)
FFFF	99999	D5011	Spare
FFFF	99999	D5012	Total Layers LSD
FFFF	99999	D5013	Total Layers MSD
FFFF	99999	D5014	Laser Status Word
FFFF	99999	D5015	Laser Alarms Status Word 1
FFFF	99999	D5016	Laser Alarms Status Word 2
FFFF	99999	D5017	Spare
FFFF	99999	D5018	Spare
FFFF	99999	D5019	Spare

Prev Next

Fig PC>PLC COMMS ADDRESSES 2

Select <ESC> to return to Service Menu Page

Select <Prev> to return to PC>PLC Comms Addresses 1

Select <Next> to go to PC>PLC Comms Addresses 3

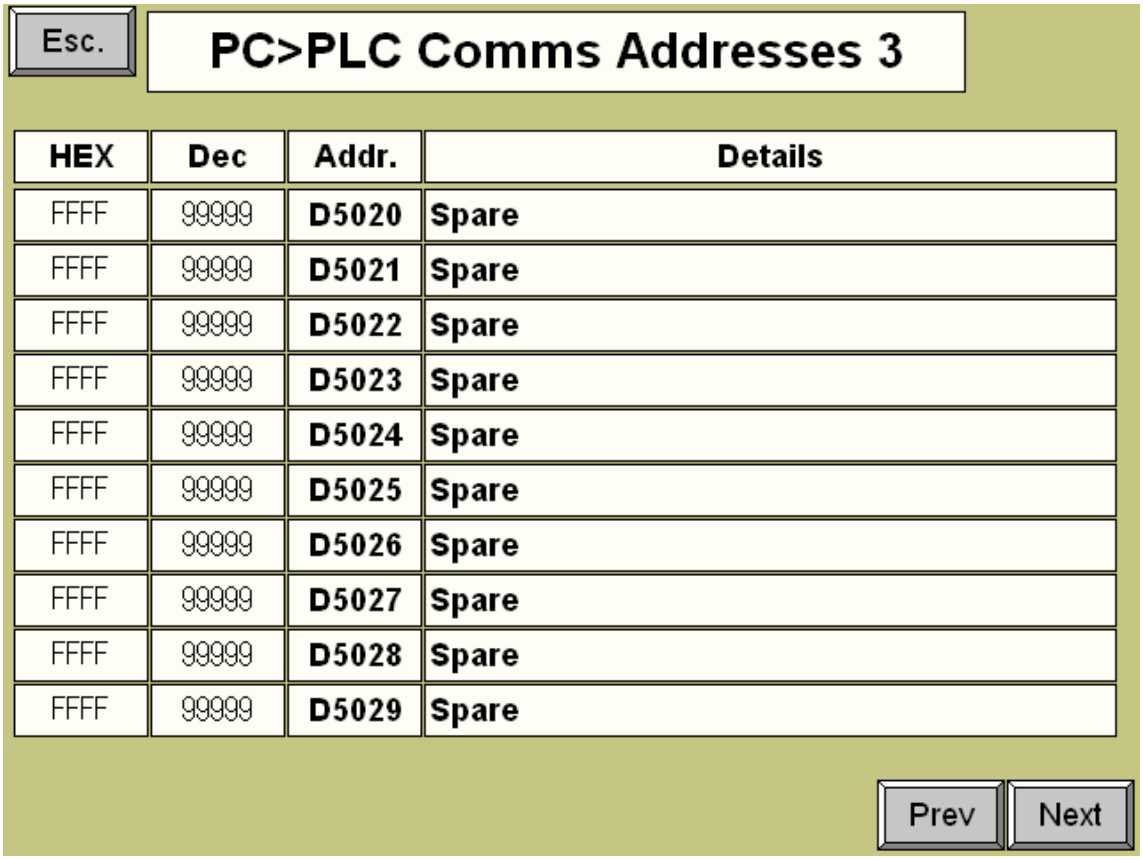


Fig PC>PLC COMMS ADDRESSES 3

Select <ESC> to return to Service Menu Page

Select <Prev> to return to PC>PLC Comms Addresses 2

Select <Next> to go to PLC>PC Comms Addresses 1

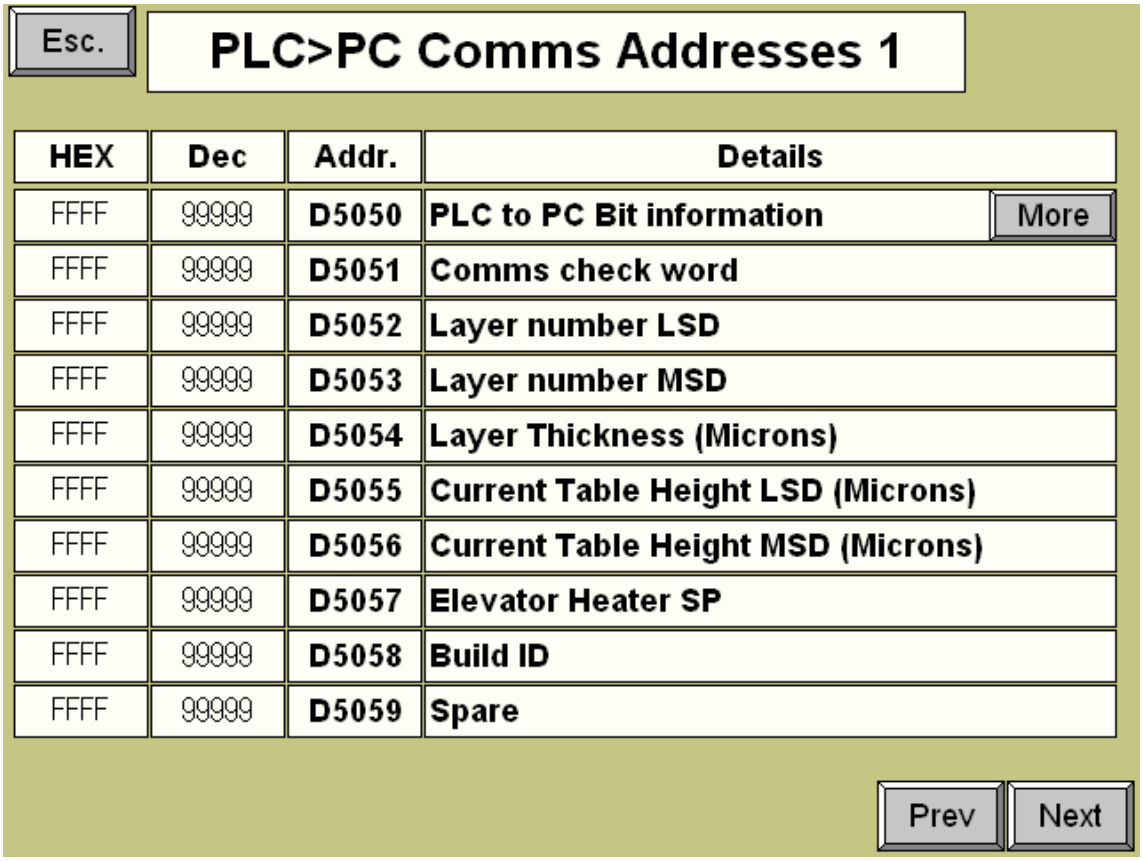


Fig PLC>PC COMMS ADDRESSES 1

Select <ESC> to return to Service Menu Page

Select <More> to go to PLC>PC Comms Bit Information

Esc.

PLC>PC Comms Bit Information

Dec	Addr.	Details
	5050.00	Initialise complete.
	5050.01	Mode select confirm OFF = Time, ON = Oxygen
	5050.02	End build complete
	5050.03	Emergency shutdown complete
	5050.04	Spare
	5050.05	Spare
	5050.06	Spare
	5050.07	Spare
	5050.08	Build Paused
	5050.09	Build Stop
	5050.10	Safe To Fire Laser
	5050.11	Build Running
	5050.12	Spare
	5050.13	Spare
	5050.14	Spare
	5050.15	Spare

Fig PLC>PC COMMS BIT INFORMATION

Select <ESC> to return to previous Page

Returns to PLC>PC Comms Addresses 1

From PLC>PC Comms Addresses 1

Select <Prev> to return to PC>PLC Comms Addresses 3

Select <Next> to go to PLC>PC Comms Addresses 2

Esc.

PLC>PC Comms Addresses 2

HEX	Dec	Addr.	Details
FFFF	99999	D5060	Error Codes (Generated by PLC)
FFFF	99999	D5061	Oxygen level
FFFF	99999	D5062	Gas pressure
FFFF	99999	D5063	Vacuum Chamber Temp
FFFF	99999	D5064	Elevator Heater Temp PV,
FFFF	99999	D5065	Process Chamber Temp
FFFF	99999	D5066	Electronics Temp
FFFF	99999	D5067	Chilled Water Temp
FFFF	99999	D5068	Optical Train Temp
FFFF	99999	D5069	Spare

Prev Next

Fig PLC>PC COMMS ADDRESSES 2

Select <ESC> to return to Service Menu Page

Select <Prev> to return to PLC>PC Comms Addresses 1

Select <Next> to go to PLC>PC Comms Addresses 3

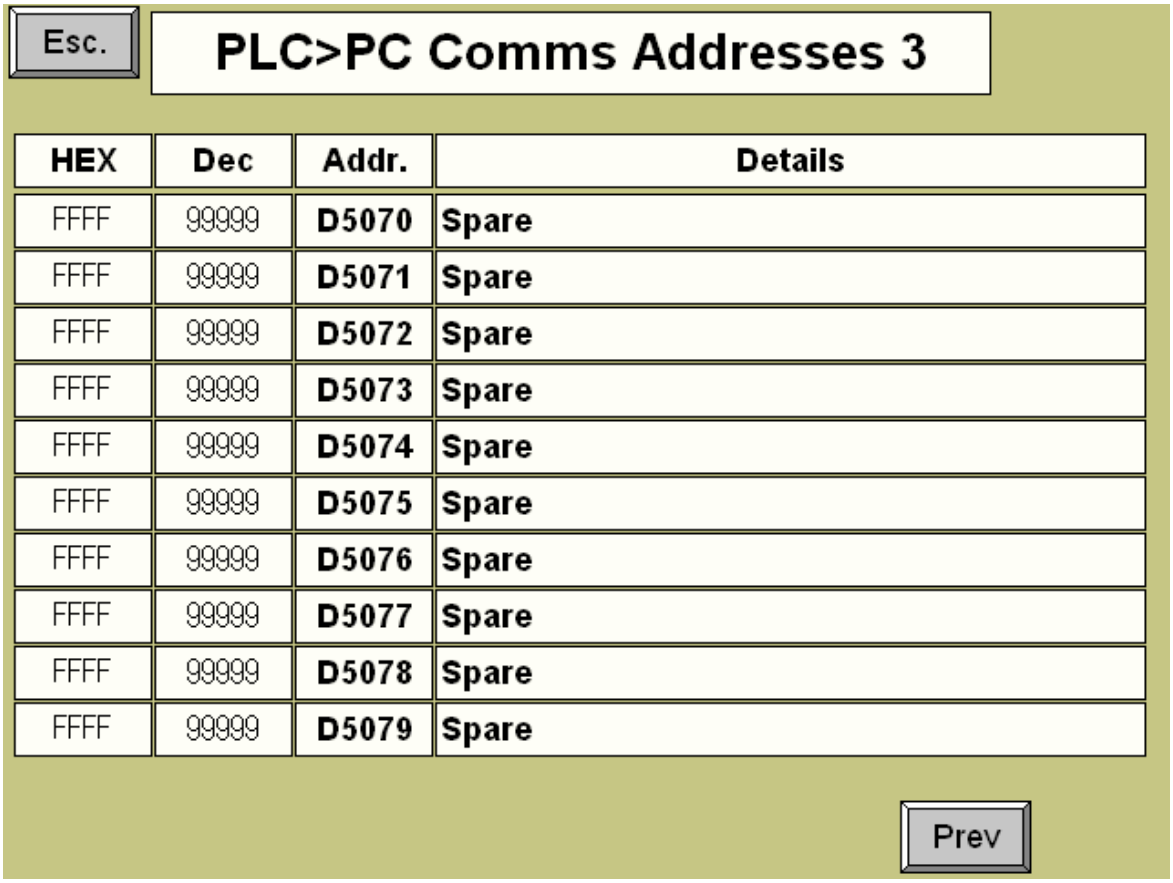


Fig PC>PLC COMMS ADDRESSES 3

Select <Prev> to return to PLC>P Comms Addresses 2

Select <ESC> to return to Service Menu Page

From Service Menu Page

Select <RS232 Comms>

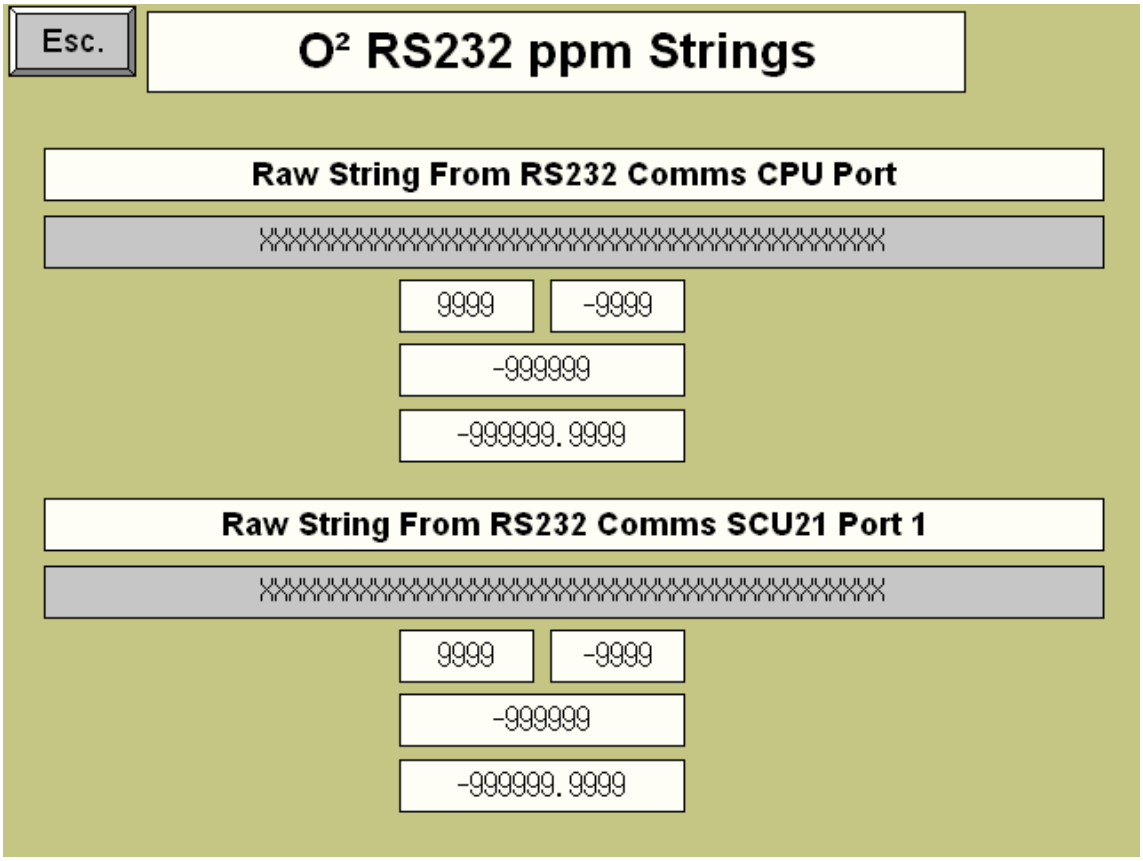
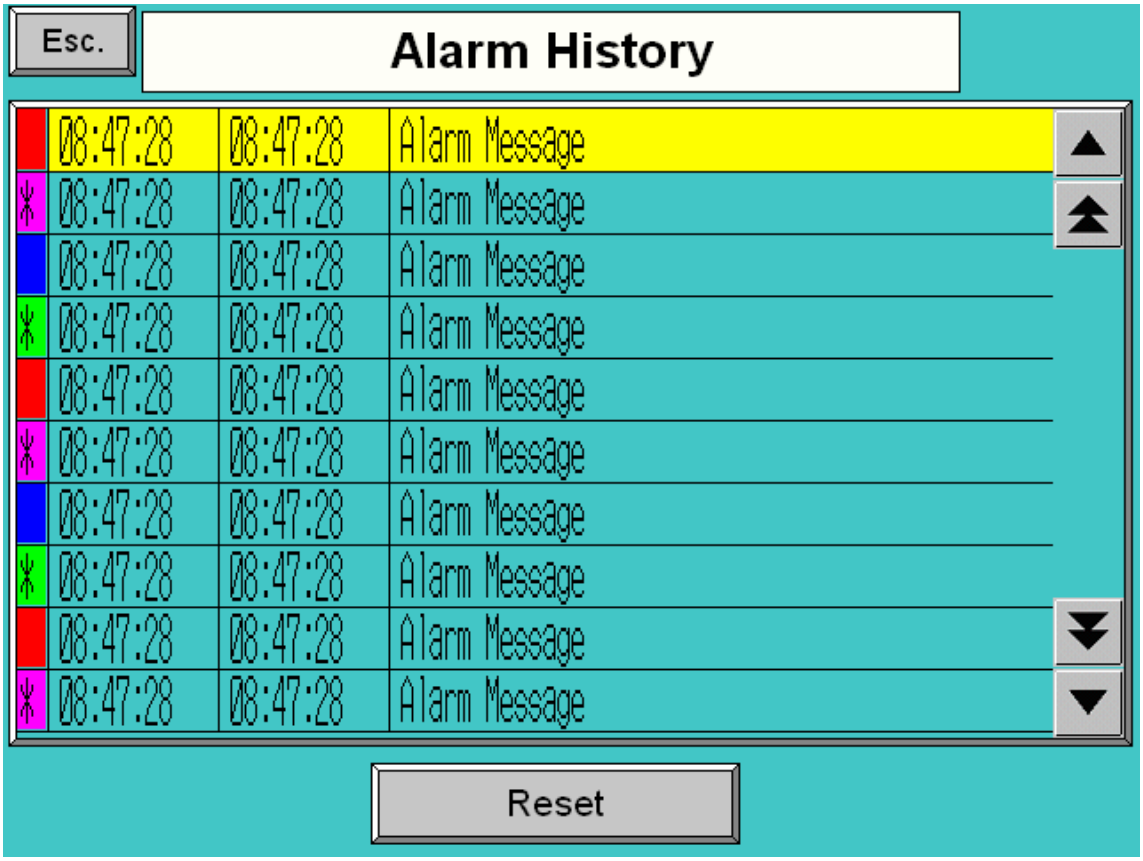


Fig OXYGEN RS232 PPM STRING

Select <ESC> to return to Service Menu Page

From Service Menu Page

Select<Reset Alarms History>



ALARM HISTORY PAGE – LEVEL 2 &3 USER

Select <ESC> to return to Service Menu Page

Selecting < ▲> or <▼> allows the list to be scrolled incrementally.

Selecting <🡅> or <🡇> allows the list to move between pages of lists

Select <RESET> to display prompt page “Reset Alarms History”

Fig PROMPT "RESET ALARM HISTORY" PAGE

Select <ESC> to return to Alarm History Page

Select <RESET ALARMS HISTORY> to confirm reset

From Service Menu Page

Select< Event Log>

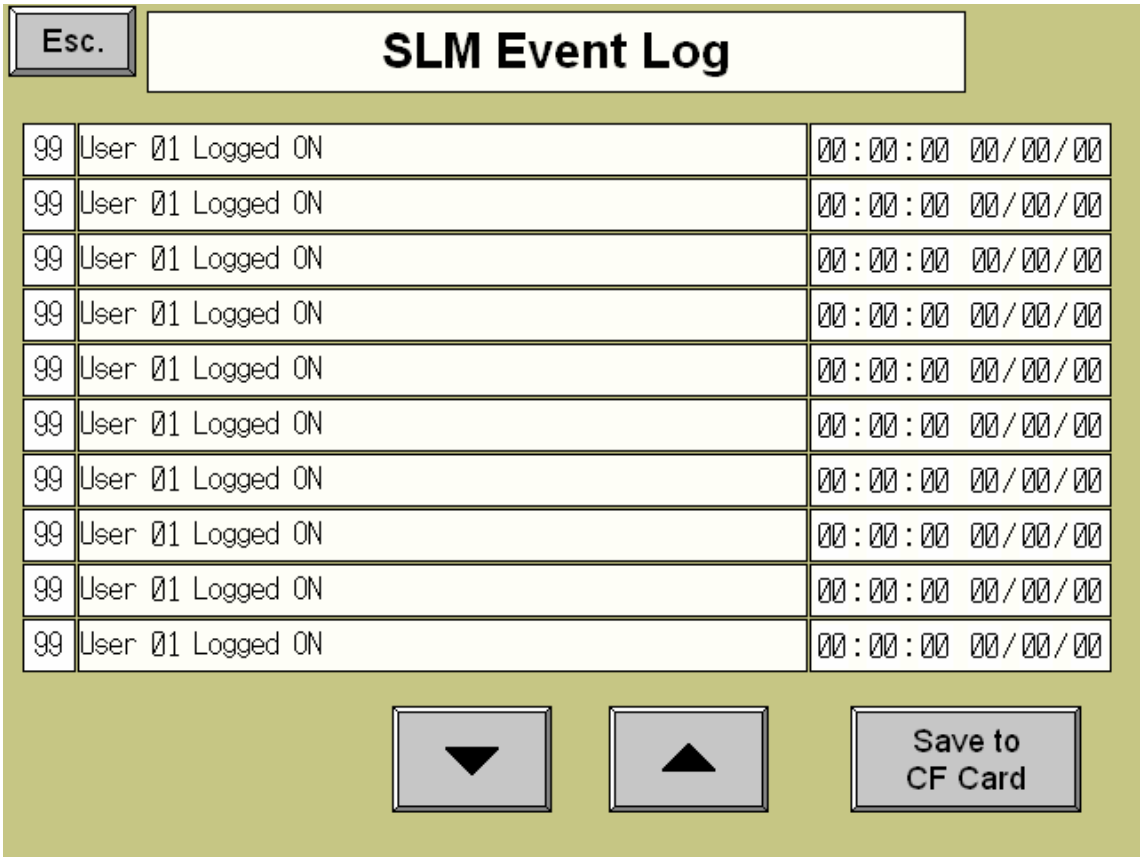


Fig SLM EVENT LOG

Select and Hold <▲> to move the table upward to any position. Release to stop

Select and Hold <▼> to move the table downward to any position. Release to stop

Select <Save to CF Card>

Select <ESC> to return to Service Menu Page

LIST OF EVENT LOG MESSAGES

User 01 Logged ON

User 02 Logged ON

User 03 Logged ON

User 04 Logged ON

User 05 Logged ON

User 06 Logged ON

User 07 Logged ON

User 08 Logged ON

User 09 Logged ON

User 10 Logged ON

User 11 Logged ON

User 12 Logged ON

User 13 Logged ON

User 14 Logged ON

User 15 Logged ON

User 16 Logged ON

User 17 Logged ON

User 18 Logged ON

User 19 Logged ON

User 20 Logged ON

User 21 Logged ON

User 22 Logged ON

User 23 Logged ON

User 24 Logged ON

User 25 Logged ON

User 26 Logged ON

User 27 Logged ON

User 28 Logged ON

User 29 Logged ON

User 30 Logged ON

User Logged OFF

Power Switched ON

CF Card Removed

CF Card Replaced

Auto Cycle Started

Auto Cycle Paused

Auto Cycle Continue

Auto Cycle Stopped

Manual Operation Enabled

Manual Operation Disabled

User Data may have been changed

Chamber Atmosphere Ready

PC Comms Error!

Doors opened

Abort Operated

Fig LIST OF *EVENT MESSAGES*

From Service Menu Page

Select<SystemSettings>

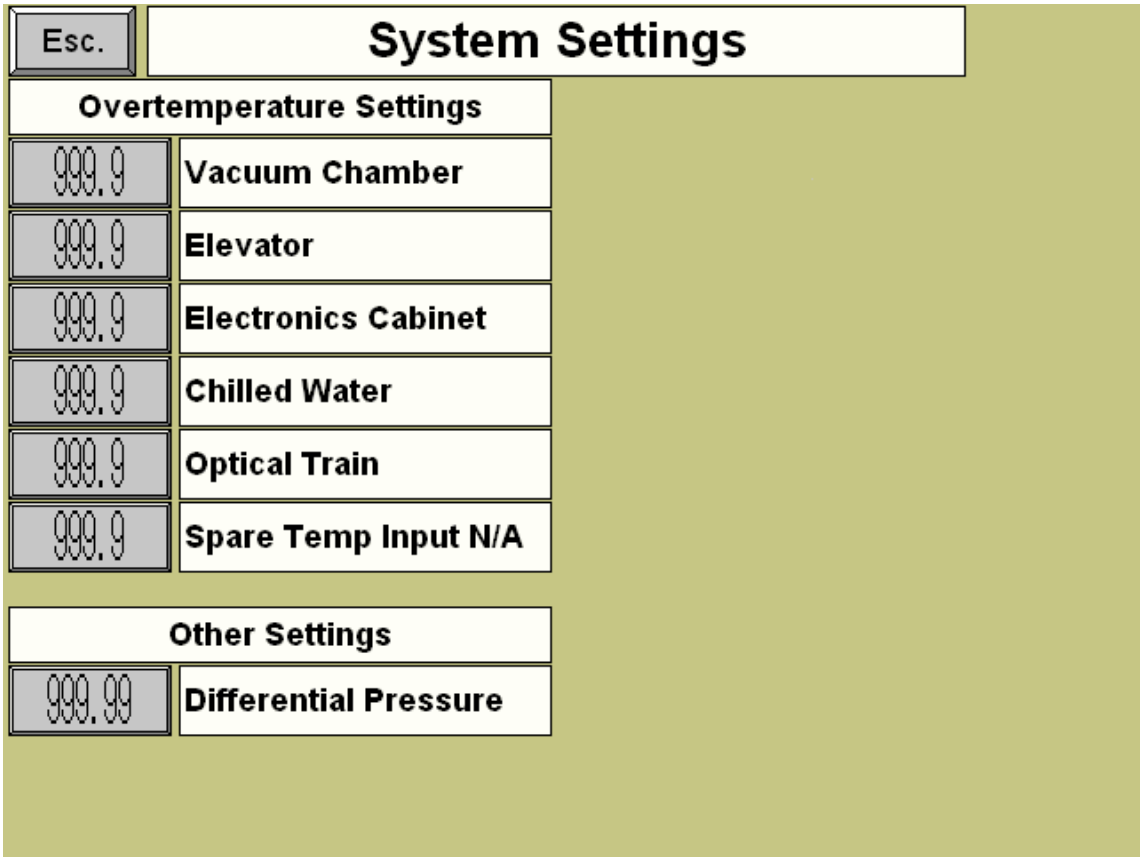


Fig SYSTEM SETTINGS-LEVEL 3

Select <ESC> to return to Service Menu Page

Select<LaserAlarms>

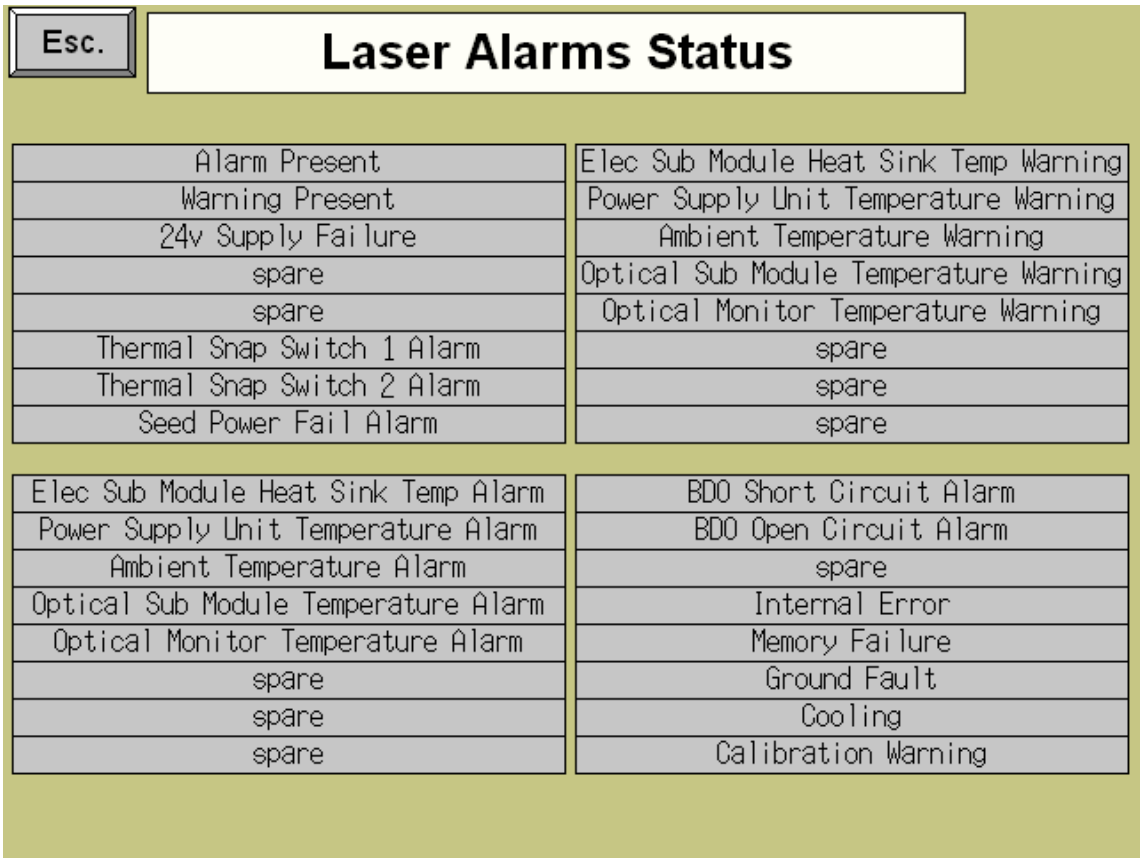


Fig LASER ALARMS - LEVEL 3

Select <ESC> to return to Service Menu Page

Select<LaserStatus>

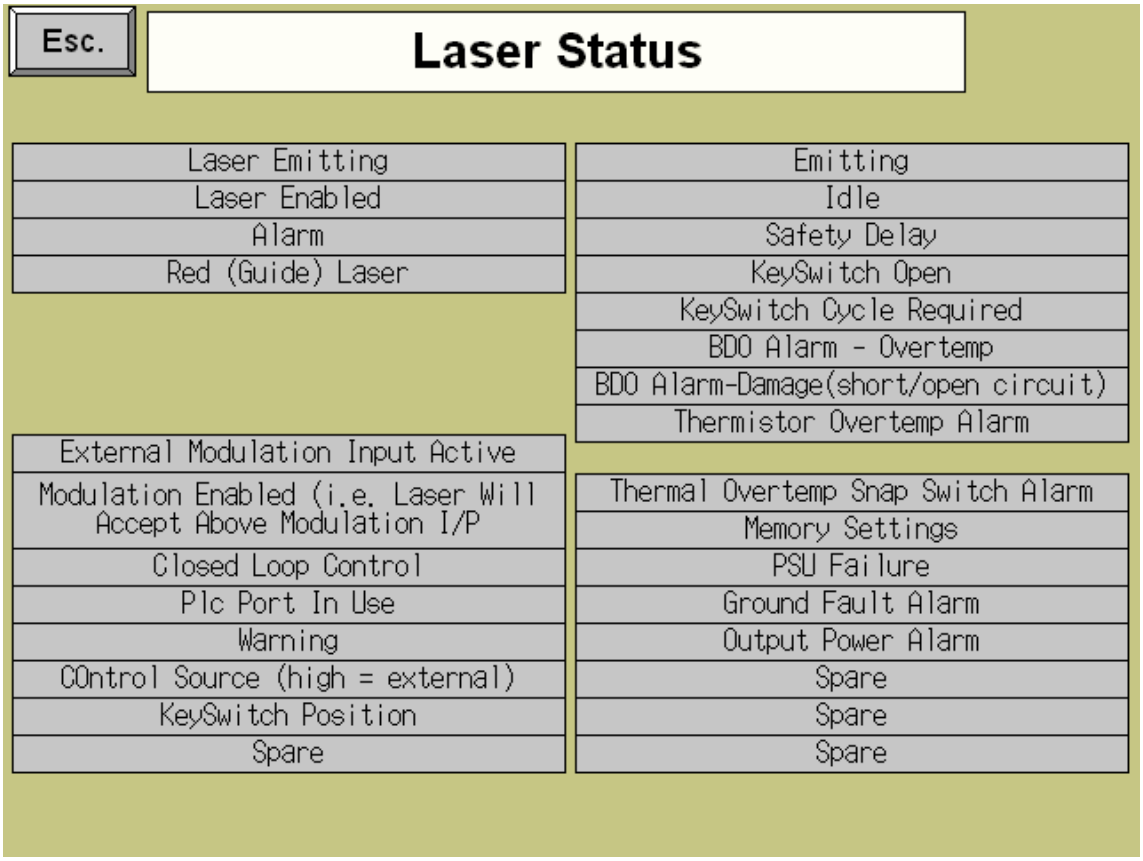
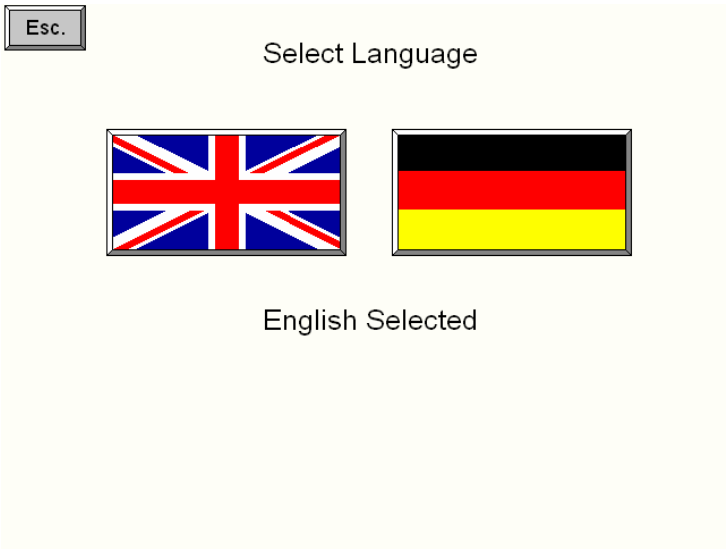


Fig LASER STATUS-LEVEL 3



LAGUAGE SELECTION PAGE-LEVEL 3

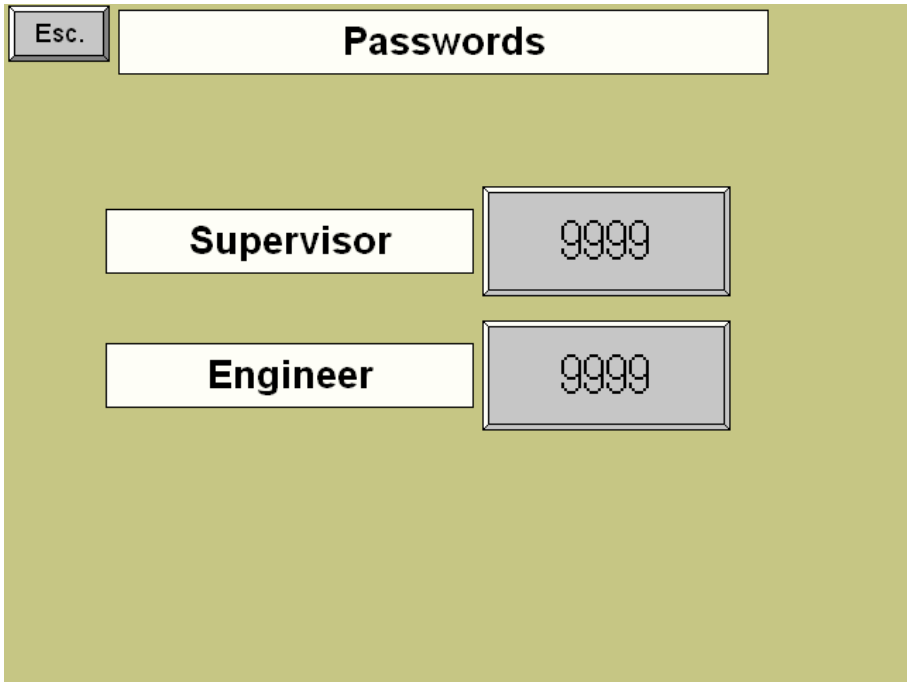
Select <”FLAG”>

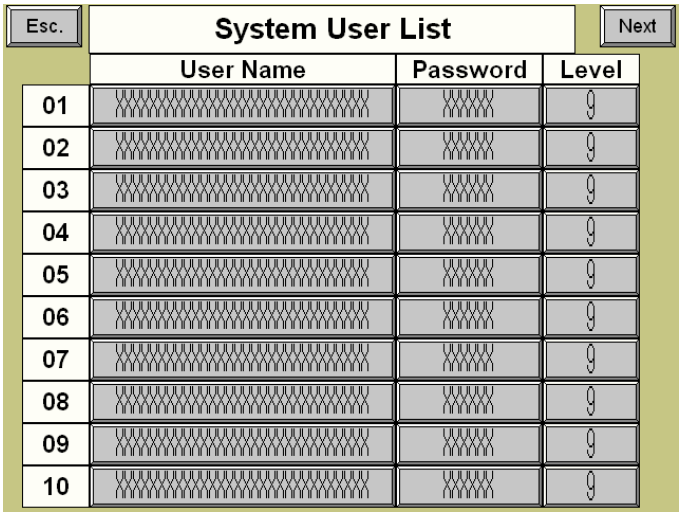
Selection is shown below flags

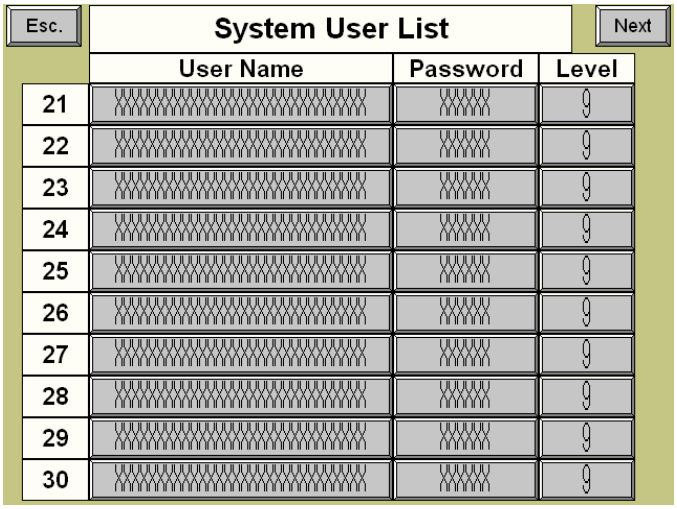
Select<ESC>to return to previous page

PASSWORD PROTECTION & USER ACCESS

Password access is granted to all users who have attended a suitable accredited training course. Only level 4 access rights will permit the creation of new passwords. Please contact MTT for details of training courses for your staff. Following the successful completion of the training appropriate access rights to the system will be granted depending on the level of training completed. Up to 30 users can be registered to each machine.




Esc.
System User List
Next
User Name
Password
Level
01
02
03
04
05
06
07
08
09
10


Esc.
System User List
Next
User Name
Password
Level
21
22
23
24
25
26
27
28
29
30

MAINTENANCE

SPECIAL SAFETY INSTRUCTIONS FOR MAINTENANCE

During maintenance the following points should be taken into account:

- The basic rules concerning the operational safety and accident prevention
- The chapter on safety and the safety warnings set out in this operating manual
- The COSHH datasheet for safe handling and disposal of metal powder

	Before beginning any maintenance all production operations should have been concluded. Isolate the equipment and affix warning labels.

- Maintenance after or during the processing of used titanium metal powder must only be carried out with a minimum of two personnel present.
- During normal operation of the unit, it is strictly forbidden to remove or take out of service any safety devices.
- During maintenance, if it is absolutely necessary to remove any safety devices, then the following minimum precautions should be taken:
- A written risk assessment of works to be undertaken to evaluate any possible safety issues which may arise during the maintenance function along with any precautions which need to be taken to minimize the possibility of an accident needs to have been completed prior to the work being initiated.
- A written method statement detailing a safe procedure for carrying out the maintenance work needs to have been completed prior to the work being initiated.
- All technicians directly involved with the maintenance work will be involved with completing the risk and method statements.
- All technicians directly involved with the maintenance work will be competent to carry out the type of maintenance work to be undertaken.

- Refitting of any safety devices must be carried out immediately after completion of maintenance and before restarting the unit.
- If removal of safety devices during maintenance proves to be absolutely

necessary, this may only take place when the unit is properly isolated.

- Before recommencing production after maintenance, the technician responsible for carrying out the work should have the work checked by his supervisor and signed off.
- Major maintenance works may require a degree of re-commissioning and testing prior to production handover. This requirement should be clearly stated as part of the method statement.
- If any part of maintenance procedure is in doubt. Then the user should contact MTT Technologies for technical support.

SERVICE ADDRESS

Service line	Hours of work: 0800 hrs – 1700 hrs GMT +44 (0)1785 815651
E-Mail	info@mtt-group.co.uk
Service Address	**MTT Technologies Limited;** **Whitebridge Way,** **Whitebridge Park,** **Stone,** **Staffordshire,** **England.** **ST15 8LQ**

Make sure you have the following data at hand when calling the Service line:

- Machine type
- Machine serial number
- Software version number

INSPECTION AND MAINTENANCE SCHEDULE

d = daily, w = weekly, m = monthly, a = annually

Work to be performed	**d**	**w**	**m**	**a**
Visual inspection of the entire unit	x	x	x	x
Check the functioning of the safety devices		x	x	x
Safety stickers/ warnings are complete and clearly legible		x	x	x
Operating manual is kept near the machine in an easily accessible place		x	x	x
Visual inspection of the door seal, check for leakage	x			
Visual inspection of the hoses, check for leakage	x			
Visual Inspection of metal bottle seals, check for leakage	x			
Lubricate the guide ways	x			
Clean the process room	x 1)			
Clean the protective glasses of the lens				
Clean the entire unit	x 1)			
Clean the working room		x		
Filter exchange	x 1)			
Check the wiper	x			
Exchange of bottles under each overflow funnel	x 1)			
Check of inert gas supply	x 2)			
Check of gas bottle (optional) for fire suppression system	x 2)			
Check of gas bottle for fire extinguishing system (optional, see separate manual)	x 2)			
Exchange of process chamber door sealing				x
Exchange of sealing on powder inlets				x
Exchange of seals for metal bottles				x
Check display of oxygen content (= 21%)	x 1)			
Check level of coolants	x			

1) After each modelling process

2) Before each modelling process, sign-off on a log sheet

MTT Technologies Group
Whitebridge Way
Whitebridge Park
Stone
Staffordshire.
ST15 8LQ

+ 44 (0) 1785 815651
info@mtt-group.com

EC DECLARATION OF CONFORMITY

Acc. To European Community Instructions for machines (98/37/EC)

We, MTT Technologies Limited, herewith declare that the product defined below meets the basic requirements regarding safety and health of the relevant EEC directives.

This declaration is valid for the unmodified original state of the product. Any product changes, which are made without our approval, will void this declaration.

Product Description: **MTT Selective Laser Melting Machine**

Model: **SLM125 (DM125 SLM)**

Serial Number: _____

_____

The product meets the requirements of the following directives:

Machinery Directive 98/37/EC
Electromagnetic Compatibility Equipment Directive 2004/108/EC
Low Voltage Directive 2006/95/EC

Applied harmonised standards:

EN ISO 12100	Safety of machinery, part 1 & part 2
EN 60204	Electrical Equipment of machines, part 1
EN1012	Safety of Compressors and vacuum pumps, part 2
EN 60825	Safety of laser products, part 1

Location, Date: _____

Signature: _____

Dr Chris Sutcliffe
Research & Development Director