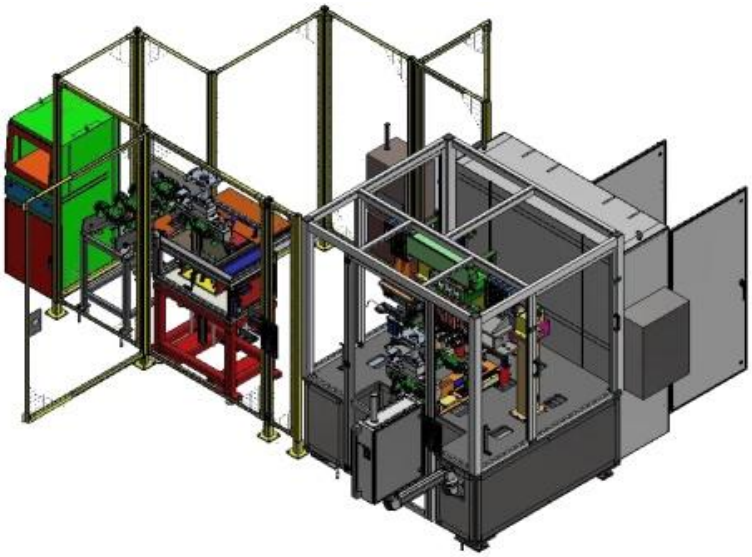
Kokomo Engine Plant

M2006021 Machine C – OP178

Operation and Maintenance Manual



JENOPTIK AUTOMOTIVE NORTH AMERICA, LLC
1500 W Hamlin Rd,
Rochester Hills, MI 48309
Phone: 248-853-5888
Website: https://www.jenoptik.com

This Page Left Intentionally Blank

Disclaimer

JENOPTIK Automotive North America, LLC has developed this documentation for customer use. The information contained herein is the properly of JENOPTIK Automotive North America, LLC and may not be copied, used, or disclosed without proper written consent from JENOPTIK Automotive North America, LLC. It is understood that the contents are confidential and will not be divulged to any other source than employees in the organizations directly engaged in supporting the equipment described in this manual. JENOPTIK Automotive North America, LLC expressly withholds permission for any other use.

For more information, contact JENOPTIK Automotive North America, LLC at the following:

JENOPTIK AUTOMOTIVE NORTH AMERICA, LLC

1500 W Hamlin Rd,

Rochester Hills, MI 48309

Phone: 248-853-5888

Website: https://www.jenoptik.us.com

Interactive Training Systems

The following Operation and Maintenance Manual was developed by Interactive Training Systems (ITS) for JENOPTIK Automotive North America, LLC

For more information on the development of this Operation and Maintenance Manual, please contact ITS at the following:

Interactive Training Systems

118 S. Leroy St.

Fenton, Michigan 48430

Phone (810) 714-7630

Website: www.its-na.com

SECTION 1
INTRODUCTION

Table of Contents

1.1 Overview

This manual is an accompanying document for the M2006021 Machine C – OP178 Crank Shaft Measuring Machine. The machine was designed and built by JENOPTIK Automotive North America, LLC.

The information in this manual reflects the product that was designed and built to the required specifications and performs the required operations. Modifications made to the equipment may cause portions of this manual to become obsolete. Therefore, it is recommended that the manual be updated if changes are made to the system.

This manual is an aid to simplify the operation and maintenance of the M2006021 Machine C – OP178 machine.

It contains important instructions on how to operate and maintain the machine safely, correctly, and economically. If these instructions are followed, dangers can be avoided, repair costs and down time reduced, and the reliability and durability of the machine maintained. The manual must be read and used by every person who is engaged in work on the M2006021 OP178 machine.

The Safety Instructions must be presented and, if necessary, explained to ALL persons working with the M2006021 – OP178 machine.

1.2 Manual Organization

A standard Chapter arrangement has been adopted to define the content of this manual. This manual consists of the following chapters.

Section 1 – Introduction

This section includes the cover page of the manual and the introduction of how the manual is laid out.

Section 2 – Safety Instructions

The Safety Instructions section details all personal safety instructions as related to the machine and equipment. It includes the location and function of the safety devices on the machine and equipment. This section also includes information on Energy Control and Power Lockout (ECPL) identifying power source location with safety shutdown and lockout and verification instructions.

Section 3 – Equipment Description Overview

This section provides an overview of the cell's machinery and equipment and describes what the machinery and equipment does and how it works. This section is further broken down into machine description of each operation of the machine including sequence of operations.

Section 4 – Operating Instructions

The Operating Instructions section includes a description of the devices used to control and operate the cell including all HMI screen displays with functional descriptions. This section details the operational procedures to properly startup, operate, and shutdown the equipment.

Section 5 – Preventive Maintenance Instructions

The Maintenance section will contain Preventive Maintenance task procedures that must be performed on the equipment. Procedures and charts will be set up according to pre-determined time intervals.

Section 6 – General Maintenance Instructions

The Maintenance section will contain General Maintenance task procedures that must be performed on the equipment.

Section 7 – Troubleshooting

The Troubleshooting section provides some cases corrective maintenance procedures for troubleshooting alarms and fault codes detected by the machine controller.

Section 8 – Spare Parts

A list of spare parts recommended by the manufacturer.

Section 9 – Drawings

A list of the drawings provided by the manufacturer.

Section 10 – Appendix

The appendix section contains sub supplier documentation for components on the system.

1.3 Locating Information in the Manual

Each of the sections in this manual is separated by a tabbed divider. To locate the major topic area (section), turn to each of the tabbed dividers. A detailed table of contents behind each tab will provide you with the specific page number for each of the topics addressed in that section.

1.4 Page Numbering

The page numbers throughout this manual reflect the section number as well as the page number. This method of numbering the pages allows you to quickly determine the exact location of a page. For example, page number 2-3 is the third page in Section 2.

1.5 Figure Numbering

The figure numbers used throughout this manual reflect the section number as well as the figure number. For example, Figure 3-2 is the second figure in Section 3.

1.6 Explanation of Symbols and Notices

Caution, Warning, and Danger notations are used throughout this manual to alert the reader to safety concerns which, if procedures are not properly performed, could cause death, serious injury or equipment damage. The boxed Caution, Warning, and Danger notations will always appear before the information or step to which they pertain. These notations are listed below in ascending order of importance. Safety instructions in this operating manual are marked as follows:

CAUTION

CAUTION

*Hazards and unsafe practices which **COULD** result in minor personal injury or product or property damage. Message indicates a low/minor hazard level situation, where a non-immediate or potential hazard or unsafe practice presents a lesser threat of injury to the employee, or which could result in damage to the machine and equipment.*

WARNING

WARNING

*Hazards and unsafe practices which **COULD** result in severe personal injury. Message indicates a medium hazard level situation, with the potential for moderate to major injury, without long term consequences to the employee.*

DANGER

DANGER

*Immediate hazards which **WILL** result in severe personal injury or death. Message indicates a high/major hazard situation, where an immediate hazard presents a threat of loss of life or serious/disabling injury to the employee.*

NOTE

NOTE

Generally used to highlight a suggestion or stress important information; may also bring attention to a unique operating condition or provide a clarifying statement.

1.7 Manufacturer Contact Information

JENOPTIK AUTOMOTIVE NORTH AMERICA, LLC
1500 W Hamlin Rd,
Rochester Hills, MI 48309
Phone: 248-853-5888
Website: https://www.jenoptik.com/

SECTION 2
SAFETY

Table of Contents

Table of Figures

2.1 EXPLANATION OF NOTICES

Caution, Warning, and Danger notations are used throughout this manual to alert the reader to safety concerns which, if procedures are not properly performed, could cause death, serious injury or equipment damage. The boxed Caution, Warning, and Danger notations will always appear before the information or step to which they pertain. These notations are listed below in ascending order of importance. Safety instructions in this operating manual are marked as follows:

CAUTION

CAUTION

*Indicates hazards and unsafe practices which **COULD** result in minor personal injury or product or property damage. Message indicates a low/minor hazard level situation, where a non-immediate or potential hazard or unsafe practice presents a lesser threat of injury to the employee, or which could result in damage to the machine and equipment*

WARNING

WARNING

*Indicates potential, moderate risk hazards and unsafe practices which **COULD** result in severe personal injury. Message indicates a medium hazard level situation, with the potential for moderate to major injury, without long term consequences to the employee.*

DANGER

DANGER

*Indicates immediate hazards which **WILL** result in severe personal injury or death. Message indicates a high/major hazard situation, where an immediate hazard presents a threat of loss of life or serious/disabling injury to the employee.*

NOTE

NOTE

Generally used to highlight a suggestion or stress important information; may also bring attention to a unique operating condition or provide a clarifying statement.

Due to variations found in the operating conditions of certain applications and their working environments, the special notations in this manual cannot identify all potential problems or hazards. Caution and discretion must always be used while operating machinery, especially when using electrical power. Equipment should be operated and maintained only by trained personnel.

2.2 SAFETY OVERVIEW

NOTE

This manual contains important warnings and safety instructions for observation by operation and maintenance personnel. Use only qualified personnel capable of operating, maintaining, and observing all the required safety measures outlined in sections of this manual.

The purpose of this safety section is to provide personnel with suggestions for safe work practices. Information in this Section intends to supplement—not replace—plant safety rules, local/state/national codes, or laws.

In relation to this machine, personnel must follow all current Energy Control and Power Lockout (ECPL) guidelines prescribed by the plant.

The objectives of the Safety Section are to:

- Define the Lockout Procedures. (ECPL)

WARNING

WARNING

Always follow ECPL (Energy Control Power Lockout) procedures including Arc Flash and Lockout / Tagout.

- Explain Energy Control & Reliability and its use.
- Describe the location and utility of all safety features.
- Provide general guidelines for personal, mechanical, electrical, and pneumatic safety.
- Illustrate the locations of lockouts and safety features for each station.
- Isolate the identified potential hazardous energy sources, including stored energy. Lockout the hazardous energy sources with assigned safety padlocks
- A qualified person shall use test equipment to test electrical circuit elements and parts of the equipment to which there will be employee exposure and shall verify that circuit elements and equipment parts are de-energized.
- Everyone is responsible for his or her own safety. After assuring that no personnel are exposed, and successfully disconnecting the energy source, the push buttons or normal operating controls will be manipulated to make certain.

Always Ensure:

- The equipment or process is clear of tools and materials.
- There are NO personnel in the process area, machine path or point of operation.
- Lockout devices are applied and removed in a safe manner and ECPL safety procedures are followed.
- After servicing and/or maintenance is completed and the equipment can be returned to normal production operation, determine that no personnel in the area are exposed, remove all personal tools from the equipment, re-install safety guards, remove lockout devices, and return lock(s) to the proper place. Notify affected employees that the equipment is about to be restarted. Operate the isolated energy devices to restore energy, and then cycle the equipment to ensure proper operation.
- If work on the equipment is not completed by the end of shift, follow ECPL procedures.

Exclusive control is defined as providing the employee conducting the assigned task with exclusive control for startup of the equipment. It is most applicable under the following conditions:

- The assigned task requires the machine or equipment to be energized for troubleshooting, testing, positioning, and other purposes.
- The assigned task is routine, repetitive, and integral to the normal production operation and it does not require the dismantling or replacement of major machine or equipment components.

Devices utilized for exclusive control are:

- Circuit control devices, such as emergency stop and start controls, providing they render the equipment inoperative and are secured by the employee, thus preventing operation without his/her knowledge and consent.
- Normal production safeguarding devices, such as interlocked gates, light screens, and presence-sensing mats, providing they also safeguard the employee during the maintenance task, are under his/her presence in the sensing zone.

2.3 GENERAL SAFETY GUIDELINES

NOTE

NOTE

Other company, industry and/or government mandated safety guidelines may also apply.

The following general safety guidelines are an overview of the safety topics covered in this section. While these guidelines provide information that will help prevent personnel injury and damage to equipment, read the entire section in this manual as well as the safety sections in the OEM documentation provided with this manual for a thorough understanding of safety practices and specific devices related to the equipment.

- Read this entire manual as well as the OEM documentation supplied with this manual and become thoroughly familiar with the machine operation and safety features before working on any part of the system.
- Follow all System Operating Safety precautions outlined in this manual and supplied OEM documentation.

The following guidelines must be followed in order to promote the safety of the operation and maintenance personnel:

- Adopt good work habits regarding safety when working on or around the system.
- Maintain clean and safe work areas at all times.
- Read and obey all signs posted on and around the system.
- Do not remove or tamper with any safety guards, safety interlock devices, or other safety equipment built into the system. Operators must not try to defeat any safety feature. Doing so could result in severe personal injury.
- Always dress properly for the job and use appropriate sight and hearing protection. PPE (Personal Protection Equipment) approved safety glasses must be worn by anyone working near the line. When required, personnel must wear protective work gloves to protect themselves from cuts or lacerations that can result from the sharp edges of metal parts used in this process. Do not wear gloves near moving parts. Ear protection and hard hats may also be required where applicable based on plant dictates.
- When equipment is shutdown by proximity limit switches, Emergency Stop pushbuttons, or other safety devices; no person should begin maintenance repairs until the shutdown procedures are completed and the system locked out observing arc flash and lockout procedures using the proper Personal Protection Equipment (PPE) where applicable.
- Know the location of the Energy Control and Power Lockout (ECPL) placard and properly follow all posted procedures.

2.3 SAFETY GUIDELINES *(continued)*

- Become thoroughly familiar with the location and function of all safety devices on the system including emergency stop pushbuttons and lockout valves.
- Understand the system's stack light color coding.
- Follow all Electrical, Fluid, and Mechanical System safety precautions outlined in this manual and dictated by plant safety specifications.
- Use tools properly and safely whenever working on the system.

2.4 PERSONAL SAFETY

2.4.1 Overview

Accidents do not occur as the result of a single cause, but may occur because of an interaction between working conditions, human error, and other events. Given the complexity of machine technology, some accidents will inevitably occur. However, an error in judgment will always be the weakest link in the chain of events leading to an accident. Even under the best circumstances, judgment is affected by:

- Knowledge (and lack of knowledge) of the system and peripheral equipment
- Personal work habits on the job
- Physical and mental fitness on the job

2.4.2 Knowledge First

It is vitally important for anyone working on a system to become thoroughly familiar with its operation before working with it. Knowledge of the system will help to avoid accidents. Read and understand all safety instructions before setting up, operating, maintaining, or servicing the system. Know the location and function of all safety devices provided with the system and check regularly to ensure their proper operation.

2.4.3 Work Habits

Personal safety combines knowledge, positive attitudes, and good work habits into a proactive awareness of potential hazards. Safe actions occur when an awareness of the importance of safety, combined with an understanding of tasks, becomes part of daily work habits on the job.

You have a responsibility to conduct your daily work actions safely. Adopt a professional attitude toward safety and develop personal safety skills you can depend on-for life!

2.4.4 Fitness for Duty

"Fitness for Duty" means; the state of being physically and mentally fit to perform job-related duties. It is important to reduce or eliminate anything that impairs job-related judgment.

Alertness is essential for sound judgment and nothing affects alertness more adversely than fatigue. Several causes are:

- **Lack of sleep** - The most common cause of fatigue; continued loss of sleep causes increased nervousness and decreased reaction time. This affects the ability to react quickly to a situation.
- **Poor eyesight** - Tired eyes lead to drowsiness, decrease your depth perception, and reduce field of vision.
- **Emotional stress** - A buildup of emotional stress causes tension, irritability, and mental distraction.
- **Anger** - If not managed appropriately, it causes drowsiness, impairs concentration and job performance.
- **Physical problems** - Even minor ailments (headache, indigestion, sore throat) and other conditions-such as consuming a heavy meal can impair judgment, cause sluggishness, or make you drowsy.
- **Drug and alcohol use** - The resulting drowsiness, nausea, or dizziness dulls reflexes and turns you into an "accident waiting to happen".

2.4.5 Dressing for Safety

Unless plant safety specifications indicate otherwise, always follow these guidelines:

- Do not wear loose or baggy clothes. They should fit close to the body, *but not so tight as to hinder free movement.*
- Do not wear ties or scarves around the system at any time.
- Do not wear jewelry such as rings, bracelets, and necklaces around the system at any time. Wear medical alert jewelry with caution.
- Do not wear gloves unless handling hot, rough, or sharp surfaces.
- Wear shoes approved by plant safety specifications.
- Wear the correct protective clothing, especially when a job calls for it.
- Tie back long hair or restrain it with a cap or net.
- Wear a hard hat or other appropriate protection when a job requires it or where a risk of falling objects or overhead moving parts may exist.

2.4.6 Eye Protection

To reduce the risk of eye injury, wear the proper eye protection. Choose eye protection equipment that will best protect your eyes against an injury that may result from the type of work performed. Unless plant safety specifications indicate otherwise, safety glasses with side shields will be sufficient for normal system operation. Keep eyewear clean at all times.

2.4.7 Hearing Protection

To reduce the risk of long-term hearing damage, use hearing protection appropriate for the job. Choose hearing protection equipment (foam earplugs, padded headset) that protects against noise levels produced by the system and surrounding systems. However, do not select hearing protection that will totally muffle all noise. During system operation, it is important to hear any unusual noises that may indicate a problem. Check with your plant safety specifications to determine the best hearing protection for the job and the area where the job is performed.

2.5 WORK AREA SAFETY

2.5.1 Cleanliness

Keep work areas clean and free of hazardous obstructions at all times. Be aware of protruding machine components. Keep floors clean and dry. Clean up chemical (cleaning solvent, beverage) and process fluid spills immediately. Follow plant-approved procedures to clean up all spills.

2.5.2 Guards and Covers

Safety guards, covers, gates, and barriers must always be properly installed while the system is operating. They should be removed only for maintenance and service purposes. If guards and covers are removed for maintenance or service, they must be re-installed before system operation can resume. Electrical interlocks, limit and proximity switches used on gates or safety guards must never be jumpered-out or bypassed.

2.5.3 Traffic Areas

Keep aisles, pathways, and catwalks clear of obstructions to allow free movement in all directions. Do not block their access with items such as boxes, tool chests, or ladders. This is especially true in case of an emergency, where rescue personnel must have quick access to an injured worker.

2.5.4 Unsafe Conditions

Immediately report any unsafe working conditions to your supervisor or safety department. Faulty safety devices, damaged hoses, and loose or broken parts all pose a safety hazard. Report all fluid leaks (oil) and unusual odors (excessive vapors, overheated metal).

2.5.5 TOOL USAGE

Tool usage safety guidelines; as they apply to the system, are as follows:

- Do not leave any tools (hand or electric) on or around the system. Any machine vibration may cause tools to fall into moving automation and cause extensive damage.
- When repairing or adjusting any part of the system, use the proper tool for the job. The incorrect size or type of tool may damage the system components.

2.6 ELECTRICAL SAFETY

The outline below provides Electrical safety precautions:

- Only qualified technicians familiar with the system, using an up-to-date set of system schematics, should perform electrical/electronic system troubleshooting or maintenance.
- Avoid wearing glasses that have a metal frame.
- Avoid wearing necklaces, watches, bracelets, earrings, rings, or chains that are made of a metallic substance.
- It must be assumed at all times that power is "**ON**" so all conditions must be treated as live. This practice develops a caution that may prevent an accident.
- Ground connections cause fault currents to flow directly into the ground instead of flowing through the body into the ground. All electrical apparatus must be properly grounded.
- Always use electrically insulated tools and utilize shock avoidance techniques.
- Remove Load from circuit or equipment. Before performing maintenance or service on any part of the Electrical System, perform all applicable ECPL procedures.
- Before performing any work on the system, verify that power is removed from all circuits.
- Electrical panels must not be opened if the ground light is on by anyone other than a qualified, authorized electrician for any reason.
- Capacitors must be given time to discharge, otherwise it should be done manually with care.
- Before any repair work is conducted on electrical circuitry, a voltage check using the proper test equipment must be made to ensure that dangerous voltages do not remain in the circuitry.

NOTE

NOTE

Test equipment must be checked at regular intervals.

- USE CAUTION when connecting test equipment probes to test points. Shock hazards could exist at the test points or in the test point area and/or transients induced by the probes could cause a machine action.
- If it is necessary to perform troubleshooting with the power on, know where power is present and proceed with extreme caution. Whenever possible, use electrically insulated tools. When troubleshooting "LIVE" equipment, take the following precautions:
- Make certain your tools and body are clear of potential grounds.
- Use extra precaution in damp areas.
- Be alert and work without any outside distraction.
- When servicing electrical enclosures, follow all PPE (personal protective equipment) requirements per posted arc flash warnings in accordance with plant safety specifications.
- Orange wire (or wires tagged with orange ends) identifies circuits that receive power from an external source, for example, an electrical enclosure lighting circuit. These circuits may still have power when the main disconnect switch or circuit breaker associated with the Electrical System is OPEN. Use extreme caution when working where this type of circuit is present.
- When conductors are replaced they must conform to the manufacturer's specifications, including proper color-coding.
- Always use an appropriate fuse puller. Only regulation fuses, with their physical and electrical characteristics clearly specified, are to be used as replacements. Never attempt to replace a specified fuse with a higher-rated fuse (such as replacing a 5-amp fuse with a 10-amp fuse).
- Before applying power to any equipment, establish, without any doubt, that all persons are clear.
- The control panel doors shall be open only when it is necessary to check out the electrical equipment or wiring. After closing the door, make certain that the disconnecting means is operating properly with the disconnect handle mechanism.
- All covers on junction boxes must be closed before leaving any job.
- Before restarting equipment, read and understand all warnings, markings, and notices.

  Read all markings such as nameplates and identification plates.

  Do not alter circuits unless authorized to do so by the manufacturer.

  Do not alter or bypass protective interlocks.

  Do not place jumper wires across fuses or trip switches.

  Do not alter over-current protective devices.
- Refer to the Motor ECPL Procedures for the proper procedure of verifying the complete lockout of power sources.

2.6.1 Arcing Fault Hazards

WARNING

WARNING
Arcing fault hazards exist at all live electrical panels and precautions must be taken when opening any one of them.

An **Arcing Fault** is the flow of current through the air between phase conductors or between phase conductors and a neutral or ground, and can be caused by any number of things, ranging from faulty panel wiring to simply dropping a screwdriver or other tool inside a live panel. They can even occur when any conductive object gets too close to a high-amp current source or by simple equipment failure (i.e. opening or closing disconnects). The hazards of arcing faults come in multiple forms.

An **Arc Flash** is exposure to the tremendous thermal energy released by an arcing fault. Arc Flash can occur if a conductive object gets too close to a high-amp current source or by equipment failure (for instance, opening or closing disconnects). The arc can heat the air to temperatures as high as 35,000° F, so hot that even metal inside the panel can be vaporized. The heat of an arc flash can cause incurable third degree burns and can even ignite clothing from up to ten feet away.

An **Arc Blast** is exposure to the pressure blast released by an arcing fault. When conductive metals are vaporized by the immense heat of an arcing fault, they expand to 67,000 times their volume instantaneously. This rapid expansion results in an explosion of concussive forces that can propel molten metal and shrapnel away from the arc center.

Electrical maintenance personnel should be fully trained in arc flash safety and protection procedures before attempting any maintenance on electrical equipment.

2.6.1 Arcing Fault Hazards *(continued)*

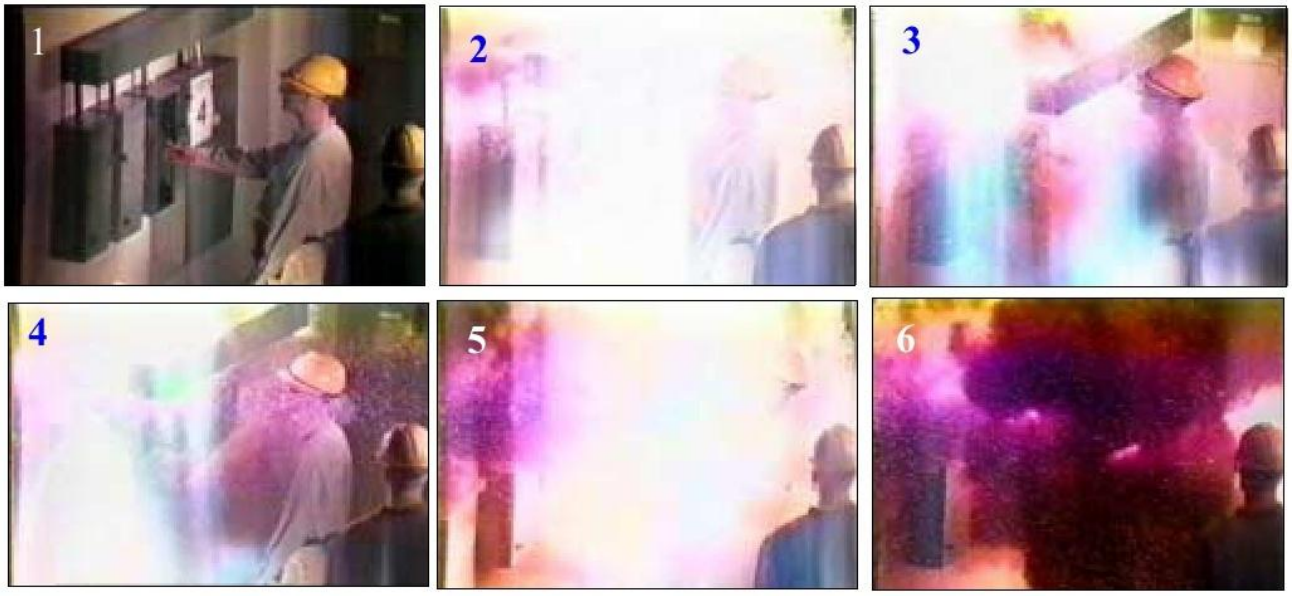


Figure 2-1: Arc Flash Sequence

Figure 2-1 above shows sequential photos of one of many staged tests that helped to understand and quantify the effects of arcing faults on workers. In this test, mannequins with temperature and pressure sensors were placed in the test cell. This was a 480 volt, three phase system with an available three phase short-circuit current of 22,600 symmetrical rms amperes. A noncurrent-limiting over current protective device was the nearest upstream protective device. An arcing fault was initiated in a combination motor controller enclosure. The arcing fault quickly escalated into a three phase arcing fault in the enclosure. The current flowed for 6 cycles (1/10 second). The temperature recorders (with maximum temperature limit of 475° F) on the neck and hand of the mannequin closest to arcing fault were pegged (beyond 457° F limit) (threshold for incurable burn is for skin to reach 205° F for 1/10 second).

The pressure sensor on this mannequin's chest pegged the recorder at over 2160 lbs/ft^2 (the threshold for severe lung damage is 2160 lbs/ft^2).

2.6.2 Arc Flash Safe Practices:

- Always observe the safe working depth and clearance for turning on the disconnect switch.
- Never face a disconnect when placing it into the open or closed position; stand off to the side of the panel and turn your body away from the disconnect.
- Always wear PPE (personnel protective equipment) appropriate to the hazard present as dictated by established flash protection boundaries (FPBs).

Be aware of all warning labels and understand them fully before attempting to service.

NFPA 70 E

An electrical incident can claim lives and cause permanently disabling injuries. Hundreds of deaths and thousands of burn injuries occur each year due to shock, electrocution, arc flash, and arc blast -- and most could be prevented through compliance with *NFPA 70E: Standard for Electrical Safety in the Workplace®.* Originally developed at OSHA's request, *NFPA 70E* covers the latest information about the effects of arc flash, arc blast, and direct current (dc) hazards, as well as recent developments in electrical design and Personal Protective Equipment (PPE)

110.16 FLASH PROTECTION. Switchboards, panelboards, industrial control panels, and motor control centers in other than dwelling occupancies that are likely to require examination, adjustment, servicing, or maintenance while energized, shall be field marked to warn qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

FPN No. 1: NFPA 70E-2000, Electrical Safety Requirements for Employee Workplace, provides assistance in determining severity of potential exposure, planning safe work practices, and selecting personal protective equipment.

FPN No. 2: ANSI Z535.4-1998, Product Safety Signs and Labels, provides guidelines for the design of safety signs and labels for application to products.

2.7 MECHANICAL SAFETY

The outline below provides Mechanical safety precautions:

- Only qualified technicians familiar with the machine should perform mechanical maintenance, adjustments, or repairs.
- If mechanical service does not require machine power, perform the appropriate ECPL procedures to disconnect or dissipate energy sources.
- Keep all moving parts of machinery and surrounding areas free of rags, dirt, and excessive oil or metal debris.

Extra caution must be exercised while working near an operating tool. Serious injury can result if personnel get in the way of moving parts while the machine is in any of its operating modes.

A machine must not be restarted until the system has been double-checked, safety guards reinstalled, safety gates and doors locked, and all personnel have been informed of impending start-up.

2.8 PNEUMATIC SAFETY

Refer to the ECPL lockout placard posted on the equipment for all lockout locations and procedures.

Use caution when working around air lines and components using compressed air. Principles of operating safely with pneumatic components are provided below.

Before locking out the air supply, secure any machine parts (such as clamps and lifts) that could move when the air pressure is removed. Such motion can result in damage to the equipment and/or personal injury.

Shut off, depressurize, and lock out the system air prior to working on pneumatic devices, unless air is absolutely required to accomplish the maintenance.

When turning on air, ensure that all components are clear of obstructions and that any personnel in the area are aware of your intentions.

Some pneumatic circuits trap air. Check the pneumatic drawings for any possible trapped air circuits and relieve any trapped air before performing any maintenance on the system.

When repair is completed, make sure to tighten all fittings and connections before turning on the air.

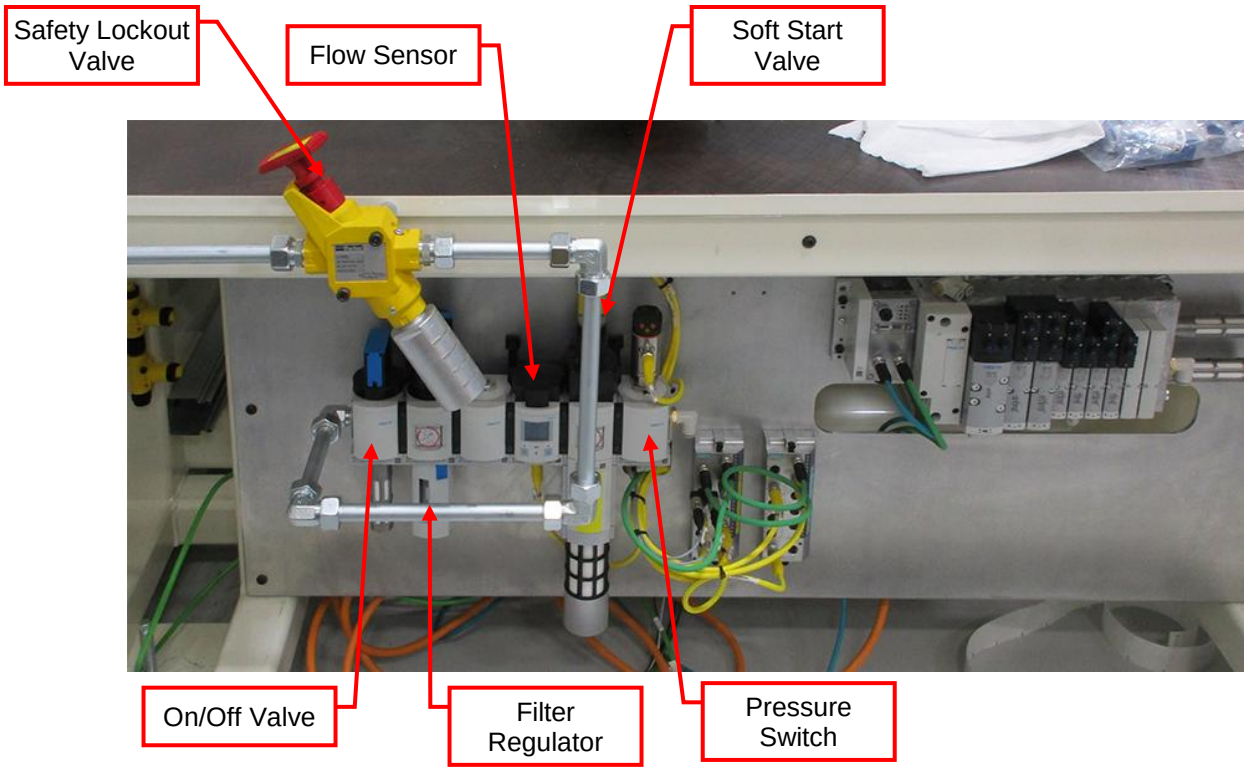


Figure 2-2: M2006021 Main Pneumatics Panel

2.9 MACHINE SAFETY DEVICES

2.9.1 Machine Access and Guarding Precautions

Personnel are protected from the work area of the cell with a combination of safety features including fencing, interlocked safety gates, guards, and light screens.

The fencing and its associated interlocking is provided to protect the operator and other persons from the following hazards:

- Slide and lift movements
- Failure of energy supplies.

Failure to properly operate and maintain the cells safety features will increase risk of injury to the operator and all other persons adjacent to the machine.

Access to the cell components is limited due to fencing, guarding, etc. As such, special precautions must be taken when gaining entry into the cell to access the equipment.

- Remove guarding only when absolutely necessary.
- Replace all guarding completely before returning machine to production.
- Repair or replace any defects before restarting machine.
- Never defeat safety devices and guards.

WARNING

WARNING

Follow ECPL before removing guarding to work on the system.

Never operate this machine unless all guarding is in place and undamaged.

Ensure that guarding is handled properly. When servicing machine, ensure guarding is placed in a safe place, away from moving parts.

Disregarding these safety precautions can result in machine damage, injury or death.

2.9.2 Fencing, Safety Gates and Guarding

When the machine is in operation, all safety guards must be in place on the equipment and safety gates and doors closed and latched. There are three (3) interlocked safety gates located around the machine.

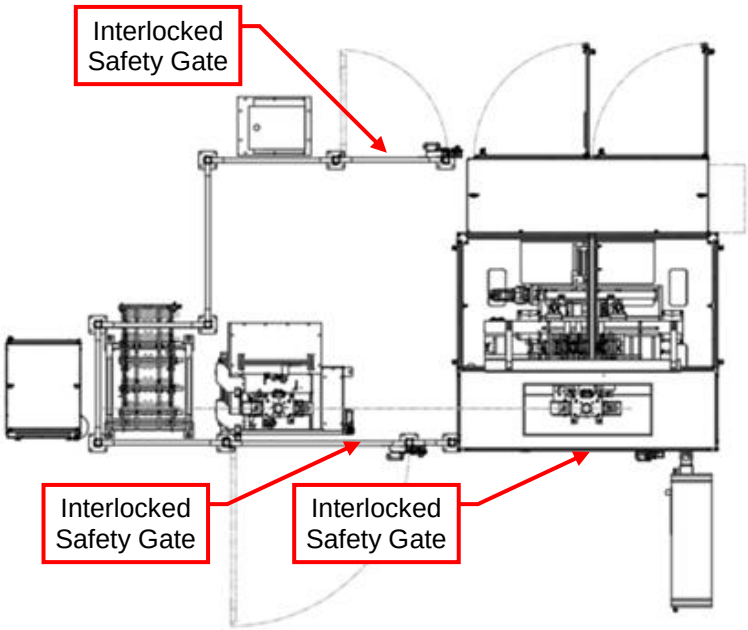


Figure 2-3: Safety Gate Locations

2.9.2.1 Interlocked Safety Gates

The safety gate incorporates a Multifunctional Gate Box (MGB-L1B-EIA-L-136390) that is an interlocking device with guard locking (type 4). Devices with Unicode evaluation possess a high coding level, devices with multi-code evaluation possesses a low coding level.

In combination with a movable safety guard and the machine control, this safety component prevents the safety guard from being opened while dangerous machine function is performed.

This means the starting commands that cause a dangerous machine function must become active only when the safety guard is closed and locked. The guard locking device must not be unlocked until the end of the dangerous machine function, and closing and locking a safety guard must not cause automatic starting of a dangerous machine function.

2.9.2.1 Interlocked Safety Gates (*continued*)

Use normal shutdown procedure to stop the machine and lockout the accessed gate before entering the safety gate. Lockout any applicable energy sources before performing any work within the gated area. Refer to the Energy Control Power Lockout (ECPL) placard posted on the Main Control Panel for the energy sources and lockout locations.

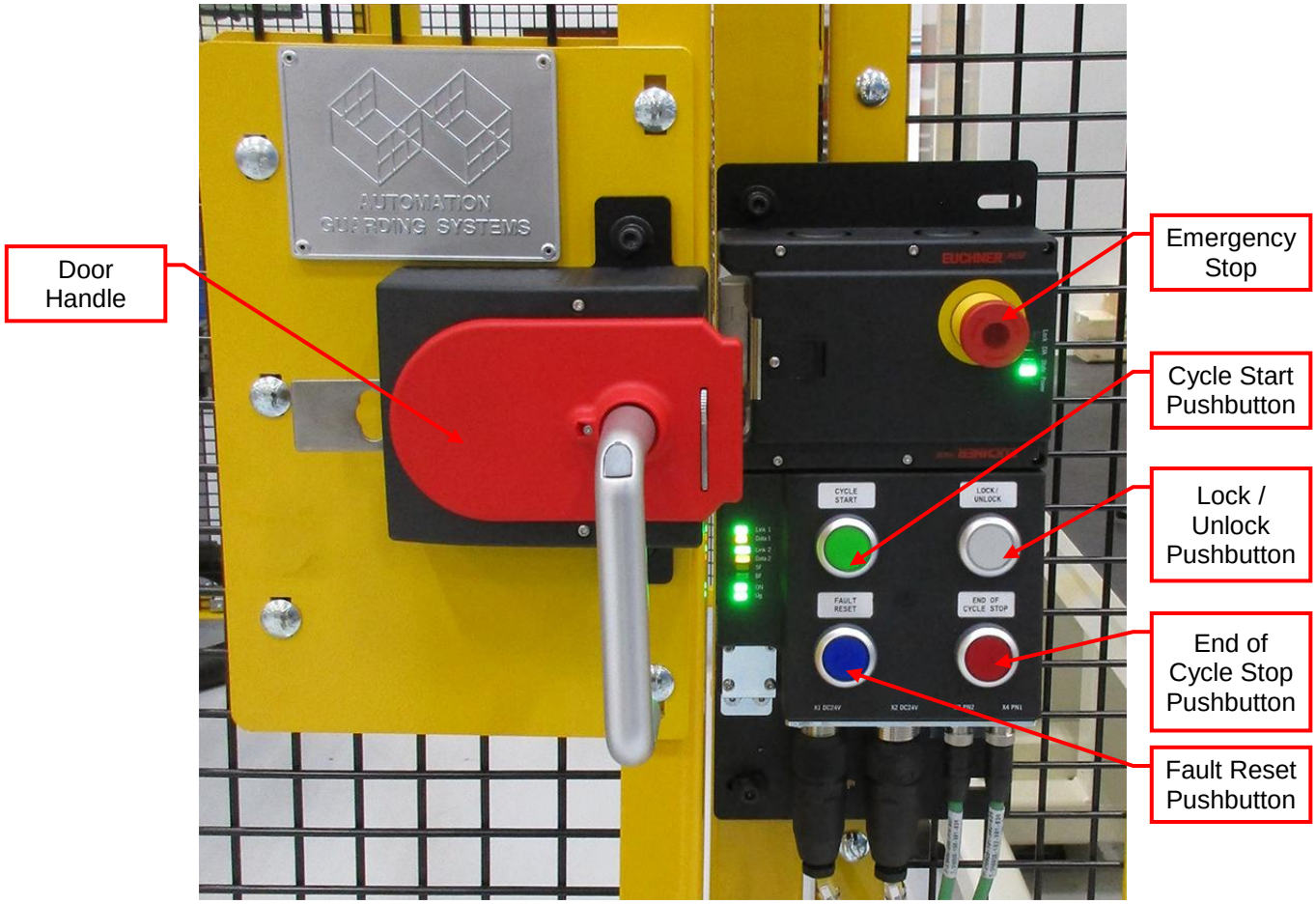


Figure 2-4: Safety Gate Switch and Multifunctional Gate Box

2.9.3 Lockable Emergency Stop Pushbuttons

Lockable detented emergency stop (E-Stop) pushbuttons are provided to interrupt the machine cycle in case of an emergency. Press in the red emergency stop palm button to immediately stop the station movements when danger to employees or damage to the equipment is eminent.

When an E-Stop pushbutton is pressed, all power to the outputs within the zone where the E-Stop was pressed is removed. A pressed E-Stop will create a fault condition. The activation of the E-Stop pushbuttons will bring the machine to an Emergency Stop irrespective of the position in the machine cycle.

A controlled stop will be applied to all machine elements, using regenerative power where applicable.

- Electrical power to all motors will be removed.
- Services will be switched off.
- “Control On” power will be maintained.

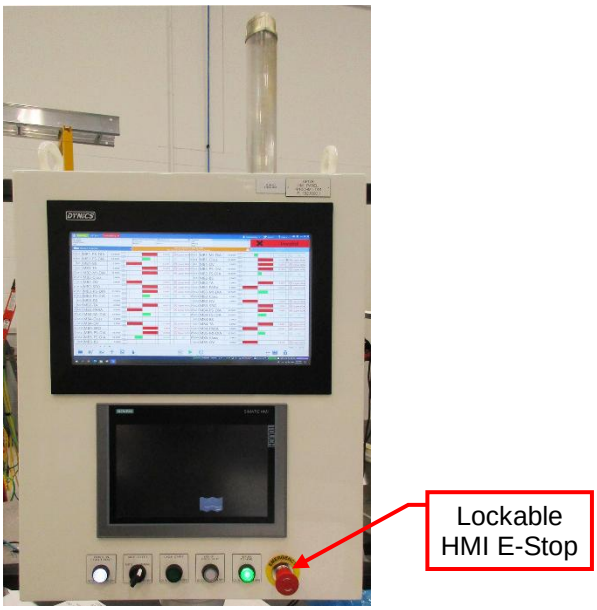


Figure 2-5: HMI Lockable E-Stop

WARNING

WARNING
Emergency Stop devices are NOT an acceptable substitute for the proper application of Energy Control and Power Lockout (ECPL) procedures.

Refer to the ECPL Placard located on the main control panel for Emergency Stop pushbutton locations.

2.10 ECPL PLACARDS

Energy Control and Power Lockout (ECPL) placards identify the primary, associated, and stored energy or power sources of the system. The ECPL placard(s) are located on the Zone main power distribution panels (PDP). Color-coded lockout tags corresponding to the source icons (such as A, B, C, etc) on the placard help locate the same sources on the machine. These tags are mounted near, or hanging directly on, the energy and power source locations.

The Energy Control Power Lockout (ECPL) placard assists authorized personnel in identifying the following:

- Lockout Location / Description
- Types of Energy Source
- Methods to lockout isolate and control hazardous energy.
- The placard consists of a graphic plan view of the cell with the location of the energy isolation points, the action to isolate the energy.

NOTE

NOTE:

The placards shown in this manual are for reference only. ALWAYS refer to the ECPL placards posted on the equipment and the associated machinery for lockout locations and procedures.

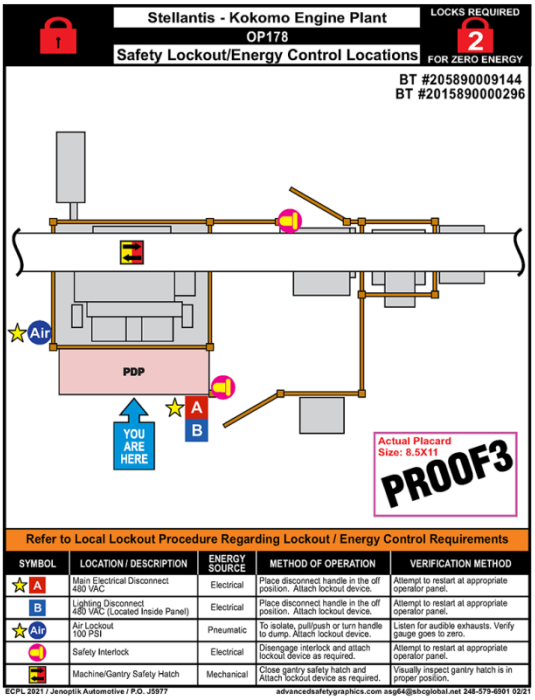


Figure 2-6: M2006021 OP178 ECPL Placard

2.11 EQUIPMENT LOCKOUT/TAGOUT

2.11.1 Equipment Lockout Procedure

NOTE

NOTE

Refer to the ECPL Placard posted on the equipment for energy sources, lockout procedures, and verification procedures.

If the machine or equipment is operating, it shall be shut down using normal shutdown procedures. Refer to the operating section of this manual for shutdown procedures.

When service or maintenance is to be conducted, the equipment must be locked and tagged out following all plant ECPL procedures. Other alternative measures that provide effective employee protection may be used for conducting minor inspections, adjustments, or servicing.

Before shutting down the equipment to lockout energy sources, the employee performing the procedure or the supervisor shall inform affected employees (such as equipment/process operators) of the intention to shut down the equipment.

Consult the graphic placard and procedures placard posted on the main electrical power distribution panel (PDP) to assess the task to be performed as it relates to the energy sources that could cause injury if energized or released during the assigned task. The employee should contact his/her immediate supervisor if there are any questions about the identification of potential energy sources.

Open the safety gate where maintenance personnel will need access to the equipment and lockout the safety gate. Lockout energy sources as stated on the ECPL placards for the work to be performed.

NOTE

NOTE

If more than one person is to perform work on the equipment, each employee must place his / her personal safety lock on the safety gate and the energy source using a multiple lock device (scissor lock).

Figure 2-7: Typical Multiple Lock Device

2.11.2 MCP Main Power Disconnect

WARNING

WARNING

There is no one main disconnect for the line. Each zone has its own power distribution panel (PDP).

On the main control panel (MCP), open the main electrical disconnect switch following the proper lockout /tagout procedures, including arc flash safety and apply personal lock. If more than one person is to perform work on the machine, each employee is to place a personal lock and **"DANGER"** tag on the energy source using a multiple lockout device (scissor lock). A switch in the OFF position, with a lock that only you have a key for is positive protection from someone turning power on while you are working.

The main electrical disconnect will shut off the main power to the machine Verify power is removed by indication on the HMI screen and attempting to start the machine.

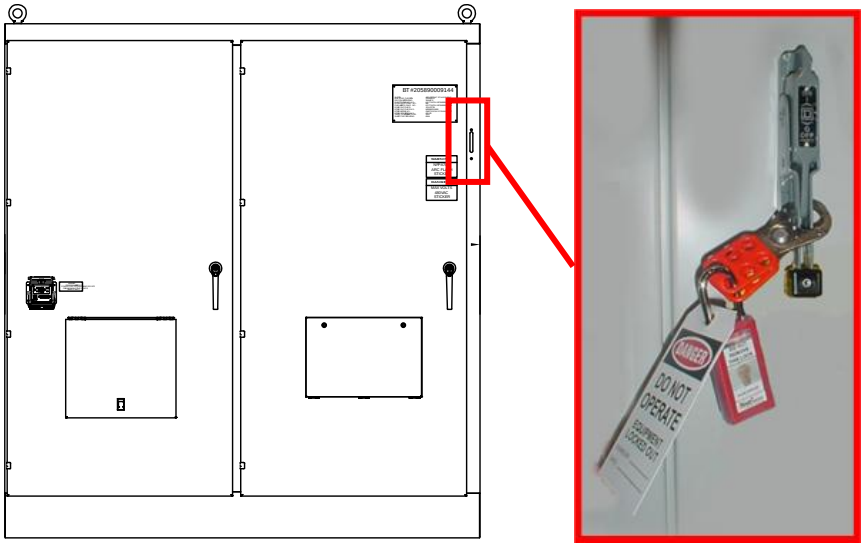


Figure 2-8: Main Electrical Disconnect with Lockout

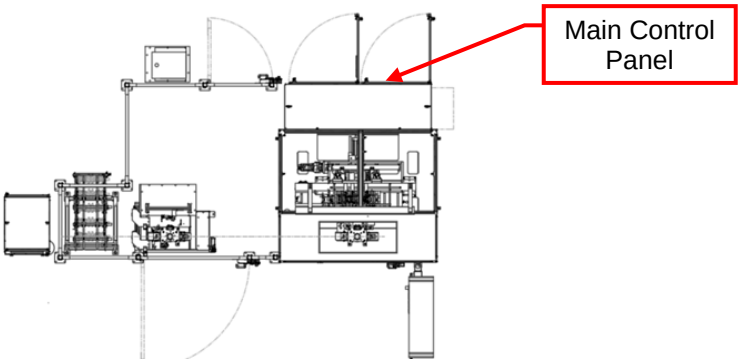


Figure 2-9: M2006021 OP178 Main Control Panel Location

2.11.3 PLC and Lighting Disconnect

PLC electrical uninterrupted power disconnect is located inside the PDP. The disconnect switch is a lockable circuit breaker located above (supply side) of the main disconnect and controls the power to the PLC. Place the disconnect switch in the OFF position by rotating the disconnect switch to the OFF position and apply a padlock.

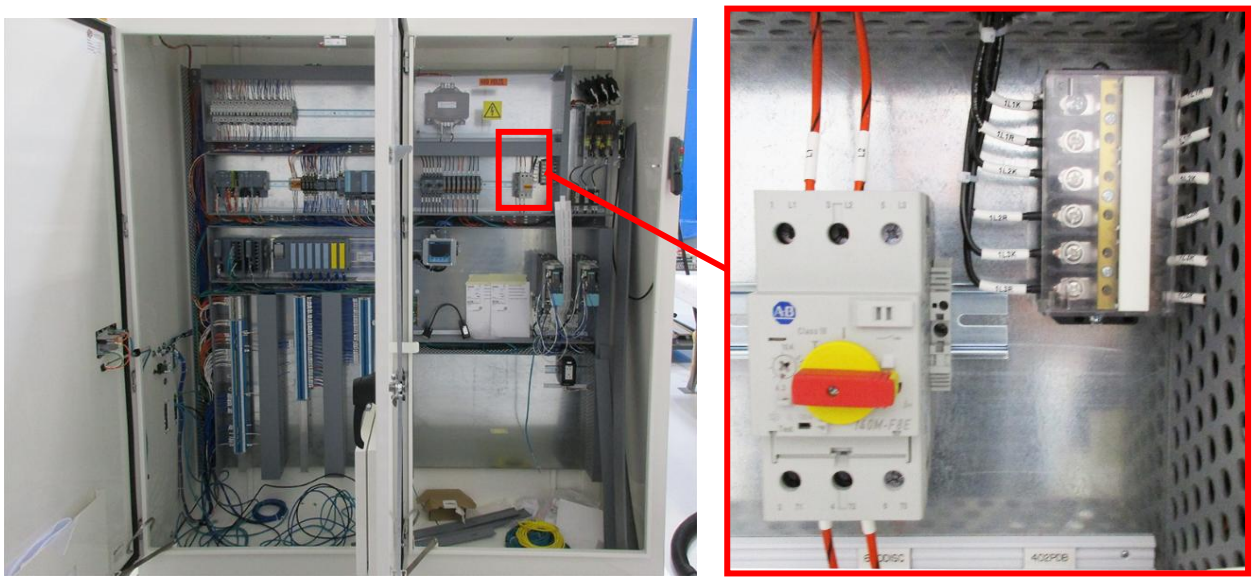


Figure 2-10: PLC Uninterrupted Electrical Power Disconnect

2.11.4 Air Lockouts

The machine air header has 1/2” air drops to the air preparation panel. The station air Individual station air circuits can be isolated from the main pipe air header without the need to purge the main air header.

Most stations air preparation panels consist of an air lockout valve, manual shutoff valve, pressure regulator and filter, flow switch, soft-start quick exhaust valve, and pressure switch. Push the red handle knob on the air lockout valve to the off position and apply padlock. This shuts off incoming air and exhaust downstream pressure. Always ensure there is zero pressure reading on the regulator gauge before starting any work on the air circuit.

Refer to the lockout placard posted on the equipment for lockout locations and procedures.

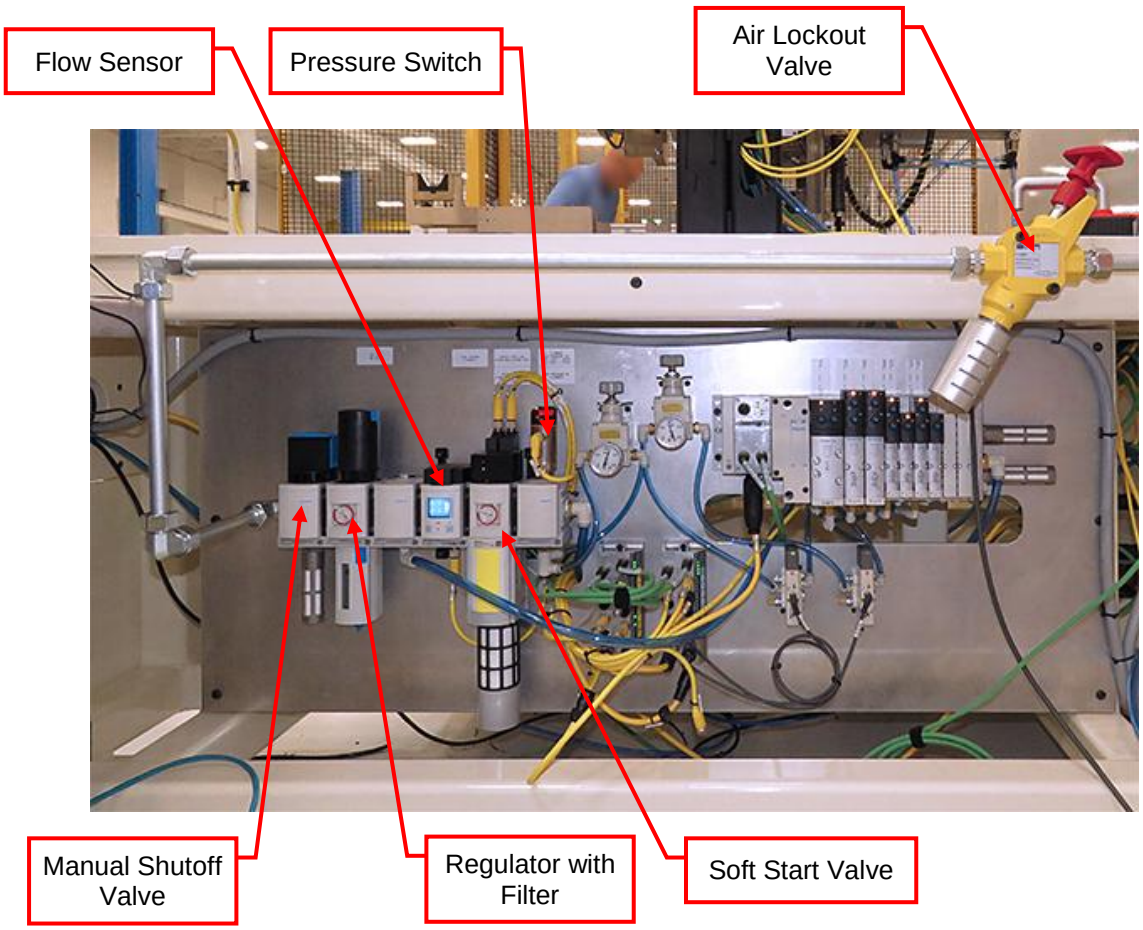


Figure 2-11: Air Preparation Panel

2.12 SDS INFORMATION

Safety Data Sheet (SDS) is a document provided by the manufacturer to provide personnel handling their materials with information regarding health and safety issues. The documents are to be located where they can be accessed by the end user. SDS documents are dated material and, as such, may be updated periodically. Ensure you are referencing the most recent information available. Consult your company's policy on how to obtain these documents.

MSDS is governed by OSHA (Occupational Safety & Health Administration) and additional information regarding SDS requirements can be obtained by visiting their website.

The SDS is typically divided into the following (16) sixteen sections:

1. Identification,
2. Hazard(s) Identification,
3. Composition / Information on Ingredients,
4. First-Aid Measures,
5. Fire-Fighting Measures,
6. Accidental Release Measures,
7. Handling and Storage,
8. Exposure Controls / Personal Protection,
9. Physical and Chemical Properties,
10. Stability and Reactivity,
11. Toxicological Information,
12. Ecological Information,
13. Disposal Considerations,
14. Transport Information,
15. Regulatory Information,
16. Additional Information.

2.13 LASER SAFETY

The laser marking system is design to be light tight to protect persons from exposure to Class 4 laser direct or scattered radiation. Exposure to the laser beam, even when reflected off of other surfaces can cause permanent eye injury and blindness. To protect you from exposure to the laser beam, the following laser safety precautions need to be taken.

Lasers are designed to deliver a large amount of energy to a very small area. In marking operations, this energy can heat metals quickly to very high temperatures. Much of the radiation that strikes the work piece is reflected into the environment, creating hazards. Some laser light used in laser equipment is invisible, so the hazard may not be readily apparent. Lasers used for marking may be infrared, and therefore the beam may be invisible.

Lasers can cause severe skin and eye injuries resulting in permanent vision loss. Studies of laser accidents have shown that there are usually several contributing factors. The following are common causes of laser injuries:

- Inadequate training of laser personnel.
- Alignment performed without adequate procedures.
- Failure to block beams or stray reflections.
- Failure to wear eye protection in hazardous situations.
- Failure to follow approved standard operating procedures or safe work practices.

2.13.1.1 Laser Hazards

Laser light poses safety hazards all laser users and persons near the laser equipment must be aware of the hazards involved in operating a laser.

Local, state or federal requirements as well as facility or building requirements may also apply for using laser or laser system.


WARNING

WARNING

The laser processing head must only be operated if all protection equipment and safety-related devices are fully functional!

2.13.2 Laser Marking Safety Concerns

Electrical: Most lasers utilize high voltages that can be lethal.

Radiation: Both visible and invisible light radiation is produced when laser marking. Due to the interaction with the work piece, high levels of hazardous blue light and ultraviolet radiation (secondary radiation) are produced. This light radiation is often reflected from the work piece into the work area. Radiation from these processes can seriously burn eyes and skin quickly and permanently.

Lasers and Eyes

Acute exposure of the eye to lasers of certain wavelengths and power can cause corneal or retinal burns (or both). Chronic exposure to excessive levels may cause corneal or lenticular opacities (cataracts) or retinal injury. Lasers operate in the ultraviolet, visible, and infrared.

Laser light in the visible to near infrared spectrum (i.e., 400 - 1400 nm) can cause damage to the retina resulting in scotoma (blind spot in the fovea). This wave band is also known as the "retinal hazard region".

Laser light in the ultraviolet (290 - 400 nm) or far infrared (1400 - 10,600 nm) spectrum can cause damage to the cornea and/or to the lens. Retinal damage may be associated with an audible "pop" at the time of exposure. Visual disorientation due to retinal damage may not be apparent to the operator until considerable thermal damage has occurred.

Eye Protection

In addition to the primary hazard of the laser beam, there may be a considerable eye hazard from high levels of secondary radiation. Ultraviolet light may be leaked into the workplace, thus the eyewear should provide primary beam protection, secondary radiation protection, and also ultraviolet protection.

Laser Protective eyewear is to be available and worn by all personnel within the Nominal Hazard Zone (NHZ) of Class 3 b and Class 4 lasers where the exposures above the Maximum Permissible Exposure (MPE) can occur.

Eyewear must be labeled with both the optical density (protective factor) and wavelength(s) for which the protection is afforded. This is especially important in areas where multiple lasers are housed. The protective eyewear must be compatible with the manufacturer’s specifications for the laser system in use, to ensure that the eyewear is suitable. Laser protective eyewear shall be inspected for damage prior to use.

Skin Hazards

High power lasers can cause skin burns. Exposure of the skin to high power laser beams (1 or more watts) can cause burns. At the under five watt level, the heat from the laser beam will cause a flinch reaction before any serious damage occurs. The sensation is similar to touching any hot object, you tend to pull your hand away or drop it before any major damage occurs. With higher power lasers, a burn can occur even though the flinch reaction may rapidly pull the affected skin out of the beam. These burns can be quite painful as the affected skin can be cooked, and forms a hard lesion that takes considerable time to heal. Ultraviolet laser wavelengths may also lead to skin cancer.

Fire - Since the laser system produces a very small spot size with high energy, the hazard of fire is present if the beam hits flammable material. Keep flammables away from the welding or cutting area. Be sure to cover and protect anything flammable in the area, since reflected radiation could start fires in unexpected places. Protect the work area.

Chemical Hazards - Harmful particulate and vapor matter can be released as a result of any thermal process, including laser processing. Certain metals and plastics release extremely toxic fumes, which must be properly ducted and disposed of during processing. A fume extraction system should be considered when such materials are to be processed.

Safety Needs

All integration and use of any laser systems should be monitored by a qualified laser safety representative. All laser welding installations are required to have a Laser Safety Officer (LSO). The LSO is responsible for personnel protection, laser cell class conformance, and enforcement of all laser safety regulations.

The laser protection officer is responsible for training the laser equipment personnel (at least once a year) in the risks associated with laser radiation and appropriate safety measures.

Due to these inherent risks, a qualified laser safety representative should be present to ensure a safe working environment.

Fully read and understand all laser safety information contained in this section as well as safety instructions found in the OEM documentation provided. The best source of safety information is provided in the instruction manual from the manufacturer of the laser equipment. Always read, understand, and follow the manufacturer’s recommended safety procedures.

2.13.3 Laser Safety Labels

Safety Labels are affixed to all laser equipment and laser associated equipment. Fully read and understand safety section of this manual and the laser manufacturer's equipment documentation for laser safety hazards.

Read, understand, and follow all laser warning labels safety instructions posted on and around the laser equipment!

WARNING

WARNING

The International Laser Label is warning to a potential Laser Hazard.

Laser equipment presents a personal hazard and if safety warnings are not fully complied with and understood, could result in great personal bodily injury and / or equipment damage. DO NOT proceed with any operation or maintenance of the laser equipment without a full understanding of the warning labels posted.

Typical Danger and Caution labels found on the laser enclosure and associated equipment:

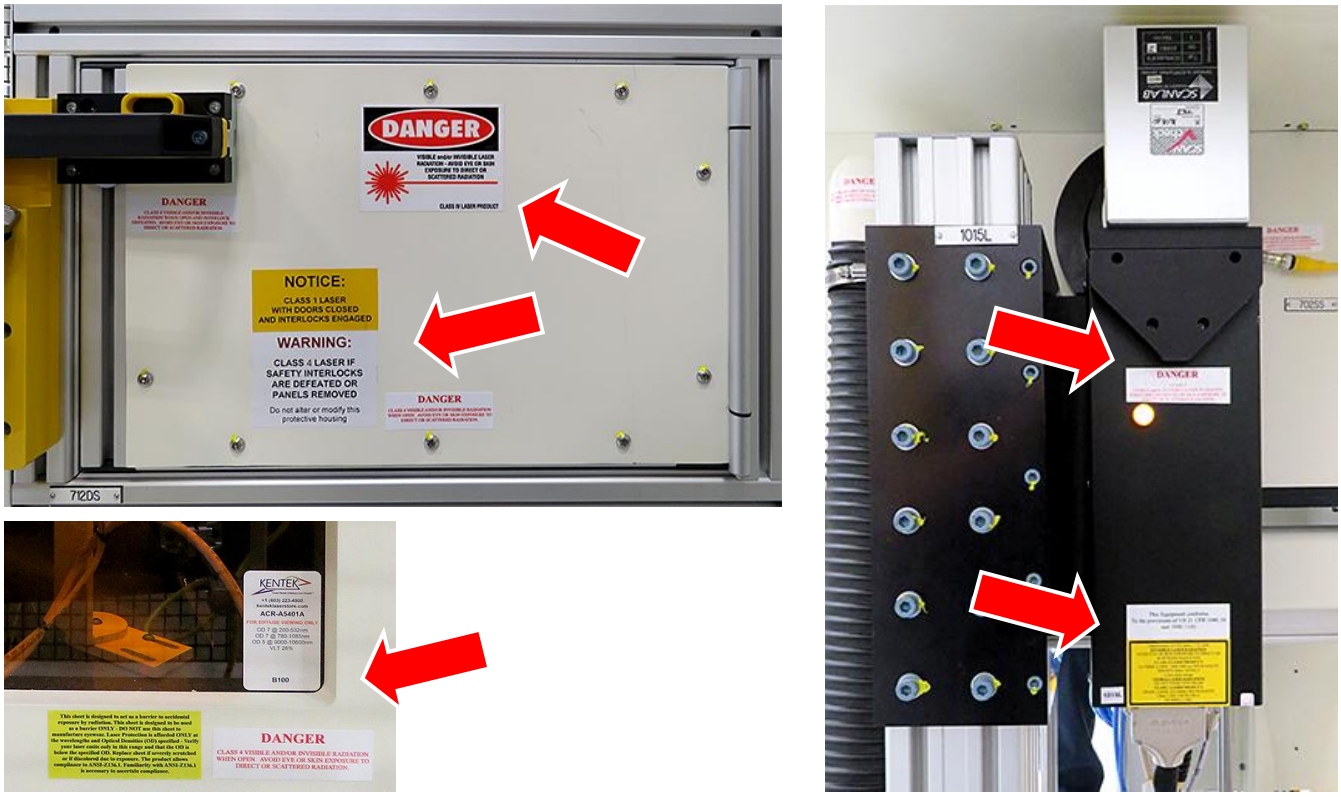


Figure 2-12: Typical Laser Warning Labels Locations

2.13.4 Laser Enclosure Safety Features

2.13.4.1 Laser Enclosure

Refers to the enclosed, light-tight enclosure where the laser marking takes place. The enclosure, when fully closed and interlocked, provides light-tight protection and prevents harmful laser emissions from leaving the enclosure.

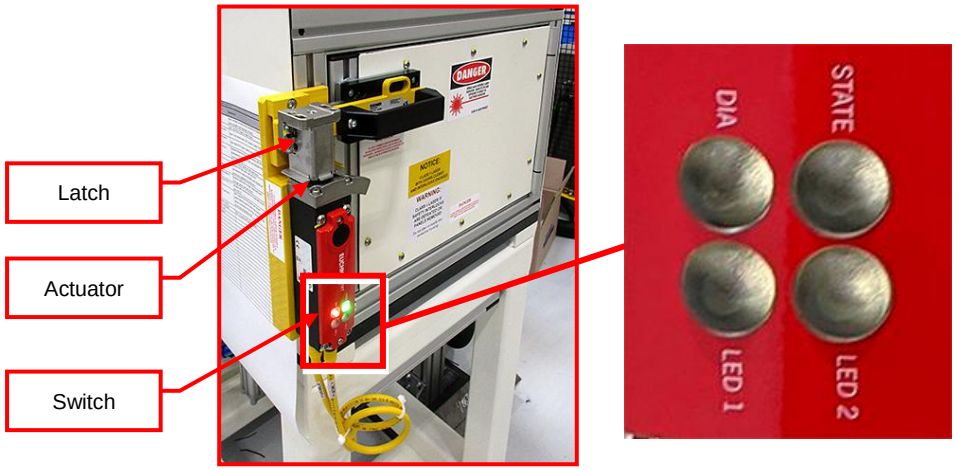
The laser enclosure is design to be light tight to protect persons from exposure to Class 4 laser direct or scattered radiation. Exposure to the laser beam, even when reflected off of other surfaces can cause permanent eye injury and blindness. To protect you from exposure to the laser beam, the following safety systems are used on the enclosure:

2.13.4.2 Interlocked Safety Door

There is one interlocked safety door to provide access to the interior of the enclosure. Safety switches series CET-AP are interlocking devices with guard locking (type 4). The device complies with the requirements according to EN IEC 60947-5-3. Devices with unicode evaluation possess a high coding level, devices with multicode evaluation possess a low coding level. In combination with a movable guard and the machine control, this safety component prevents the guard from being opened while a dangerous machine function is being performed.

- Starting commands that cause a dangerous machine function must become active only when the guard is closed and locked.
- The guard locking must not be released until the dangerous machine function has ended.
- Closing and locking a guard must not cause automatic starting of a dangerous machine function. A separate start command must be issued. For exceptions, refer to EN ISO 12100 or relevant C-standards.

If you open the access door to the enclosure while the laser is operational, the Interlocks (switch) send signals to the control system to immediately stop the laser and all gantry motion.



LED	Color
State	Green
DIA	Red
LED 1	Red
LED 2	Green

Figure 2-13: Laser Enclosure Door Safety Interlock Switch

The door handle has no provisions for applying a multiple lockout device (scissor lock) to the door handle in the retracted position. Persons working within the cell will apply a lockout bar, then attach a scissor lock device, and apply their personal padlock.

When entry into the laser is required, stop the machine using normal stop procedures, retract the slide handle, insert lockout bar, place the multi-lockout device (scissor lock), and personal padlock. Every person entering the enclosure must place their personal padlock on the scissor lock.

Figure 2-14: Laser Door Safety Switch Lockout Point

2.13.4.3 Safety Glass Windows Used On Laser Marking Enclosure

The laser enclosure safety door windows prevent harmful laser emissions from leaving the device. You can look safely at the laser operation through these windows.

Figure 2-15: Laser Enclosure Window

2.13.4.4 Fume Extraction System

The fume extraction system evacuates laser marking dust and fumes from the laser marking enclosure, specifically from the points where the marking takes place. The system filter enclosure is located on the back side of the cell outside the guarding. The fume extraction system consist of a the filtration enclosure, ducts, a blower, and air filters. Refer to the OEM documentation provided with the machine for further information.

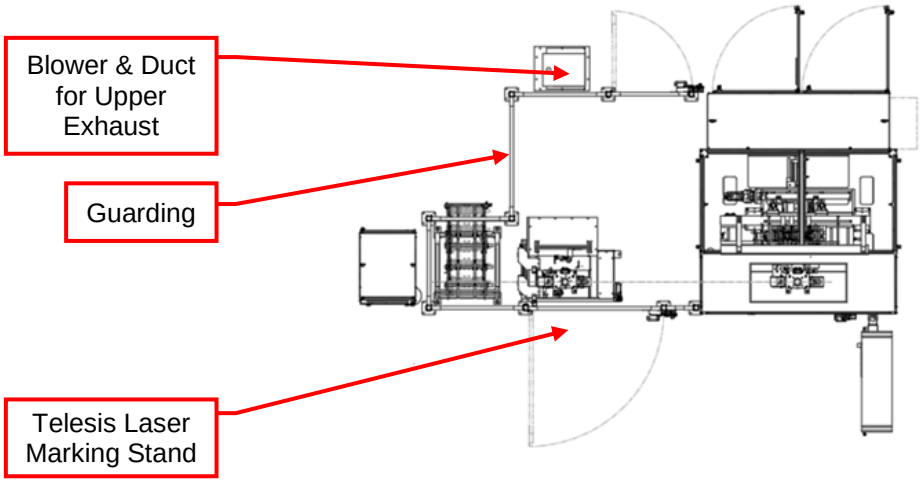


Figure 2-16: Fume Extraction System Location

Fume/dust extractors are located above the fixtures inside the laser enclosure.

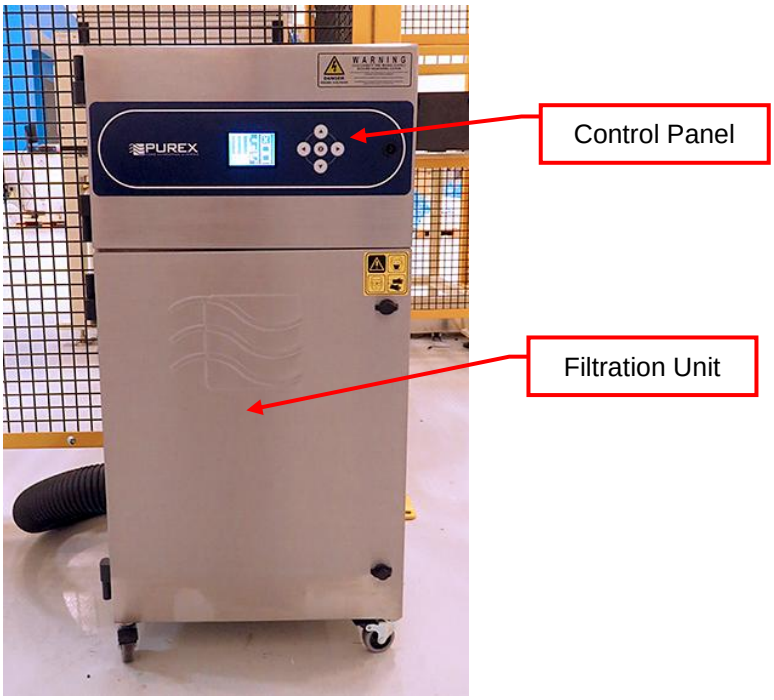


Figure 2-17: Fume Extractor System Enclosure

SECTION 3
EQUIPMENT DESCRIPTION OVERVIEW

Table of Contents

Table of Figures

3.1 SYSTEM OVERVIEW

The process source for this machine is JENOPTIK.
The mechanical design source for this machine is JENOPTIK.
The controls design source for this machine is JENOPTIK.
The run plant for this system is: Kokomo Engine Plant, Stellantis / USA

3.2 SYSTEM PROCESS

Product style of this machine is capable of: *Stellantis GME-T4 Crankshafts HO/SO Crankshafts*

3.3 GENERAL EQUIPMENT OVERVIEW

Programmable Logic Controller & Safety Devices
Siemens Sinamics Power Module PM240-2
Siemens S7-1516F-3 PN/DP PLC CPU Unit
Siemens Scalance 16-Port EtherNet Switch
Siemens Scalance 8-Port EtherNet Switch
Siemens 6ES7521-1BH00-0AB0 Digital Input Module
Siemens 6ES7522-1BH01-0AB0 Digital Output Module

- **Safety Interlocks**
  Safety PLC Software Function Blocks

- **Network and Field Communication**
  EtherNet

- **HMI**
  Siemens TP1200 12” HMI

3.4 SEQUENCE OF OPERATIONS

No.	Description
1	Close Locator
2	Open Locator
3	Advance Shuttle
4	Raise Part To Gage Position
5	Advance Headstock
6	Advance Tailstock
7	Advance Gage Probes
8	Rotate Part (Measure)
9	Retract Probes
10	Retract Tailstock
11	Retract Headstock
12	Lower Part
13	Return Shuttle To Unload

3.5 M2006021 MACHINE C – OP178 STATION LAYOUT

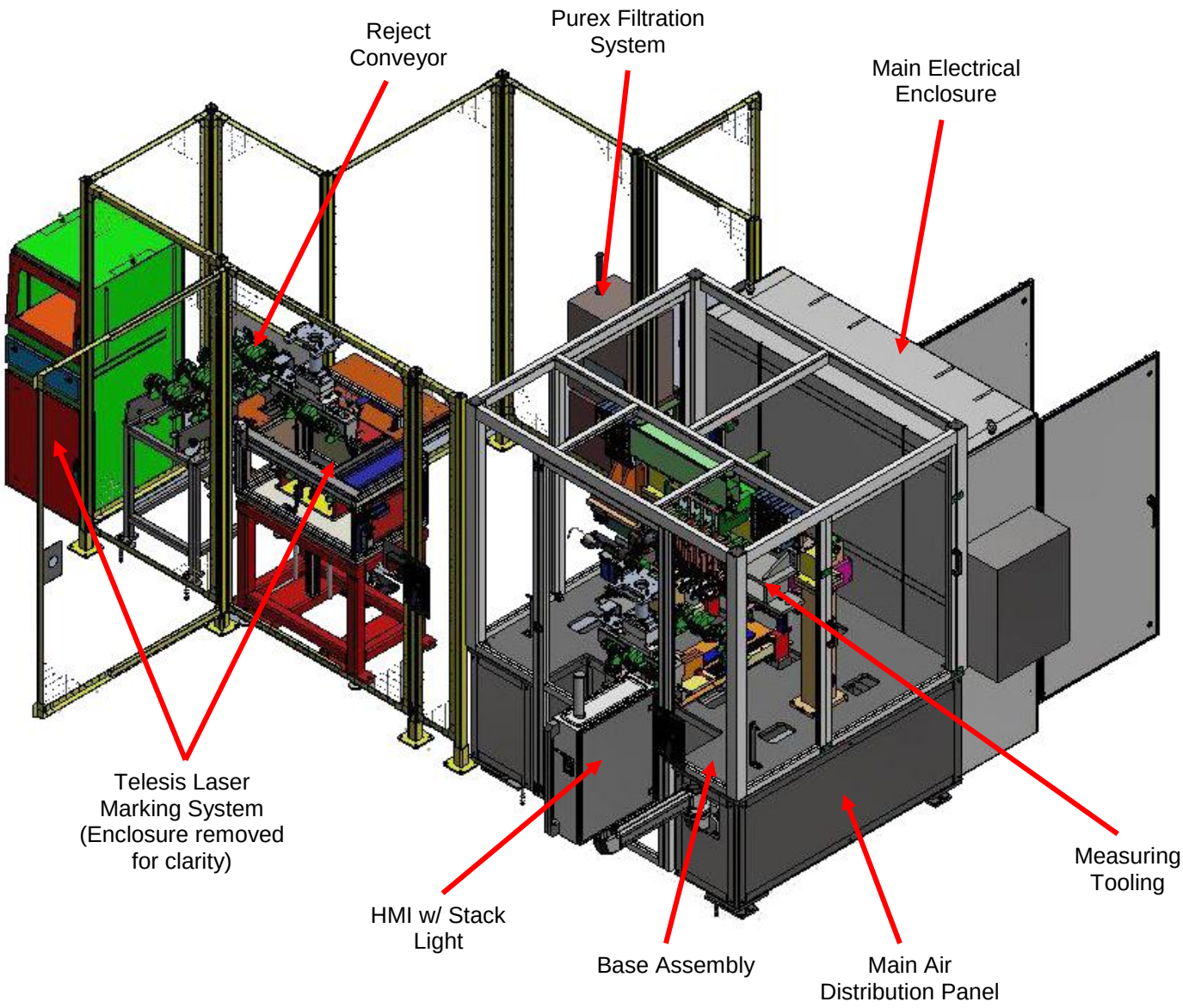


Figure 3-1: Crank Shaft Measuring Machine Station Layout

3.6 M2006021 – MACHINE C – OP178 LAYOUT

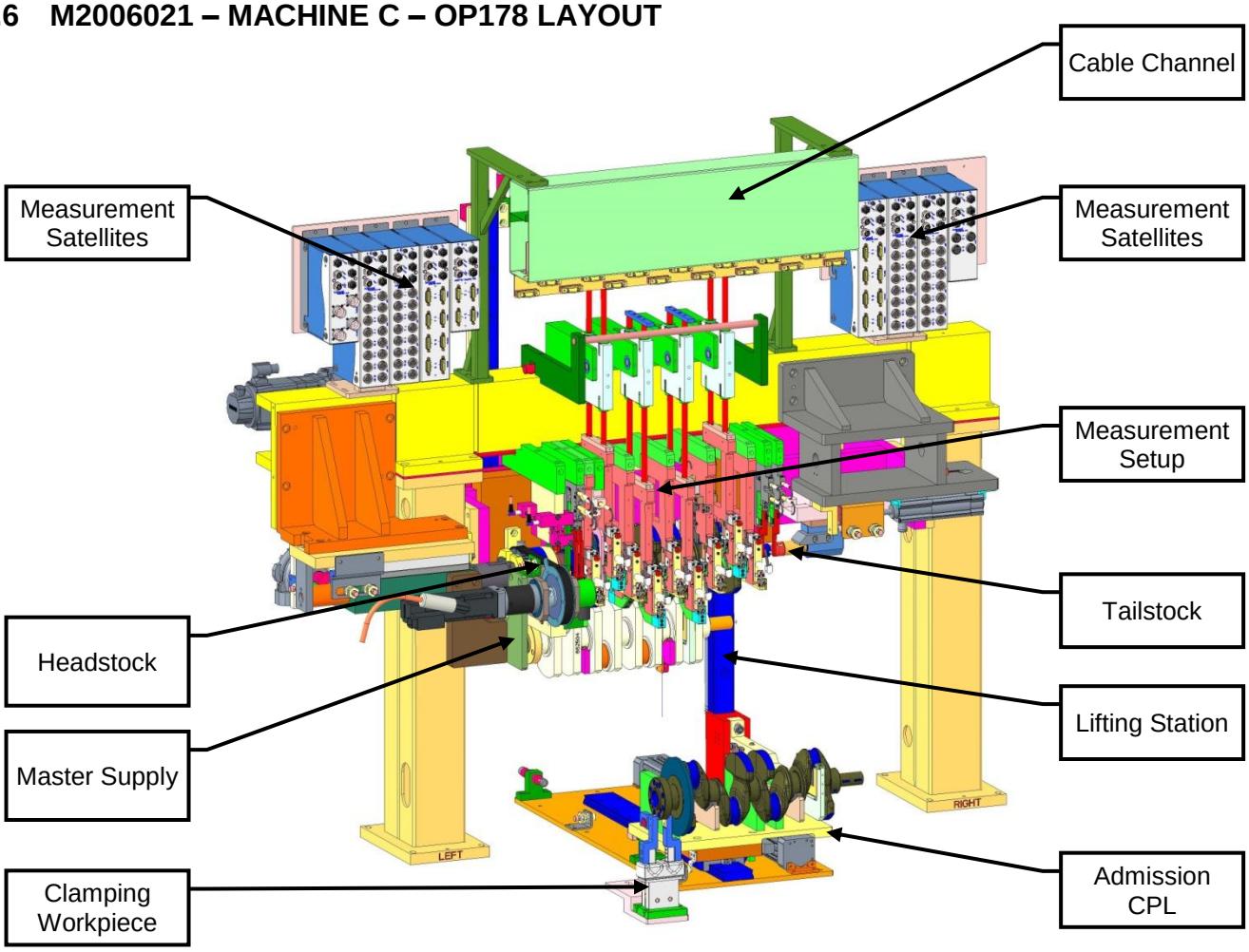


Figure 3-2: M2006021 - Machine C - OP178 Layout

3.7 MAJOR EQUIPMENT OVERVIEW

The following list below is an overview of the major subassemblies for M2006021 Machine C – OP178:

- Measurement Setup
- Lifting Station
- Headstock (Rotary Drive)
- Tailstock
- Setting Master Supply
- Admission Complete (Entry Workpiece and Drive Unit)
- Clamping Workpiece
- Measurement Satellites
- Masters (HO & SO models)
- Telesis Laser Marking System
- Reject Conveyor
- Electrical
- Field Devices
- Pneumatic
- Lubrication

3.7.1 Measurement Setup

The measurement setup is used to position the measuring elements. The basis for the measurement setup is the measuring bridge. The individual measuring elements are attached to the measuring bridge. Due to the swivel bearings fixed at the top, an angle measurement is possible with the lifting bearing measuring elements (4x).

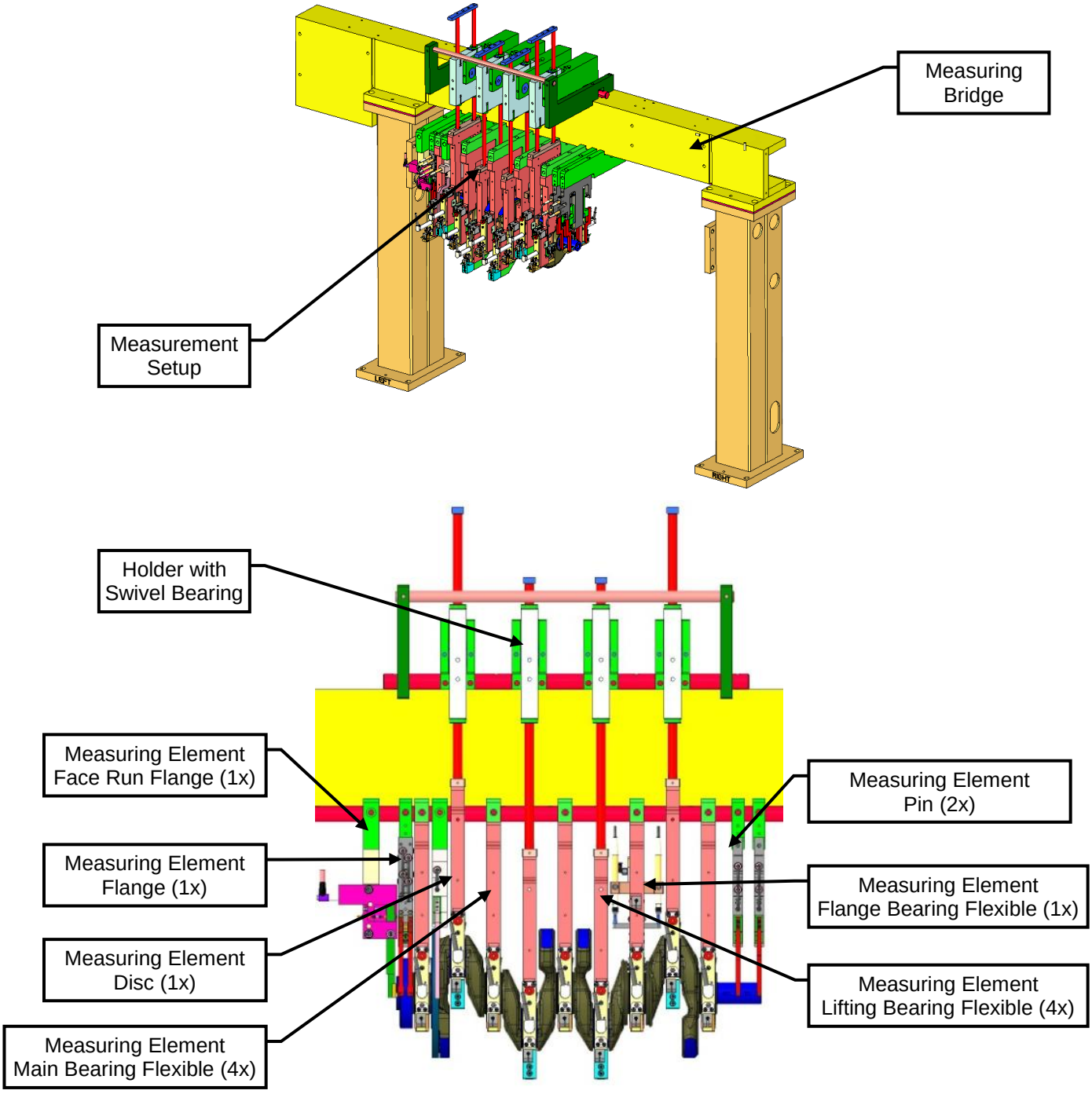


Figure 3-3: Measuring Setup

3.7.1 Measurement Setup (continued)

3.7.1.1 Description of the Measuring Elements:

Measuring Element Face Run Flange (1x):

Measurement of radial run axial run.

Two measurement tracks for squareness. The second measurement track will be realized via the internal measuring element. (see Rotary Drive)

Measuring Element Flange (1x):

Two measurement tracks for diameter measurement and concentricity.

Measuring Element Disc (1x):

“Tooth to tooth” measurement of the timing ring.

Measuring Element Main Bearing Flexible (4x):

Compact measuring element with flexible diameter range (49 – 55 mm).

Three measurement tracks for radial measurement (six measuring probes, middle measurement track digital, outer measurement track analog).

Measuring Element Lifting Bearing Flexible (4x):

Compact measuring element with flexible diameter range (49 – 53 mm).

Three measurement tracks for radial measurement (six measuring probes, middle measurement track digital, outer measurement track analog).

Storage via the swivel bearings. The swivel bearing enables the dynamic measurement of the lifting bearing pin by allowing the lifting bearing measuring element to follow the lifting bearing pin. The integrated incremental angle measuring system can also be used to measure the stroke of the lifting bearing pin.

Measuring Element Flange Bearing Flexible (1x):

Compact measuring element with flexible diameter range (49 – 55 mm).

Three measurement tracks for radial measurement (six measuring probes, middle measurement track digital, outer measurement track analog).

Additional measuring tracks for the passport bearing width (bilateral) and squareness.

Measuring Element Pin (2x):

Two measurement tracks for diameter measurement and concentricity.

3.7.2 Lifting Station

The lifting station is used to lift or position the workpiece in the measuring station. The workpiece is placed on the two roller prisms on the left and right and driven upwards via the ball circulation guides. The figure shows the top (left) and lowest (right) position of the ball circulation guide.

The drive is carried out via gears and racks by means of servo gear motor.

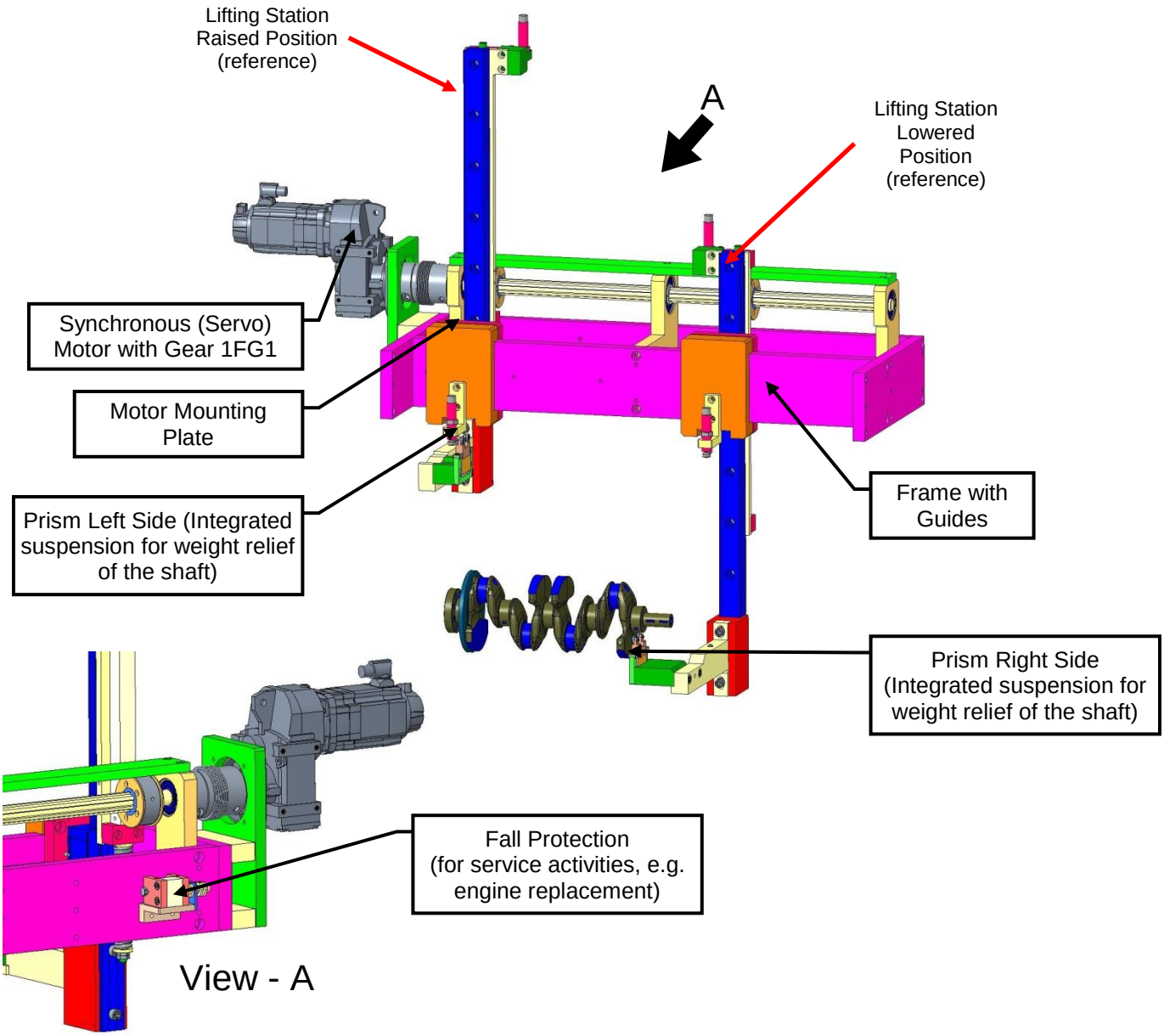


Figure 3-4: Lifting Station

3.7.3 Rotary Drive (Headstock)

The Rotary Drive (Headstock) is used for recording and rotation of the workpiece. Once the Lift Station positions the crankshaft, the rotary drive indexes to engage the crankshaft end.

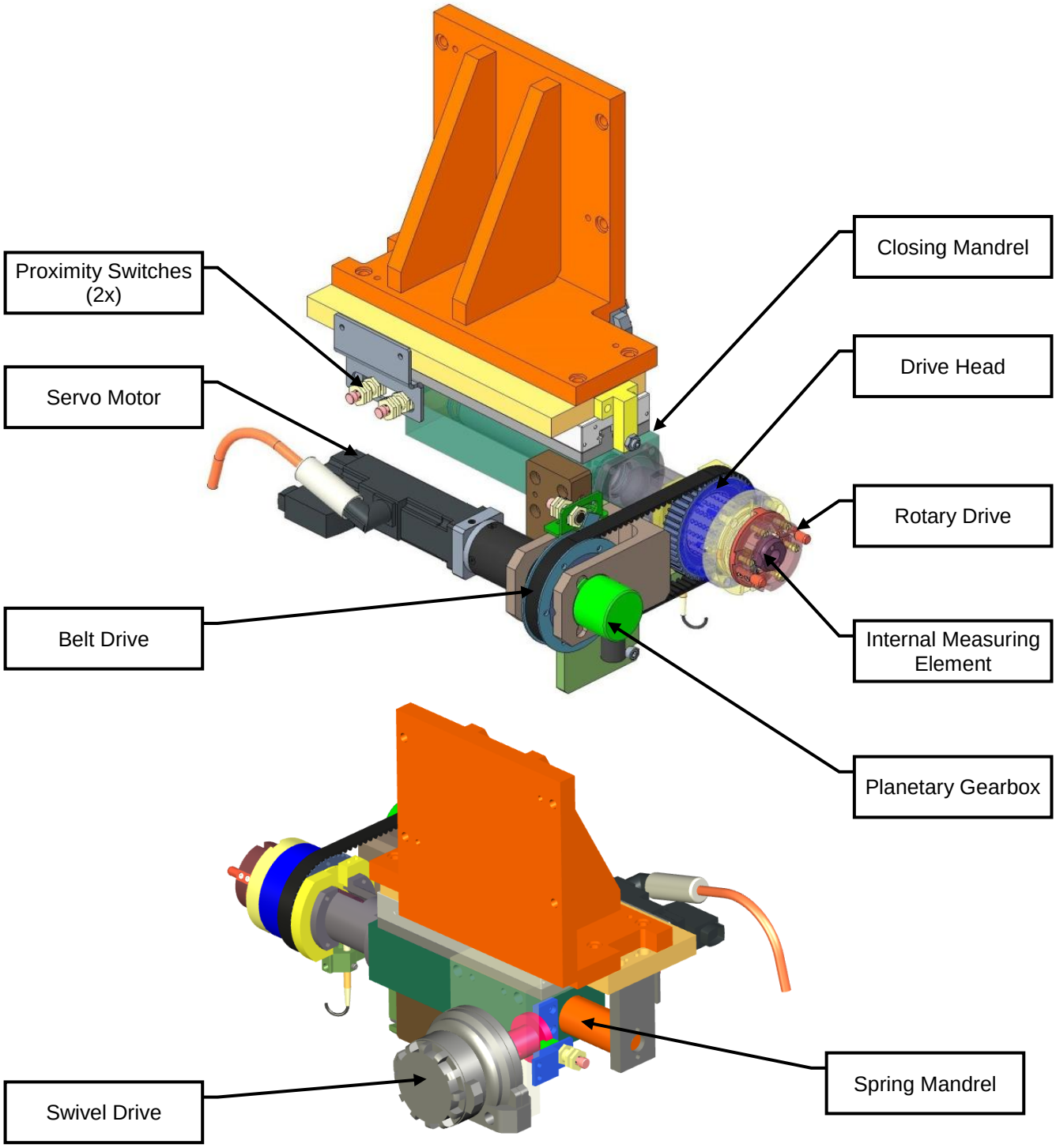


Figure 3-5: Rotary Drive Headstock

Supply Unit (Closing Mandrel)

The supply unit with motor drives the drive head into the entrainment position of the crankshaft and back using a swivel drive/eccentric with cam follower, and spring mandrel. The position of the mandrel slide is monitored by two proximity switches. The crankshaft is rotated via the rotary pickup by means of tooth belt and servo motor (for rotary drive) via the drive head. At the same time, the respective angular position is queried via the incremental encoder.

Drive Head

The drive head consists of the bearing for the rotary drive.

Internal Measuring Element

The internal measuring element sits on the rotary pickup and measures the external diameter and the length of the small flange on the crankshaft.

Rotary Drive

The gimbal-suspended rotary pickup turns the crankshaft during the measuring process only over the torque and thus acts force-free on the crankshaft. Driver pins engage two holes on the flywheel mounting flange to provide rotation. When changing to another crankshaft type, the attachment pins must be changed on the rotary drive. See Section 4 - Operating Instructions for details.

Headstock Motor

The Headstock Motor drives the Rotary Drive unit using a servo motor, planetary gearbox, pulley and belt system.

3.7.4 Tailstock

The tailstock is used to accommodate the workpiece in the centering hole and is pneumatically movable using a cylinder and roller table slide. The centering tip engages the crank nose pulley end of the part. A pneumatic cylinder indexes the centering tip via a slide with position monitored by two proximity switches.

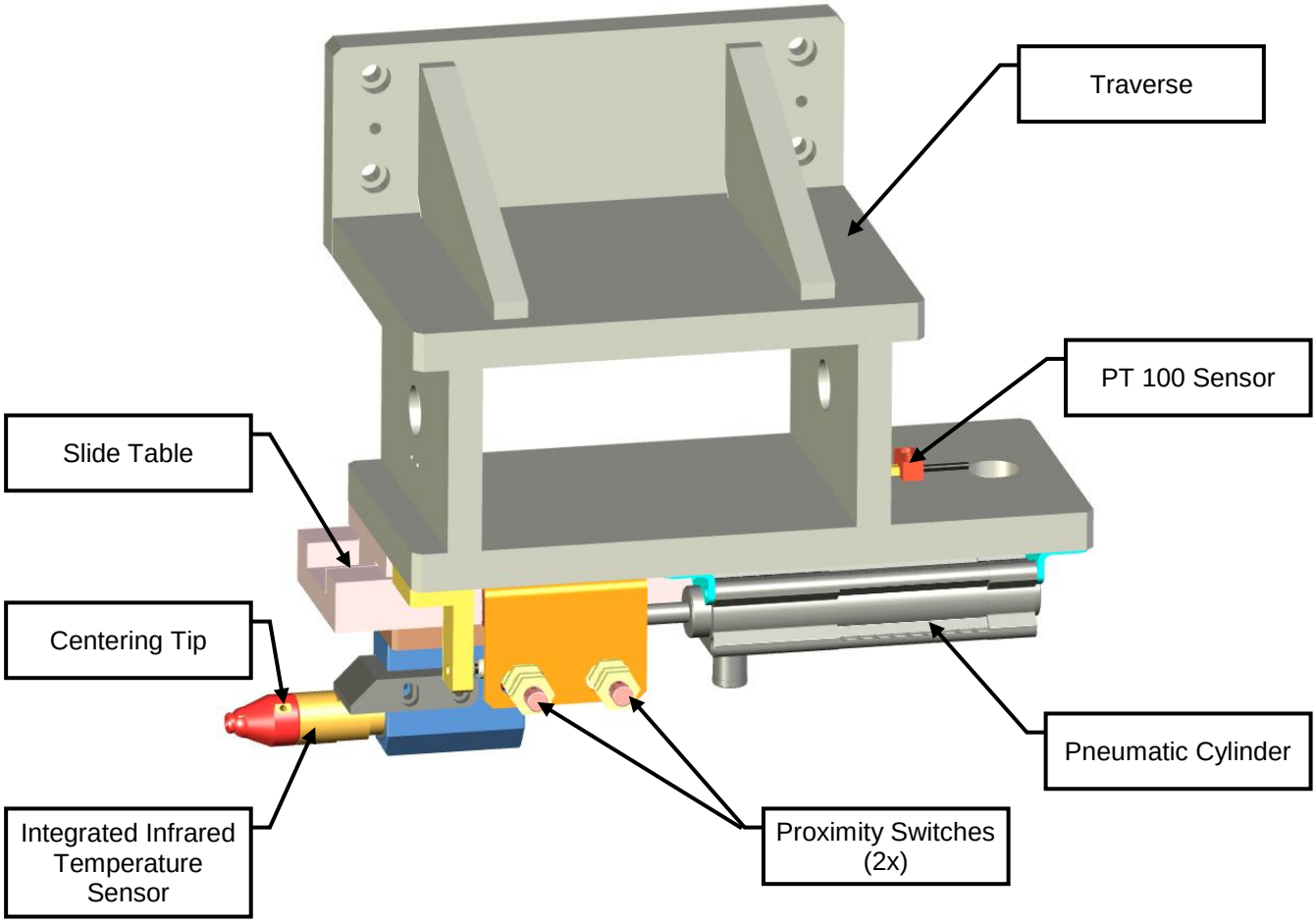


Figure 3-6: Tailstock

PT100 Sensor

Measures the room temperature.

Integrated Infrared Temperature Sensor

Measures the workpiece temperature.

3.7.5 Setting Master Supply

The setting master supply consists of a pneumatically controlled guide unit. The recording of the setting master takes place via manually adjustable storage prisms. The query is monitored via light sensors. The slide is actuated by a pneumatic cylinder and the position is monitored by two proximity switches.

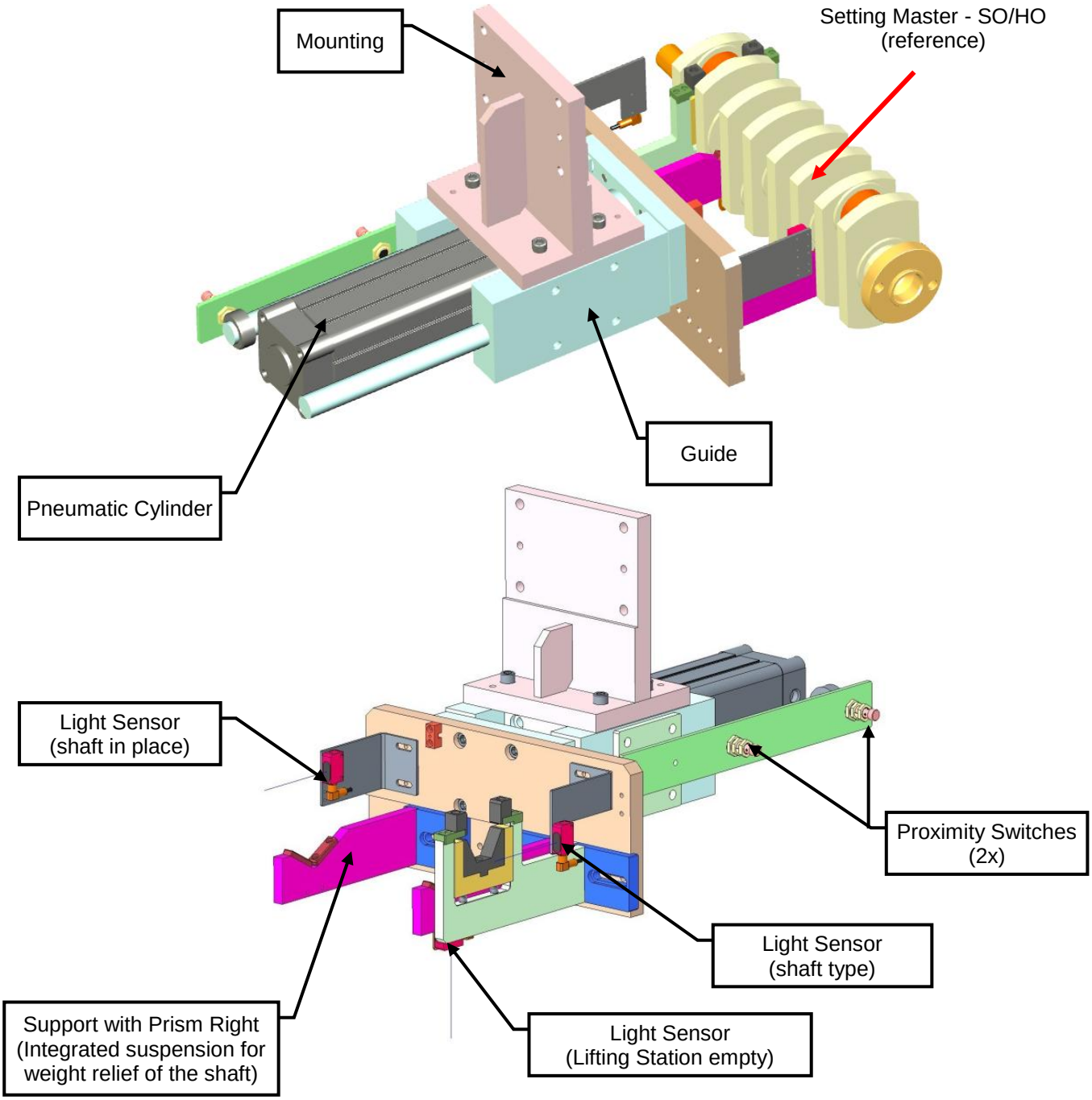


Figure 3-7: Setting Master Supply

3.7.6 Admission CPL (Entry Workpiece and Drive Unit)

Referred to as the Admission Complete, consisting of the Entry Workpiece and Drive Unit. Together they make up the assembly that the gantry loads the part automatically and then indexes into the gauging unit to be picked up by the Lifting Station.

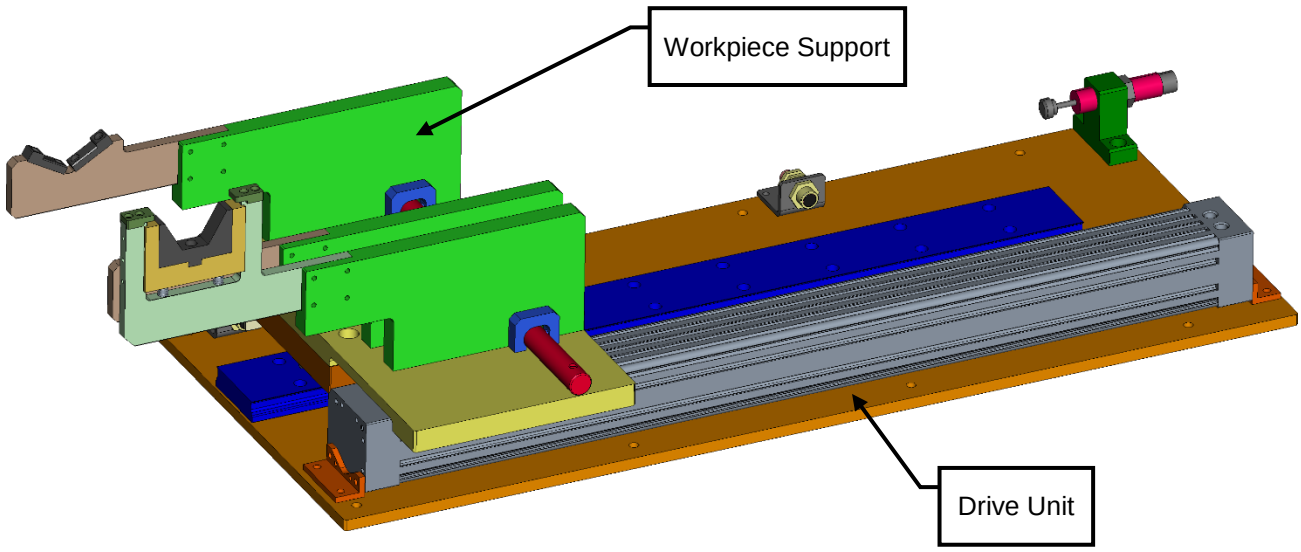


Figure 3-8: Admission Complete

3.7.6.1 Admission CPL - Drive Unit

The drive unit carries the holder for the workpiece. The movement is carried out by a pneumatic cylinder via a linear guide. Inductive proximity switches query the corresponding position. The end position is dampened by a shock absorber.

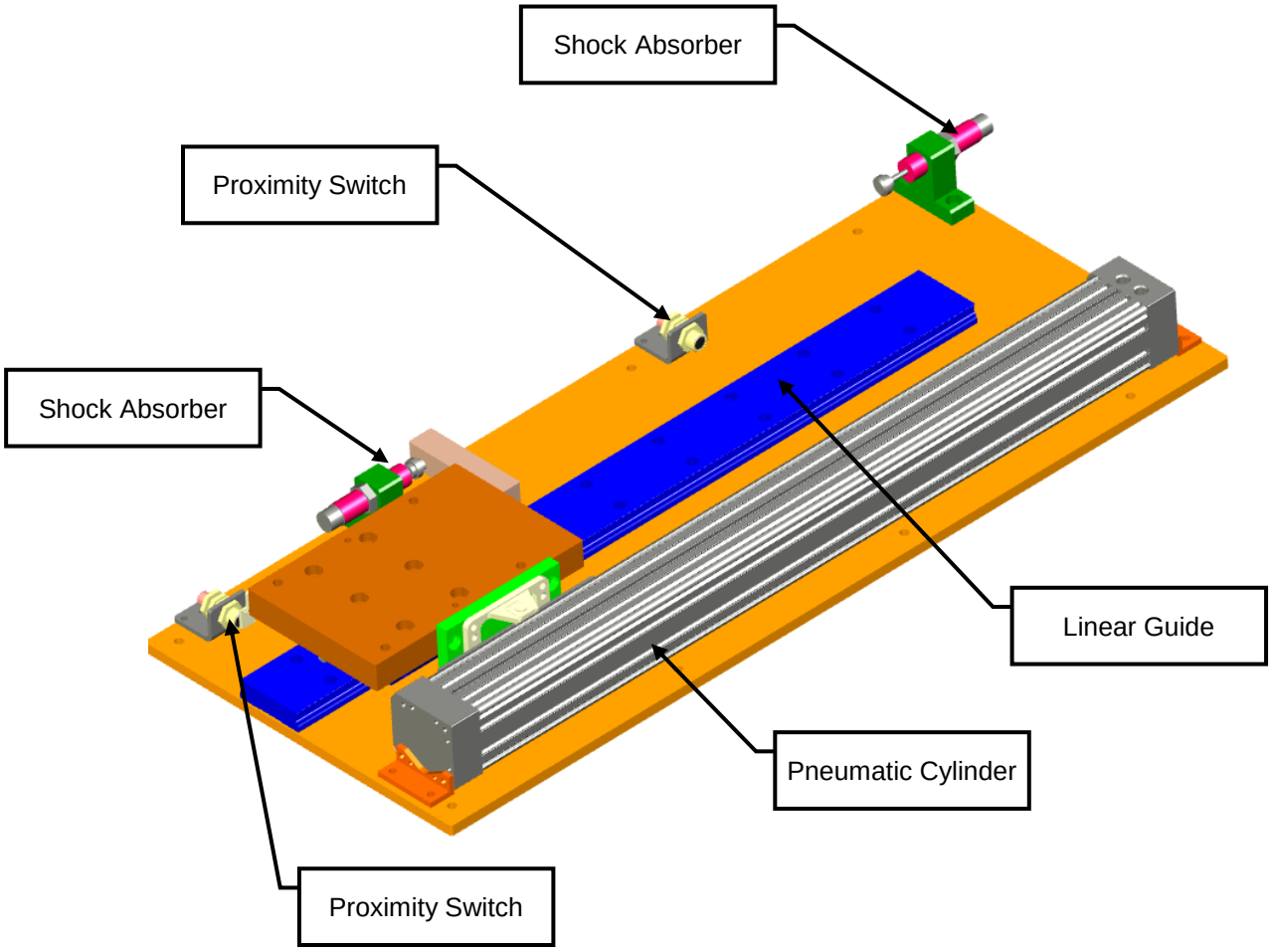


Figure 3-9: Admission CPL Drive Unit

3.7.6.2 Admission CPL - Entry Workpiece

The assembly mounted on the access carriage is used to accommodate the workpiece. The crankshaft is picked up via 3 recording prisms (Integrated suspension for weight relief of the shaft).

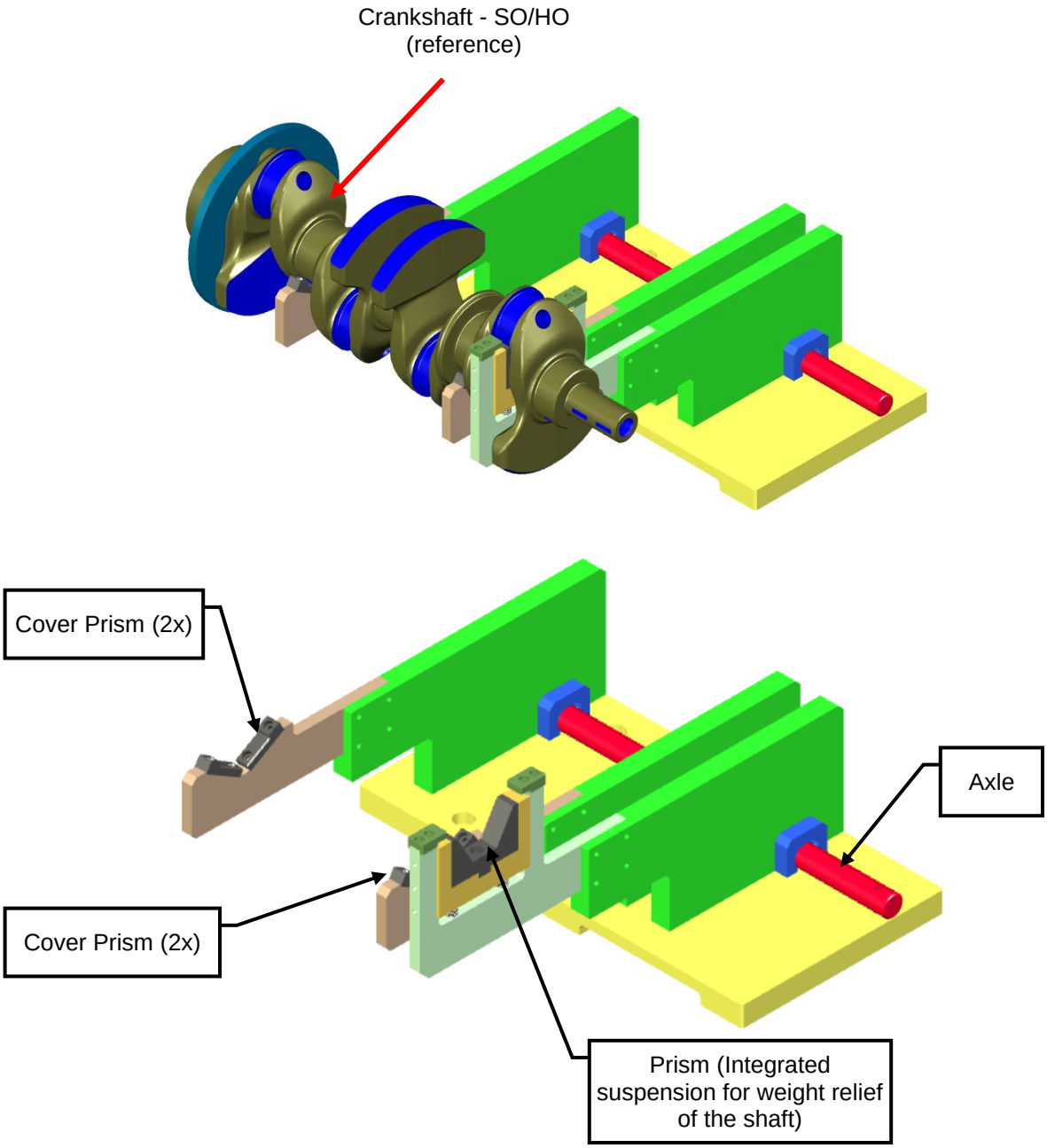


Figure 3-10: Admission CPL Entry Workpiece

3.7.7 Clamping Work Piece

The assembly is mounted on the Drive Unit. When placing the crankshaft on the workpiece holder, the workpiece is stretched briefly and thus the axial alignment is ensured.

Clamping is carried out via a pneumatic parallel gripper.

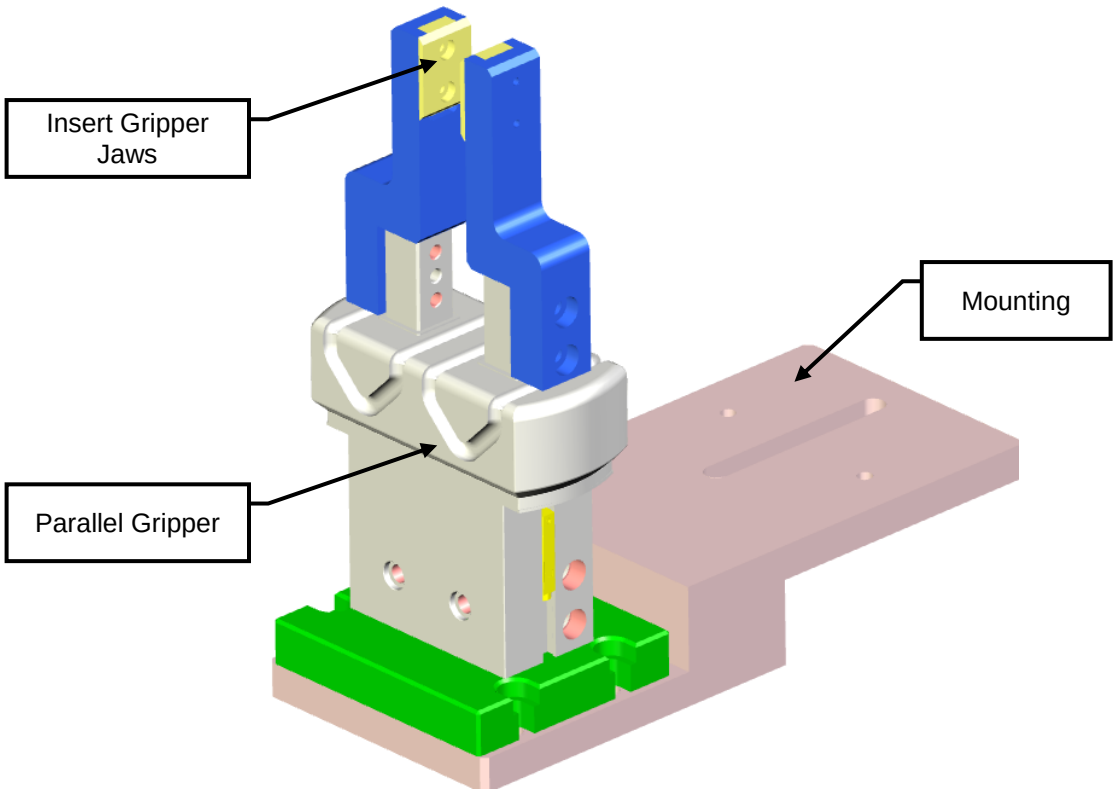


Figure 3-11: Clamping Workpiece

3.7.8 Measurement (Probe) Satellites

On the Measurement Satellites, the connection cables of the measuring elements are plugged in. Also referred to as Probe Satellites, detailed technical description can be found in the operating instructions located in the Appendix section.

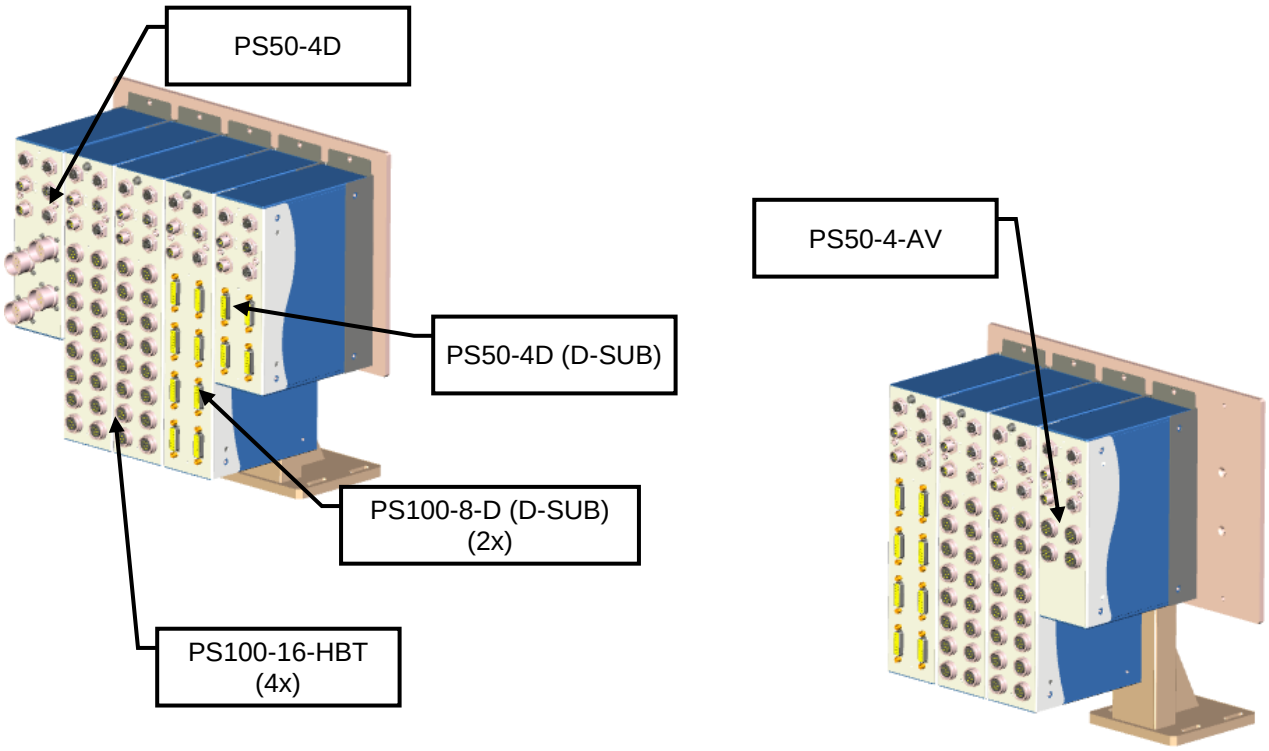
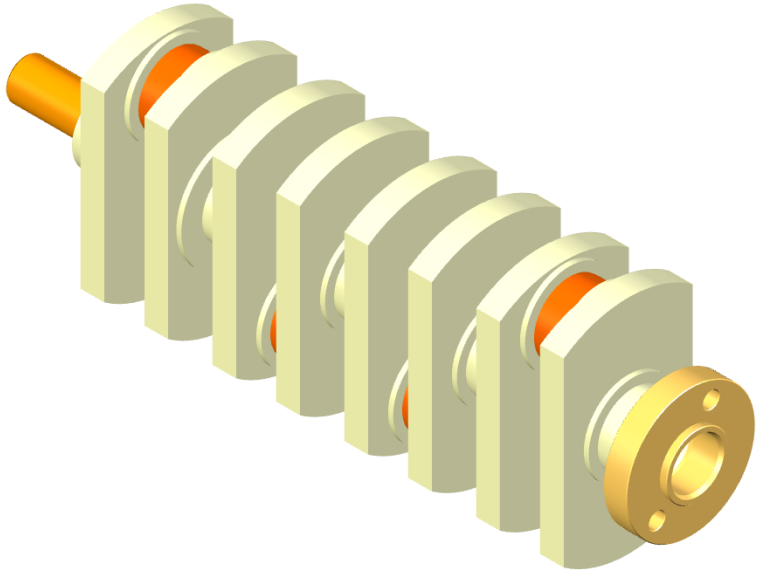


Figure 3-12: Probe Satellites

3.7.9 Setting Masters

The scope of delivery of the measuring system includes two setting masters for calibration.

Setting Master Middle SO-OP178



Setting Master Middle HO-OP178

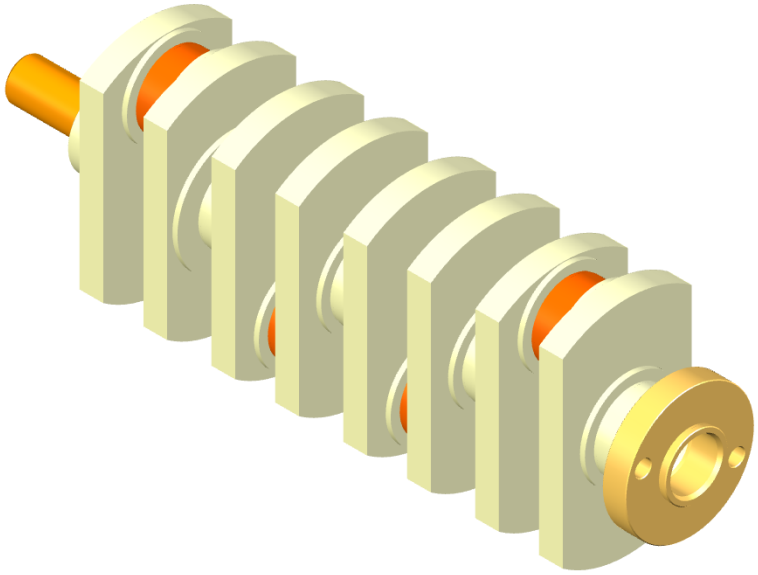


Figure 3-13: Setting Masters SO & HO

Detailed information can be found in the drawings of the setting masters and measuring principles provided with the machine and in the Appendix section of this manual.

3.7.10 Telesis Laser Marking System

The laser marking unit is used to etch identification information onto the crankshaft once it goes through the gauging process and is verified as a good part. This is a self contained laser unit mounted on a stand and faces into an light-tight enclosure to prevent exposure to laser emissions. The part is gantry loaded/unloaded and pauses to be scanned via a camera mounted on top of the enclosure to ensure marking quality before continuing on. Parts enter and exit through an automatic access hatch. Once in place on the resting fixture, the laser etches the part information via 2D Data Matrix and Human Readable codes onto the crankshaft counterweights #2 and #3 respectively. An exhaust system vacates the fumes out to a separate filtration unit. The enclosure incorporates a viewing window that utilizes laser safety glass. The access door on the side of the enclosure is provided for troubleshooting or maintenance purposes and entry is protected by an interlocked door latching system.

Laser equipment safety features are described in detail in Section 3 Safety Instruction.

Read, understand, and follow all laser warning labels safety instructions posted on and around the laser equipment!

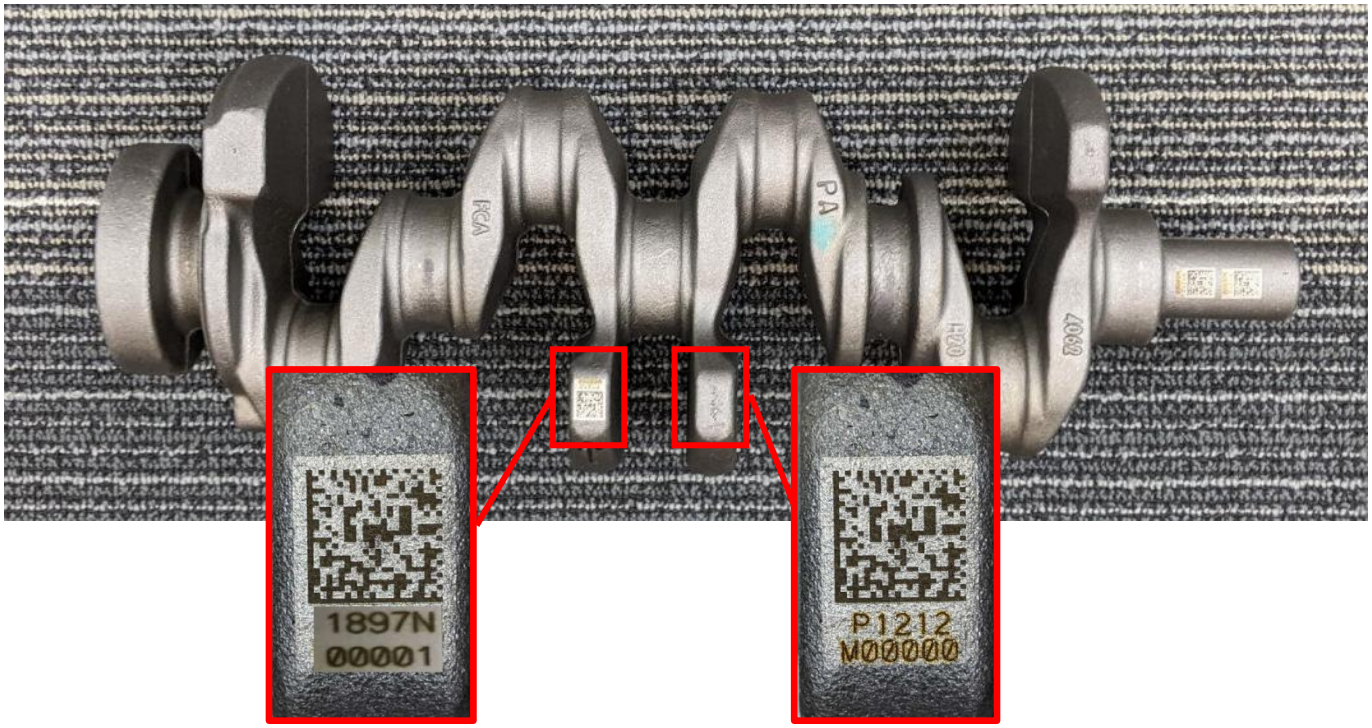


Figure 3-14: Primary (left) and Secondary (right) Laser Marks

The 2D code and Human Readable marking location for the primary and secondary mark applied in machining shall be located as shown above. The primary 2D code and Human Readable Serial Numbers shall be located on counter weight (CW) #2. The secondary 2D code and Human Readable Class Codes shall be located on counter weight (CW) #3.

Figure 3-15: Telesis Laser Marking System

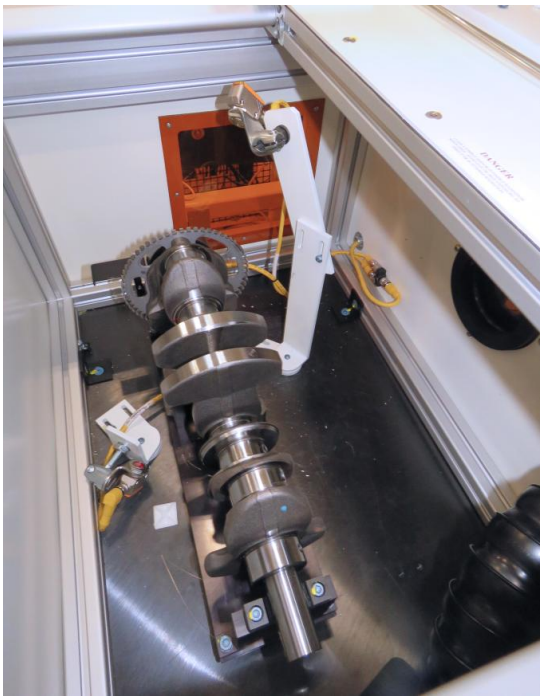


Figure 3-16: Telesis Laser Marking System View Inside Enclosure

An air cylinder lifts the part nest up to allow the gantry loading gripper to place and retrieve the crankshaft. Mounted on the front of the support frame is the solenoid valve manifold used to control the lift cylinder movement.

Figure 3-17: Telesis Laser Marking System Front View

3.7.10.1 Controller

The controller supplies power to and generates the laser beam which travels through the fiber optic cable to the Laser Marking Head. There is a monitor and system computer for the laser software and Cognex camera software as well as UPS (Uninterruptable Power Supply), and other components such as I/O that make up the laser system. An air conditioner mounted on the back of the cabinet monitors and regulates the interior temperature. A stack light is mounted on top of the controller cabinet which visually displays the laser system status.

Figure 3-18: Telesis Controller Cabinet (Front and Back views)

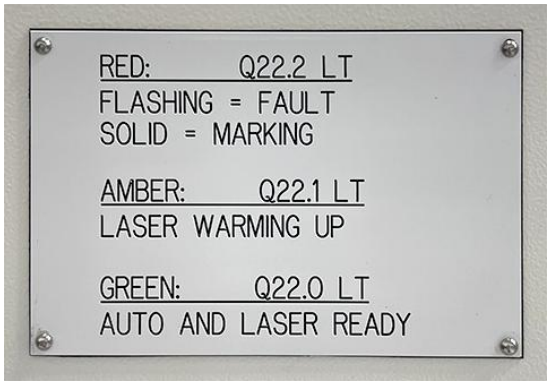


Figure 3-19: Telesis Stack Light Signals

3.7.10.2 Laser Marking Head

The Telisis laser is mounted to a stand outside of the enclosure with the lens entering the cabinet. There is a light on the back side of the laser that warns that radiation is present when the laser is activated. The laser is generated at a system computer controller and is sent through a fiber optic cable to the Laser Marking Head unit, which directs the light beam onto the crankshaft.

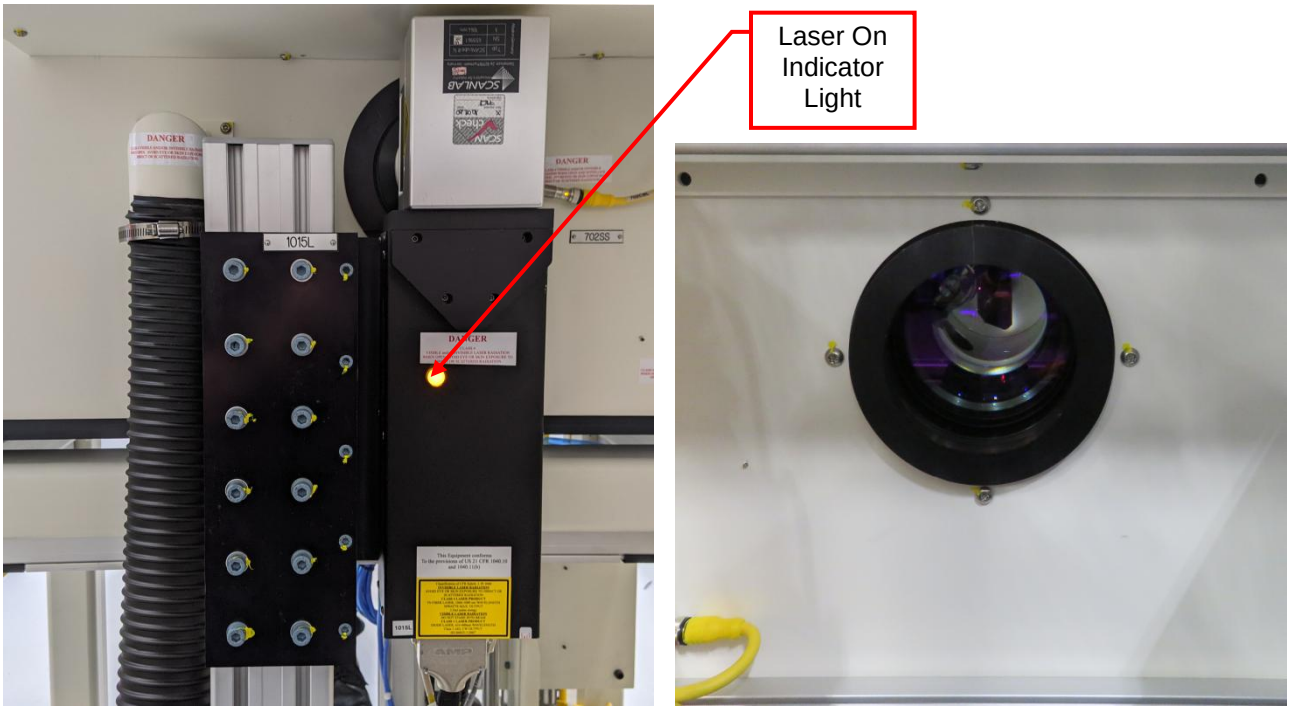


Figure 3-20: Telesis Laser Marking Unit and Lens

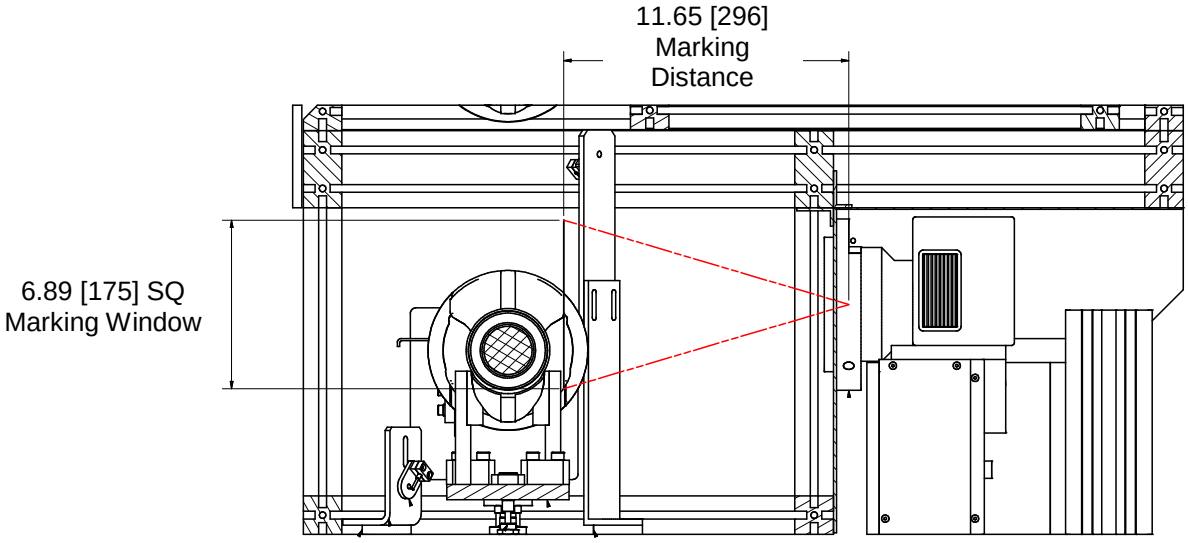


Figure 3-21: Telesis Laser Marking Unit and Lens Dimensions

3.7.11 Cognex Camera

The Cognex camera is used to verify that the markings etched onto the crankshaft are in the right location and are readable. If the markings are not readable by the camera, the marking unit will scrub the area and re-etch the information. The camera will then attempt to verify the markings again. This is repeated three times, if the marking is not readable on the third etching, the part is moved to the Reject Conveyor. The Cognex camera is mounted on a channel with an adjustable bracket that allows for precise adjustment.

Figure 3-22: Cognex Camera

Mounted on top of the enclosure with the camera is a non-contact safety switch, proximity sensor for the access hatch, and an optical distance sensor. The distance sensor continuously detects the distance to the crankshaft and generates output signals according to the parameter settings at the sensor controller unit.

Figure 3-23: Cognex Camera and Distance Sensor Controls

3.7.11.1 Purex Filtration

The fume extraction system evacuates laser marking dust and fumes from the laser marking enclosure, specifically from the points where the marking takes place. The air system vacuums contaminates from the enclosure. This prevents the laser from mismarking the crankshaft. It also prevents buildup of small amounts of metal from the enclosure. The fume extraction system consists of several air filters to clean the air thoroughly.

The system filter enclosure is located on the back side of the cell outside the guarding. The fume extraction system consist of a the filtration enclosure, ducts, a blower, and air filters.

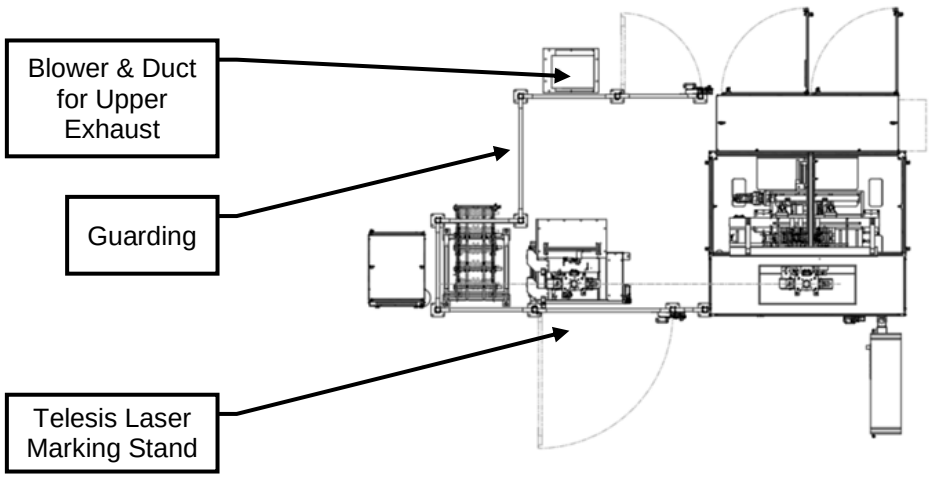


Figure 3-24: Fume Extraction System Location

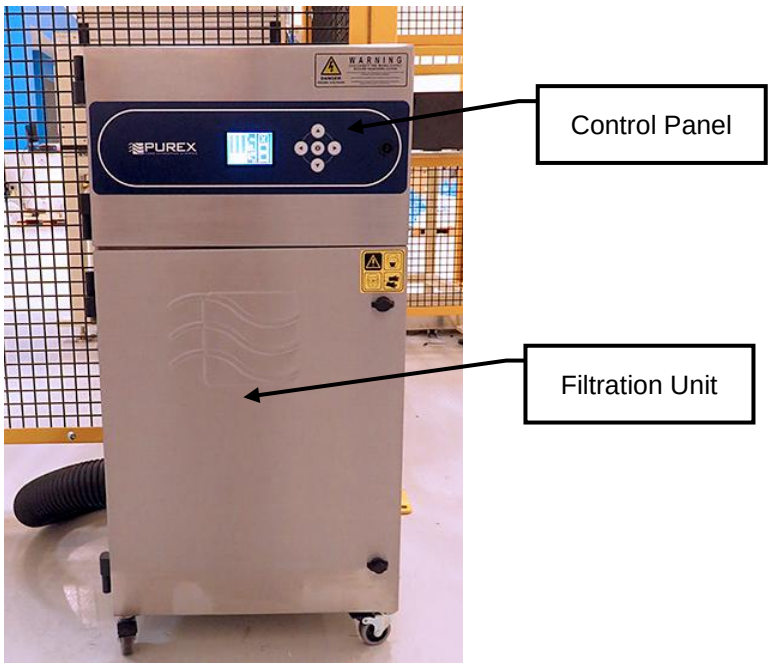


Figure 3-25: Fume Extractor System Enclosure

3.7.9.1 Purex Filtration (continued)

Purex Digital machines warn the operator if the chemical filter is saturated or the particle filter is blocked. Sensors are also used to warn the operator if particles or gas are passing through the machine into the workplace due to a missing, damaged or incorrectly fitted filter. When gas or particles are sensed or the filter is nearly saturated/blocked, the machine will warn the operator with an audible chime and the keypad will flash (red). At this point the appropriate filter icon (see Figure 3-26) will flash to show which filters may need attention. See the Changing Filters section of the OEM Operators Manual provided.

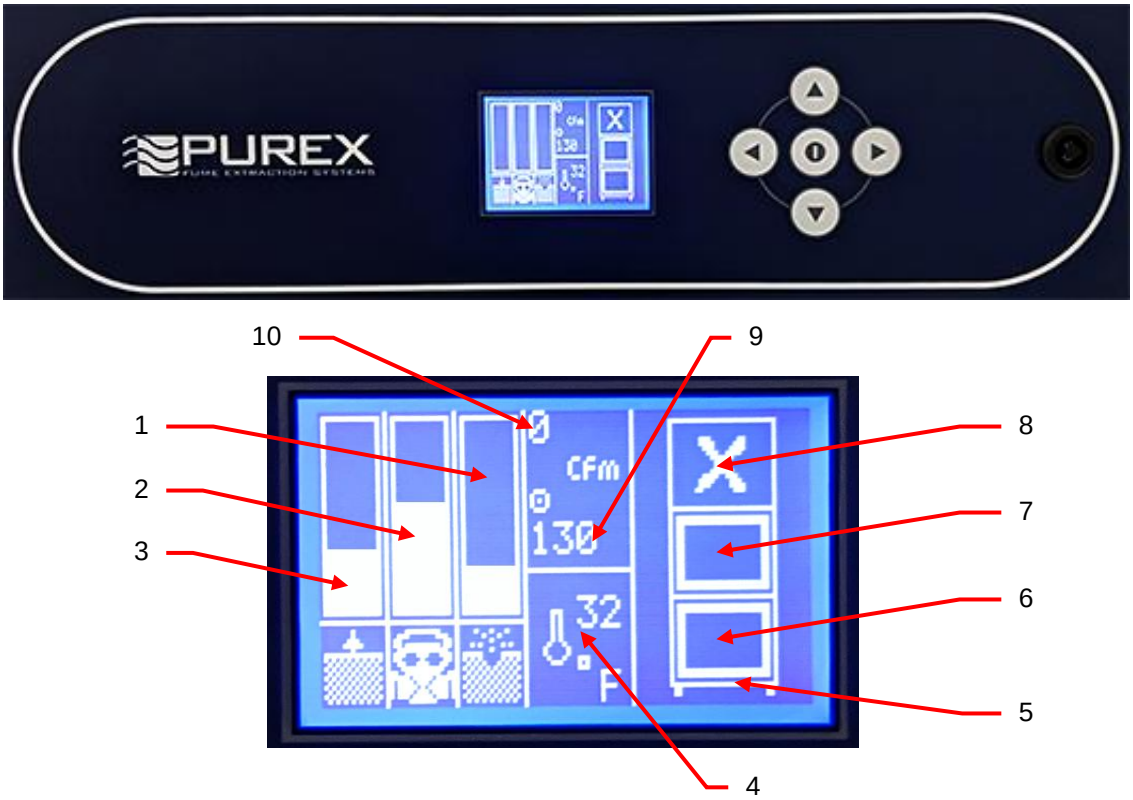


Figure 3-26: Purex Fume Extraction System Graphic Display and Controls

Item	Function	Item	Function
Column 1	Filter Blocked Warning	6	Filter Fault Indicator (Pre-Filter)
Column 2	Gas Sensor	7	Filter Fault Indicator (Main Filter)
Column 3	Particulate Filter	8	Motor Run Indicator
4	Exhaust Temperature	9	Target Airflow
5	Machine Icon	10	Actual Airflow

Fume/dust extractor hose is located inside the laser enclosure.

Figure 3-27: Fume Extractor Vent Hose

3.7.12 Reject Conveyor Rack

If a part fails the gauging process or the laser marking is not readable, the part is moved via the gantry to a reject rack which holds the crankshaft until it is manually removed by plant personnel. It is enclosed in its own guarding and is accessible through an interlocked gate door. The parts will index down to an exit opening located at the back of the cell. This allows for the removal of parts without interrupting production flow. Part present sensors send a signal to the PLC of a reject and indicate on the HMI screen to notify the operator.

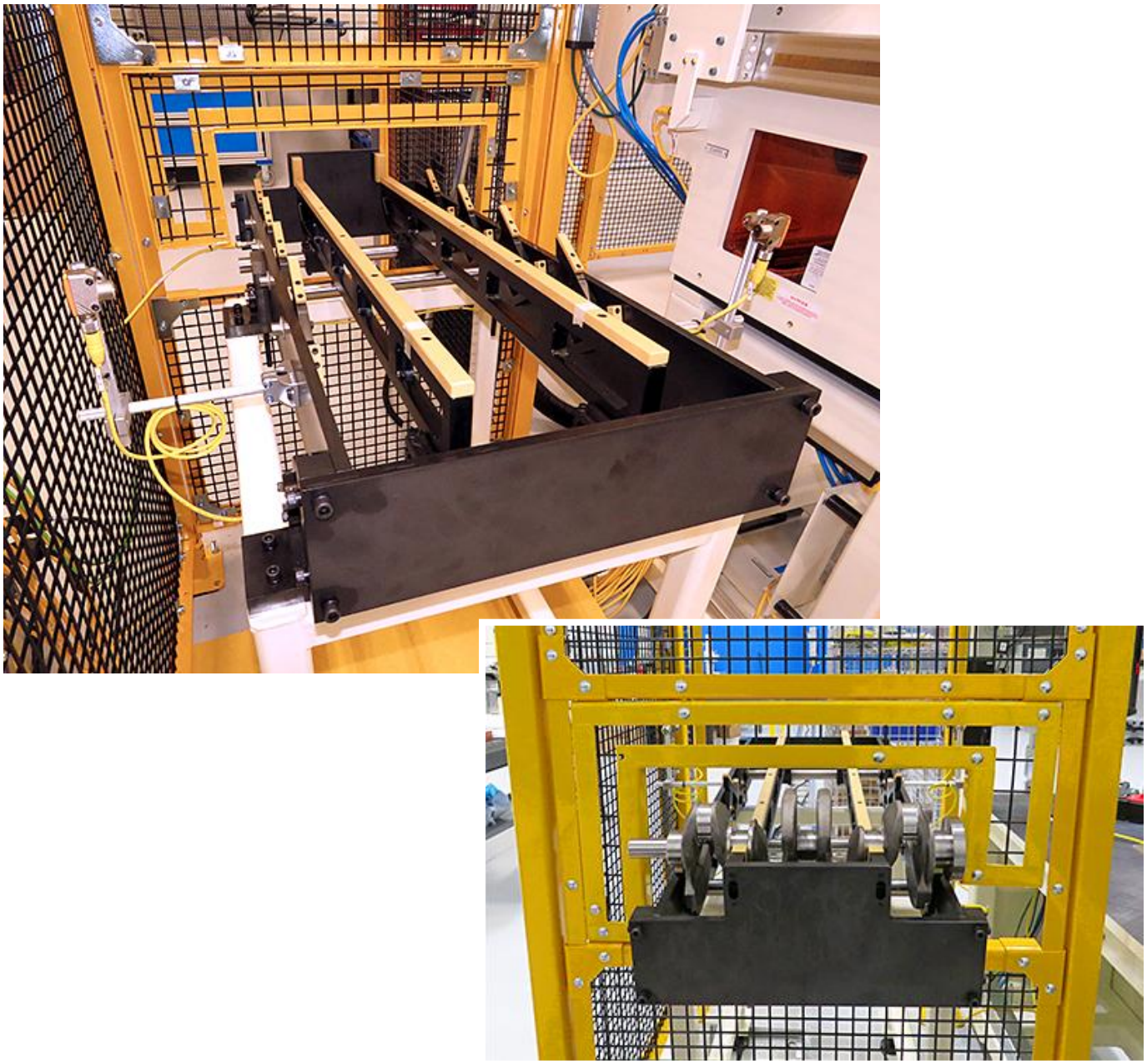


Figure 3-28: OP178 Reject Rack and Typical Part Exit

3.8 ELECTRICAL

3.8.1 Main Electrical Enclosure

There is one (1) Main Electrical Enclosure used for the M2006021 Machine C – OP178 Crank Shaft Measuring Machine. The panel is responsible for distributing 480 VAC 120VAC and 24VDC to all the components require it. The components include: Servo Motors, Automatic Gauging System, Actuators, HMI Panels, Processor, and Control Transformers.

The panel has a lockable disconnect switch on the front of the panel for locking out the panel for maintenance or service of the equipment. As with all electrical panels, there is a DANGER sign with voltage displayed with reference to lockout/tagout information.

Main Electrical Panel components will be described in further detail in Section 4 – Operating Instructions.

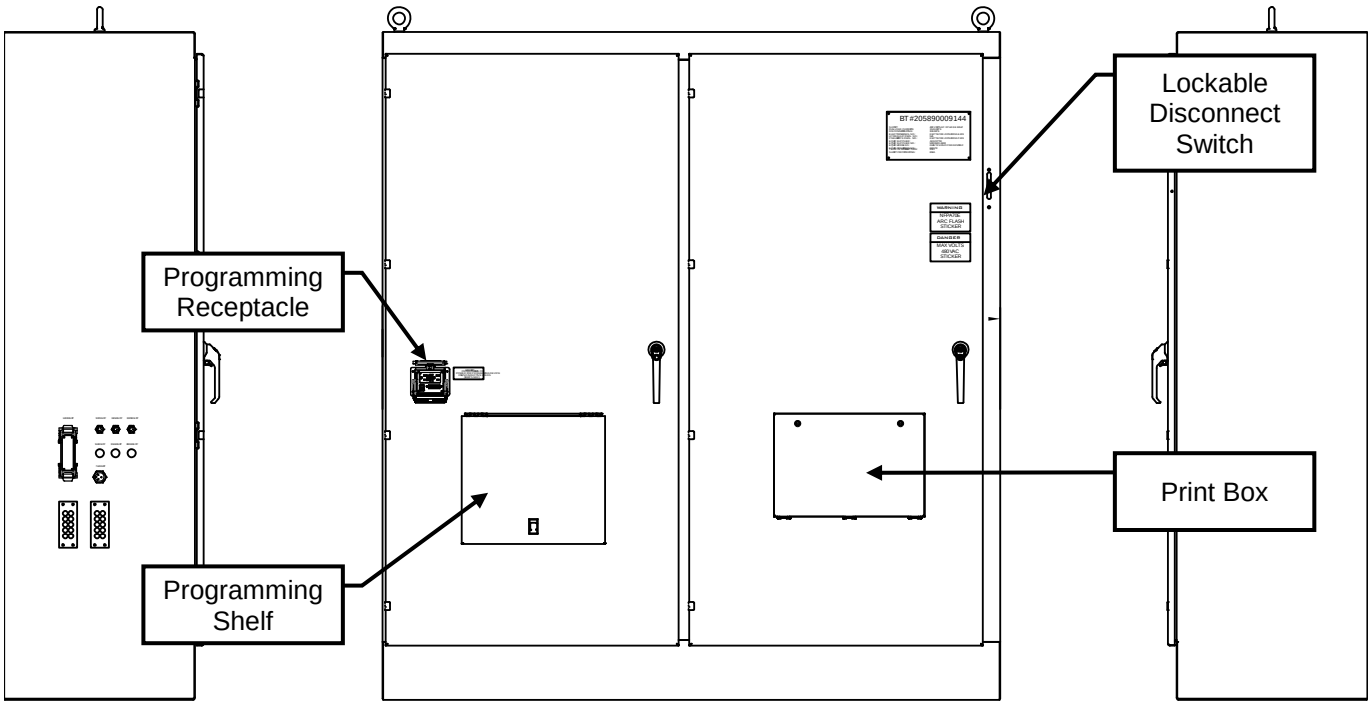


Figure 3-29: Main Electrical Enclosure Panel

3.8.2 Siemens S7-1516F-3 PN/DP PLC CPU Unit

Inside of the Main Electrical panel is the Siemens S7-1516F-3 PN/DP PLC CPU Unit. The primary purpose of the PLC is to communicate with the subsystems of the machine using the PLC and EtherNet. The PLC receives 24VDC hot power (above the main electrical disconnect).

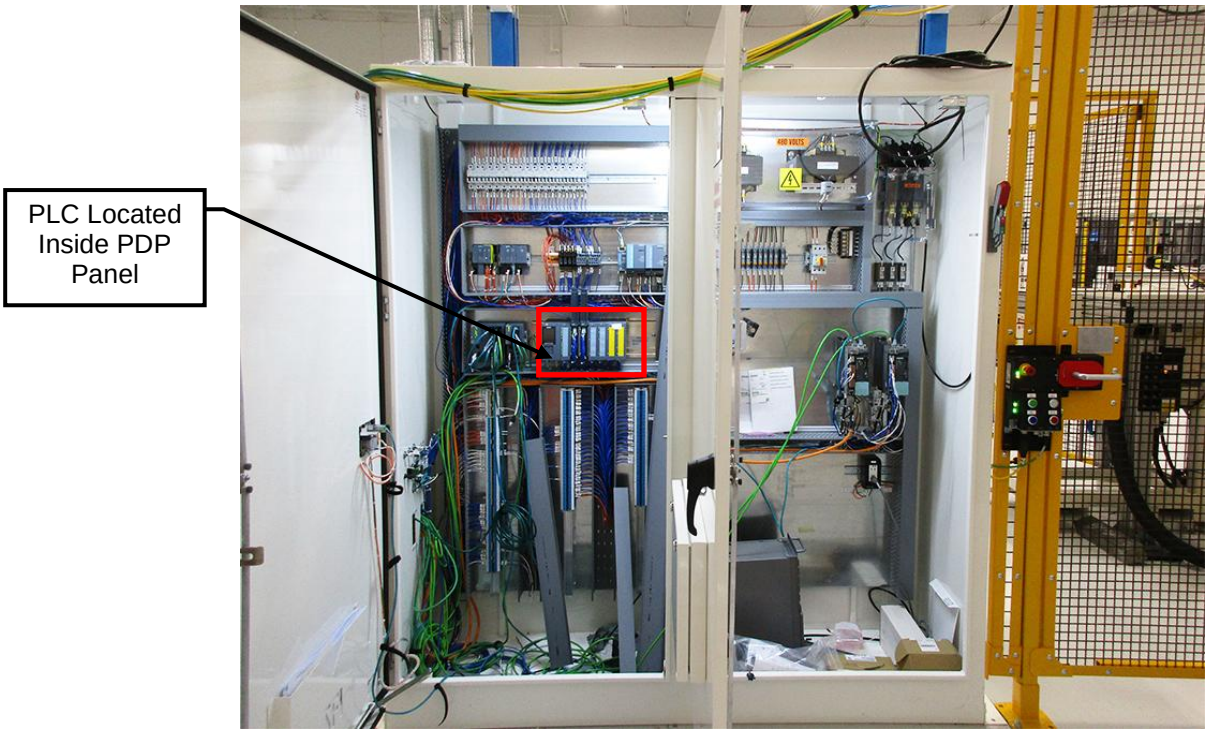


Figure 3-30: Siemens S7-1516F-3 PN/DP PLC CPU Unit

3.8.3 HMI Panel

The Human Machine Interface (HMI) panel is the main control interface between the operator and machine. The panel consists of an Siemens SIMATIC touch screen, and hardwired control button (E-Stop), Power ON / Fault Reset pushbutton, Mode Select 2-position switch (Auto / Manual), Cycle Start pushbutton, End of Cycle Stop pushbutton, and Return To Home pushbutton. There is a Dynics display monitor which interfaces with the gauging sensors and software package. The HMI displays process functions and diagnostic information to system operators. Screen selections are made by touching directly on the screen.

Human Machine Interface (HMI) components will be described in further detail in Section 4 – Operating Instructions.

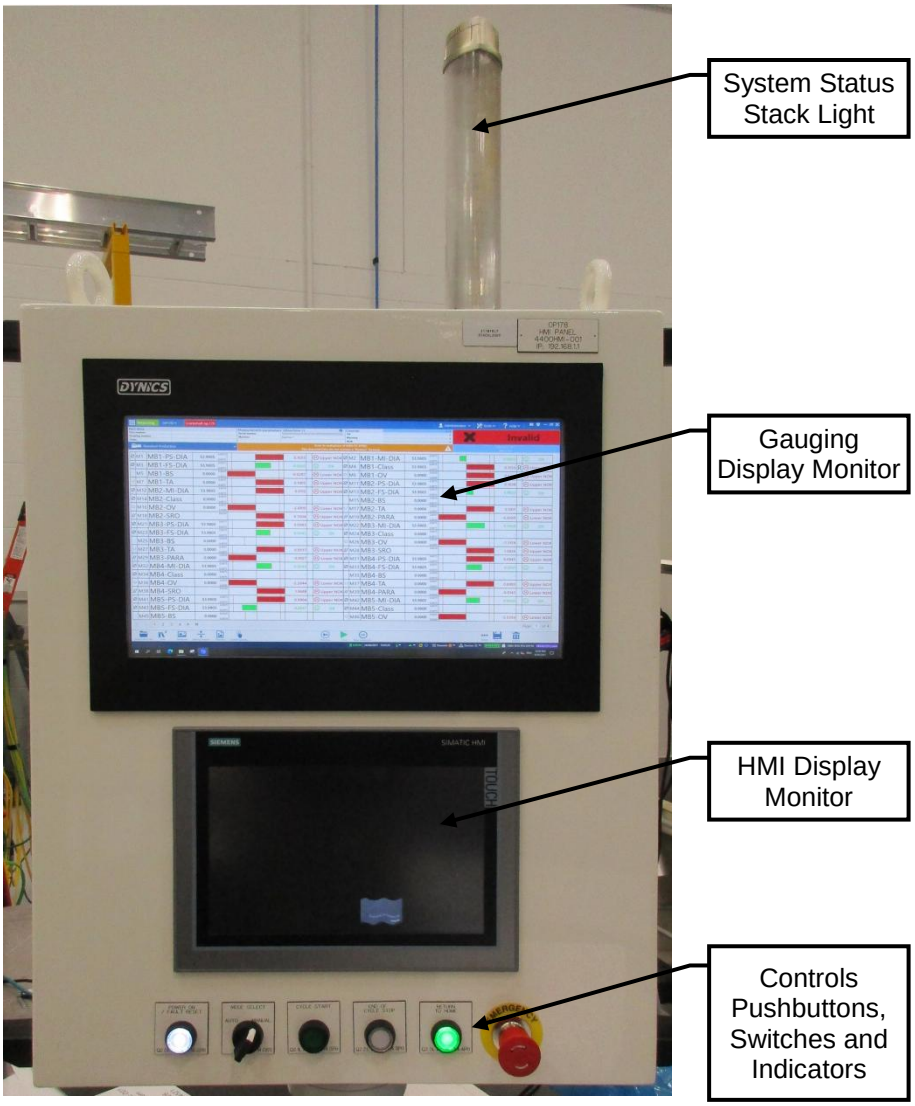


Figure 3-31: Typical HMI Panel

3.8.4 Field Devices

Field devices include the I/O blocks, cables and connectors used to convey data and signals between the PLC and HMI to or from the various components such as gauges, VFD motors, sensors, valves, manifolds, etc. Field devices also include the sensors, photo-eyes, part present proximity switches, etc., that monitor states or component locations on the machine. All field devices are clearly labeled and tagged to provide easy identification for tracing purposes.

Figure 3-32: Typical Field Devices

Figure 3-33: Field Devices Identification

3.9 PNEUMATICS

3.9.1 Main Air Distribution Panel

The Main Air Distribution Panel receives air from the from the plant main air header that will supply the air needs of the Crank Shaft Measuring Machine. The air distribution panel conditions, regulates, and supplies air to the machine's pneumatic components.

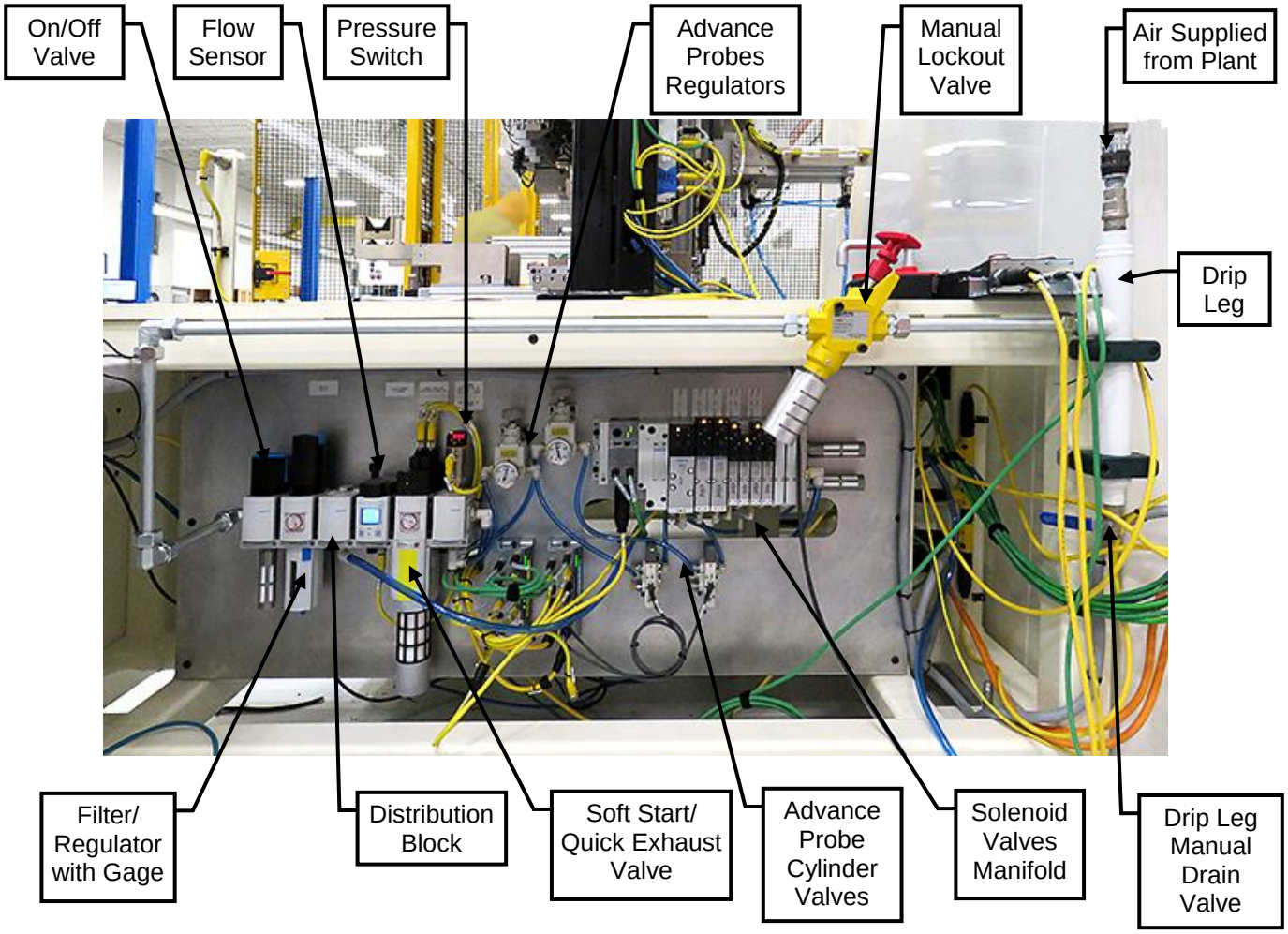


Figure 3-34: Main Air Distribution Panel

The main air distribution panel features the following:

The main air drop line has a manual shut ball valve located above the drip leg (not shown). This valve is used to shut off the air when working on the system before the main P1 lockout valve.

The first line of defense against system air contamination is the drip leg. The drip leg will capture air line contamination in the form of condensation from the plants main air drop. Any condensation captured in the drip leg will need to be periodically drained by opening the manual ball valve at the bottom of the drip leg.

3.9.1 Main Air Distribution Panel (continued)

Air is piped out of the side of the drip leg to a Air Safety Shut-off Lockout valve. This valve is manually actuated by pushing in the red handled plunger, shutting off the air supply and releasing the air pressure to atmosphere. Once in the closed position, a multi-lock hasp and personal lock can be attached for LOTO. Next in line are the Festo air preparation modules. The first module in the air prep block is the main air lockout valve. Turning the blue/black handle on top of the 3/2 valve will shut-off the incoming air and exhaust downstream pressure out through the muffler located at the bottom of the valve.

The next unit in the block system is the regulator / filter unit with a gauge on the face of the regulator body. The filter removes contamination not caught in the drip leg down to a 40 micron level. The filter bowl has a manual drain valve that need to be periodically drain to prevent a build-up of contamination. The regulator adjusts the incoming air pressure to system pressure (set @ 60 PSI). The gauge on the face of the regulator displays the systems current pressure setting.

The distribution block branches out the air to supply the Telesis Laser Marking System.

Following the distribution block is the flow sensor. This device monitors the movement of air and sends a signal back the PLC.

The air continues to an Enable Air On soft-start / quick exhaust valve that allows the inrush of air to be gradually ramped up before continuing on. The electro-pneumatic soft-start and quick exhaust valve is used to reduce pressure quickly and reliably and to build up pressure gradually (soft-start) in industrial pneumatic system. The PLC controlled solenoid is activated to actuate the air on for the system. The other solenoid on the unit is actuated to open exhaust to reduce pressure quickly out through the muffler.

Finally, the air pressure is monitored by an Air Pressure OK switch that has two settings to make sure that the incoming air pressure in adequate for system functions but not exceedingly high enough to damage equipment:

High Limit - 65 PSI

Low Limit - 55 PSI

3.10 LUBRICATION

3.10.1 Central Lubrication Tank

A measured amount of oil is delivered to the various slides during the gaging machine operational cycle. At timed intervals, a metering pump delivers set amounts of lubricating oil from the gravity feed reservoir to the lubrication points through distribution lines. The amount of lubrication oil and how often it's applied is controlled by the PLC.

Tank levels are monitored by a two position float level switch: Oil Reservoir Level Maximum and Oil Reservoir Level Minimum.

For Lubrication diagrams and lube points consult the Lubrication Maps delivered with the machine.

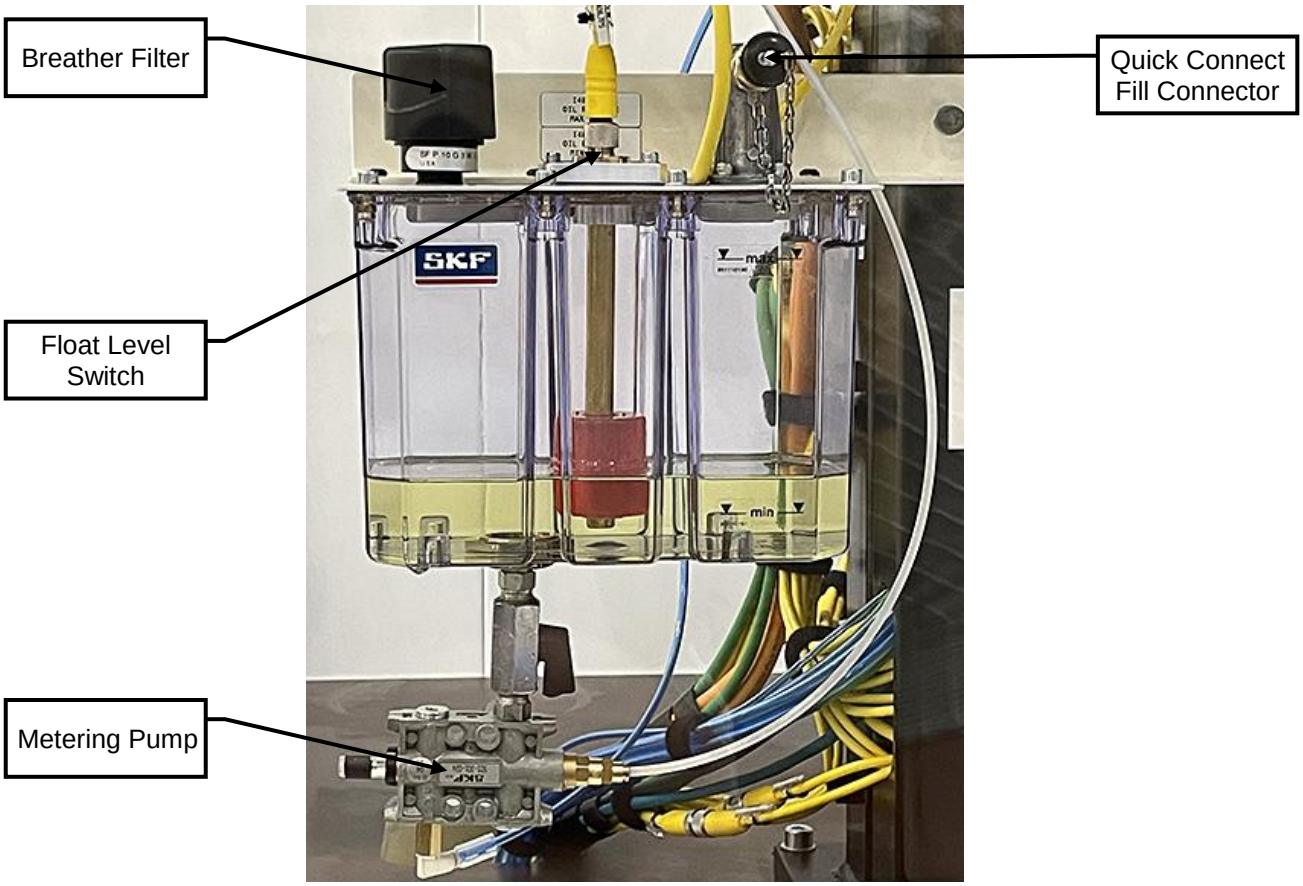


Figure 3-35: Central Lubrication System Reservoir

SECTION 4
OPERATING INSTRUCTIONS

Table of Contents

Table of Figures

4.1 Introduction

This section describes the station control interfaces, operating procedures, and the operational guidelines necessary to run the machinery. Only qualified personnel trained in machine operation as well as state, local, company, and plant safety procedures should attempt to operate the equipment.

This manual only covers the basic operation of the station, which is limited to the execution of pre-programmed operations on a specific part type. Programming the system to accept additional part types, medication of machine setups, and adjustment of programming variables all require advanced training, which is not covered in this manual. Do not attempt to make modifications to station software and hardware on your own. If you feel that such actions are necessary, contact your supervisor.

Procedures outlined in this section are not intended to be performed in a step-by-step fashion while reading along in the manual. The operator must read and understand the entire procedure before attempting to perform them on the equipment.

4.2 CONTROLS AND Indicators

4.2.1 MCP Control

There is one (1) Master Control Panel (MCP) located on the M2006021 OP178 machine. The MCP receives 480VAC 3-phase 60 Hz power supplied from the plant control bus electrical drop. The MCP location is shown in Figure 4-1 below.

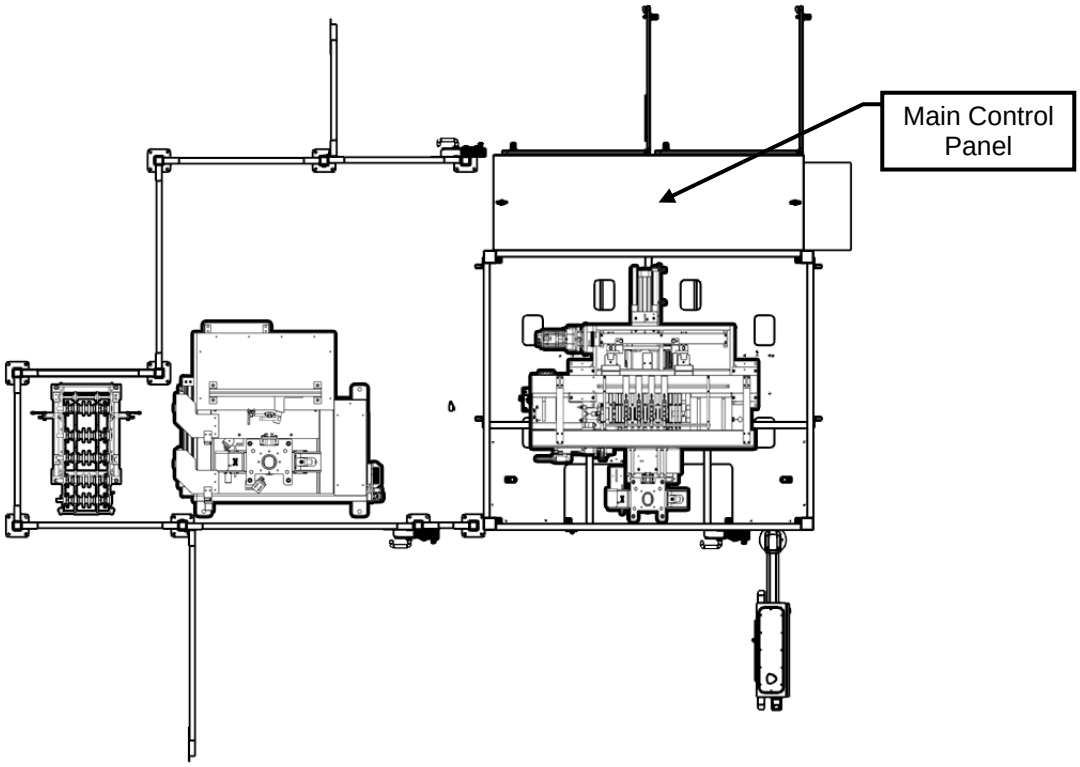


Figure 4-1: Main Control Panel Location

4.2.2 MCP Enclosure Layout

Each MCP enclosure has a lockable electrical power disconnect switch of switching the main power ON / OFF.

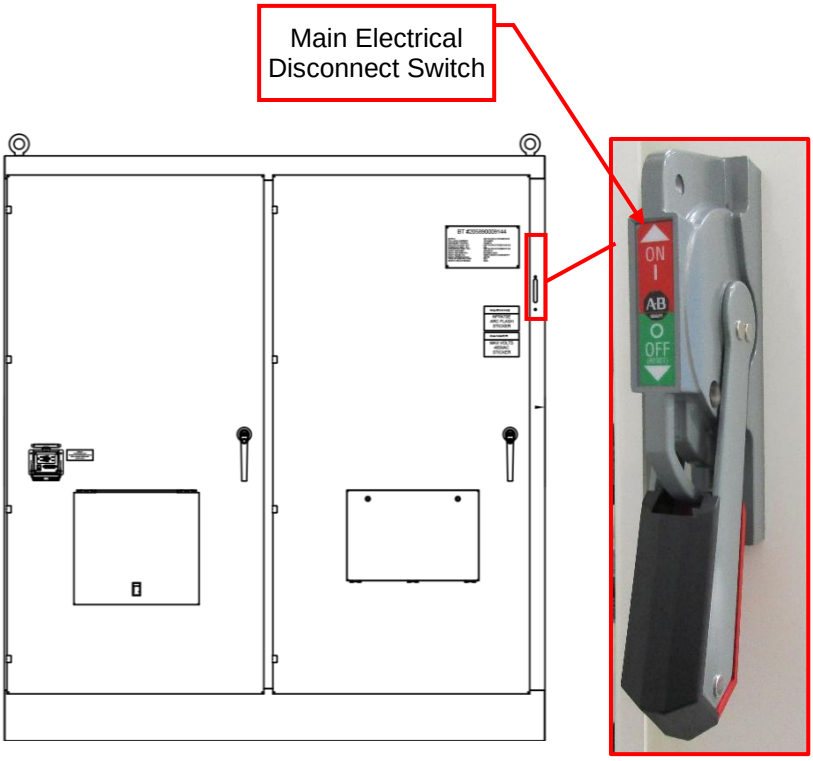


Figure 4-2: Main Disconnect Switch

4.2.2.1 Transformers

There are two transformers mounted inside of the MCP panel.

60T transformer is wired above the main electrical disconnect and provides 120VAC service to the Main Panel Lighting, PLC, Ethernet Switch/ProfiNet Coupler, and the HMI Panel. This transformer has its own disconnect **600DISC**.

705T transformer is wired below the main electrical disconnect and provides 120VAC service to the Telesis Laser Marking Station. This transformer has no disconnect of its own.

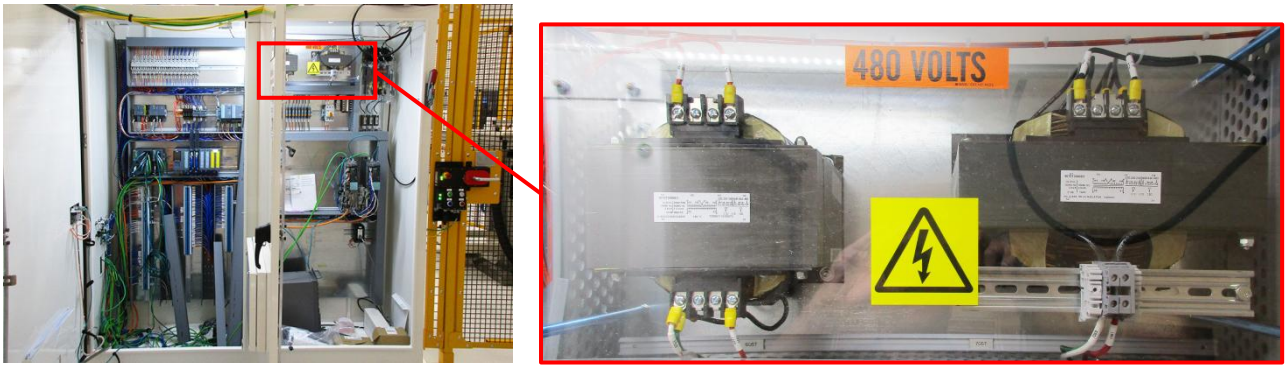


Figure 4-3: MCP Transformers

4.2.3 Safety Gate Switch

The controls and indicators for the safety gate switch as follows:

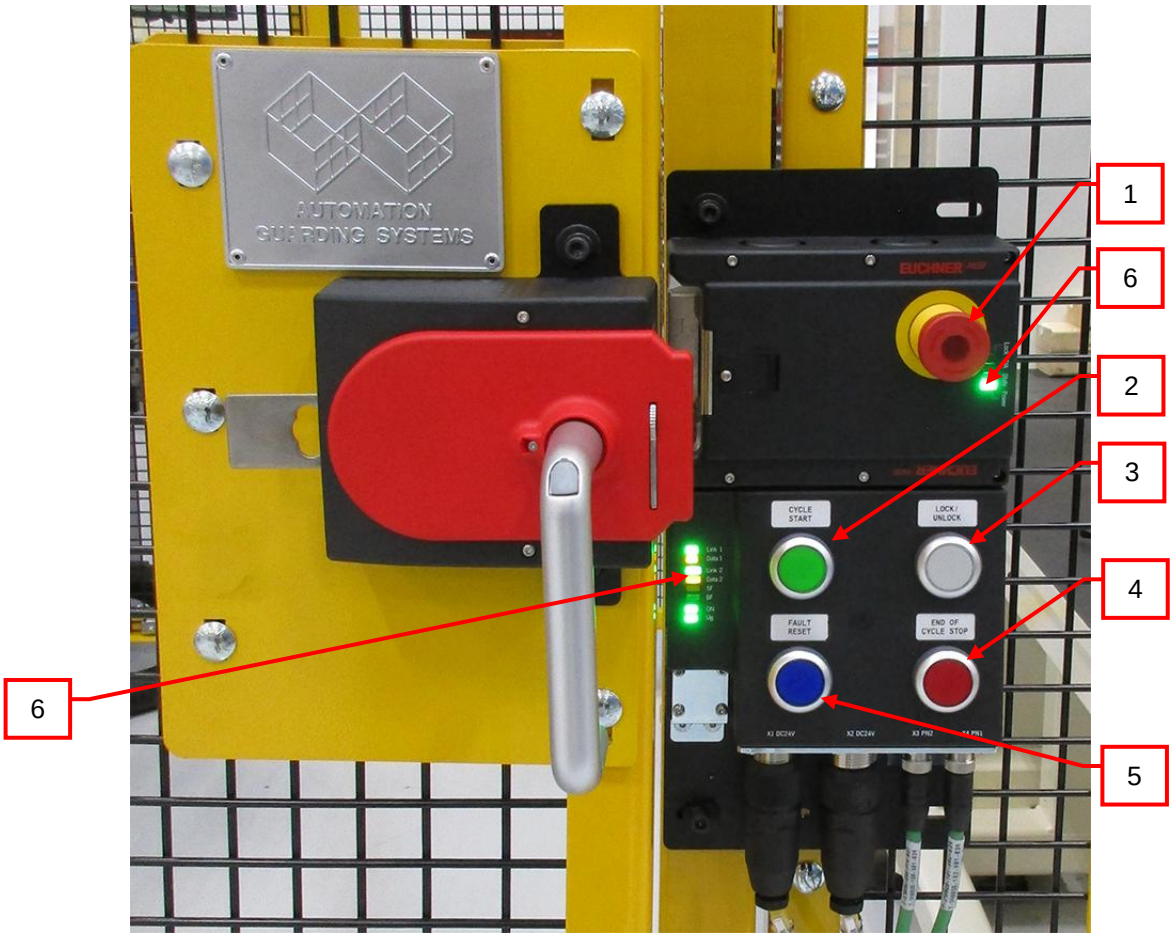


Figure 4-4: Safety Gate Switch

No.	Name	Description	Function
1	E-STOP	Red Mushroom Head Pushbutton	This lockable, detented, Emergency Stop (E-Stop) pushbutton is provided to interrupt the machine cycle in case of an emergency. The activation of the E-Stop pushbuttons will bring the machine to an immediate Emergency Stop irrespective of the position in the machine cycle.
2	CYCLE START	Green Illuminated Pushbutton	If all safety devices are properly set, pressing this pushbutton initiates an Automatic Cycle when the 2-position Mode Selector switch is in the AUTO position.

3	LOCK/UNLOCK	White Illuminated Pushbutton	When pressed, this pushbutton locks or unlocks the interlocking mechanism of the gate latch depending on current state. If the machine is in cycle the gate switch will not release until the cycle is complete.
4	END OF CYCLE STOP	Red Illuminated Pushbutton	When pressed, this pushbutton will stop the Automatic cycle of the machine at the end of the current cycle.
5	FAULT RESET	Blue Illuminated Pushbutton	When pressed, this pushbutton will clear the current fault. Make sure the condition that caused the fault has been remedied before resetting the fault. Additional information on faults and solutions can be found in Section 6 Troubleshooting of this manual.
6	Status Indicators	LEDs	Displays status indication. See OEM documentation provided with the machine and in the Appendix section of this manual for detailed information.

4.2.4 HMI Panel

The HMI Panel is the primary operator interface for controlling the machine. The HMI enclosure includes a Siemens TP1200 touch screen. The HMI has a lockable HMI E-Stop pushbutton as well. There is a Stack Light mounted on top of the HMI that will help personnel determine the overall status of the machine.

Above the HMI panel, there is a DYNICs panel that displays various information on the Measuring Setup that the operator can quickly refer to.

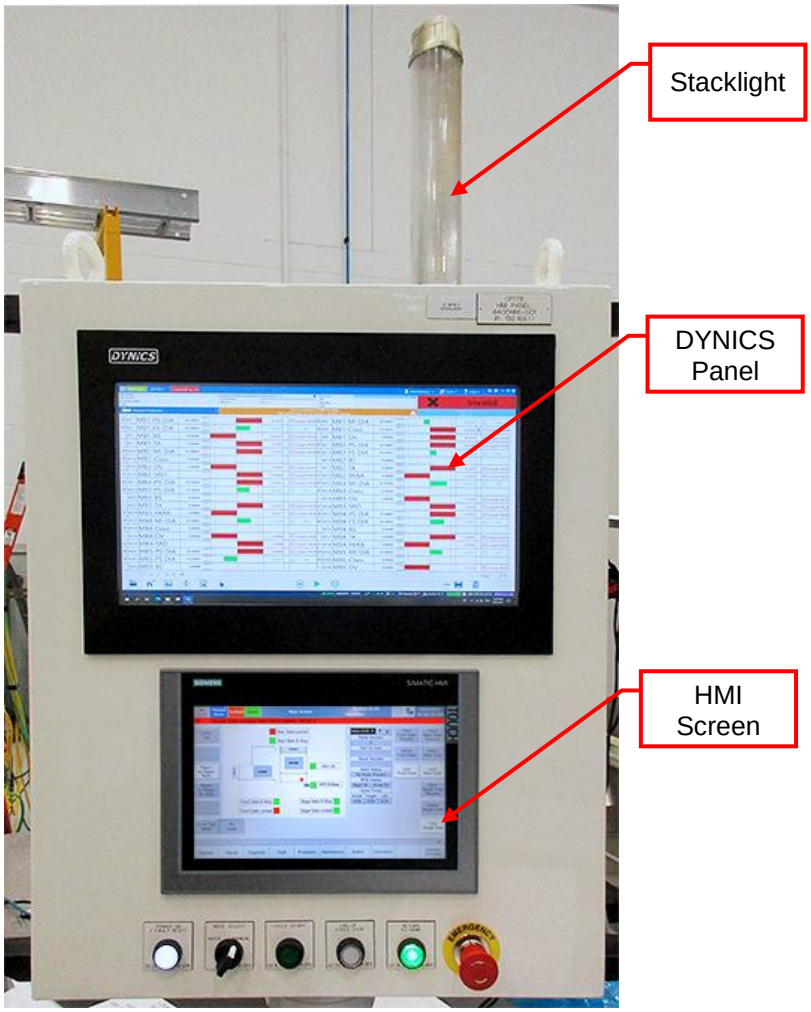


Figure 4-5: Typical HMI Panel

4.2.5 HMI Controls and Indicators

The HMI Controls and Indicators are as follows:

Figure 4-6: HMI Panel Controls and Indicators

No.	Name	Description	Function
1	POWER ON / FAULT RESET	White Illuminated Pushbutton	If all safety devices are properly set, pressing this pushbutton energizes the master control relay. This allows power to the motion circuits. This white pilot light illuminates when the 24VDC Control Power circuit is energized. Pressing this pushbutton will clear the current fault. Make sure the condition that caused the fault has been remedied before resetting the fault. Additional information on faults and solutions can be found in Section 6 Troubleshooting of this manual.

No.	Name	Description	Function
2	MODE SELECT AUTO MANUAL	2-position Selector Switch	This selector switch places the Crank Shaft Measuring Machine into one of (2) modes of operation: **Auto** - which is required when production is in operation. Auto mode is established after the CYCLE START PUSHBUTTON is pressed. **Manual** - which is required when plant personnel verify equipment functions in an offline environment.
3	CYCLE START	Green Illuminated Pushbutton	If all safety devices are properly set, pressing, this pushbutton initiates an Automatic Cycle when the 2-position Mode Selector switch is in the AUTO position.
4	END OF CYCLE STOP	White Illuminated Pushbutton	When pressed, this pushbutton will stop the Automatic Cycle of the machine at the end of the current cycle.
5	RETURN TO HOME	Green Illuminated Pushbutton	When pressed, this pushbutton resets the machine and will send the equipment to its home position.
6	EMERGENCY STOP	Red Mushroom Head Pushbutton	This lockable, detented, Emergency Stop (E-Stop) pushbutton is provided to interrupt the machine cycle in case of an emergency. The activation of the E-Stop pushbuttons will bring the machine to an immediate Emergency Stop irrespective of the position in the machine cycle.

4.3 HMI SCREENS

4.3.1 HMI General Layout

These are the common screen features that are present on all or on most screens.

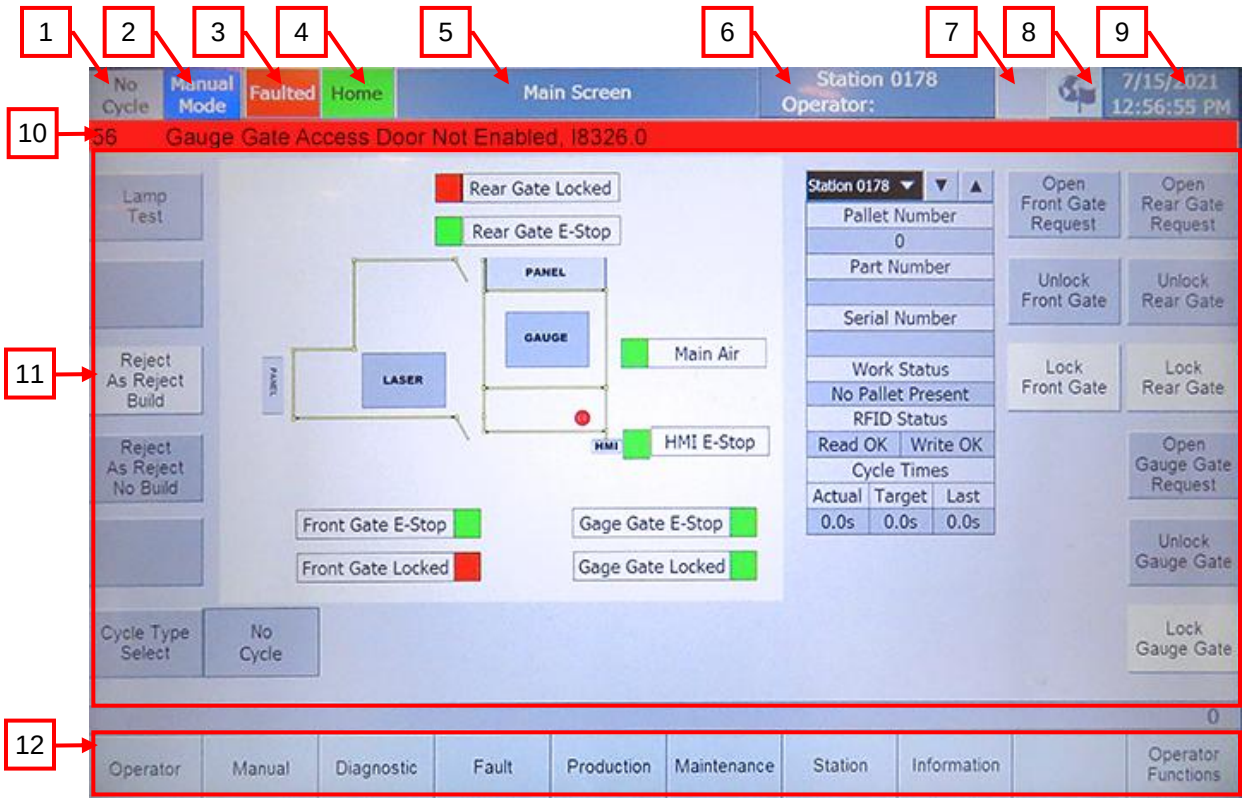


Figure 4-7: Common Screen Features

No.	Button/Field	Description
1	Cycle Status Indicator	Displays the current cycle of operation the machine is currently in.
2	Mode Status Indicator	Displays the current mode of operation the machine is currently in.
3	Fault Status Indicator	Displays fault status of the machine.
4	Machine Status Indicator	Displays the current state of the machine.
5	Screen Name	Field displays the name of the screen that is currently accessed.
6	Operation/Operator Name	Field displays the Operation number and operator currently logged in.
7	Network Status Indicator	Displays green when the connectivity and data transfer over the network is active.
8	Language Button	Allows the operator to change the language displayed.
9	Date/Time Stamp	Field displays the current Date (M/D/Y) and Time (H/M/S).
10	Fault/Warning Banner	Field displays the current fault number, description, and I/O.
11	Screen Specific Field	Field displays the information and buttons for the selected screen.
12	Main Screen Menu	Displays buttons to quickly access screens without going back to the Main Screen based on the screen currently accessed.

4.3.2 Main Screen

The Main Screen is the default screen to select and navigate to all other screens used for the Crank Shaft Measuring Machine. The buttons and information displayed will vary depending on the station HMI accessed. This screen displays an overview of the station with indicators to show the current status of key operational functions such as gate interlocks, services, E-Stops.

The operator can access pallet/part specific information as well RFID Read/Write Status, and Cycle Times (Actual, Target, Last).

The operator can perform a Lamp Test, set part Reject status, select Cycle Type, Lock/Unlock and Open gates remotely.

From any other screen, one can navigate back to the Main Screen by selecting the Main Menu (Main Screen) button in the lower left-hand corner.

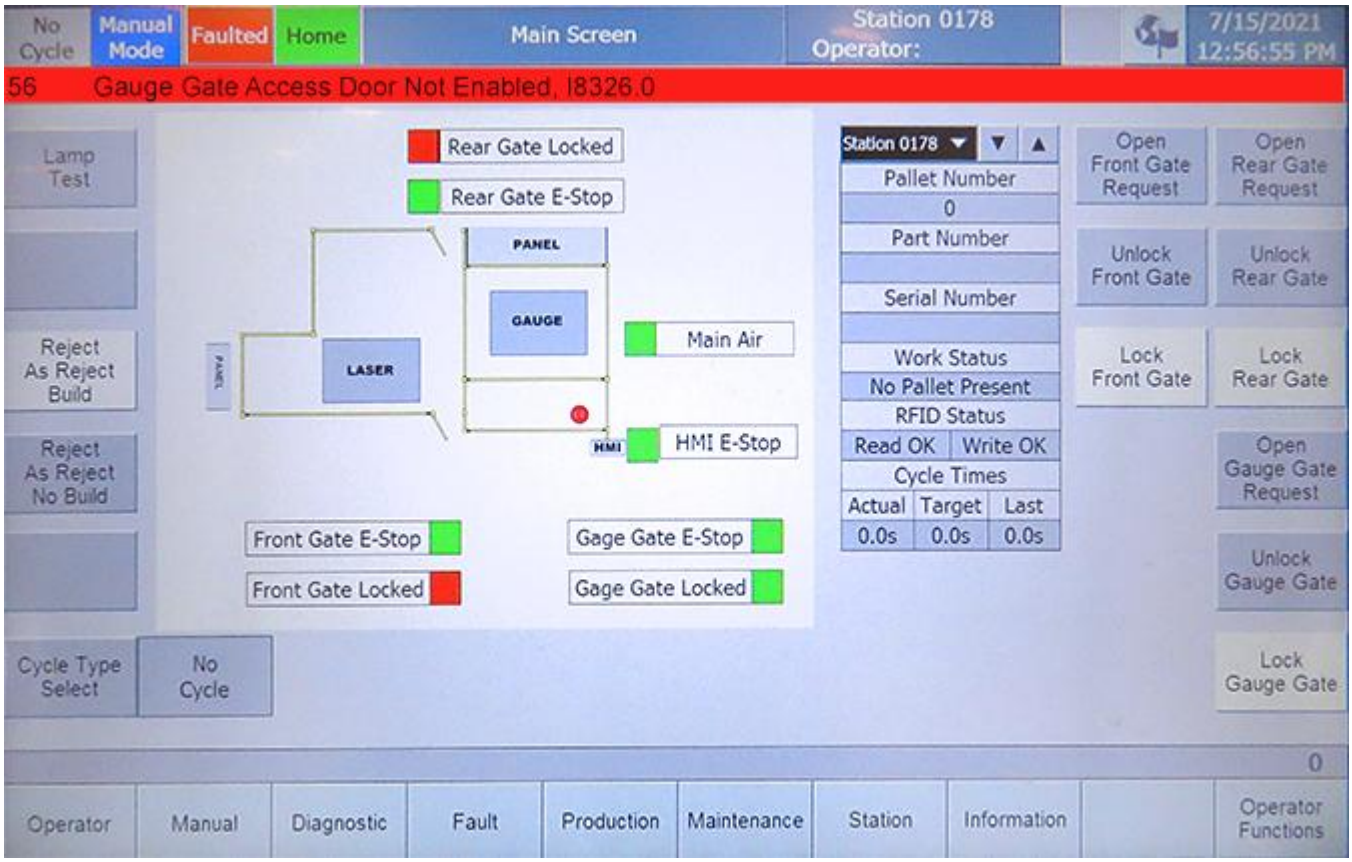


Figure 4-8: Main Screen

4.3.3 Directory Screen

The Directory screen is used to display the top level screens available to the operator. Pressing the name button on the display opens the screen window. Screen buttons that are greyed out are not available at this time. Buttons with a down arrow (▼) denote submenus with links to related screens.

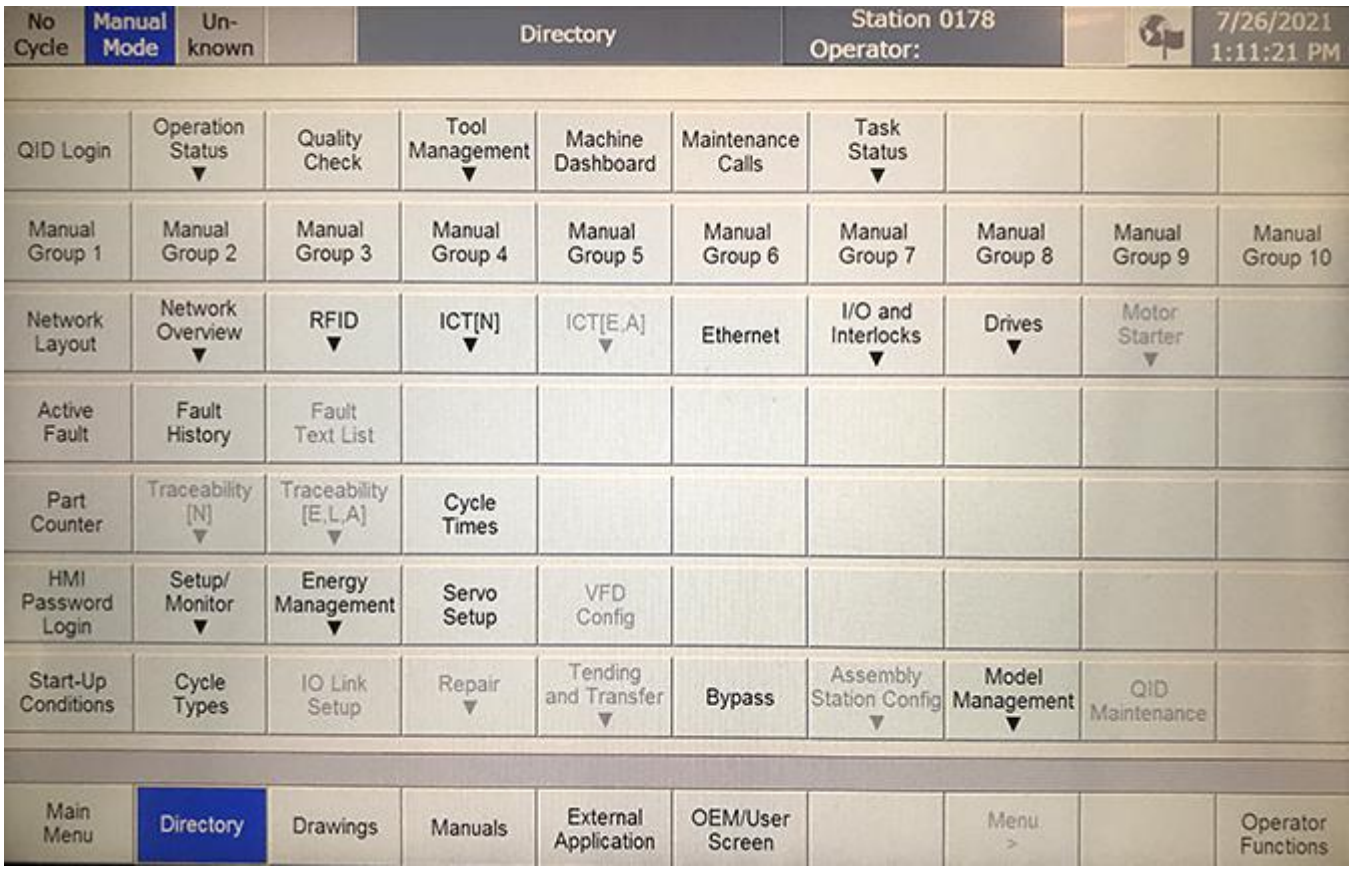


Figure 4-9: Directory Screen

4.3.4 QID Login Screen

The QID Login screen is used to log into the system as administrator or as a "Trainee". Login status is color-coded with or without icons as shown in the table onscreen.

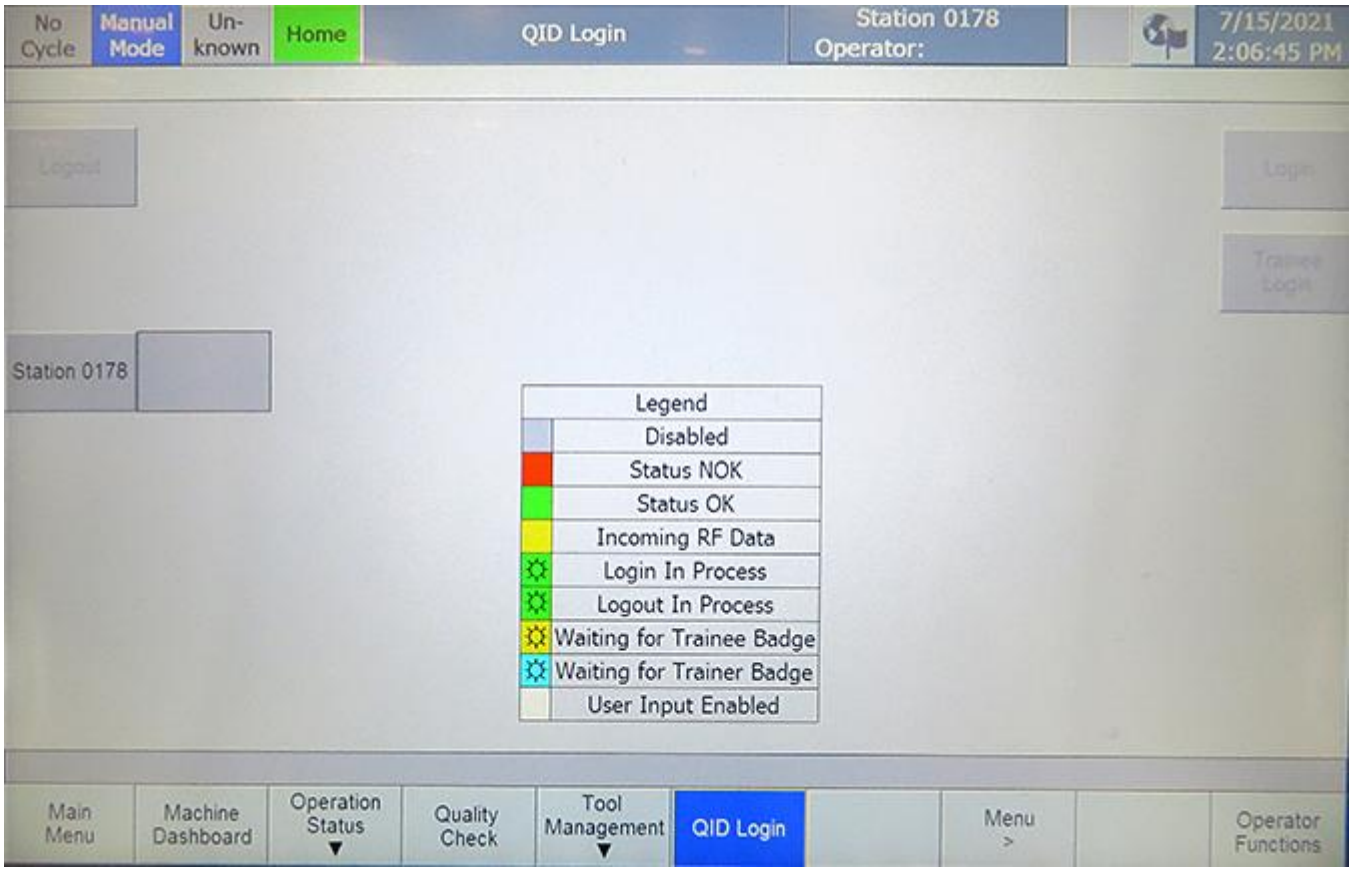


Figure 4-10: QID Login Screen

4.3.5 Manual Movements – Load Motions Screen

The Manual Movements – Load Motions screens are used to remotely control machine functions related to the loading/unloading of the part manually. The screen also displays non-moveable components status such as part present proximity switches and photo-eyes. The screen displays the component name, the type of function, and in some cases, numerical values to control in the middle of each row.

The actuation pushbuttons on the right and left edges are the opposing action button for each device (e.g., Locating Gripper, Advance / Return). In manual mode, the pushbutton is pressed and held until the action is complete and will be noted by the corresponding indicator being highlighted. Page 1 is shown below with additional pages (Page 2, Page 3 are shown on the following page) when selected will display other components and their functions.

Selecting the Symbolic/Absolute button will alternate how the control function appears, either showing the status as descriptive text (default) or alpha numeric positioning values.

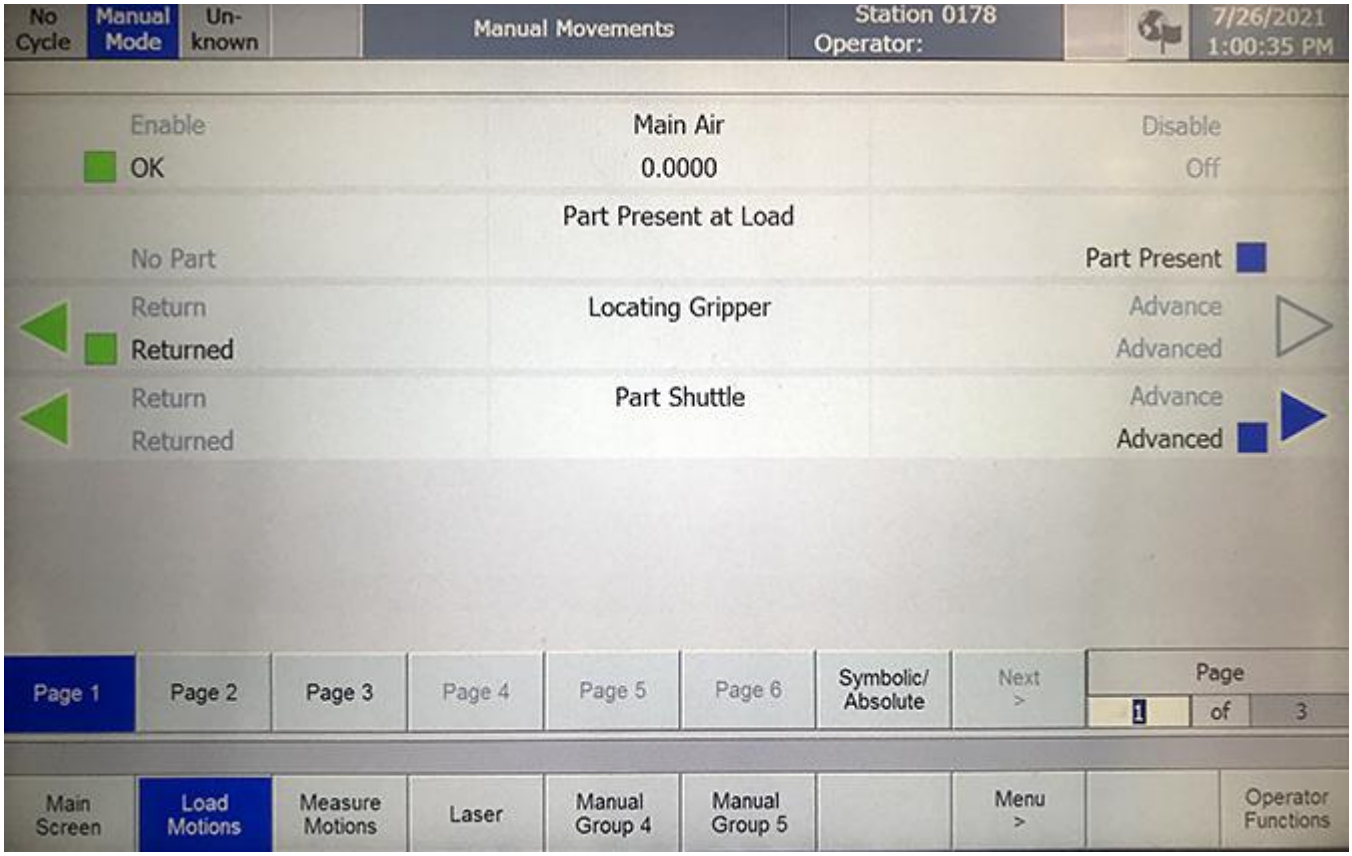


Figure 4-11: Manual Movements - Load Motions Page 1 Screen

Manual Movements – Load Motions Screen *(continued)*

Figure 4-12: Manual Movements - Load Motions Page 2 Screen

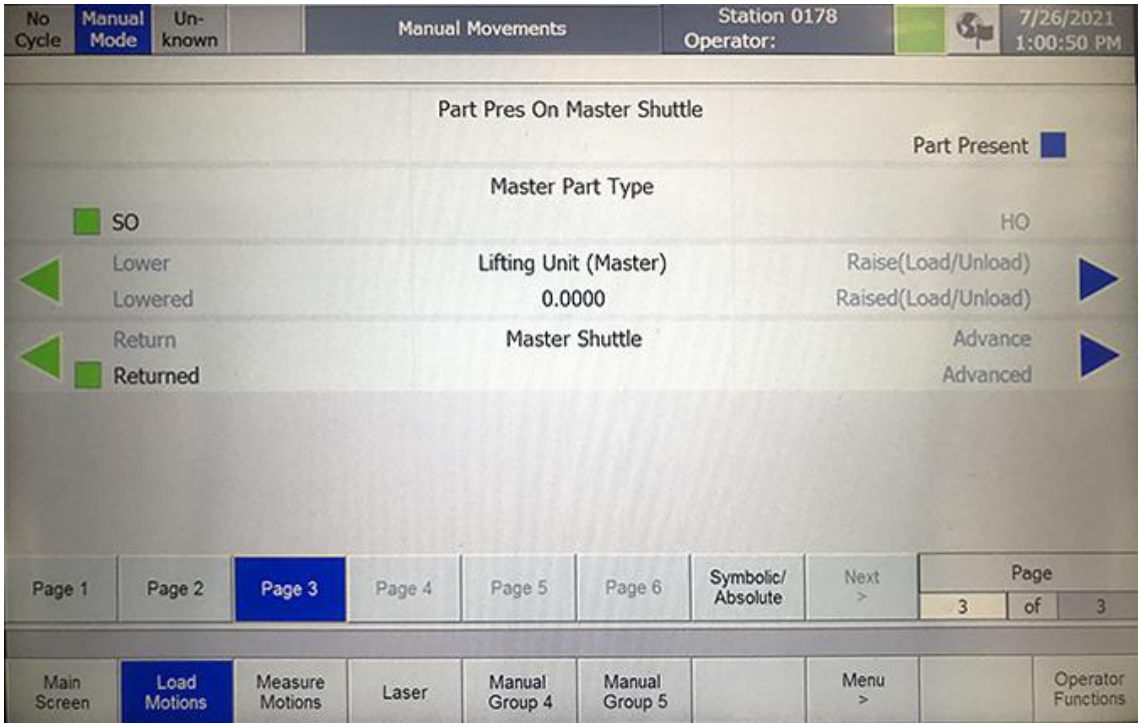


Figure 4-13: Manual Movements - Load Motions Page 3 Screen

4.3.6 Manual Movements – Measure Motions Screen

The Manual Movements – Measure Motions screens are used to remotely control machine functions related to the probes and gaging motions manually. The screen also displays other components status such as axis rotation. The screen displays the component name, the type of function, and in some cases, numerical values to control in the middle of each row.

The actuation pushbuttons on the right and left edges are the opposing action button for each device (e.g., Snap Probes, Advance / Return). In manual mode, the pushbutton is pressed and held until the action is complete and will be noted by the corresponding indicator being highlighted. Page 1 is shown below with additional pages (Pages 2 ~ 5) when selected will display other components and their functions.

Selecting the Symbolic/Absolute button will alternate how the control function appears, either showing the status as descriptive text (default) or alpha numeric positioning values.

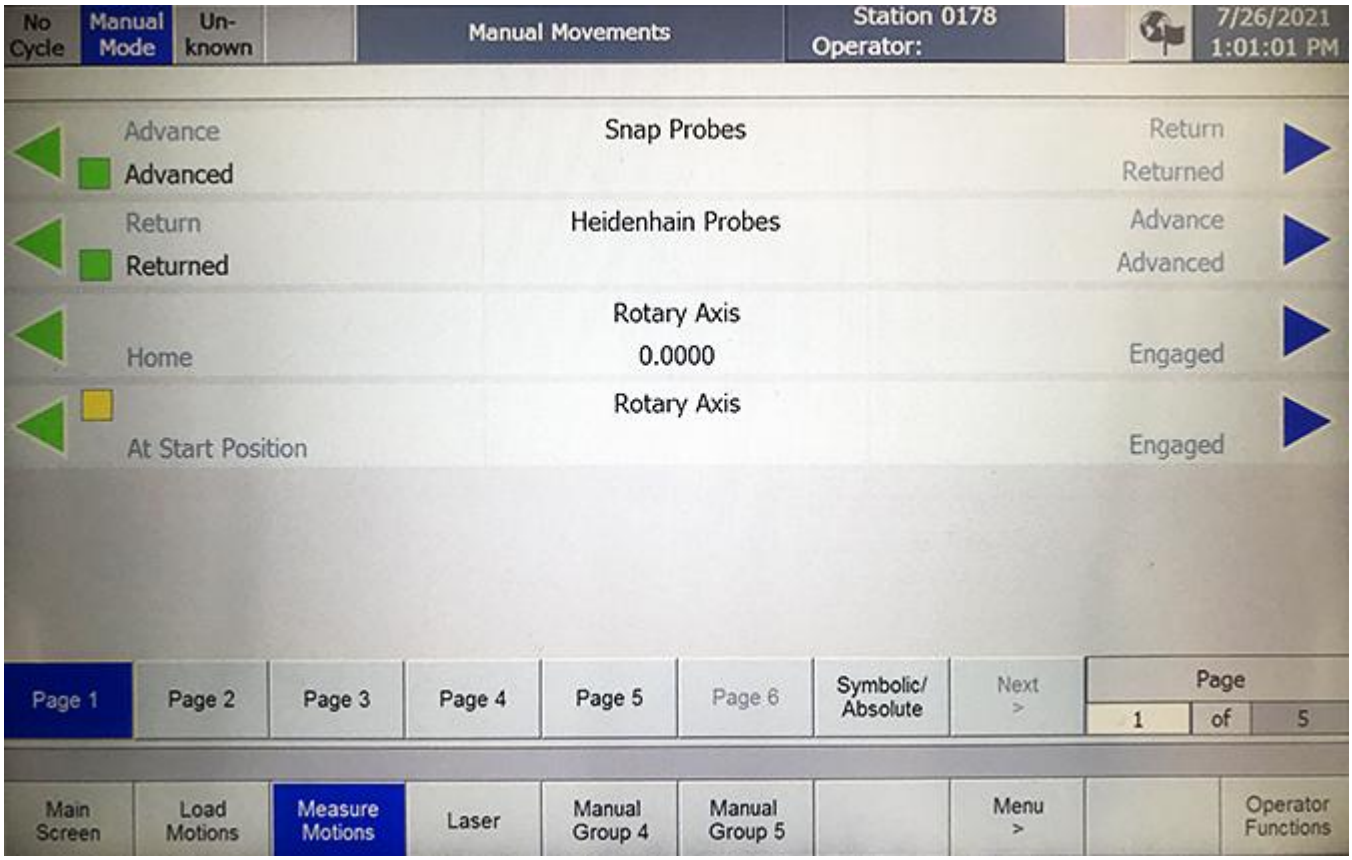


Figure 4-14: Manual Movements - Measure Motions Page 1 Screen

Manual Movements – Measure Motions Screen *(continued)*

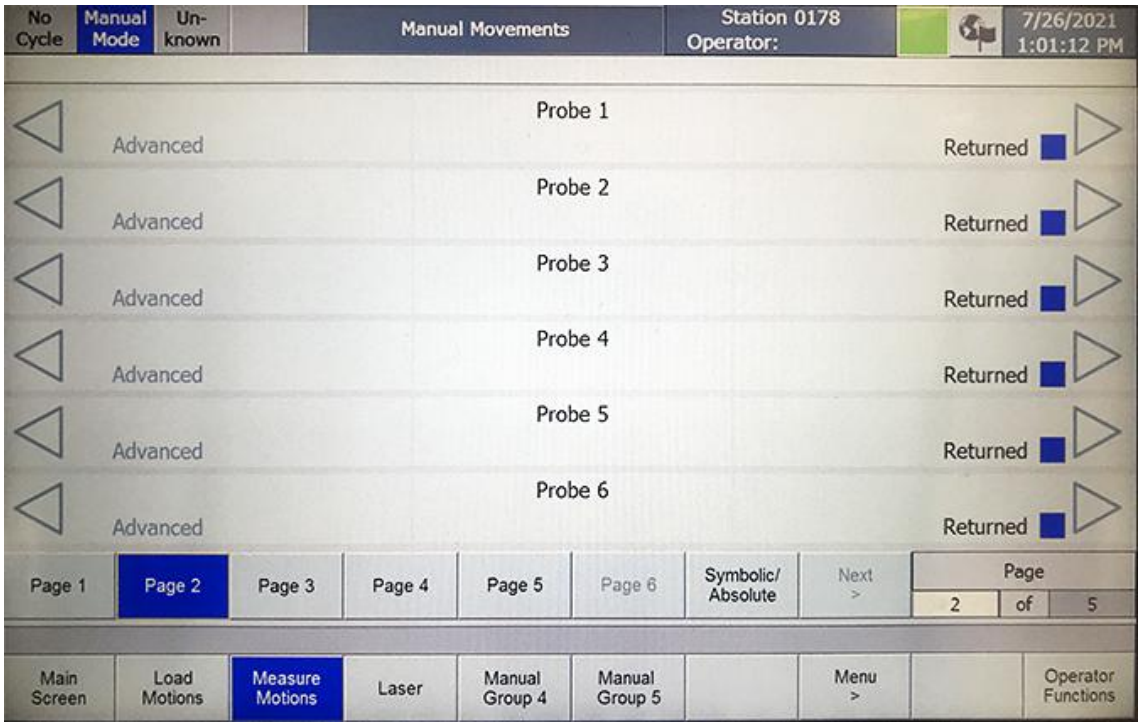


Figure 4-15: Manual Movements - Measure Motions Page 2 Screen
(Pages 3 & 4 similar)

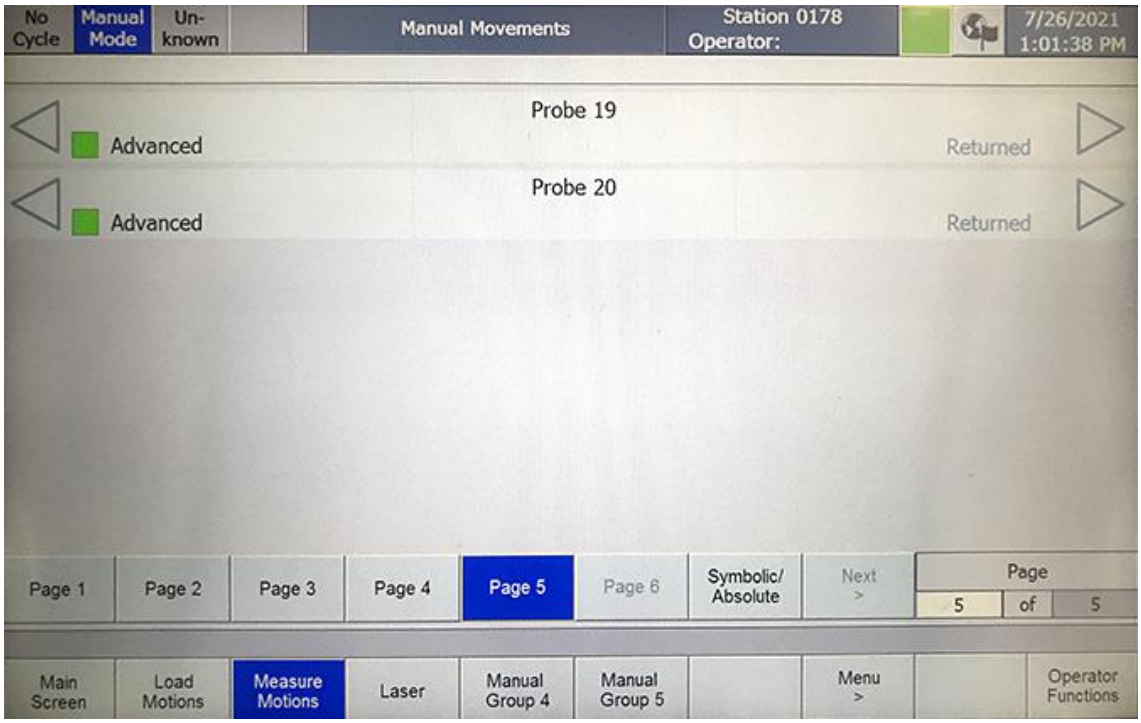


Figure 4-16: Manual Movements - Measure Motions Page 5 Screen

4.3.7 Manual Movements – Laser Screen

The Manual Movements – Laser screen is used to remotely control machine functions related to the Telesis Laser system motions manually. The screen also displays other components status such as part present proximity switches and photo-eyes. The screen displays the component name and the type of function to control in the middle of each row.

The actuation pushbuttons on the right and left edges are the opposing action button for each device (e.g., Laser Door, Open / Closed). In manual mode, the pushbutton is pressed and held until the action is complete and will be noted by the corresponding indicator being highlighted.

Selecting the Symbolic/Absolute button will alternate how the control function appears, either showing the status as descriptive text (default) or alpha numeric positioning values.

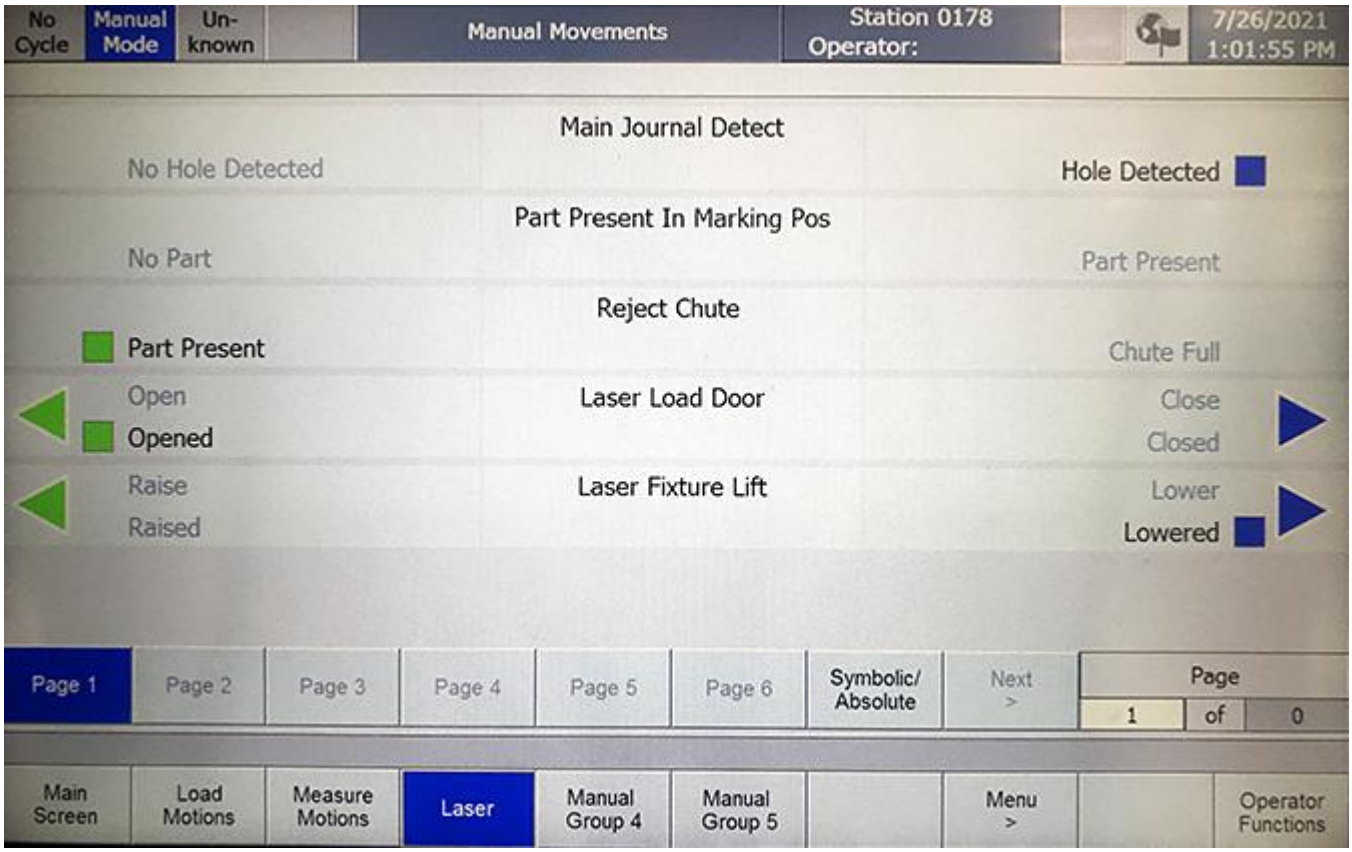


Figure 4-17: Manual Movements - Laser Page 1 Screen

4.3.8 Network Layout Screen

The Network Layout screen is used to display information and current status of the I/O Network and Nodes located within the station graphically. Network nodes are identified by number and current state are indicated by color code. The navigation panel on the left is used to select network nodes.

A color code legend is provided on the following Network Overview screen.

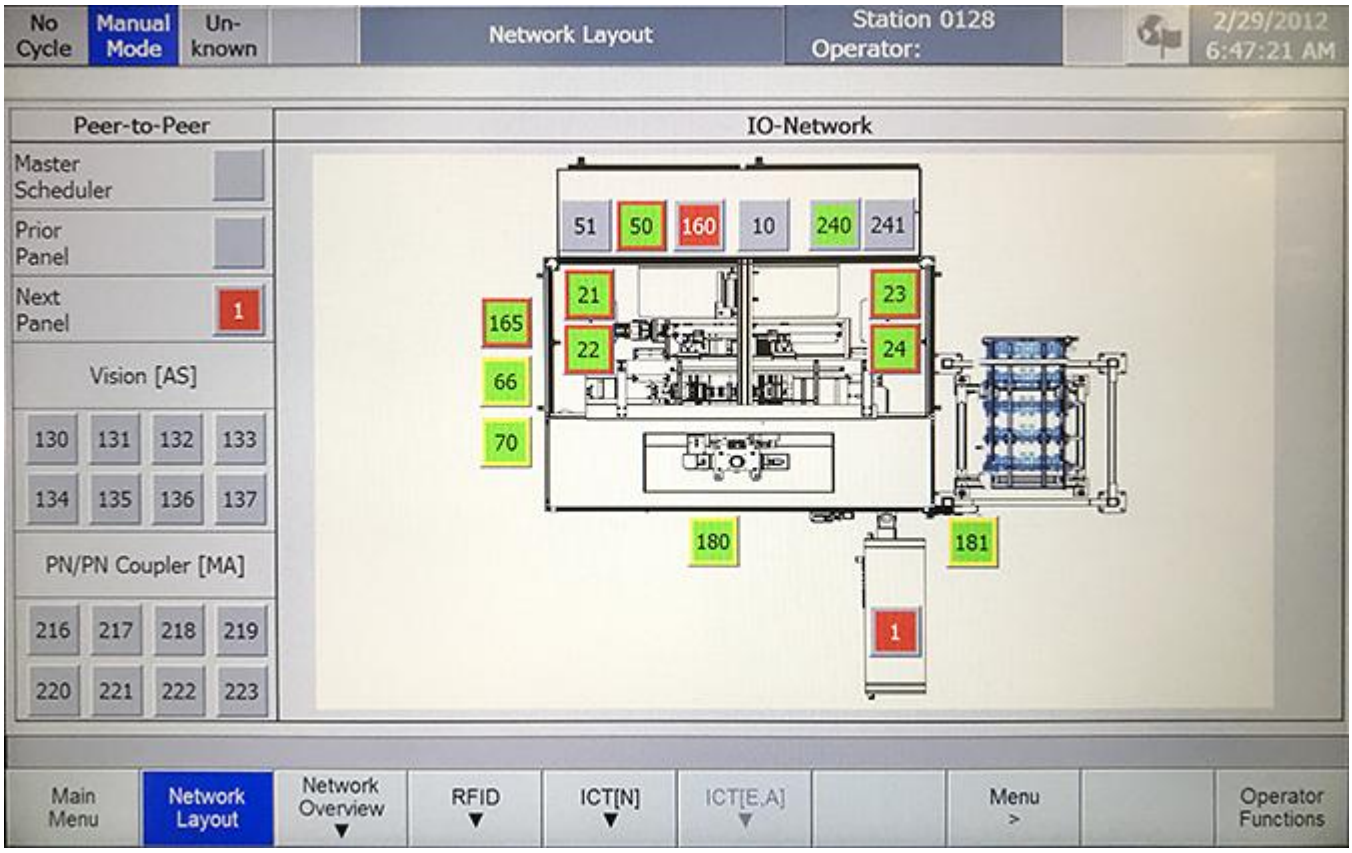


Figure 4-18: Network Layout Screen
(OP128 shown, OP178 similar)

4.3.9 Network Overview Screen

The Network Overview screen is used to display information and current status of the I/O Network and Nodes located within the station in chart form. Network nodes are identified by number and current state are indicated by color code. Use the up and down arrows on the display above the chart to select the network, node to view. The selected node's current status is displayed in the indicator field to the right of the navigation.

A node status color code legend is provided on the right side of the screen.

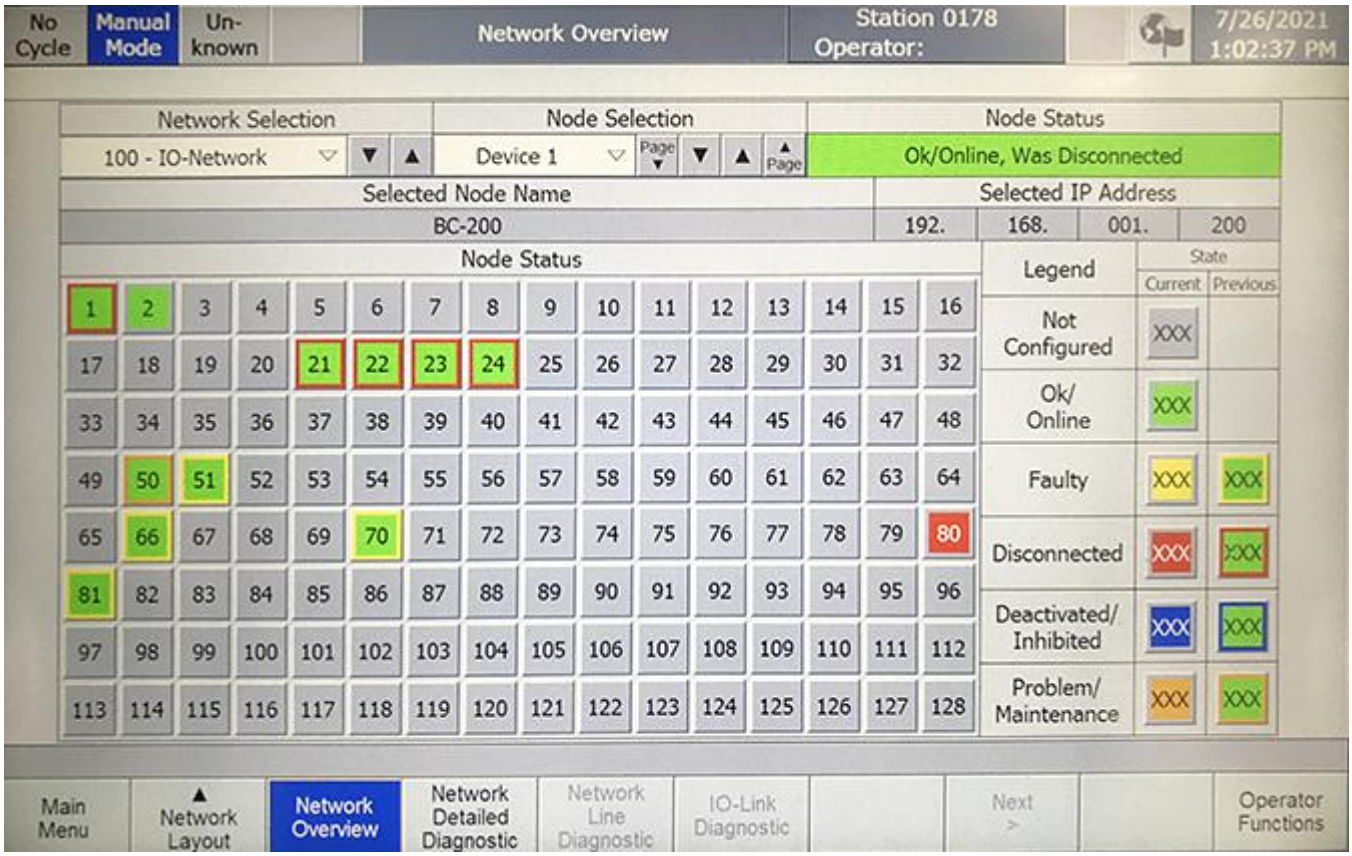


Figure 4-19: Network Overview Screen

4.3.10 Network Detailed Diagnostic Screen

The Network Detailed Diagnostic screen is used to display information and current status of the Network and Nodes located within the station. Component name, type, and network addressing are shown in the display window. Selecting a network node in the window populates identifying information in the field above it and specific information in the table below it. Color coding and icons are used for diagnostic purposes when troubleshooting networks.

Additional hidden information may be revealed by using the vertical scroll bars on the right side of the windows.

The buttons on the far right side of the screen allow for changing the view, moving the focus of the cursor up or down, and changing the diagnostics information to display.

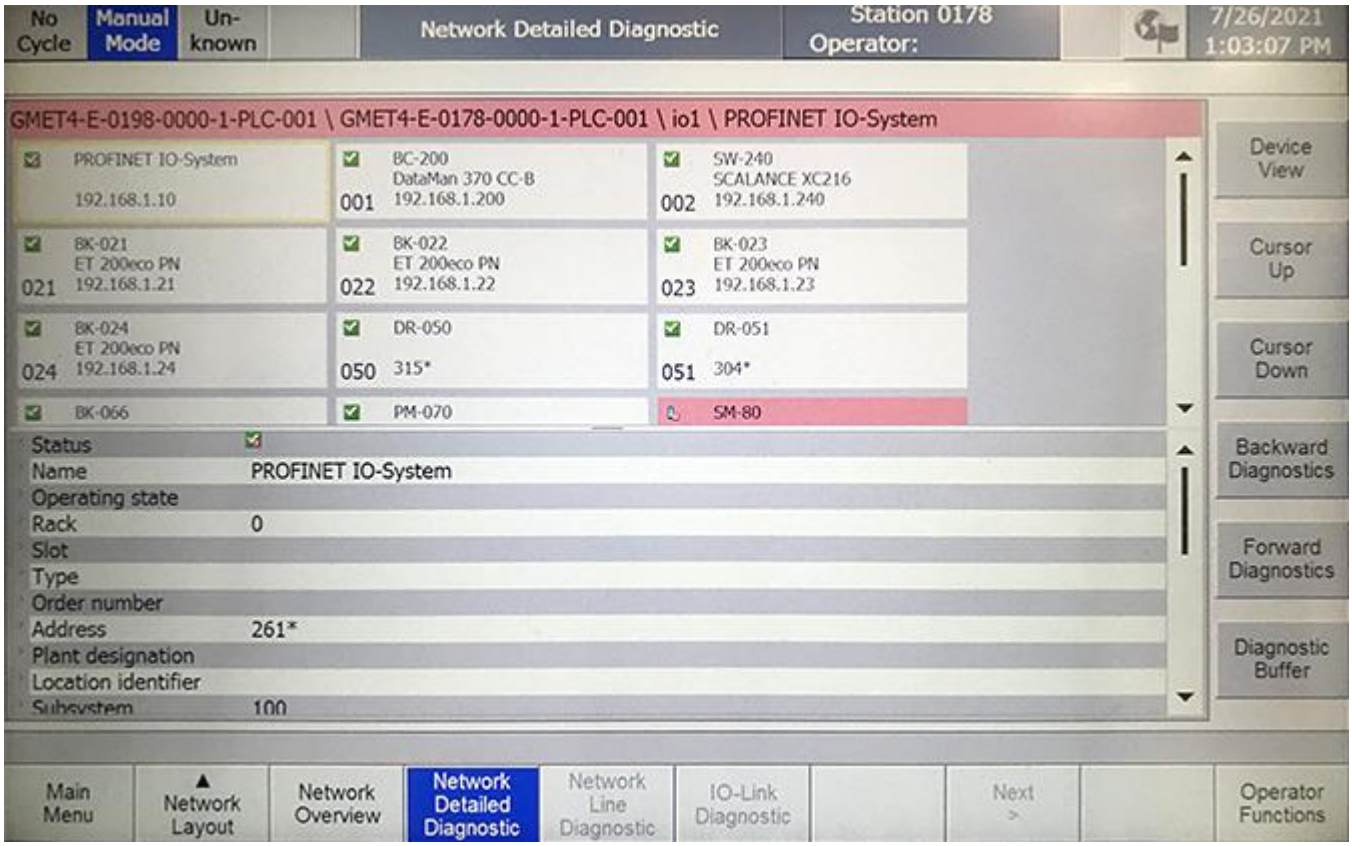


Figure 4-20: Network Detailed Diagnostic Screen

4.3.11 Active Fault Screen

The Active Alarm screen displays any current active alarms and warnings for the machine. Faults and warnings requiring immediate attention are displayed with red background, informational messages are displayed on a blue background. The newest active alarm is displayed first, previous active faults and warning are displayed in order as they occurred and can be viewed by using the scrolling arrows on the right side of the window.

After the fault or warning is diagnosed and rectified, the fault can be cleared and the safety circuits reset by pressing the Power ON / Fault Reset button on the HMI control panel. The cleared fault will be sent and displayed on the fault history screen.

The "No." column displays the alarm/warning number, the "Time" column displays the time the fault/warning occurred, and the "Status" column displays the condition of the alarm.

The Infotext button in the lower left corner will pop-up a legend explaining the status categories.

The Text column displays the associated I/O device with a brief description of the fault/warning.

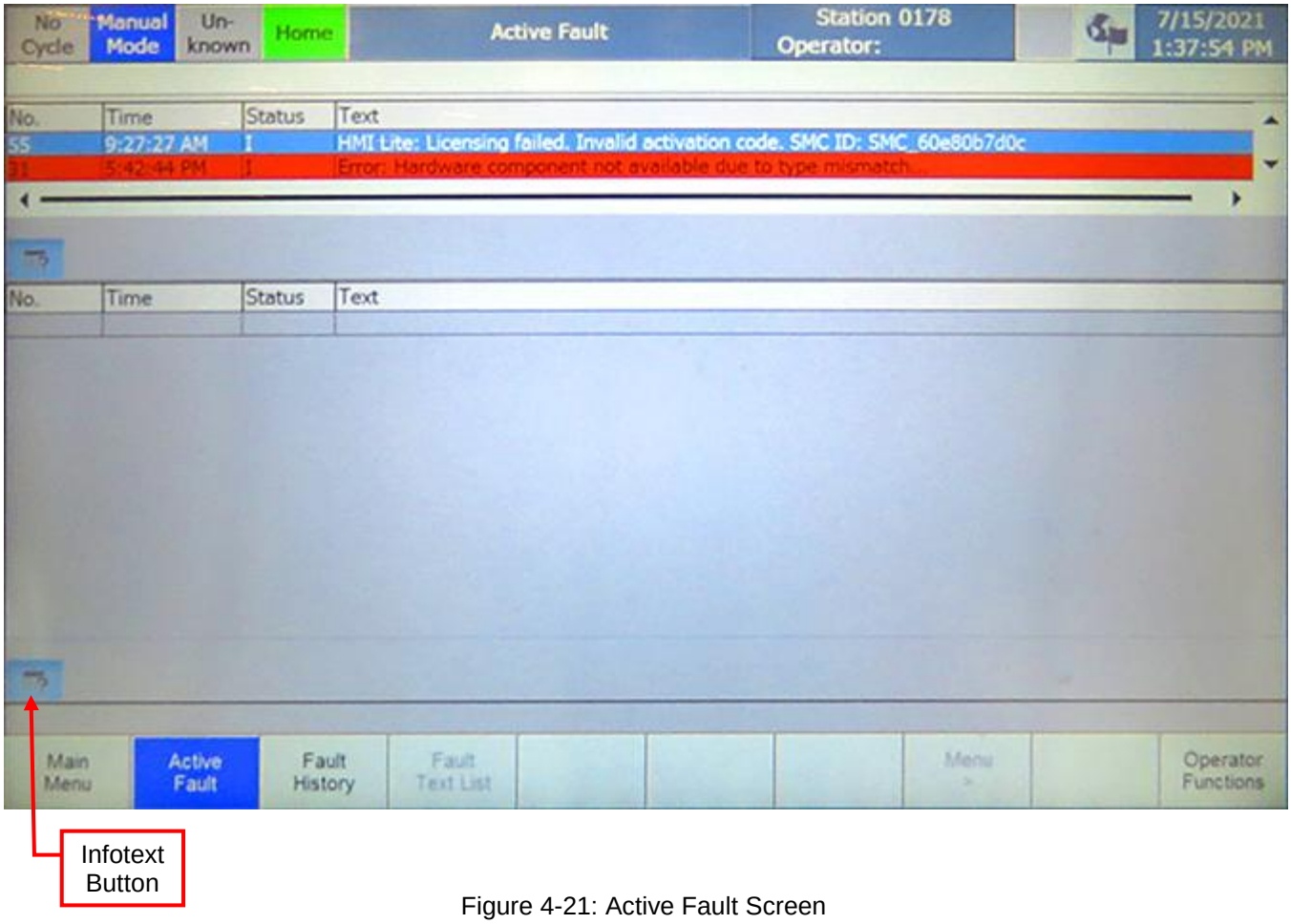


Figure 4-21: Active Fault Screen

4.3.12 Fault History Screen

The Fault History Screen displays any previous fault that had been cleared from the Active Fault Screen. The Alarm No., time and date of occurrence, status and the alarm description are displayed. Newer faults are displayed at the top. Use the scroll bar button on the far right of the screen to scroll through the list.

Note that the rows will enlarge to display the fault text in its entirety as shown on the next page.

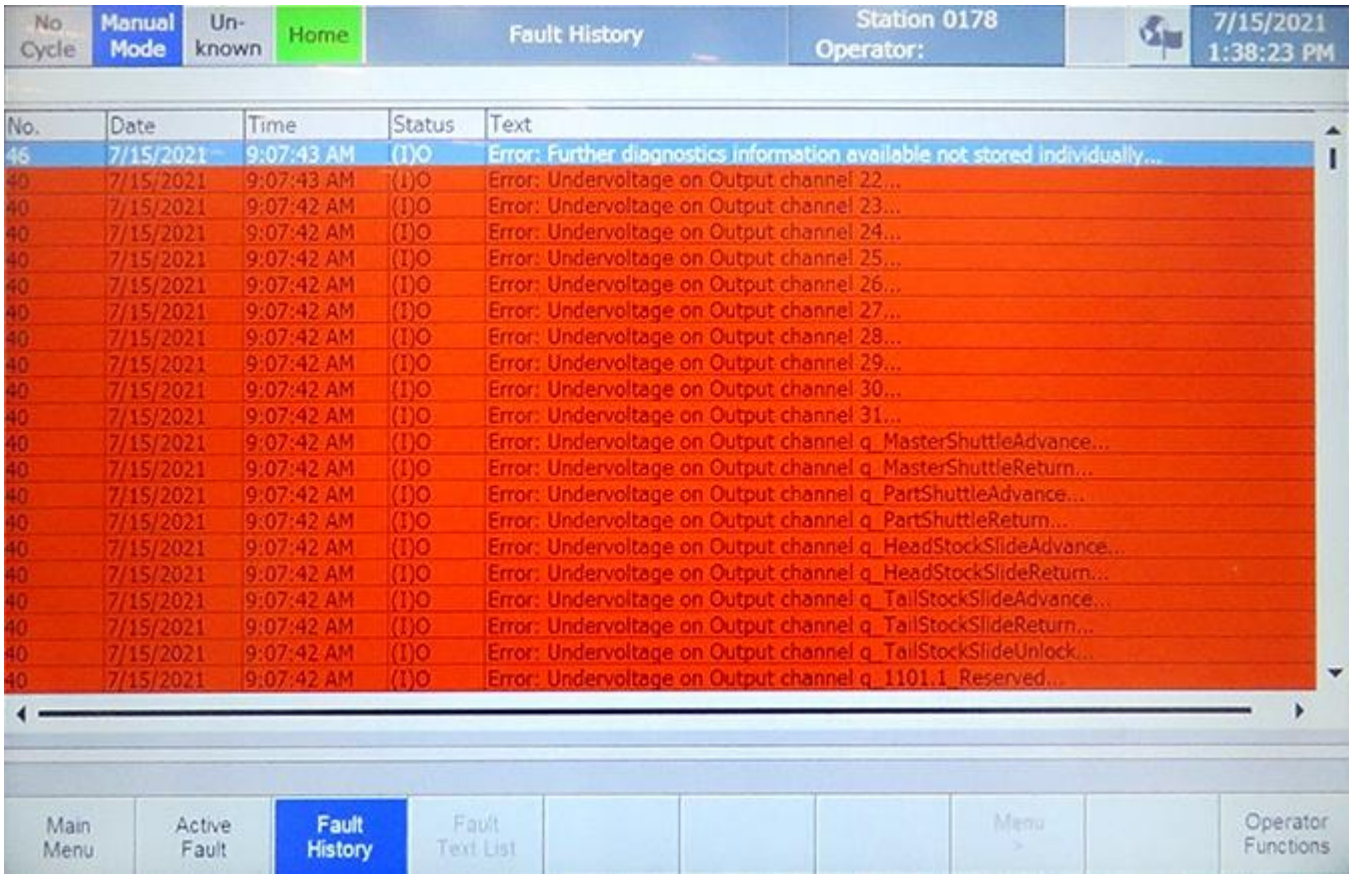


Figure 4-22: Fault History Screen

Fault History Screen *(continued)*

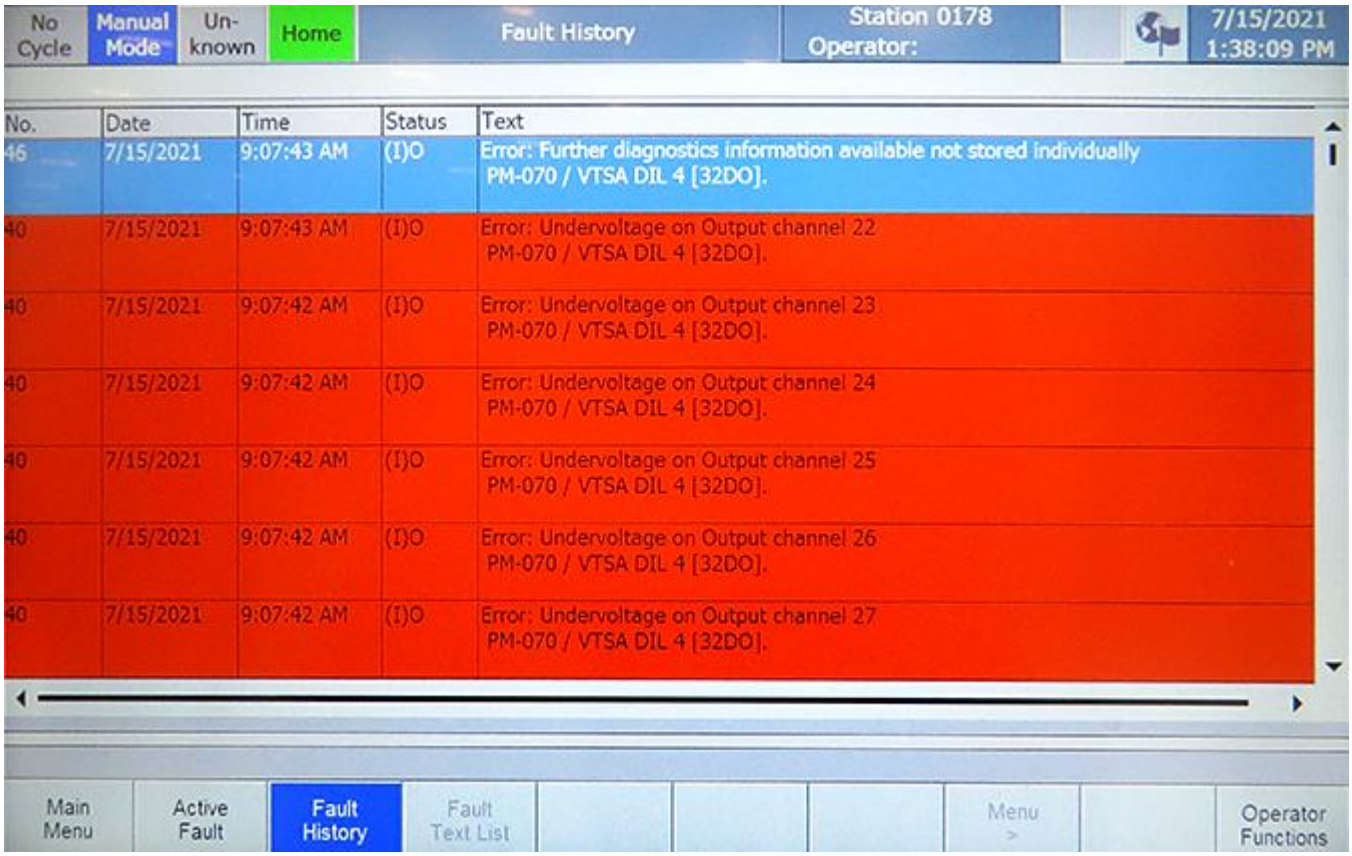


Figure 4-23: Fault History Screen Enlarged

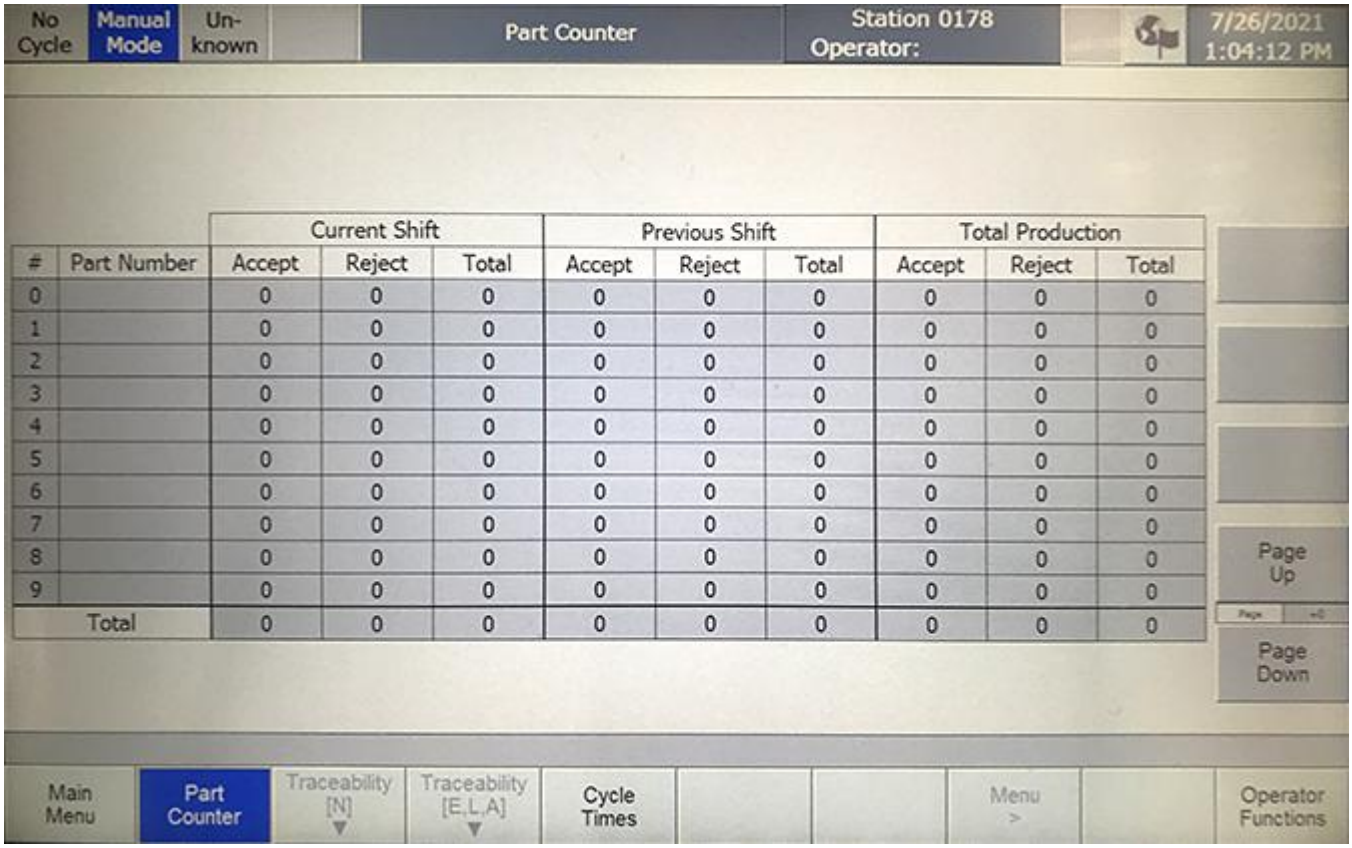
4.3.13 Part Counter Screen

The rows of the Part Counter screen are populated as any new Part Numbers are introduced. If the part is OK to build, the part count function block will scan the rows for an instance of the Part Number. If a Part Number is found, the count for that part is incremented per shift.

Part Numbers are tracked for accepted, rejected, and total counts for the Current Shift and Previous Shift.

The Total Production overall and part number specific counters are the addition of each shift.

Additional rows of Part Numbers can be shown by using the Page Up and Page Down buttons in the lower right side of the screen.



#	Part Number	Current Shift			Previous Shift			Total Production		
		Accept	Reject	Total	Accept	Reject	Total	Accept	Reject	Total
0		0	0	0	0	0	0	0	0	0
1		0	0	0	0	0	0	0	0	0
2		0	0	0	0	0	0	0	0	0
3		0	0	0	0	0	0	0	0	0
4		0	0	0	0	0	0	0	0	0
5		0	0	0	0	0	0	0	0	0
6		0	0	0	0	0	0	0	0	0
7		0	0	0	0	0	0	0	0	0
8		0	0	0	0	0	0	0	0	0
9		0	0	0	0	0	0	0	0	0
Total		0	0	0	0	0	0	0	0	0

Figure 4-24: Part Counter Screen

4.3.14 Cycle Times Screen

The Cycle Times screen tracks the current and previous 15 cycle times in seconds for this station. The display shows the Target value, the actual values, and a comparison bar graph of the values exceeding the Target value by percentage.

The Average of all cycle times is calculated and displayed in the field at the bottom of the rows.

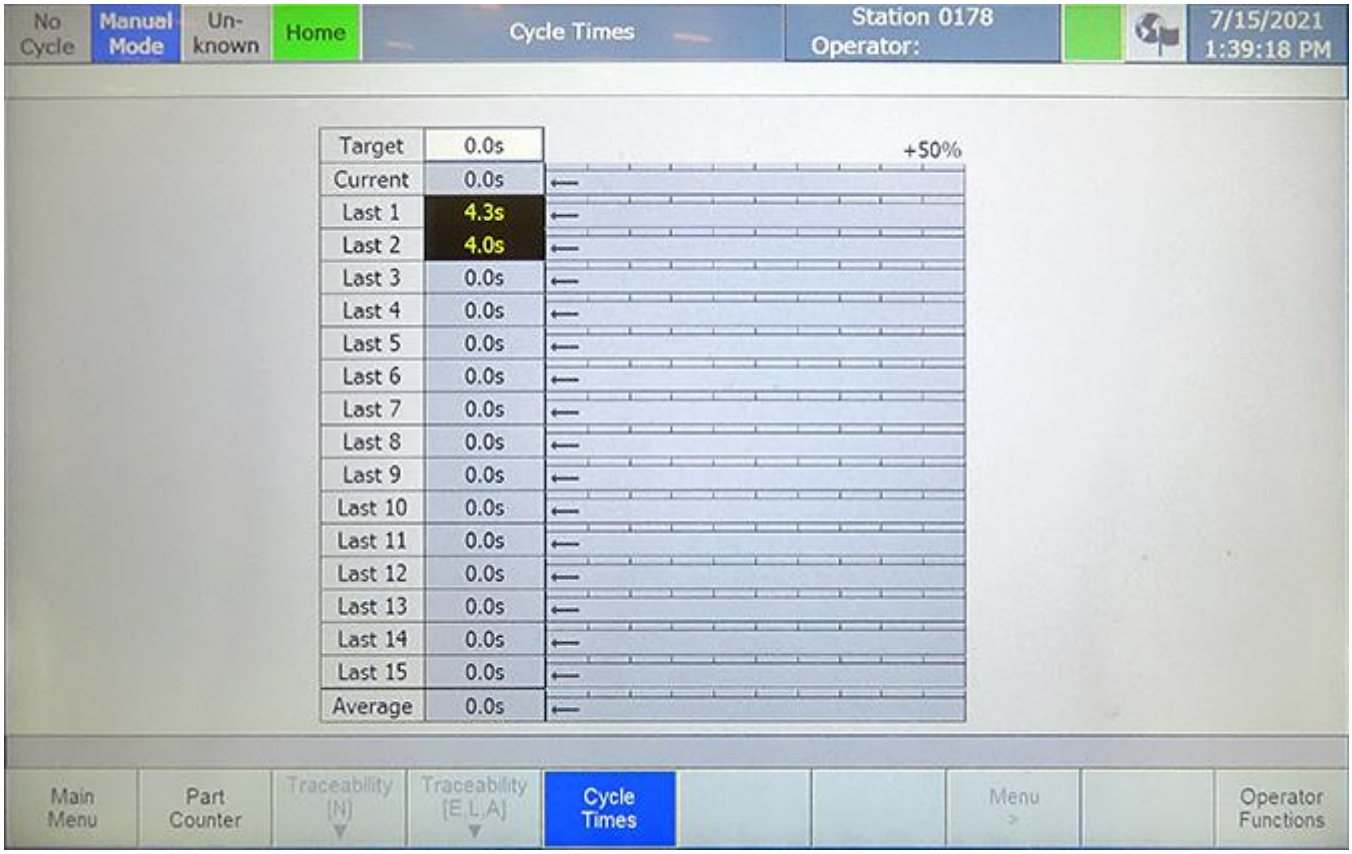


Figure 4-25: Cycle Times Screen

4.3.15 HMI Password Login Screen

The HMI Password Login screen allows for the logging in to the system by personnel authorized to do so. Depending on authorization level (by number), access to certain screens or functions of screens are made available.

The screen displays the Current user logged in with authorization level. This screen allows for the user to input User name, Password, Group assigned to and tracks Logoff time. Password may be imported and exported using the two buttons on the top right side or the screen. Log On User and Log Off User buttons are located on the lower right side of the screen.

To access the various functions of the HMI Screens, enter the login information as shown below.

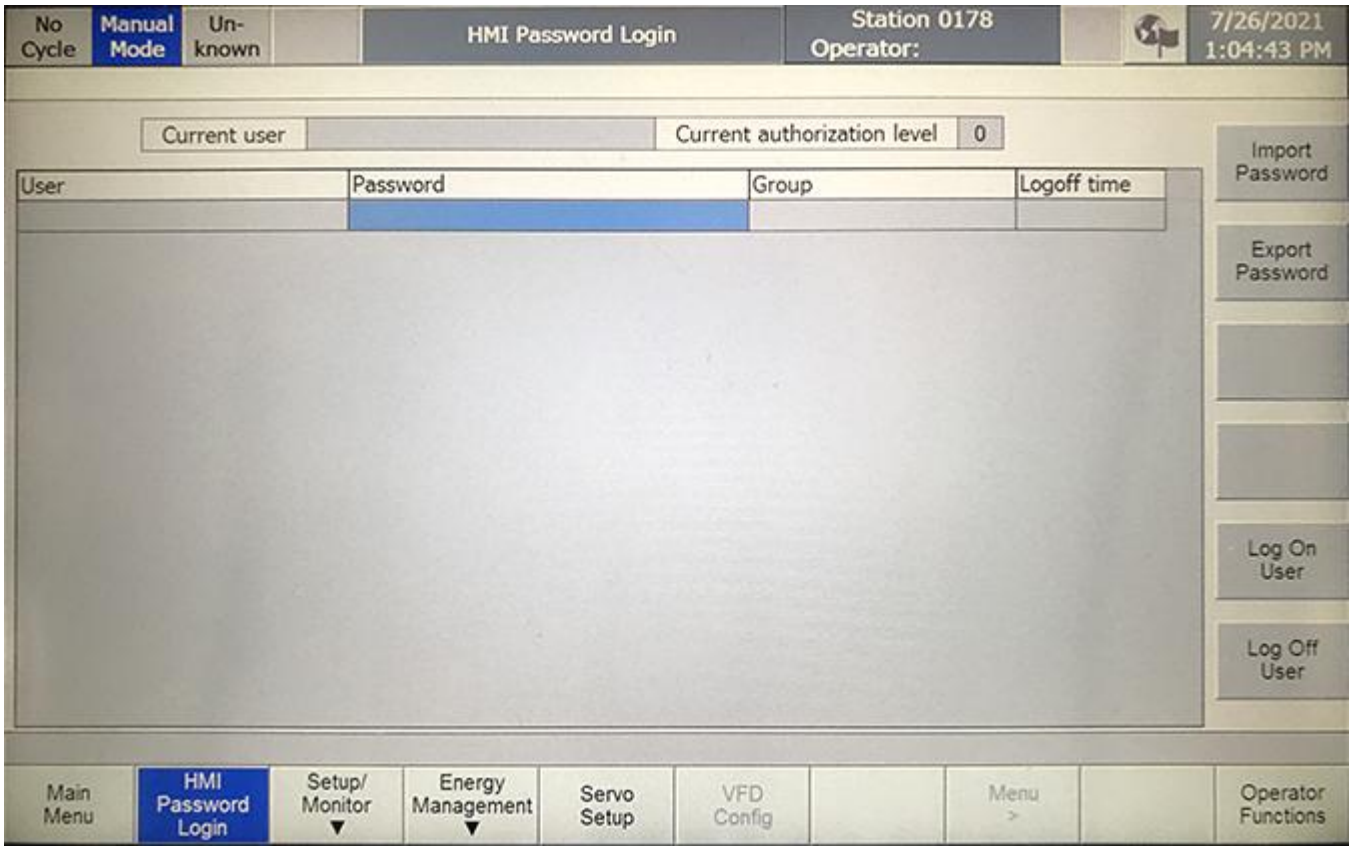


Figure 4-26: HMI Password Login Screen

4.3.16 PLC/CNC Status Screen

The PLC/CNC Status screen displays the current status of the PLC (Programmable Logic Controller) and if applicable CNC (Computer Numerical Control) devices. This screen is used mainly for setup, diagnostic, and troubleshooting system configurations.

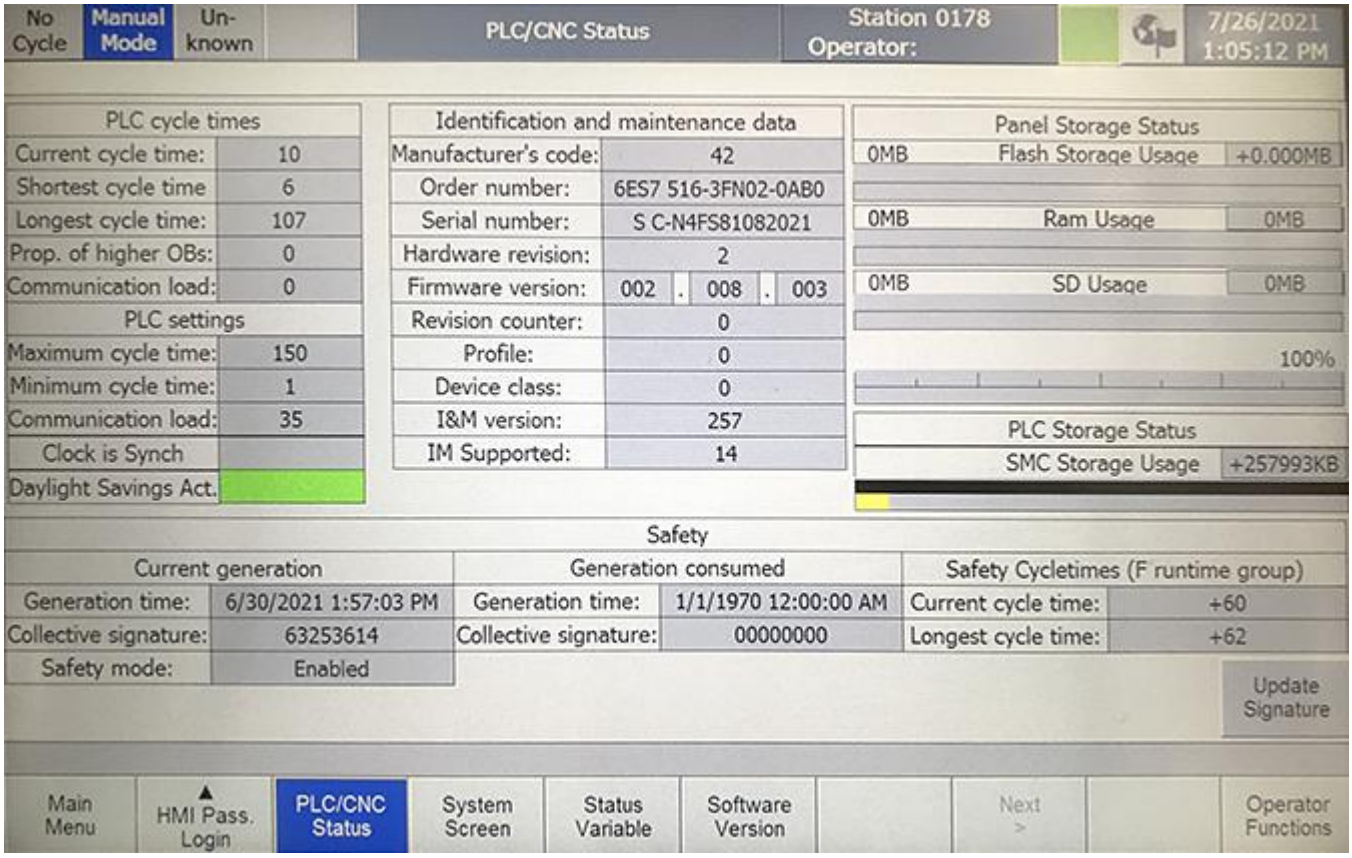


Figure 4-27: PLC/CNC Status Screen

4.3.17 Startup Conditions Screen

The Startup Conditions screen allows the user to quickly see the current condition of the system during startup and allow for the manual startup of individual functions. This screen is used mainly for setup, diagnostic, and troubleshooting system configurations.

The screen displays the component name, the type of function, and in some cases, numerical values to control in the middle of each row.

The actuation pushbuttons on the right and left edges are the opposing action button for each device (e.g., Main Air, NOK / OK). In manual mode, the pushbutton is pressed and held until the action is complete and will be noted by the corresponding indicator being highlighted. Page 1 is shown below with additional pages (Pages 2 ~ 6) when selected will display other components and their functions. Additional pages (7~12) can be accessed by pressing the Next > button.

Selecting the Symbolic/Absolute button will alternate how the control function appears, either showing the status as descriptive text (default) or alpha numeric positioning values.

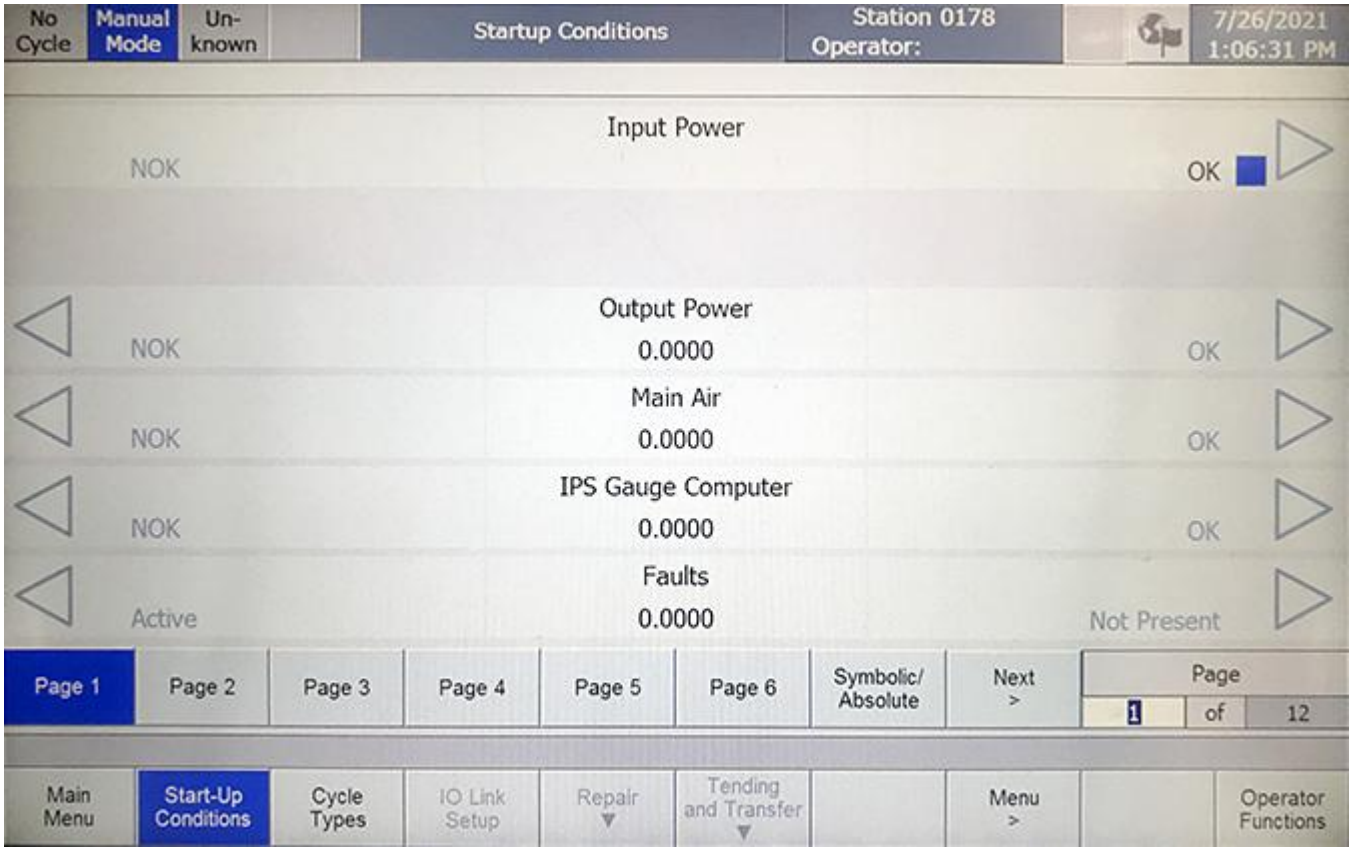


Figure 4-28: Startup Conditions - Page 1 Screen

Startup Conditions Screen *(continued)*

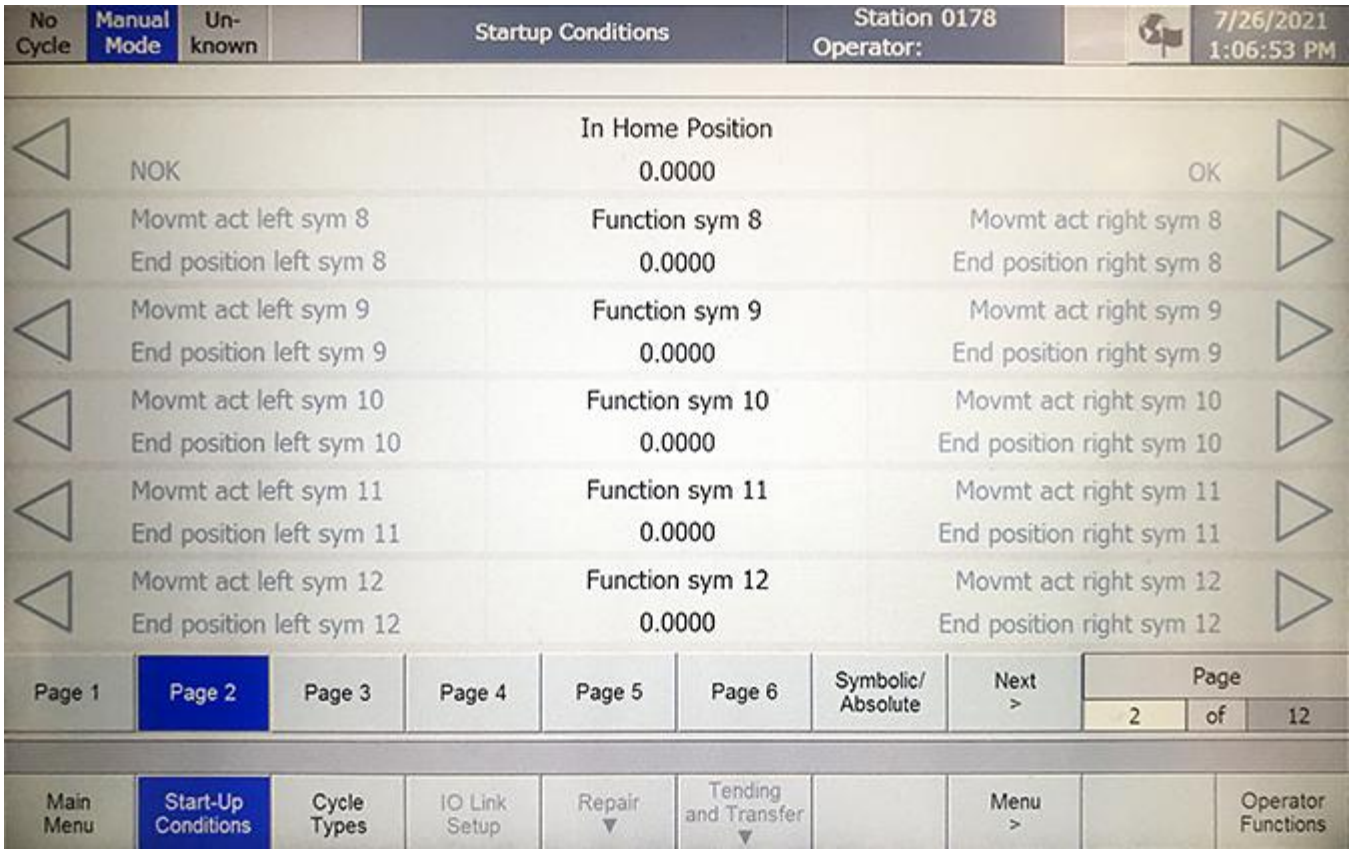


Figure 4-29: Startup Conditions - Page 2 Screen
(Pages 3~12 similar)

4.3.18 Cycle Types Screen

The Cycle Types screen allows the user to choose between Dry Cycle (run station without parts) and Unload/Load Master for calibration purposes. This screen is used mainly for setup, diagnostic, and troubleshooting system configurations.

The screen displays the component name, the type of function, and in some cases, numerical values to control in the middle of each row.

The actuation pushbuttons on the right and left edges are the opposing action button for each device (e.g., Unload/Load master, Unload Master / Load Master). In manual mode, the pushbutton is pressed and held until the action is complete and will be noted by the corresponding indicator being highlighted. Page 1 is shown below with additional pages (Pages 2 ~ 6) when selected will display other components and their functions. Additional pages (7~12) can be accessed by pressing the Next > button.

Selecting the Symbolic/Absolute button will alternate how the control function appears, either showing the status as descriptive text (default) or alpha numeric positioning values.

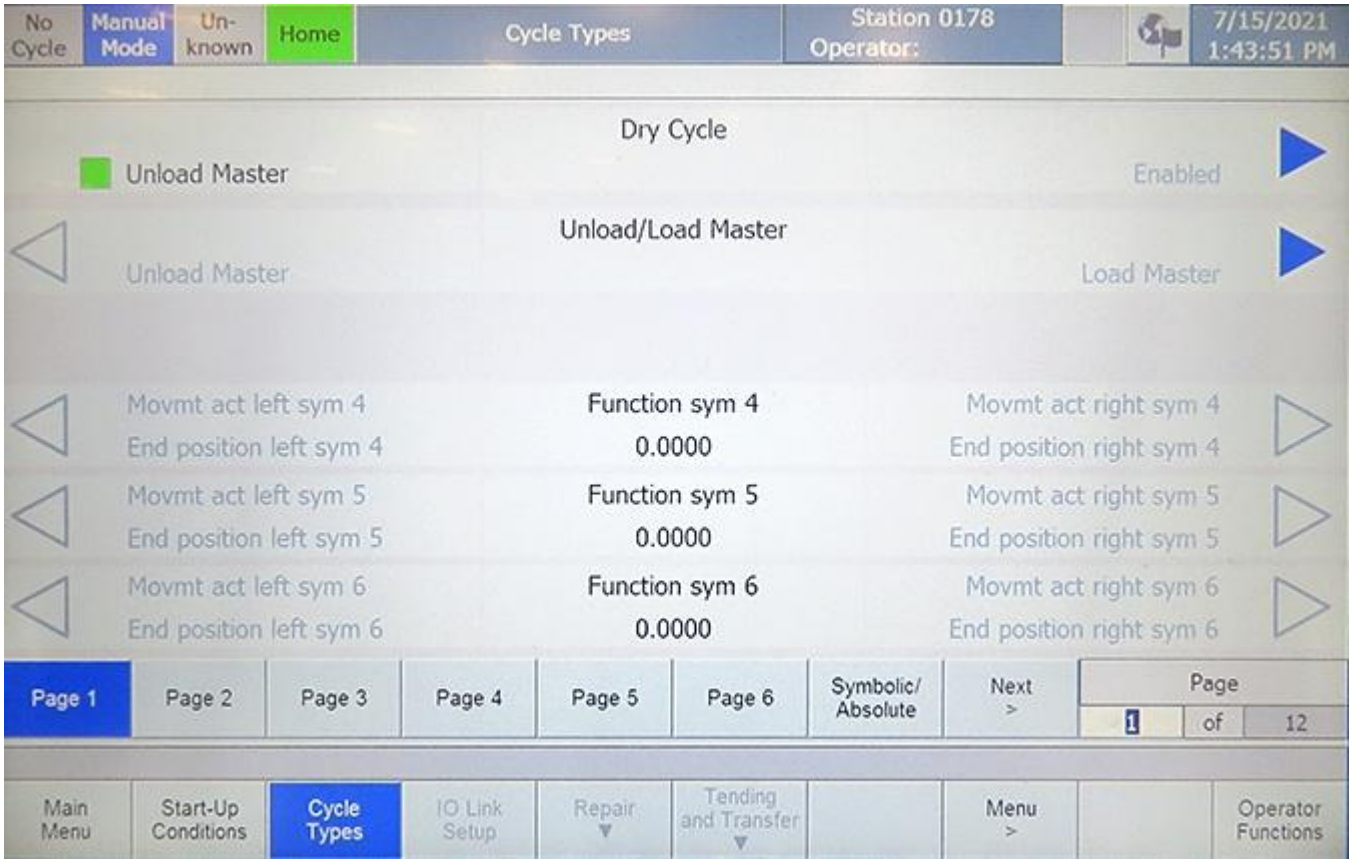


Figure 4-30: Cycle Types - Page 1 Screen

4.4 OPERATION PROCEDURES

4.4.1 Pre-Start Check

These steps must be performed at the beginning of each shift to ensure that the machine is ready for start-up.

WARNING

WARNING

Starting up the machine without performing the following checks can result in damage to the machine, injury to personnel, and even death!

Before applying any power to the cell, walk the entire cell (inside and outside the fenced area) and visually inspect the area for the following:

- If any maintenance is scheduled, ensure that all required maintenance has been completed and safety locks and tags are removed.
- There are no personnel performing maintenance or other work on any of the machine equipment. Look for lockout devices that may have been applied to the equipment.
- Ensure all tools, rags, etc. have been removed from the maintenance area. Remove all objects that do not belong.
- Ensure the working area is clean and free of oil, water, or debris. Immediately report unsafe working conditions to the supervisor or safety department.
- Check for any damage and/or obstructions.
- Ensure all air preparation stands located inside the cell have not been locked out and the lockout valves are in the open position (station main air stand).
  Refer to the ECPL placard for all air preparation stand locations.
- All guarding is in place.
- All electrical panel doors are closed and latched.
- Ensure the facility air and electrical power is available to the system.
- All light screens and safety mats are clear of obstructions where applicable.
- Ensure there are no personnel inside the gated area of the cell.
- Safety gates are securely closed and latched. The system cannot be powered up if any safety guards are open.
- Reset any Emergency Stop pushbuttons that may have been activated.
- All laser marking system doors/hatches are closed, secure and latched where applicable.

4.4.2 Full Power Up from All Power Sources Off Procedure

This procedure covers the power up of the cell when the cell has been completely powered down. This procedure provides full power up instruction for the cell and readies the cell for auto cycle.

The nature of the cell's “Power Up Procedure” will be conditioned by the manner in which the previous cycling was terminated. In actual operation, some of the steps may only need to be verified.

NOTE

NOTE

Make sure the Pre-Start Check procedure has been performed! Refer to heading 4.4.1 Pre-Start Check on page 4-35.

NOTE

NOTE

Clear any lockouts in the station. Follow procedures outlined on the energy control power lockout placard(s) posted on the main electrical panel.

WARNING

WARNING

Follow all plant guidelines and regulations for start-up safety. Follow all safety warning labels posted on the equipment. Refer to the ECPL placard for energy source locations. Failure to comply could result in severe personal injury or death, and/or equipment damage.

WARNING

WARNING

Allow only personnel with appropriate training and experience to operate or service the equipment. The use of untrained or inexperienced personnel to operate or service the equipment can result in injury, including death, to themselves and others, and / or damage to the equipment.

(Procedure starts on next page)

Full Power-Up from All Power Sources Off Procedure *(continued)*

1. Complete the Pre-Start Check procedure.
2. If control power had been shutoff:

   Before powering on the power distribution panel (PDP's), ensure the uninterrupted power (line side – above the main disconnect) circuit breaker inside the PDP in placed in the ON position, then close and latch the PDP door.

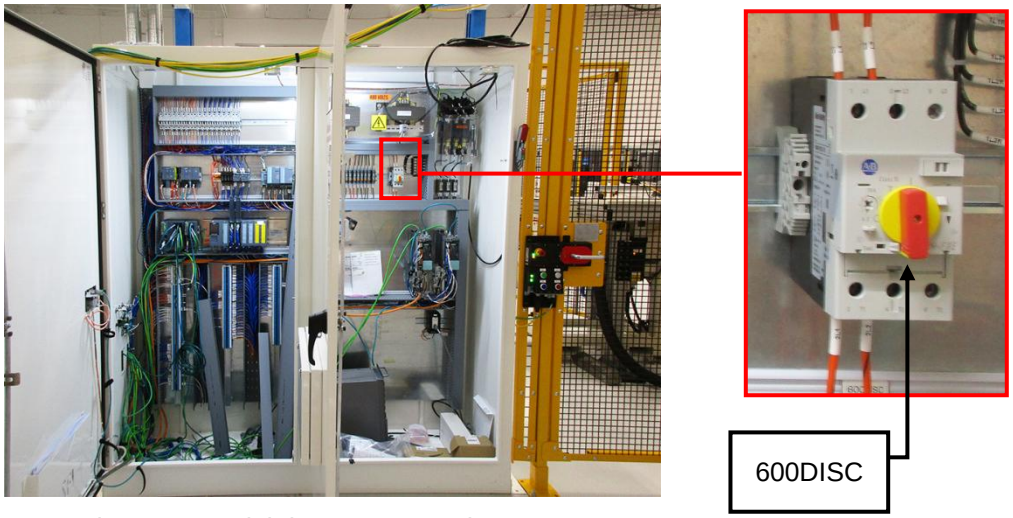


Figure 4-31: Lighting 600DISC Disconnect

3. Power ON the MCP by placing the main power disconnect switch to the ON position..

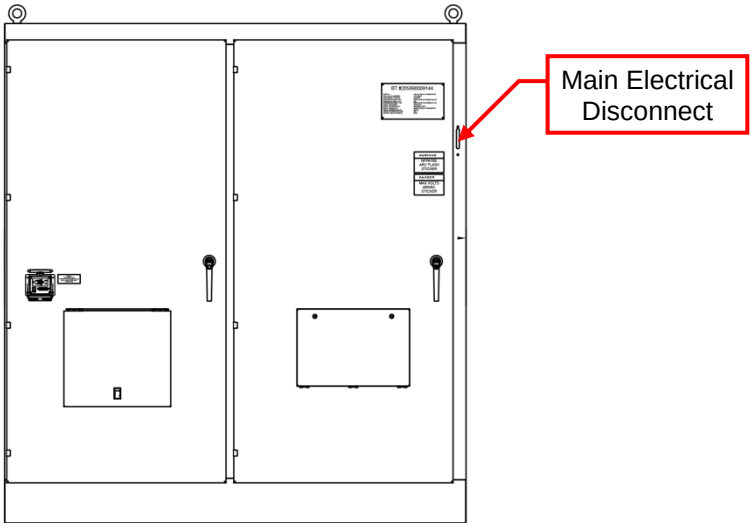


Figure 4-32: Main Disconnect at Station Electrical Panel

The Telesis Laser Marking and Purex Filtration units are powered by 120VAC power out from the station PDP. These units may have been powered off from the PDP and not shut off individually. However verify the following:

4. Telesis Control Panel Computer is ON and software is running.
5. Telesis Marking Laser unit is ON and Laser On indicator light is illuminated.
6. Purex Air Filtration unit is powered on and ready.

Figure 4-33: Telesis Laser Marking Equipment

7. At the System HMI Panel, ensure the Emergency Stop pushbutton is reset.

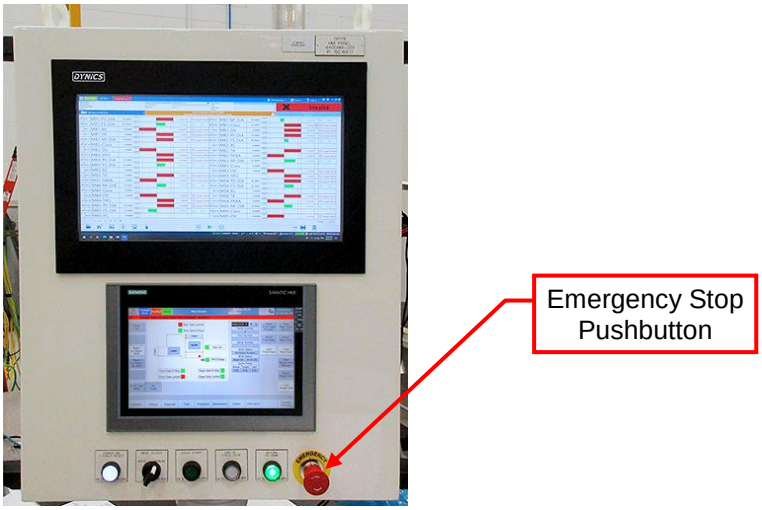


Figure 4-34: Station HMI Panel

8. Access Active Fault Screen to check system status.

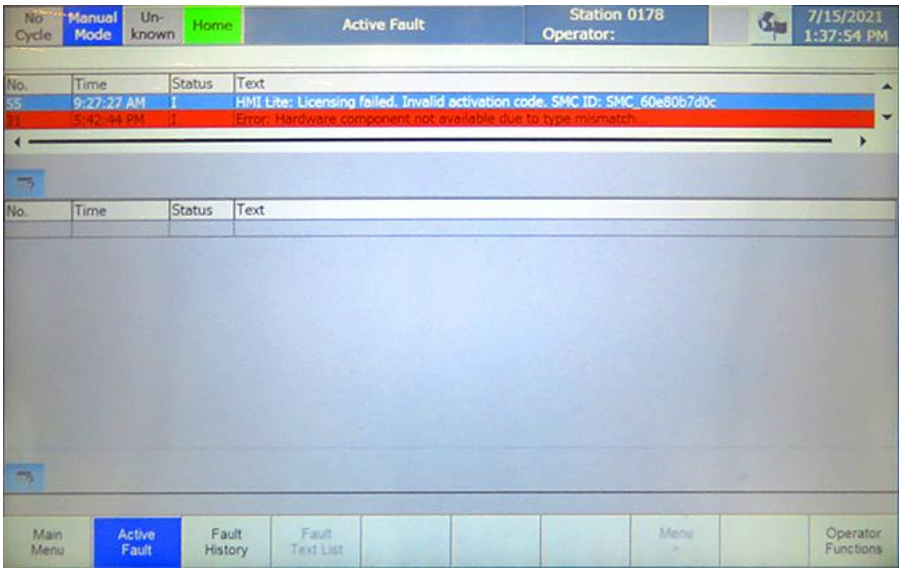


Figure 4-35: HMI Active Fault Screen

9. If any conditions exist to prevent startup, rectify the situation to enable start up.
10. Clear any faults by pressing the POWER ON / FAULT RESET button on the system HMI panel.

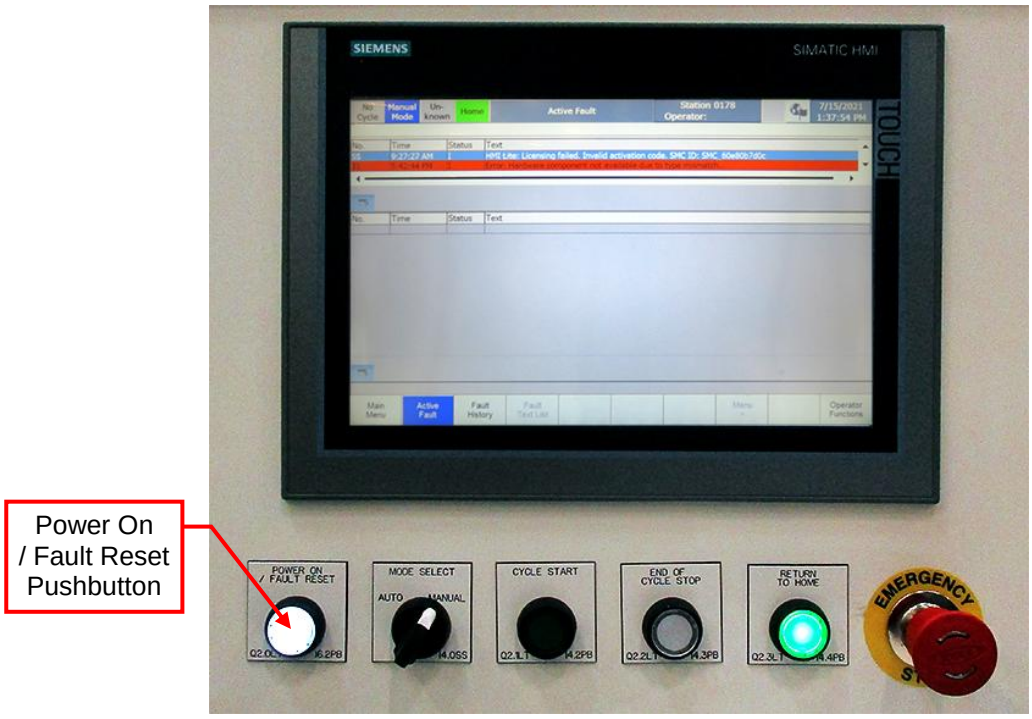


Figure 4-36: HMI Control Panel

4.4.3 Full Power-Up from Next Shift Procedure

1. Reset any E-Stop pushbuttons that may be engaged.
2. Make sure that no one is inside the cell.
3. Rectify any system faults to enable start up.
4. Clear any faults by pressing the POWER ON / FAULT RESET button on the system HMI control panel.
5. Put the system in automatic mode by turning the MODE SELECT two-position switch to the AUTO position on the system HMI control panel.

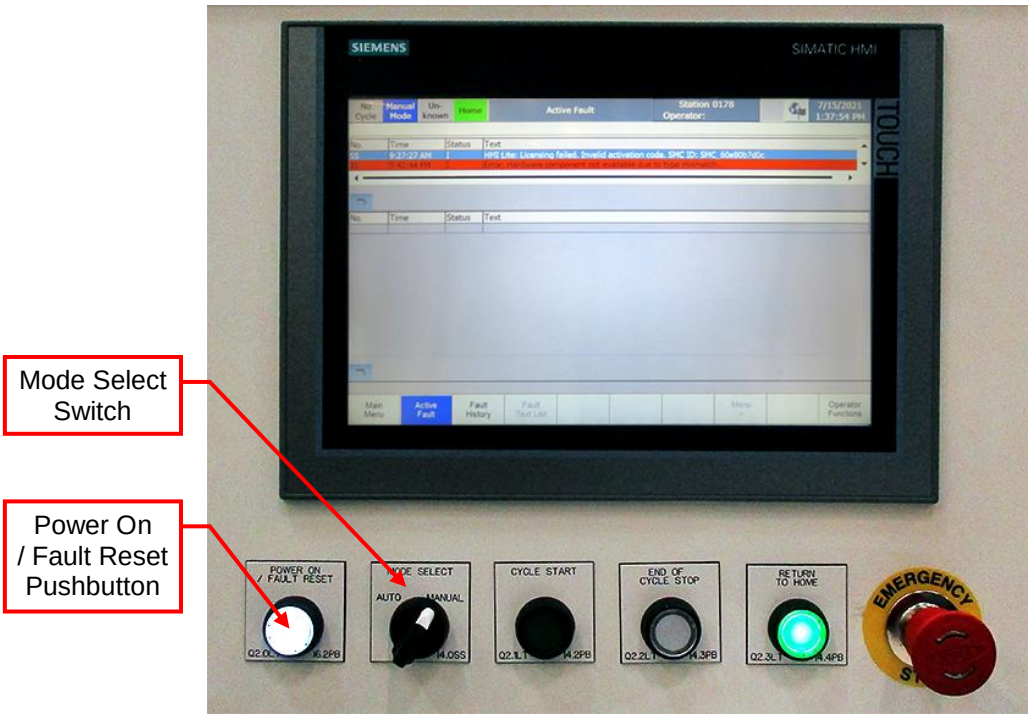


Figure 4-37: HMI Control Panel

4.4.4 Automatic Mode of Operation Procedure

This procedure will assist personnel in placing the Crank Shaft Measuring Machine into Automatic Mode of Operation used for production.

Auto Mode of Operation Procedure

1. At the station HMI control panel, press the POWER ON / FAULT RESET pushbutton to ensure that all faults have been reset and power on the equipment.
2. Place the MODE SELECT two-position switch in the AUTO position to place the system in automatic mode.

Figure 4-38: HMI Screen Auto Mode Indicator

4.4.5 Manual Mode of Operation

Manual mode is not part of normal production and is used to manually control the equipment for the purposes of maintenance or troubleshooting.

WARNING

WARNING

If any maintenance or repair work is to be performed on the equipment, follow all safety and lockout procedures outlined on ECPL placard that is posted on the equipment.

Manual Mode of Operation Procedure

1. At the station HMI control panel, press the POWER ON / FAULT RESET pushbutton to ensure that all faults have been reset and power on the equipment.
2. Place the MODE SELECT two-position switch in the MANUAL position to place the system in manual mode.

Figure 4-39: HMI Screen Manual Mode Indicator

4.4.6 Emergency Stop Procedure

The emergency stop procedure is used to immediately stop all machine motion where applicable to a controlled stop. Used in situations to avert harm to persons, avert damage to the machinery or work in progress.

It is important to know the locations of all the Emergency Stops for the machine and what other items are affected when an E-Stop is activated. The ECPL placard displays the locations of all the e-stops. Know all E-Stop locations ***before*** operating the equipment.

WARNING

WARNING

The emergency stop should never be used as a means of isolating an energy source when performing any type of maintenance or repairs on the equipment. Always perform the proper lockout / tagout procedures as outlined on the ECPL placard that is posted on the zone power distribution panels before entering the cell or performing any work on the equipment.

Procedure:

1. Press in the emergency stop red palm button at machine's HMI to immediately remove motion power from the machine by opening the safety circuit relay.
2. A pressed emergency stop is displayed as a fault on the HMI.
3. If entering the cell is required to investigate the reason for an E-Stop, place a multiple locking device with your personal padlock on the lockable E-Stop pushbutton before opening the safety gate. If more than one person enters the fenced in area, everyone must place their personal padlock on the multiple locking device.
4. If work is required on the equipment, perform all necessary ECPL lockout procedures before posted on the equipment for lockout locations and procedures.

Lockable
E-Stop Pushbutton

4.4.7 Emergency Stop Recovery Procedure

WARNING

WARNING

If you have activated the EMERGENCY STOP button and thereby brought the equipment to a standstill, the EMERGENCY STOP button may only be released (reset) under the following conditions:

- *The reasons for the stop have been eliminated.*
- *A safe restart is possible.*

1. Investigate reason for an emergency stop and rectify any problems before continuing production.
2. If a multiple locking device with your personal padlock was placed on the E-Stop pushbutton, remove your personal lock and multiple locking device.
3. If any energy source lockout procedures were implemented, remove any lockouts placed on the energy sources.
4. Reset the emergency stop pushbutton that was pressed by pulling the red mushroom button out.

Figure 4-40: Emergency Stop (E-Stop) Pushbutton

5. At the HMI panel, press the white POWER ON / FAULT RESET pushbutton.

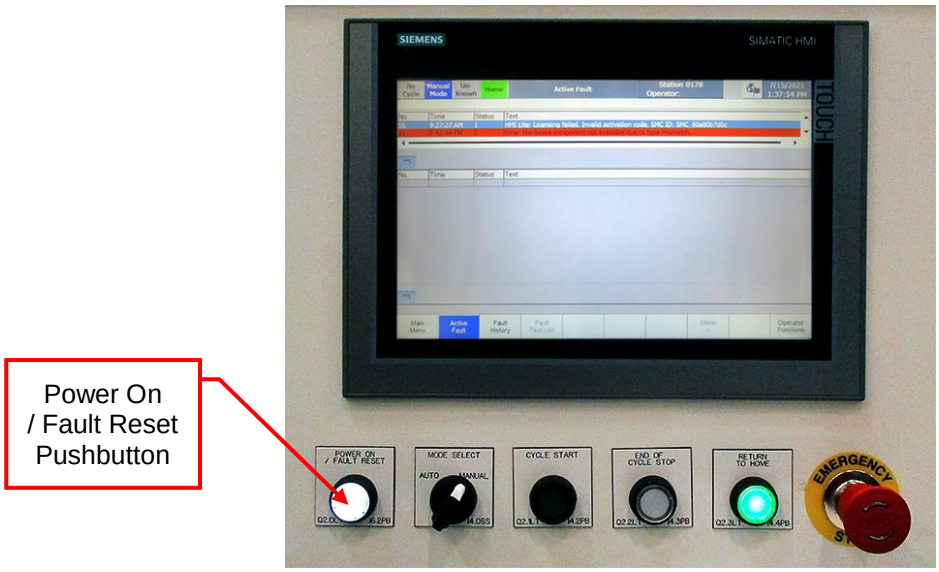


Figure 4-41: Power On / Fault Reset Pushbutton

6. At the safety gate switches, press the blue FAULT RESET pushbutton to reset the safety circuit.

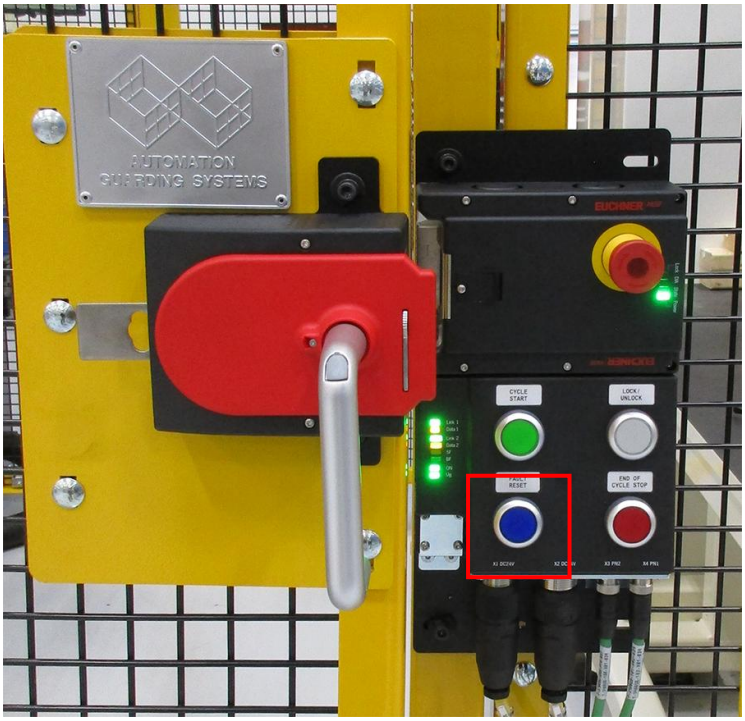


Figure 4-42: Safety Gate Interlock Fault Reset Pushbutton

4.4.8 Fault Recovery Procedure

1. Access the Active Fault screen to display the active alarms (faults) and warnings for the machine. This screen displays all active station alarms.

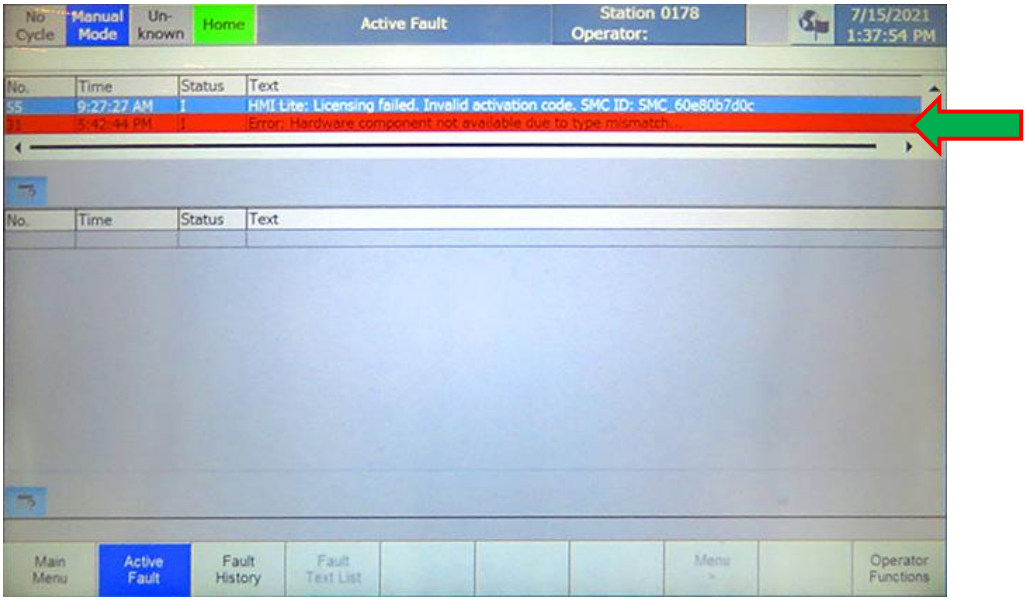


Figure 4-43: HMI Active Fault Screen

2. Diagnose and rectify the fault.

WARNING

WARNING

If rectifying a fault requires entry into a guarded area, follow all Access or Master Lockout / Tagout procedures before entering into the guarded area to perform work on the equipment. Failure to observe this precaution may result in death, severe injuries or considerable damage to property.

3. After the fault or warning is diagnosed and rectified, the fault can be cleared and the safety circuits reset by pressing the POWER ON / FAULT RESET pushbutton on the system HMI control panel. The cleared fault will be sent and displayed on the fault log.

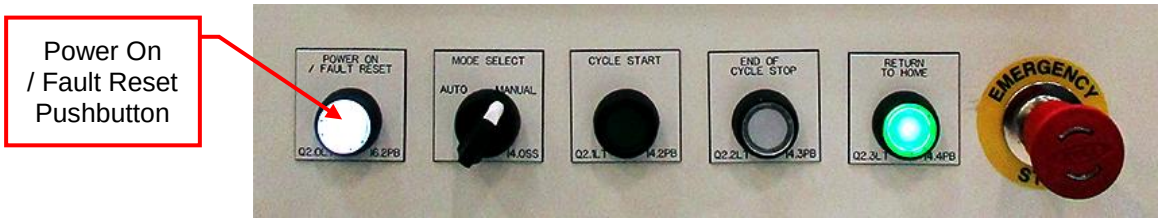


Figure 4-44: Power On / Fault Reset Pushbutton

4.4.9 Power Down Procedure

For daily / weekend shutdowns, the power can remain on.

1. Prior to shut down, runout the cell. After all the crank shafts have stopped, the cell can be shutdown without affecting quality of parts that may be in process.
2. At the HMI control panel, turn the Mode Select two-position switch to the Manual position to place the system in manual mode.

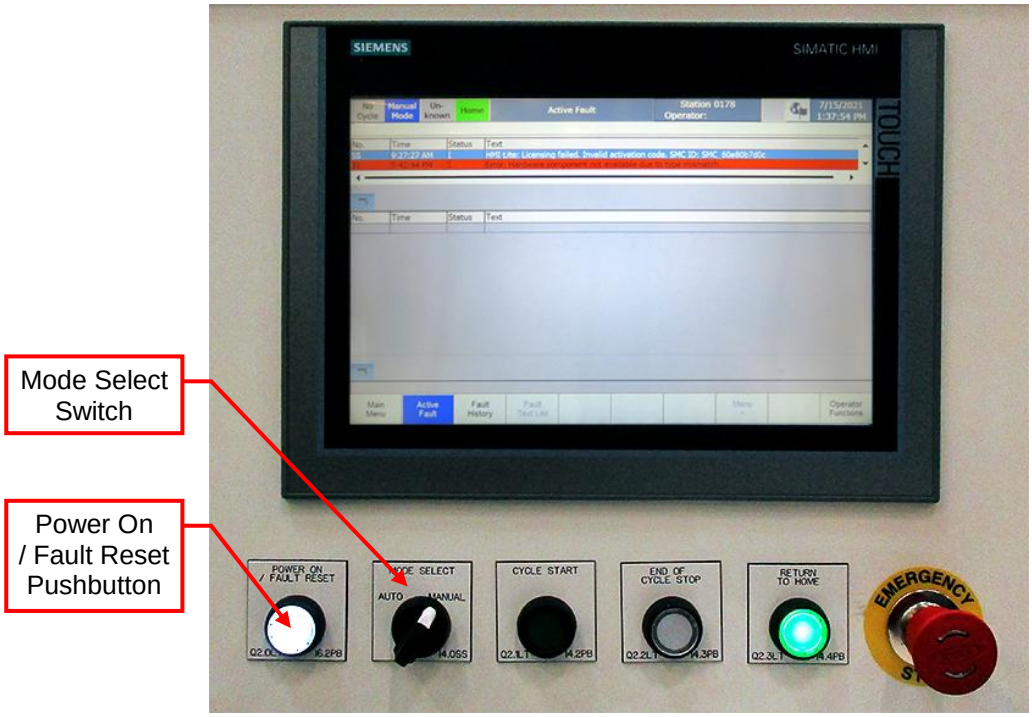


Figure 4-45: HMI Control Panel

Note:

Follow step 3 only if the cell is to be shut down for maintenance purposes:

3. Power off and lockout the machine following the procedures outlined on the Master ECPL placard.

4.4.10 Safety Gate Entry Procedure

The following procedure is used to safely open a safety gate and lockout the gate safety switch before entering into the danger area of the machine. This procedure assumes the machine is currently cycling in automatic mode.

1. Press the red END OF CYCLE STOP pushbutton on the safety gate box. The automatic cycle will stop production at the end of the current cycle.

Figure 4-46: Safety Gate Interlock End Of Cycle Stop Pushbutton

2. Once the cycle has ended, press the white LOCK / UNLOCK pushbutton on the safety gate box.

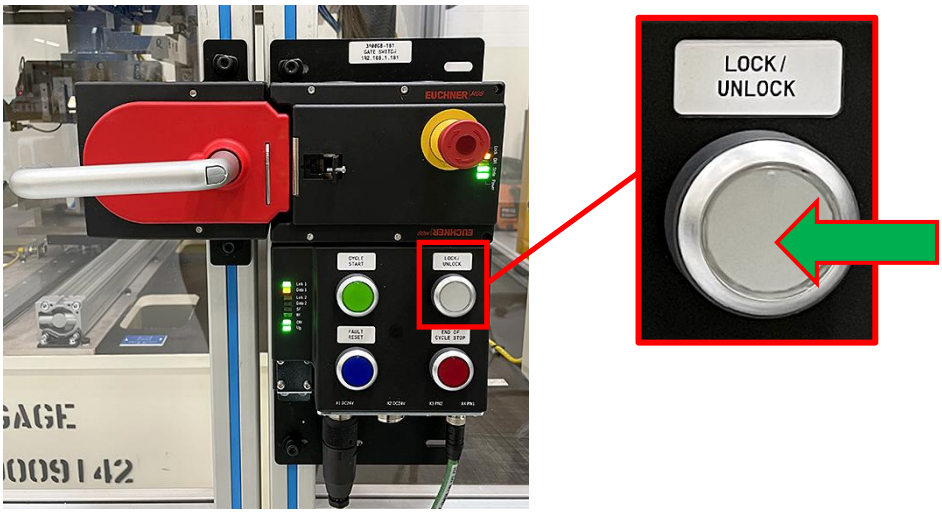


Figure 4-47: Safety Gate Interlock Lock / Unlock Pushbutton

3. When permission to access has been granted by the system, the LOCK / UNLOCK will transition from flashing to solid.

4. Turn the handle downward to open the safety gate and gain access to the cell.

Figure 4-48: Safety Gate Interlock Handle
(Left Hand shown, Right Hand similar)

5. Leave the cell, close the gate, and engage the handle by rotating upward. Press the LOCK / UNLOCK pushbutton on the safety gate box to relock the gate.

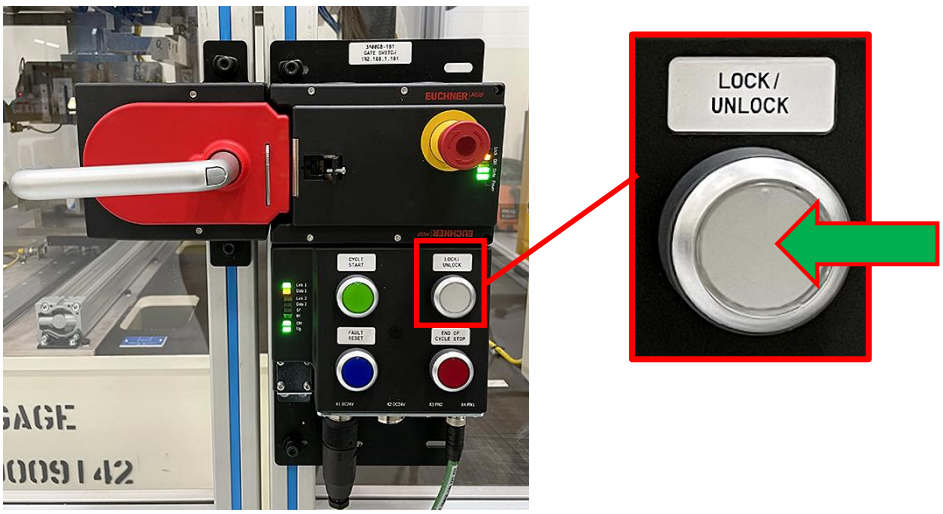


Figure 4-49: Safety Gate Interlock Lock / Unlock Pushbutton

6. Press the FAULT RESET pushbutton on the safety gate box to reset the safety circuits.

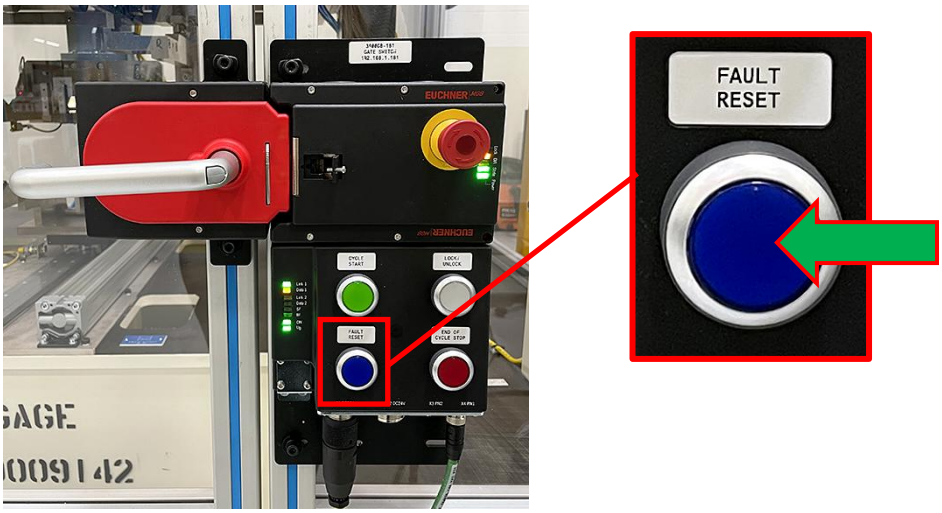


Figure 4-50: Safety Gate Interlock Fault Reset Pushbutton

7. Press the CYCLE START pushbutton on the safety gate box to return production to automatic cycle.

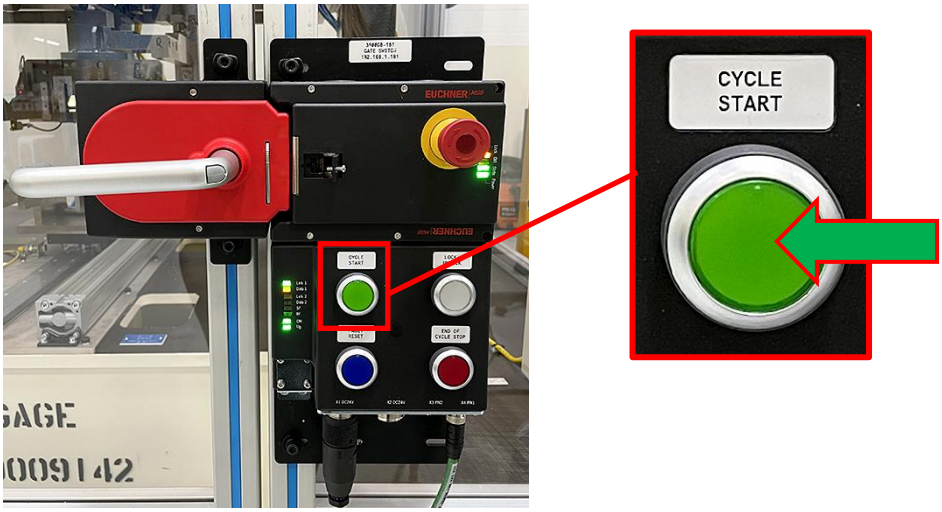


Figure 4-51: Safety Gate Interlock Cycle Start Pushbutton

4.4.11 Mastering Calibration Procedure

For calibration, the power must remain on.

1. Prior to calibration, runout the cell. After all the crank shafts have exited, the station can run a calibration Mastering cycle.
2. At the HMI, place the machine in Manual mode using the two-position selector switch.

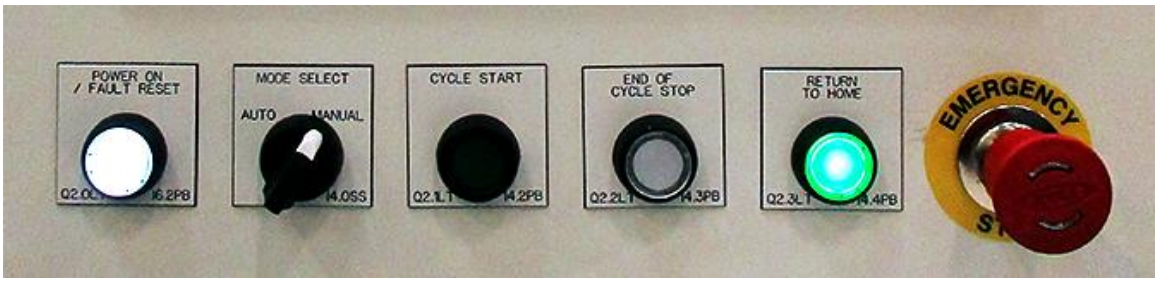


Figure 4-52: HMI Control Panel

3. If the correct Setting Master is not installed, at the HMI, access the Cycle Type screen.

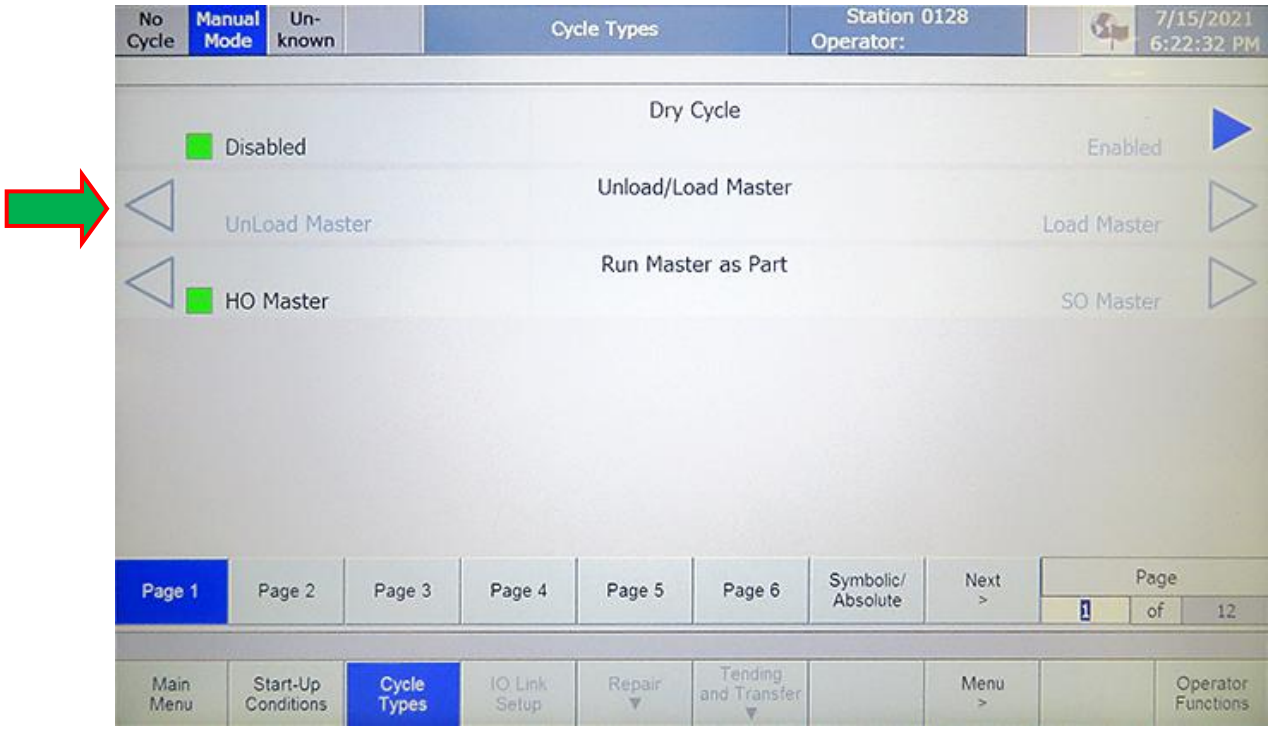


Figure 4-53: Cycle Type Screen - Unload Master (Typical shown)

4. Press the Unload Master function actuation button on the left side of the screen. The station will unload the installed Master automatically.

5. Unlock and open the gate to access the station Setting Master Supply using the *Safety Gate Entry Procedure*.
6. Carefully remove the Master from the Admission Workpiece support and place it into its storage case.
7. Obtain the Setting Master (SO or HO) from its storage case and carefully load it onto the Admission Workpiece Support.

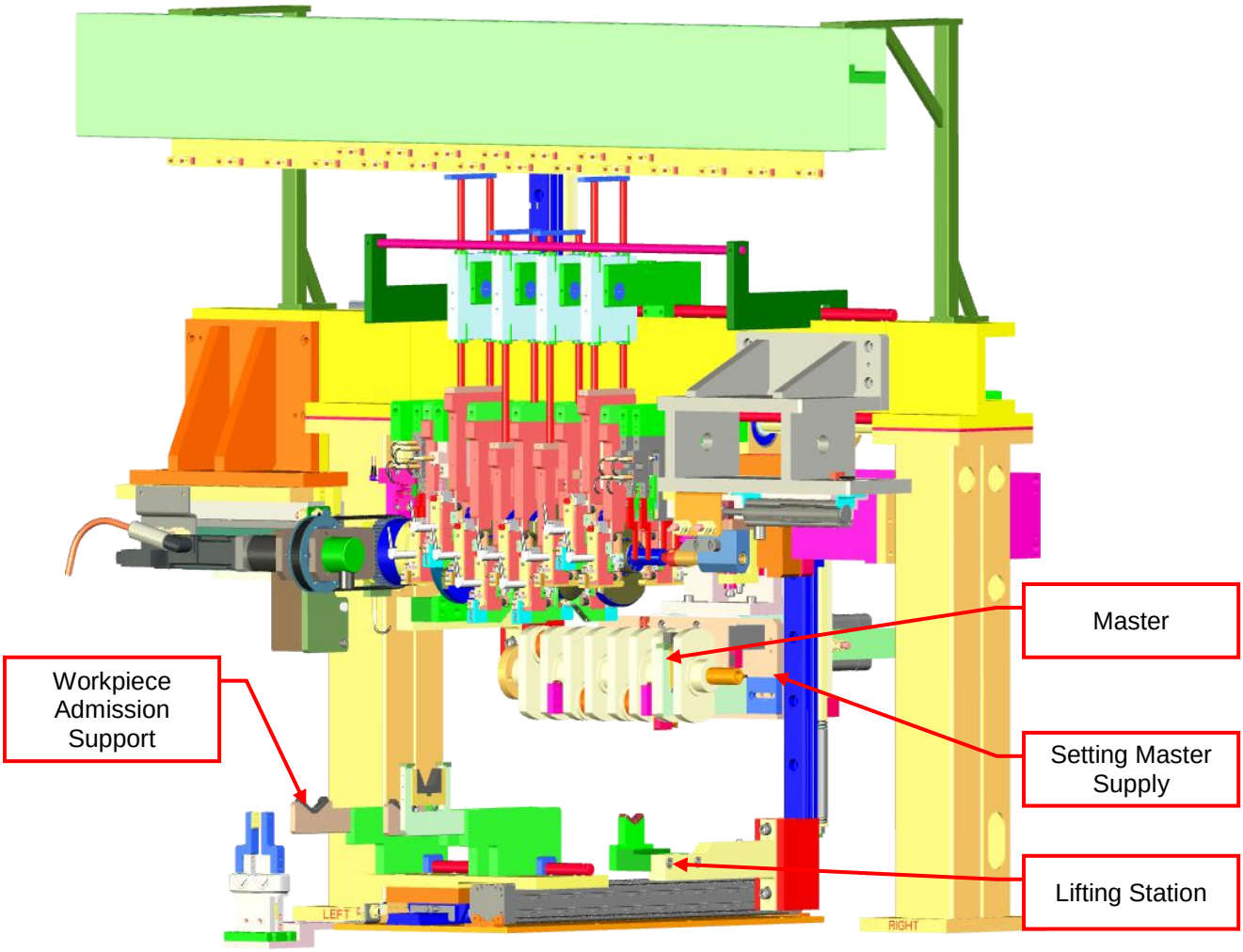


Figure 4-54: OP178 Measuring Station Mastering Components

8. Close and lock the access gate to access the station Setting Master Supply.
9. At either the Safety Gate Interlock Box or the HMI Control Panel, press the Fault Reset pushbutton if any faults are present.

10. At the HMI, access the Cycle Type screen.

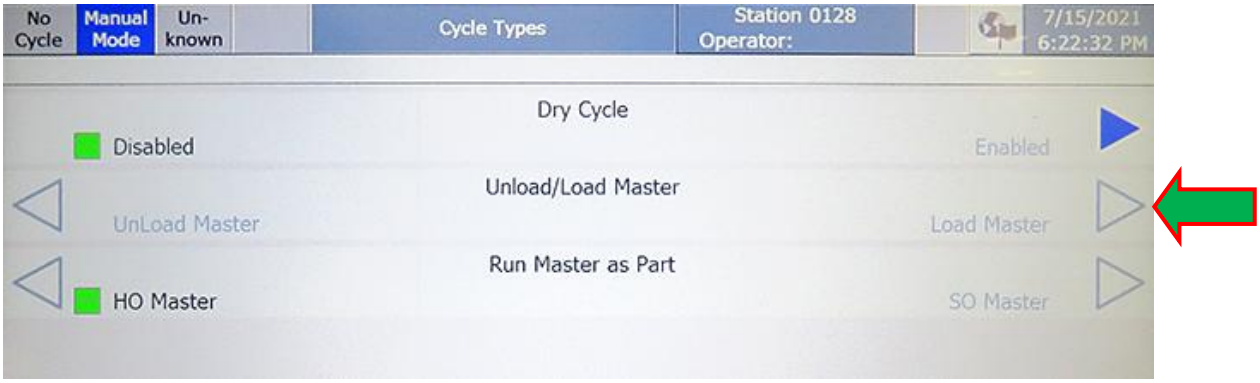


Figure 4-55: Cycle Type Screen - Load Master (Typical shown)

11. On the right side of the Unload/Load Master function, press the Load Master function actuation button. The Admission indexes in to allow the Lifting Station to acquire the Master and raise it into position to transfer to the Setting Master Supply support.
12. Once the Master is in place, press the Run Master as Part function for the Master type loaded (HO or SO).

Figure 4-56: Cycle Type Screen - Run Master as Part (Typical shown)

13. The Setting Master Supply will index out to allow the Lifting Station to raise the Master to the measuring position, the Headstock and Tailstock will index to the Master, the Lifting Station lowers and the Master will rotate in the fixture while the system performs the calibration.

    The results can be observed on the Dynic screen.
14. When the mastering cycle is complete, the Master is returned to the Setting Master Supply home position.

NOTES

SECTION 5
PREVENTIVE MAINTENANCE INSTRUCTIONS

Table of Contents

Table of Figures

5.1 INTRODUCTION

This chapter discusses periodic inspection and adjustment tasks, which are necessary to maintain the equipment with the highest reliability.

Sample tables of general preventive maintenance requirements have been included in the chapter for reference purposes. The tables are intended as a guideline and should not replace periodic maintenance schedules derived in the plant.

CAUTION

CAUTION
Before performing maintenance procedures, follow posted Lockout Procedures.

5.2 OVERVIEW

All machine parts wear with use. This wear usually results in a gradual increase of out of tolerance conditions rather than sudden equipment failure. Preventive Maintenance (PM) must be performed on a regular basis to keep the equipment operating at peak efficiency.

An established PM program is important because it results in increased reliability and longer equipment life. Such a program also results in the consistent manufacture of higher quality parts.

The following information is provided to aid the maintenance personnel in maintaining and repairing the equipment.

5.3 GENERAL SAFETY PRECAUTIONS

When working around moving components, use caution as these devices could be activated without warning. Always lock out energy sources. Do not re-start the machinery until the entire system has been checked, all guards are in place, all gates closed and locked, and all personnel are informed of start-up!

Maintenance Personnel should be familiar with equipment safety features prior to any maintenance action.

Ensure that all power is removed and locked out prior to any maintenance action.

WARNING

WARNING

Follow ECPL before removing guarding to work on the system.

Never operate this machine unless all guarding is in place and undamaged.

Ensure that guarding is handled properly. When servicing machine, ensure guarding is placed in a safe place, away from moving parts.

Disregarding these safety precautions can result in machine damage, injury or death.

If any safety device tests fail, stop the system immediately, lockout the disconnect switch, and notify your supervisor to have the problem corrected.

Before attempting any troubleshooting procedures, ensure machine is taken out of automatic mode at the HMI. Equipment left in automatic mode is dangerous, especially if the system stopped during an automatic sequence.

When the equipment shuts down because of a fault, do not perform any maintenance until the equipment is first properly locked out.

5.3.1 Maintaining Safety Features

Failure to properly operate and maintain the cells safety features will increase risk of injury to the operator and all other persons adjacent to the machine.

Access to the cell components is limited due to fencing, guarding, etc. As such, special precautions must be taken when gaining entry into the cell to access the equipment to perform maintenance or repairs.

- Remove guarding only when absolutely necessary.
- Replace all guarding completely before returning machine to production.
- Repair or replace any defects in the safety device before restarting machine.
- Never defeat safety devices and guards.

WARNING

WARNING

Follow ECPL before removing guarding to work on the system.

Never operate this machine unless all guarding is in place and undamaged.

Ensure that guarding is handled properly. When servicing machine, ensure guarding is placed in a safe place, away from moving parts.

Disregarding these safety precautions can result in machine damage, injury or death.

5.4 GENERAL MAINTENANCE SAFETY

Some general maintenance safety precautions are outlined below. The procedures are intended as a guideline and should not replace maintenance safety standards derived in the plant.

5.4.1 Mechanical Maintenance Safety Precautions

- Mechanical maintenance, adjustments, and repairs should be performed only by qualified technicians familiar with the system.
- If mechanical service does not require the station to be powered up, disconnect and dissipate all energy sources by performing the appropriate lockout / tagout procedures.
- Maintenance work will not be performed until the hazardous energy to which employees may be exposed is controlled.
- Vertical or inclined sliding members should be properly blocked. Use of safety pins (where provided) to mechanically disable machine motions is required.
- All moving machinery components, as well as their surrounding areas should be kept free of tools, rags, dirt, and excessive oil.
- When guards are removed for repair work, they should be properly re-installed as soon as the work is completed. Prior to operating any machinery all protective guards and covers must be in position.
- For troubleshooting, it may be necessary to leave the power **“ON”**. Always be aware of hazardous energy sources.

5.4.2 Electrical Maintenance Safety Precautions

- Electrical system maintenance should be performed only by qualified electrical technicians familiar with the system using the latest up-to-date electrical controls drawings.
- A qualified electrician should be present when the electrical control panels are opened to perform checks and required repairs.
- Before performing maintenance or service on any part of the electrical system, perform all applicable lockout / tagout procedures. Before proceeding, verify that power is removed from all circuits.
- Maintenance work will not be performed until the hazardous energy to which employees may be exposed is controlled. This prevents the system from being powered on or re-started unexpectedly.
- A preliminary test should be conducted to confirm that no voltage is present before working on any circuit.
- Use only specified regulation fuses and never improvise for the replacement of fuses. Use approved fuse pullers when replacing the fuses.
- For troubleshooting, it may be necessary to leave the power "**ON"**. Always be aware of hazardous energy sources.
- Keep all moving parts of machinery and surrounding areas free of tools, rags, dirt, and oil. Clean up any spills immediately to prevent slip hazards.
- Before operating any moving machinery after maintenance is performed, all protective guards must be in place, all panel doors are closed and secured, and all safety gates are closed and secured.

5.4.3 Pneumatic Maintenance Safety Precautions

- Pneumatic system maintenance should be performed only by qualified technicians familiar with the system.
- Before performing maintenance or service on any parts of the Pneumatic System, shut off the air supply at the main shutoff valve and bleed air from pneumatic lines. Perform all applicable lockout / tagout procedures.
- While moving a pneumatic lockout valve to the off position, beware that high pressure and contaminates in the circuit will expel from the valve into a silencer/muffler to relieve pressure in that circuit.
- Trapped air may exist in air circuits between a 3-position control valves (with all ports blocked in the center position) and the air cylinder. Trapped air may also exist in air circuits between a check valve and the air cylinder. Check the pneumatic drawings provided for any trapped air circuits. Relieve pressure in any trapped air circuits prior to working on the pneumatic equipment.
- Use extreme caution around automation (such as slides, clamps, dumps, or lifts) that may move when air is relieved from the station. Before relieving air from lines, secure all such automation. Use safety pins where provided.
- If the operating pressure is set too low, insufficient force may be developed at the pneumatic actuator. Operating pressures that are set too high will cause excessive force at the actuator and may damage the machinery or pneumatic components.
- For troubleshooting, it may be necessary to leave the power "**ON"**. Always be aware of hazardous energy sources.
- Keep all moving parts of machinery and surrounding areas free of tools, rags, dirt, and oil. Clean up any spills immediately to prevent slip hazards.
- Before operating any moving machinery after maintenance is performed, all protective guards must be in place, all panel doors are closed and secured, and all safety gates are closed and secured.

5.5 GENERAL PREVENTIVE MAINTENANCE TASKS

The tasks are intended as a guideline and should not replace periodic maintenance schedules derived in the plant. Note: Not all of the following general guidelines will apply to your equipment.

5.5.1 General Mechanical PM Tasks

- Verify all covers and doors are closed and secure.
  Guards, shields, and other mechanical safety devices: Ensure all safety devices are properly installed and fully functional.
- Check all limit switches for looseness, wear or malfunction.
- Check all hoses, piping, cylinders, valves, fittings, mufflers, and gauges for damage, wear or leaks.
- Bearings, couplings; Check for excessive wear, noise, heat, vibration, binding or out of position. If fitted with grease fittings, grease and/or lubricate.
- Check all rough locators and locating pins for wear or damage. Look for loose bolts, missing shims, and bent or distorted details. Verify that all part locators are in correct alignment and that the parts are being located correctly.
- Check all slide unit port seals for wear or damage. Replace as needed.
- Inspect shot pins for wear and replace if needed.
- Check rest pads for wear, loose bolts and fasteners. Make sure that part makes even contact on the rest pad surface. Clean blocks of debris and other foreign parts.
- Part clamping fixtures: Verify clamping fixture is clear of debris. Verify that all part clamping units are in correct alignment and that the parts are being clamped correctly.
- Clamping parts: Check for loose or missing shims on clamping details, check side plates for loose fasteners, wear and cracks. Check clamps for alignment side play and bushing wear.
- Check metal (part) clearance to clamps and adjust as required.
  Check clamping cycles for timing with part.
- Clean and inspect linear rails and carriages. Check for unusual wear patterns on the rails. Ensure rails are operating smoothly and are getting proper lubrication.
- Check for loose fasteners. Ensure the match marks on fasteners are still aligned. For misaligned marks, retightened to specifications and use paint markers to remark.

5.5.2 General Electrical PM Tasks

- Perform function test to verify gate safety switches are functioning properly.
- Check all emergency stop push buttons for function and indicator lamp illumination. Repair or replace non-functioning push buttons and lamps.
- Check all indicator lights on the electrical panels for burned out light bulbs.
- Check electrical panel for spare fuses and I/O fuses. Make sure they are not blown.
- Check terminals and connectors for looseness or signs of overheating. If there is evidence of overheating, termination points should be cleaned or replaced.
- Limit switches: Check for proper trip position, location and operation.
- Proximity switches: Check for presence of debris on unit. Clean proximity switches as needed to maintain system uptime. Check for loose connections and damaged housings. Tighten where needed and replace unit if defective.
- Wiring: Check for broken, loose, and damaged wires. Check all electrical cables for signs of damage and make sure all connections are tight and secure.
- If fitted, inspect light curtains interconnecting electrical and data cables for evidence of wear or damage. Replace if necessary. Clean the lenses using a clean soft cloth moistened with 70-100% isopropyl alcohol or an equivalent non-abrasive glass cleaner.
- Electrical enclosures: Wipe and clean the inside of the main electrical enclosures. Check for obvious signs of damage and repair as necessary.
- Disconnect assembly: Verify the disconnect function. Check for loose, bent, or broken components.
- Circuit breakers: Inspect for loose or broken terminals. Check for the presence of contaminants like dirt, dust, grease, or rust. Remove dust, dirt, soot, grease, or moisture from the surface of the circuit breaker using a lint-free dry cloth, brush, or vacuum cleaner. If contamination is found, look for the source and eliminate the problem.
- Power distribution blocks: Verify blocks are tight and free of corrosion. Check for presence of contaminants like: dirt, dust, grease, or rust.
- PLC and power supply units: Inspect for loose or broken terminals. Check for the presence of contaminants like dirt, dust, grease, or rust. Replace as required.
- Pushbutton bases: Check the wiring insulation for heat damage, small cracks, brittleness, or sections of missing insulation. Check for oil or chemical exposure, swelling or loose terminals.
- Contact relays: Check for broken or shading coils, dirty magnet faces, and loose terminals. During operation, verify no excessive arcing is present. Replace if damaged.
- Servo motors: Inspect servo motor for damage or overheating. Verify the motor power and feedback connectors are tight. Check for any signs of impact on the outer shaft that may

indicate damage to the bearings. Blower vents on motor must be kept clear for air circulation, clean any accumulated dirt.

- Check that all cables, terminals, and connectors are clean, undamaged, and tightly seated.
- Check all electrical cables and connections for signs of damage or deterioration and make sure all connections are tight and secure.
- Check contacts for wear. Contacts should be replaced when silver has become badly worn. Always replace contacts in complete sets to avoid misalignment and uneven contact pressure.

5.5.3 General Pneumatic System PM Tasks

- Check lines, hoses, and fittings: Check for leaks, loose fittings, and damaged or kinked lines. Replace if necessary.
- Drain drip leg.
- Check condition of air filter to see if the filter needs changing. Change filter if necessary. Drain any accumulated condensation in the filter bowls if not fitted with automatic drain.
- Pressure regulator: Verify the regulator valve is functioning properly.
- Pressure regulator: Check for correct pressure settings. Adjust according to tag setting.
- Inspect hoses and tubing for leakage due to cracks and loose fittings.
- Inspect fittings and couplings for looseness resulting from machine vibration.
- Manifolds: Check for leaks, loose manifold fittings, and broken or kinked lines. Replace or repair as required.
- Directional valves: Verify the valves are operational. Increase or decrease pressure according to values on tags and gauges.
- Cylinders: Verify seals on cylinders for leaks and inspect the cylinder rod for scoring.
- Flow controls: Inspect flow controls for proper settings, leaks and for proper operation.
- Silencers (Mufflers): Check filter element cartridge for dirt, metal chips, and other contaminates. Replace element cartridge if necessary.
- Pressure switches: Verify the switch is operating to set points. Verify the pressure readings comply with the tags and adjust pressure if necessary.
- Inspect regulators and flow controls for proper pressure settings, leaks and for proper operation.
- Clean and inspect air cylinder magnetic reed switches mountings for security and proper placement. Check wiring for looseness, tighten or align if necessary.
- Check and inspect all pneumatic cylinders, pneumatic manifolds and valves for wear, leaks or other signs of deterioration.

5.6 LOCKOUT BEFORE PERFORMING MAINTENANCE TASKS

Safety Lockouts are a set of safety standards used to describe all potential hazards and energy sources associated with a machine. These hazards include all electrical energy (i.e., motors, switches) as well as any stored energy (i.e., pneumatic pressure, hydraulic pressure, water pressure, mechanical gravity devices). Using Lockout standards, operating and maintenance work on the machine and associated mechanical devices can be performed in a safe manner.

Energy Control and Power Lockout (ECPL) placards identify the primary, associated, and stored energy or power sources of the system. The ECPL placard(s) are located on the Station main power distribution panels (PDP). Color-coded lockout tags corresponding to the source icons (such as A, B, C, etc) on the placard help locate the same sources on the machine. These tags are mounted near, or hanging directly on, the energy and power source locations.

The Energy Control Power Lockout (ECPL) placard assists authorized personnel in identifying the following:

- Symbol used to identify Lockout energy isolation point.
- Lockout point Location / Description.
- Types of Energy Source.
- Methods of Operation to lockout isolate and control hazardous energy.
- The Verification Method to use to check Lockout was completed.

The placard consists of a graphic plan view of the cell with the location of the energy isolation points, the action to isolate the energy. The Lockout placards are posted on the equipment in a location that is easily accessible to the operating and maintenance personnel, typically on the main electrical panel door.

- ALWAYS follow the instructions on the sign(s) POSTED ON THE EQUIPMENT for proper Lockout before performing any maintenance or repairs.
- If more than one person is to perform work on the equipment, each employee must place his / her personal safety lock on the safety gate or energy source using a multiple lock device (scissor lock).
- Consult the placard lockout procedures posted on the equipment before performing any maintenance or repair task. No person should begin maintenance repairs until the proper LOCKOUT procedures are completed. The employee should contact his/her immediate supervisor if there are any questions about the identification of potential energy sources.
- When service or maintenance is to be conducted, equipment must be put in the OFF position via energy isolating devices such as electrical disconnects and valves.
- Before shutting down the equipment to Lockout energy sources, the employee performing the procedure or the supervisor shall inform affected employees of the intention to shut down the equipment.

5.7 PREVENTIVE MAINTENANCE TASKS

Refer to the A.M. Calendar for this machine for further information and proper documenting of scheduled maintenance.

5.7.1 Safety and Cleaning

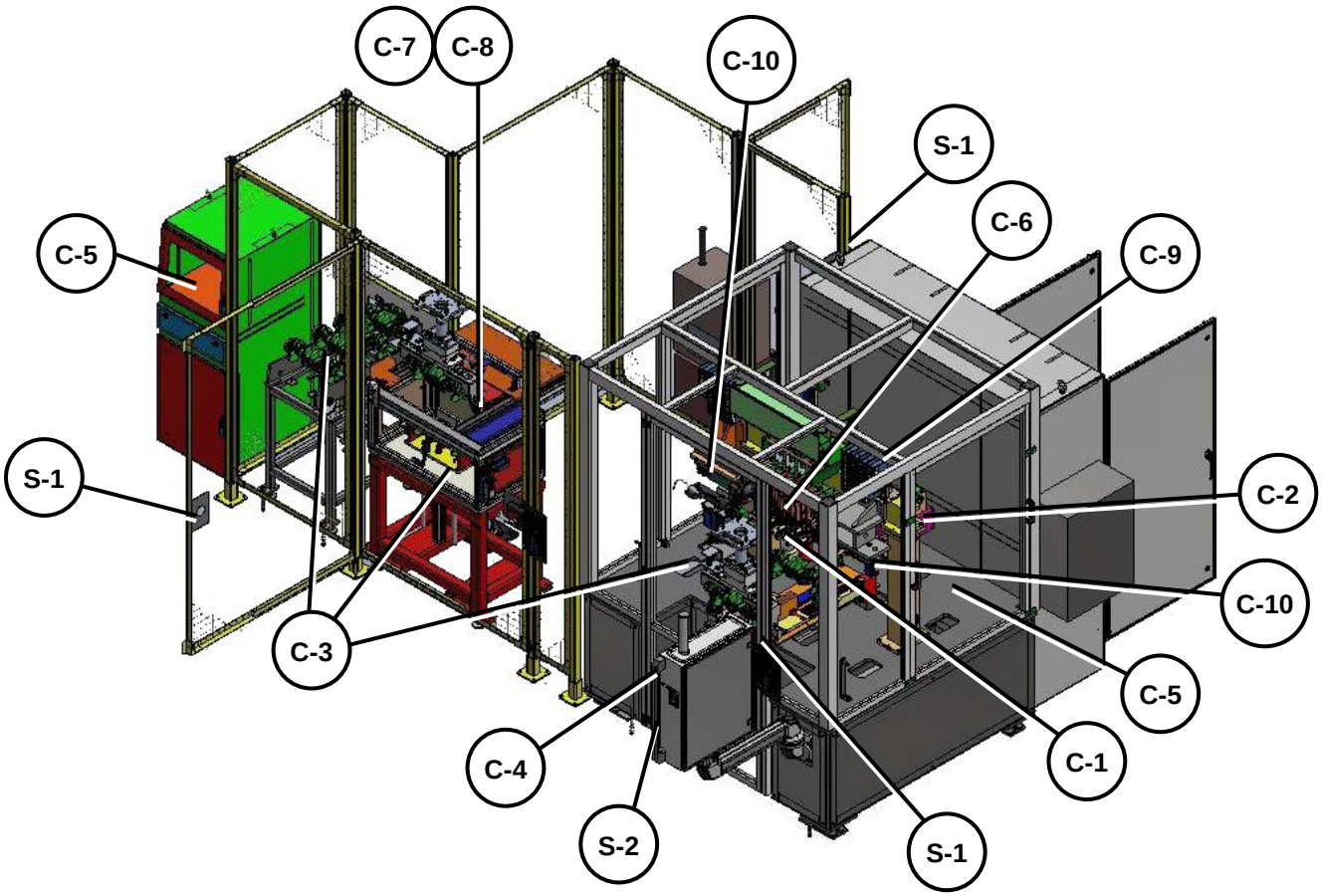


Figure 5-1: Crank Shaft Measuring Machine Station Layout

Activity	Description	Type (S or C)	Duration (mins)	Frequency (D, W, M, S-A, A)
Machine	Verify guards and interlocks are in place and properly secured.	S-1	2	Daily
Machine	Verify that all E-Stop pushbuttons operate properly.	S-2	2	Daily
Fixture	Visually inspect measuring pieces, and if necessary, clean them.	C-1	3	Daily
Fixture	Clean the setting masters.	C-2	2	Daily

Activity	Description	Type (S or C)	Duration (mins)	Frequency (D, W, M, S-A, A)
Machine	Clean all sensors and proximity switches (with damp cloth, then wipe with lint-free rag).	C-3	3	Daily
Machine	Clean the HMI and Dynics screens with a lint-free cloth.	C-4	1	Daily
Machine	Wipe down exterior machine of prints and streaks.	C-5	5	Daily
Fixture	Clean the sampling points on the measuring element with a small clean brush. Ethanol can be used as a detergent.	C-6	5	Weekly
Laser	Clean and inspect the F-Theta lens using compressed air.	C-7	5	Weekly
Laser	Clean the cover of the laser marking head with a lint-free cloth and a mild detergent.	C-8	5	Monthly
Fixture	Clean linear rails at the swivel bearing with a clean soft rag.	C-9	4	Semi-Annually
Fixture	Clean linear rails at the headstock and tailstock with a clean soft rag.	C-10	8	Semi-Annually

5.7.2 Inspection and Lubrication

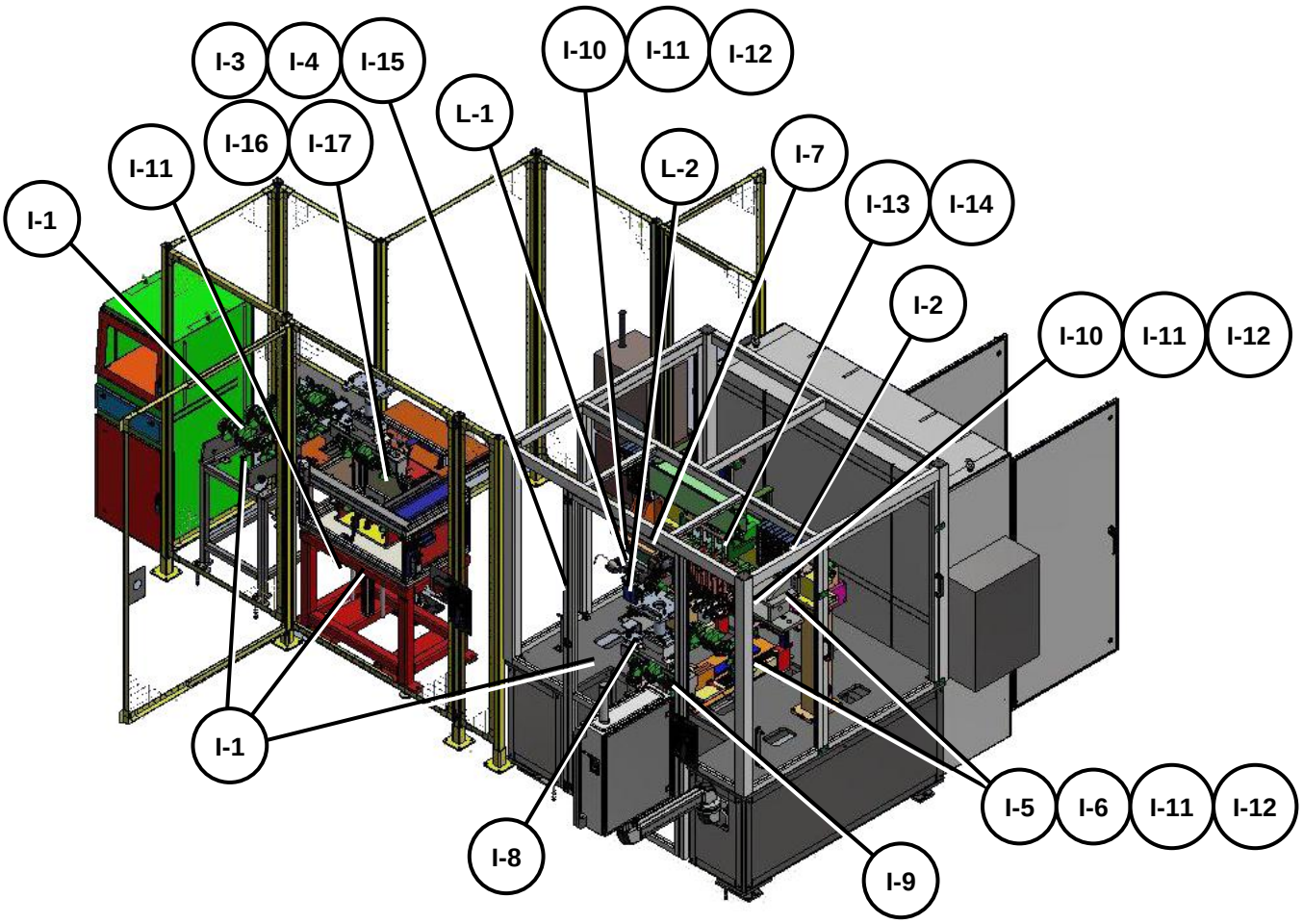


Figure 5-2: Crank Shaft Measuring Machine Station Layout

Activity	Description	Type (I or L)	Duration (mins)	Frequency (D, W, M, S-A, A)
Machine	Inspect all sensors and proximity switches for loose or damaged connections.	I-1	3	Daily
Pneumatic	Check all hoses lines, fittings, cables and pneumatic elements for correct fit (also verify that hoses are properly secured).	I-2	3	Daily
Pneumatic	Visually inspect the filter/regulator (set to 60 psi (.41 MPa).	I-3	2	Daily
Pneumatic	Visually inspect the advance probe cylinder precision regulator (set to 35 psi (.24 MPa).	I-4	3	Daily

Fixture	Visually inspect shock absorbers while machine is running, making sure there is not a hard hit.	I-5	2	Daily
Fixture	Visually inspect slide horizontal and vertical slide units, making sure there are no pits or damage, as well as a film of lubrication exists.	I-6	3	Daily
Fixture	Visually inspect the synchronous belt for any wear, cuts, missing teeth or other damage as well as looseness.	I-7	2	Daily
Fixture	Visually inspect the SKF lubrication unit to ensure that the oil level is between the minimum and maximum markers.	L-1	2	Daily
Fixture	Visually inspect the gear motor oil level and top off if necessary.	L-2	2	Daily
Fixture	Visually inspect the gripper jaws for any broken, worn, or missing details.	I-8	2	Weekly
Fixture	Visually inspect prism and prism covers for wear or damage, and verify that both springs exist and are not worn. Clean surface with a soft rag.	I-9	2	Weekly
Fixture	Visually inspect the head and tailstock for excessive wear, damage, looseness or missing details.	I-10	2	Weekly
Fixture	Inspect all pneumatic cylinders for misalignment, and coupling damage.	I-11	3	Weekly
Machine	While the machine is running, listen for any unusual noise, such as worn bearings or slides not being lubricated.	I-12	5	Weekly
Fixture	Visually inspect the contact pins and locators on the measuring gantry setup and make sure they are not loose or damage.	I-13	2	Weekly
Fixture	Visually inspect the curve rollers for uniformity and wear traces (matte surface). Check all key sets and measuring pieces for wear.	I-14	4	Weekly
Pneumatic	Visually inspect the advance Heidenhain probes precision regulator (set to 26 psi (.18 MPa).	I-15	3	Weekly
Laser	Inspect the fume extraction system hoses and filters and replace if necessary.	I-16	3	Monthly
Laser	Inspect all fiber and external cables for damage, looseness, or kinks and repair if necessary.	I-17	3	Annually

NOTES

SECTION 6
GENERAL MAINTENANCE INSTRUCTIONS

Table of Contents

Table of Figures

No table of figures entries found.

6.1 INTRODUCTION

This chapter discusses periodic inspection and adjustment tasks, which are necessary to maintain the equipment with the highest reliability.

Sample tables of general preventive maintenance requirements have been included in the chapter for reference purposes. The tables are intended as a guideline and should not replace periodic maintenance schedules derived in the plant.

CAUTION

CAUTION
Before performing maintenance procedures, follow posted Lockout Procedures.

6.2 OVERVIEW

All machine parts wear with use. This wear usually results in a gradual increase of out-of tolerance conditions rather than sudden equipment failure. Preventive Maintenance (PM) must be performed on a regular basis to keep the equipment operating at peak efficiency.

An established PM program is important because it results in increased reliability and longer equipment life. Such a program also results in the consistent manufacture of higher quality parts.

The following information is provided to aid the maintenance personnel in maintaining and repairing the equipment.

6.3 GENERAL SAFETY PRECAUTIONS

When working around moving components, use caution as these devices could be activated without warning. Always lock out energy sources. Do not re-start the machinery until the entire system has been checked, all guards are in place, all gates closed and locked, and all personnel are informed of start-up!

Maintenance Personnel should be familiar with equipment safety features prior to any maintenance action.

Ensure that all power is removed and locked out prior to any maintenance action.

CAUTION

CAUTION
Before performing maintenance procedures, follow posted Lockout Procedures.

If any safety device tests fail, stop the system immediately, lockout the disconnect switch, and notify your supervisor to have the problem corrected.

Before attempting any troubleshooting procedures, ensure machine is taken out of automatic mode at the HMI. Equipment left in automatic mode is dangerous, especially if the system stopped during an automatic sequence.

When the equipment shuts down because of a fault, do not perform any maintenance until the equipment is first properly locked out.

6.4 GENERAL MAINTENANCE SAFETY

Some general maintenance safety precautions are outlined below. The precautions are intended as a guideline and should not replace maintenance safety standards derived in the plant.

6.4.1 Mechanical Maintenance Safety Precautions

- Mechanical maintenance, adjustments, and repairs should be performed only by qualified technicians familiar with the system.
- If mechanical service does not require the station to be powered up, disconnect and dissipate all energy sources by performing the appropriate lockout / tagout procedures.
- Maintenance work will not be performed until the hazardous energy to which employees may be exposed and exposed is controlled.
- Vertical or inclined sliding members should be properly blocked. Use of safety pins (where provided) to mechanically disable machine motions is highly required.
- All moving machinery components, as well as their surrounding areas should be kept free of tools, rags, dirt, and excessive oil.
- When guards are removed for repair work, they should be properly re-installed as soon as the work is completed. Prior to operating any machinery all protective guards and covers must be in position.
- For troubleshooting, it may be necessary to leave the power “ON”. Always be aware of hazardous energy sources.
- Keep all moving parts of machinery and surrounding areas free of tools, rags, dirt, and oil. Clean up oil spills immediately.
- Before operating any moving machinery after maintenance is performed, all protective guards must be in place, all panel doors are closed and secured, and all safety gates are closed and secured.

6.4.2 Electrical Maintenance Safety Precautions

- Electrical system maintenance should be performed only by qualified electrical technicians familiar with the system using the latest up-to-date electrical controls drawings.
- A qualified electrician should be present when the electrical control panels are opened to perform checks and required repairs.
- Before performing maintenance or service on any part of the electrical system, perform all applicable lockout / tagout procedures. Before proceeding, verify that power is removed from all circuits.
- Maintenance work will not be performed until the hazardous energy to which employees may be exposed is controlled. This prevents the system from being powered on or re-started unexpectedly.
- A preliminary test should be conducted to confirm that no voltage is present before working on any circuit.
- Use only specified regulation fuses and never improvise for the replacement of fuses. Use approved fuse pullers when replacing the fuses.
- For troubleshooting, it may be necessary to leave the power “ON”. Always be aware of hazardous energy sources.
- Keep all moving parts of machinery and surrounding areas free of tools, rags, dirt, and oil. Clean up any spills immediately to prevent slip hazards.
- Before operating any moving machinery after maintenance is performed, all protective guards must be in place, all panel doors are closed and secured, and all safety gates are closed and secured.

6.4.3 Pneumatic Maintenance Safety Precautions

- Pneumatic system maintenance should be performed only by qualified technicians familiar with the system.
- Before performing maintenance or service on any parts of the Pneumatic System, shut off the air supply at the main shutoff valve and bleed air from pneumatic lines. Perform all applicable lockout / tagout procedures.
- While moving a pneumatic lockout valve to the off position, beware that high pressure and contaminates in the circuit will expel from the valve into a silencer/muffler to relieve pressure in that circuit.
- Trapped air may exist in air circuits between a 3-position control valves (with all ports blocked in the center position) and the air cylinder. Trapped air may also exist in air circuits between a check valve and the air cylinder. Check the pneumatic drawings provided for any trapped air circuits. Relieve pressure in any trapped air circuits prior to working on the pneumatic equipment.
- Use extreme caution around automation (such as clamps, dumps, slides, or lifts) that may move when air is relieved from the station. Before relieving air from lines, secure all such automation. Use safety pins where provided.
- If the operating pressure is set too low, insufficient force may be developed at the pneumatic actuator. Operating pressures that are set too high will cause excessive force at the actuator and may damage the machinery or pneumatic components.
- For troubleshooting, it may be necessary to leave the power “ON”. Always be aware of hazardous energy sources.
- Keep all moving parts of machinery and surrounding areas free of tools, rags, dirt, and oil. Clean up any spills immediately to prevent slip hazards.
- Before operating any moving machinery after maintenance is performed, all protective guards must be in place, all panel doors are closed and secured, and all safety gates are closed and secured.

6.5 LOCKOUT BEFORE PERFORMING MAINTENANCE TASKS

Safety Lockouts are a set of safety standards used to describe all potential hazards and energy sources associated with a machine. These hazards include all electrical energy (i.e., motors, switches) as well as any stored energy (i.e., pneumatic pressure, hydraulic pressure, water pressure, mechanical gravity devices). Through the use of Lockout standards, operating and maintenance work on the machine and associated mechanical devices can be performed in a safe manner.

Energy Control and Power Lockout (ECPL) placards identify the primary, associated, and stored energy or power sources of the system. The ECPL placard(s) are located on the Station main power distribution panels (PDP). Color-coded lockout tags corresponding to the source icons (such as A, B, C, etc.) on the placard help locate the same sources on the machine. These tags are mounted near, or hanging directly on, the energy and power source locations.

The Energy Control Power Lockout (ECPL) placard assists authorized personnel in identifying the following:

- Symbol used to identify Lockout energy isolation point.
- Lockout point Location / Description.
- Types of Energy Source.
- Methods of Operation to lockout isolate and control hazardous energy.
- The Verification Method to use to check Lockout was completed.
- The placard consists of a graphic plan view of the cell with the location of the energy isolation points, the action to isolate the energy.

The Lockout placards are posted on the equipment in a location that is easily accessible to the operating and maintenance personnel, typically on the main electrical panel door.

- ALWAYS follow the instructions on the sign(s) POSTED ON THE EQUIPMENT for proper Lockout before performing any maintenance or repairs.
- If more than one person is to perform work on the equipment, each employee must place his / her personal safety lock on the safety gate or energy source using a multiple lock device (scissor lock).
- Consult the placard lockout procedures posted on the equipment before performing any maintenance or repair task. No person should begin maintenance repairs until the proper LOCKOUT procedures are completed. The employee should contact his/her immediate supervisor if there are any questions about the identification of potential energy sources.
- When service or maintenance is to be conducted, equipment must be put in the OFF position via energy isolating devices such as electrical disconnects and valves.
- Before shutting down the equipment to Lockout energy sources, the employee performing the procedure or the supervisor shall inform affected employees of the intention to shut down the equipment.

6.5.1 Maintaining Safety Features

Failure to properly operate and maintain the cells safety features will increase risk of injury to the operator and all other persons adjacent to the machine.

Access to the cell components is limited due to fencing, guarding, etc. As such, special precautions must be taken when gaining entry into the cell to access the equipment to perform maintenance or repairs.

- Remove guarding only when absolutely necessary.
- Replace all guarding completely before returning machine to production.
- Repair or replace any defects in the safety device before restarting machine.
- Never defeat safety devices and guards.

WARNING

WARNING

Follow ECPL before removing guarding to work on the system.

Never operate this machine unless all guarding is in place and undamaged.

Ensure that guarding is handled properly. When servicing machine, ensure guarding is placed in a safe place, away from moving parts.

Disregarding these safety precautions can result in machine damage, injury or death.

6.6 ELECTRICAL MAINTENANCE OVERVIEW

WARNING

WARNING

Only qualified technicians familiar with the system, using an up-to-date set of system schematics, should perform electrical/electronic system troubleshooting or maintenance.

Follow all plant ECPL Lockout / Tagout procedures when working on the equipment.

Obey all Warning tags posted on the equipment/panels.

Read, understand, and obey all safety procedures outlined in the Safety Section of this manual.

In order to ensure that the system works properly, ensure that electrical facilities and control cabinets are kept closed (fouling, humidity, cooling).

For all work in the control cabinet, except measurement and testing, the control cabinet must be de-energized according to generally applicable safety plant regulations.

Always avoid damaging the insulation or parts that are used to protect against contact. If damage occurs, the protective capacity of the prescribed contact part protection can no longer be guaranteed. Immediately rectify these defects.

The safety of the system is only ensured if the wiring has been installed as specified in the documentation for electrical systems. The documentation for electrical systems was transferred when the system was accepted. Any change to the control system (wiring, program) can cause malfunctions and releases the manufacturer from his warranty obligation. Electrical systems have voltages present that can potentially be fatal. Only a skilled electrician should attempt any repair or adjustments to the electrical system. Most electrical devices within the system will trigger a fault upon breakdown. Personnel should observe electrical components on the equipment for wear that would lead to potential faults.

6.6.1 Electrical Maintenance of Control Equipment

6.6.1.1 Periodic Inspection

Industrial control equipment should be inspected periodically. Inspection intervals should be based on environmental and operating conditions and adjusted as indicated by experience. An initial inspection within 3 to 4 months after installation is suggested.

6.6.1.2 Contamination

If inspection reveals that dust, dirt, moisture or other contamination has reached the control equipment, the cause must be eliminated. This could indicate an incorrectly selected or ineffective enclosure, unsealed enclosure openings (conduit or other) or incorrect operating procedures.

Replace any improperly selected enclosure with one that is suitable for the environmental conditions.

Repair or replace any other damaged or malfunctioning parts (e.g., hinges, fasteners, etc.).

Dirty, wet or contaminated control devices must be replaced unless they can be cleaned effectively by vacuuming or wiping. Compressed air is not recommended for cleaning because it may displace dirt, dust, or debris deeper into the equipment, or damage delicate parts.

6.6.1.3 Operating Mechanisms

Check for proper function and freedom of movement.

Replace any broken, deformed or badly worn parts or assemblies according to individual product renewal parts lists.

Check for and retighten any loose fasteners.

Lubricate if specified in individual product instructions.

6.6.1.4 Contacts

Check contacts for excessive wear and dirt accumulations. Contacts should never be filed, as dressing only shortens contact life. Contact spray cleaners should not be used as their residues on magnet pole faces or in operating mechanisms may cause sticking, and on contacts can interfere with electrical continuity. Contacts should only be replaced after silver has become badly worn.

Vacuum or wipe contacts with a soft cloth if necessary to remove dirt.

Discoloration and slight pitting do not harm contacts.

Always replace contacts in complete sets to avoid misalignment and uneven contact pressure.

6.6.1.5 Terminals

Loose connections in power circuits can cause overheating that can lead to equipment malfunction or failure. Loose connections in control circuits can cause control malfunctions. Loose bonding or grounding connections can increase hazards of electrical shock and contribute to electromagnetic interference (EMI).

Check the tightness of all terminals and bus bar connections and tighten securely any loose connections.

Replace any parts or wiring damaged by overheating, and any broken wires or bonding straps.

6.6.1.6 Coils

If a coil exhibits evidence of overheating (cracked, melted or burned insulation), it must be replaced. In that event, check for and correct over voltage or under voltage conditions, which can cause coil failure. Be sure to clean any residues of melted coil insulation from other parts of the device or replace such parts.

6.6.1.7 High Voltage Testing

High voltage insulation resistance (IR) and dielectric withstanding voltage (DWV) tests should not be used to check solid-state control equipment. When measuring IR or DWV of electrical equipment such as transformers or motors, a solid-state device used for control or monitoring must be disconnected before performing the test. Even though no damage is readily apparent after an IR or DWV test, the solid-state devices are degraded and repeated application of high voltage can lead to failure.

6.6.1.8 Voltage, Connectors, and Memory Batteries

Voltages need to be checked. Check the incoming power, the power supplies, and the transformer secondaries. Most power companies will only guarantee their power to be within 10% of their rated values. High or low voltage can cause damage to everything in the cabinet.

Inspect all connectors for tightness. Machines vibrate and components will loosen. Do not forget to turn the power off for this step. Inspect the door gasket. If this gasket is bad, contaminants can enter the cabinet.

Check records to find out when the memory batteries were last replaced. Most replacements are done with the power on; otherwise, there may be a time limit to replace the batteries.

6.6.1.9 Air Cooling Systems and Fans

Electronics do not like heat; heat can cause everything from intermittent, unexplainable faults to complete component failure. Most drives and PCBs (printed circuit boards) are very costly to replace.

Excessive heat is probably a sign that the air-cooling system is not functioning correctly.

There is an air-cooling system in the cabinet that uses small axial-type fans to move the air. Servo drives normally will also have a fan mounted to them as well as card rack and control module.

The best way to inspect the fans is to make sure they are maintaining good airflow. If not, replace them. The fans that are exposed to outside air should be inspected for cleanliness. If dirty, turn the power off, remove the fan, and wipe off the dirt with a clean rag, before remounting the fan. Turn the power on and check for airflow. Do not dip fans in cleaning solution; it could ruin the motor. Some propellant-type motor cleaners also work, but the fan blades will still require wiping by hand.

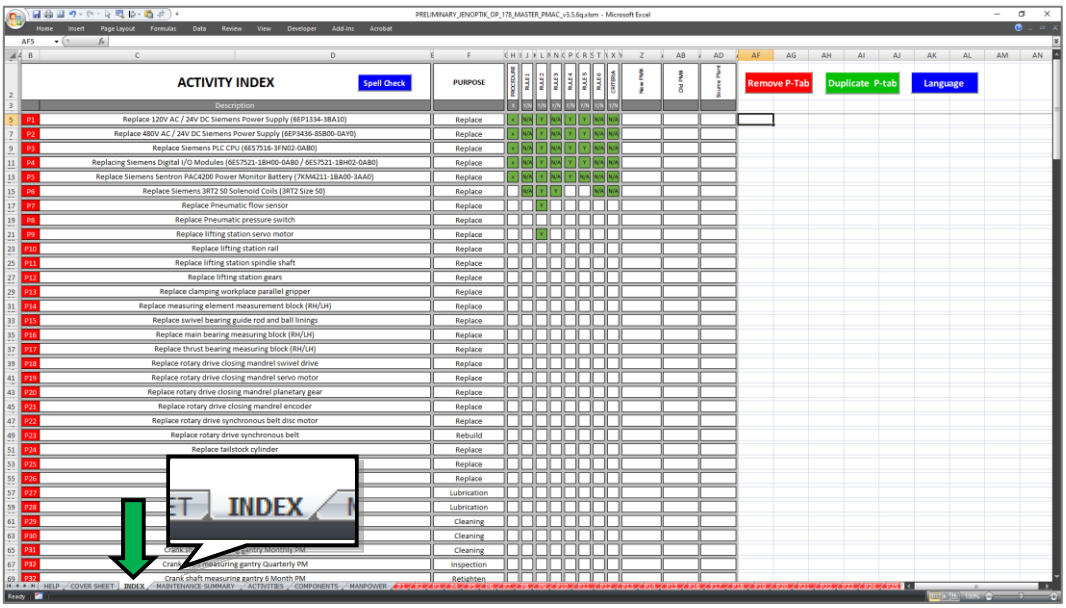
6.6.1.10 Electrical Connections and Wiring

Electrical connections and terminal blocks should be tight and free of corrosion. Loose or corroded connections cause increased resistance and heat. Discoloration of the terminals and associated wiring are often a sign of loose connections. Insulation and cleanliness are the major maintenance concerns. Tie-wrap all lines to stable components. Replace any wires that have sections of missing, cracked, brittle, swollen, or split insulation immediately.

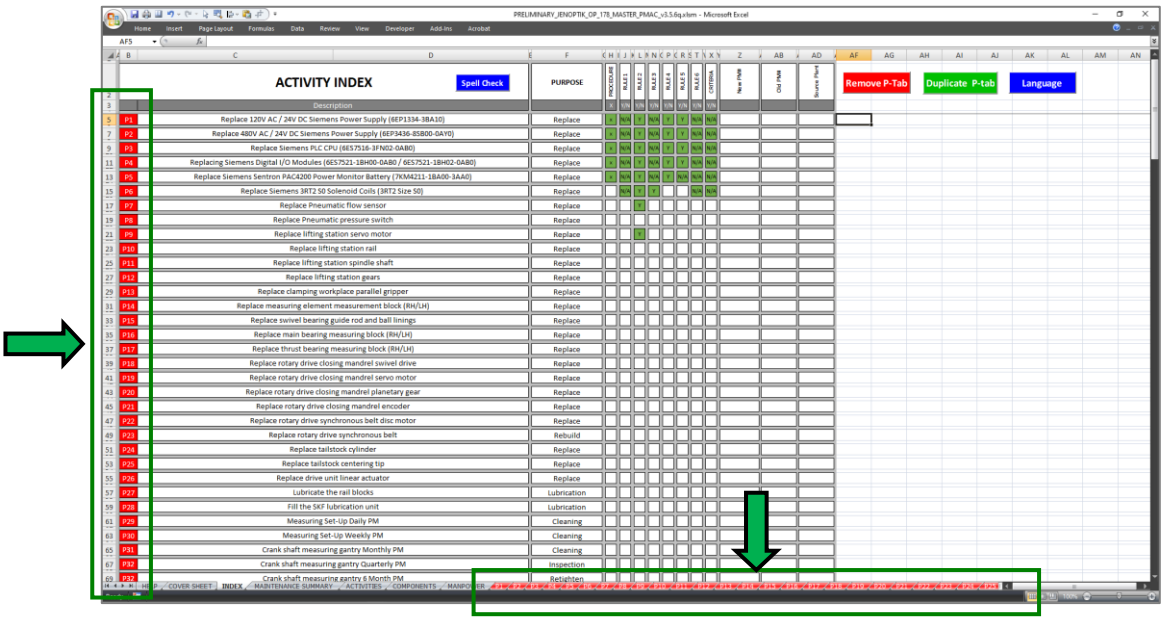
6.7 INSTRUCTIONS ON USING PMAC

The following is a general overview of the JENOPTIK PMAC SMP (Standard Maintenance Procedure) system for viewing purposes.

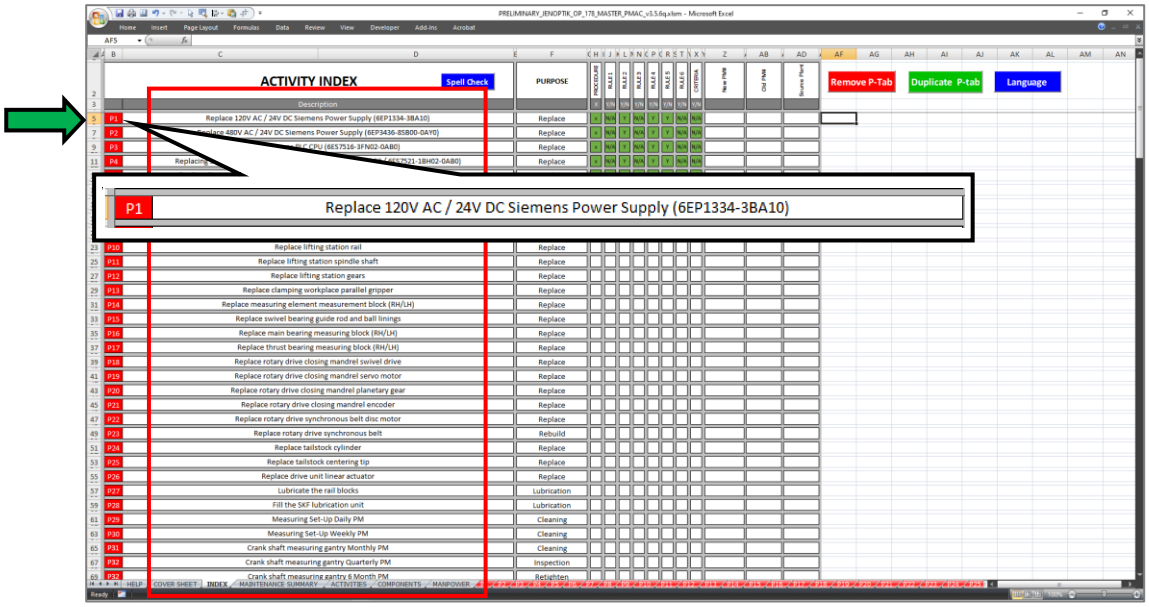
1. Locate the latest version of PMAC Excel document specific to the machine you are servicing. Note that printed copies are not version controlled.
2. Open the INDEX tab at the bottom of the workbook. The ACTIVITY INDEX will appear.



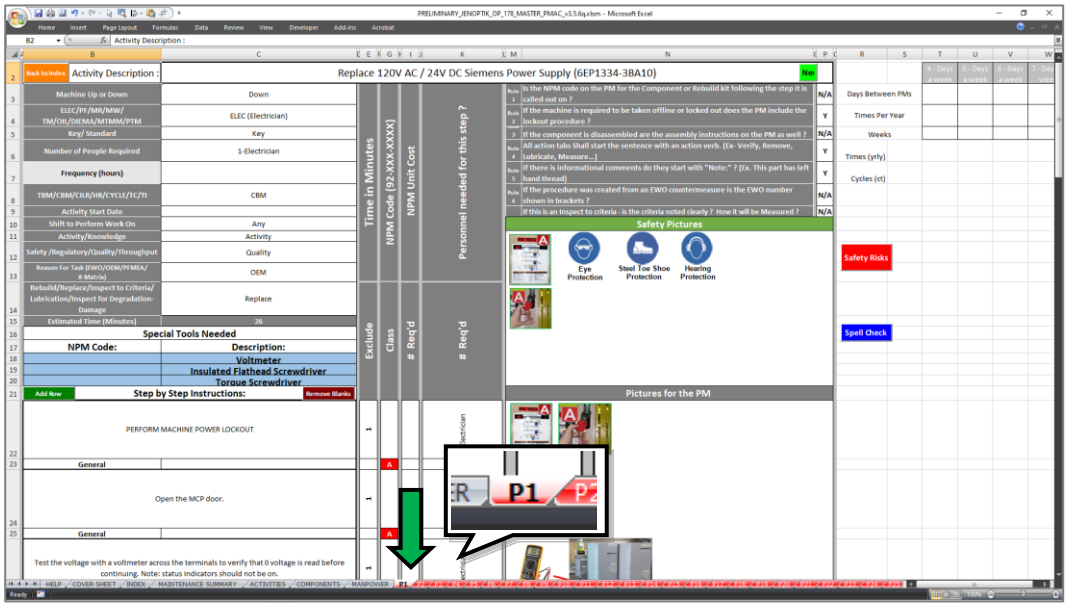
3. Along the left hand Column B are P#s in the red cells. Each one of these are separate maintenance procedures and correspond to the P# red tabs along the bottom of the workbook.



4. The column to the right of the P#s are the descriptions of the maintenance procedures. Locate the maintenance procedure to perform, then the P# associated with it.



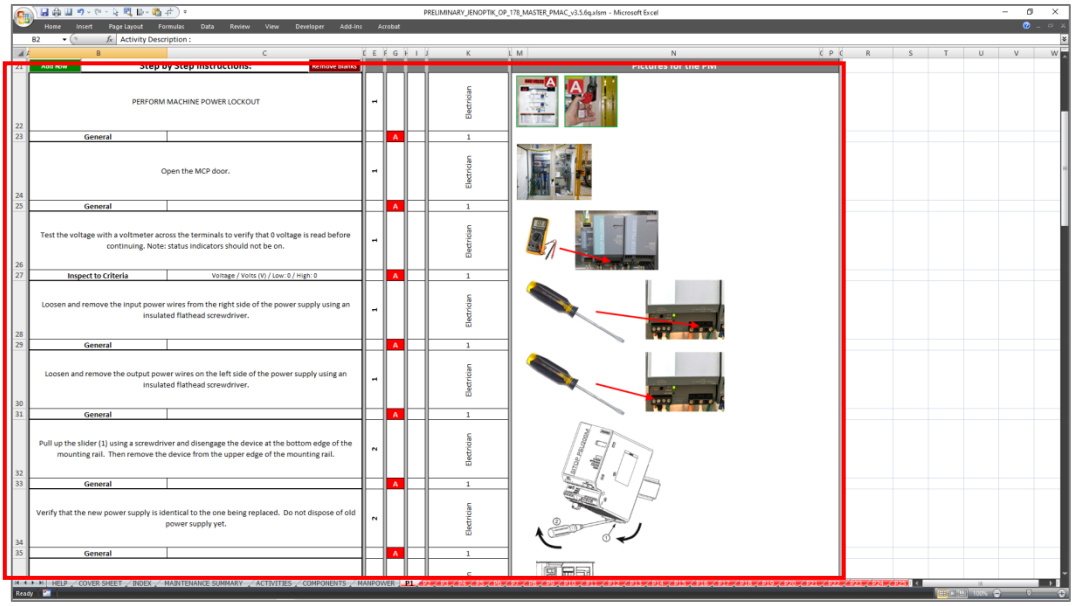
5. Click on the tab at the bottom of the workbook of that P#. Use the scroll bar to the right of the P# tabs to reveal additional P# tabs hidden from view.

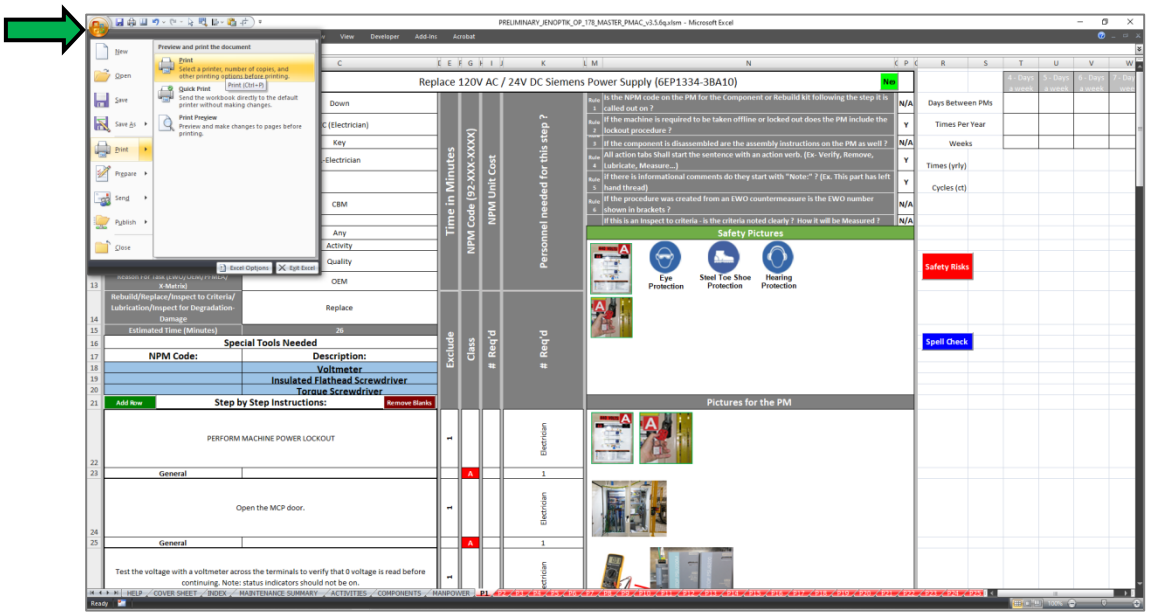


6. Here you will find the information and Step-By-Step procedure to perform the task. The top-left portion will have the Activity Description regarding machine condition, personnel required, etc., needed to complete the task. Any key information such as safety, special tools required is also located on the sheet.

7. Each step details the task, the type of step (General or Inspect to Criteria), the class, Skill Trades, # of personnel required and visuals.

   Use the vertical scroll bar on the right side of the sheet to display steps that may be hidden from view.





8. Use the Print button from the Excel menu (Control + P) or the Quick Access menu to print a copy of the procedure.
9. When finished, advance to the next procedure using the P# tabs, or if done, close the document using the Excel menu (Control + W).

   Do <u>not</u> save the document if prompted.

6.8 STANDARD MAINTENANCE OPERATING PROCEDURES

This section provides a list of standard maintenance procedures (SMP) available in PMAC. The actual SMP procedures are located at the Machine along with the associated WCM documentation.

Note that this list was up-to-date at the time of the publishing of this manual and may be revised.

P#	Description	Purpose
P1	Replace 120V AC / 24V DC Siemens Power Supply (6EP1334-3BA10)	Replace
P2	Replace 480V AC / 24V DC Siemens Power Supply (6EP3436-8SB00-0AY0)	Replace
P3	Replace Siemens PLC CPU (6ES7516-3FN02-0AB0)	Replace
P4	Replacing Siemens Digital I/O Modules (6ES7521-1BH00-0AB0 / 6ES7521-1BH02-0AB0)	Replace
P5	Replace Siemens Sentron PAC4200 Power Monitor Battery (7KM4211-1BA00-3AA0)	Replace
P6	Replace Siemens 3RTS2 S0 Series Contactor Solenoid	Replace
P7	Replace Festo Pneumatic Flow Sensor (SFAM-62-1000L-M-2SV-M12)	Replace
P8	Replace IFM Pneumatic Pressure Switch (PN7594)	Replace
P9	Replace Lift Station Servo Encoder (Siemens F1G1)	Replace
P10	Gearmotor Oil Change	Lubrication
P11	Replace Lifting Station K-Tech Splined Shaft	Replace
P12	Replace Lifting Station Spline Shaft Gears	Replace
P13	Replace Clamping Workplace Festo Parallel Gripper (HGP-25-A-B-SSK)	Replace
P14	Replace Gantry Measuring Setup Measurement Blocks (RH/LH)	Replace
P15	Replace Measuring Setup Swivel Bearing Guide Rod and Ball Linings	Replace
P16	Replace Lifting Station Ace Shock Absorber (MA 225M)	Replace
P17	Replacing Rotary Drive Closing Mandrel Heidenhain Encoder (ECN 120/3600)	Replace
P18	Replace Rotary Drive Closing Mandrel Festo Swivel Drive (DSR-40-180-P)	Replace
P19	Replace Rotary Drive Closing Mandrel Siemens Servo Motor (1FK7022-5AK71-1LH3)	Replace
P20	Replace Rotary Drive Closing Mandrel Neugart Planetary Gear (PLE-60-100-SSSB3A0)	Replace
P21	Inspect Rotary Drive Norlem Synchronous Belt	Inspect to Criteria
P22	Retensioning Rotary Drive Synchronous Belt	Rebuild
P23	Replace Rotary Drive Synchronous Belt	Replace
P24	Replace Tailstock Festo Cylinder (DSBC-32-50-C)	Replace
P25	Replace Tailstock Centering Tip	Replace
P26	Replace Drive Unit Festo Linear Actuator (DGP-40)	Replace
P27	Lubricate the Rail Blocks	Lubrication
P28	Fill the SKF Lubrication Unit	Lubrication

P#	Description	Purpose
P29	Replace Drive Unit Ace Shock Absorber (MA 225M)	Replace
P30	Measuring Set-Up Daily Inspection	Inspection
P31	Measuring Set-Up Weekly Inspection	Inspection
P32	Crank Shaft Gantry Monthly Inspection and Cleaning	Inspection
P33	Replace Digital Probe	Replace
P34	Replace Analog Probe	Replace
P35	Cleaning Analog and Digital Probes	Cleaning
P36	Telesis General Cleaning	Cleaning
P37	Telesis F-Theta Lens Cleaning	Cleaning
P38	Telesis Controller Fuse Replacement	Replace
P39	Replace Festo Pneumatic Filter	Replace
P40	Replace Purex Pre-Filter	Replace
P41	Replace Purex HEPA Filter	Replace

NOTES

SECTION 7
TROUBLESHOOTING

Table of Contents

Table of Figures

7.1 TROUBLESHOOTING GUIDELINES

The procedures contained in this section serve as an aid in the process of isolating and recovering from malfunctions due to control and/or operation problems. Isolating a fault is accomplished by using a systematic approach, which makes troubleshooting easier. This section, however, is not the only document that can be used for troubleshooting. The PLC and other vendor manuals should be consulted if problems occur within the scope of that equipment.

This section is intended to be flexible. There are no concrete rules that must be observed. There are, however, some guidelines that will assist personnel with being more successful with attempts to recover from system faults.

These guidelines are:

- Begin troubleshooting by accessing the faulted station(s) HMI terminal. The faulted station(s) will be indicated by an illuminated fault banner at the associated station(s) HMI screen.
- Identify the type of fault displayed in the fault display at the HMI screen. The faults are displayed on a priority type basis, with the System fault being the highest priority fault in the system.
- If the trouble has occurred with a vendor supplied item, consult the reference material supplied by the manufacturer.
- Follow instructions in the reference and vendor information to complete the recovery process.

7.1.1 The Five General Guidelines

The four general rules mentioned above are broad statements that govern good troubleshooting. Listed below are more specific action items, which are essential in successful troubleshooting:

1. **Verify that a problem exists**. A problem is usually indicated by a change in equipment performance or product quality. Verification of a problem through observation will allow the troubleshooter to determine if a problem actually exists, or if the reports of trouble are due to a lack of equipment understanding.
2. **Identify and locate the root cause of the trouble**. Trouble is often caused by a change in the system. An understanding of the system, its modes of operation, and how they are supposed to work, will aid in finding the cause of the trouble.
3. **Correct the problem**. It is very important to correct the root of the problem, not just the symptom(s). This often involves replacing or repairing a part or making adjustments. A process or piece of equipment should never be adjusted to compensate for a problem and that action considered finishing the job: Correct the problem!

4. **Verify that the problem has been corrected**. Repeating the same check that originally indicated the problem can often do this. If the fault has been corrected, the system should operate properly.
5. **Follow up to prevent further trouble**. A plan should be suggested that would prevent a future recurrence of this problem.

7.1.1.1 Experience

There is a way to capture a small part of the experience of personnel so those who have not seen a particular event for themselves can refer to it in the future. Equipment history or an equipment trouble log can tell quite a tale over the life of a piece of equipment.

The trouble log provides a valuable source of information that draws on the experience of past troubles and troubleshooting efforts, to quickly restore the equipment to service. Problems, symptoms, corrective actions, modifications, and preventive maintenance actions should all have entries that can be referenced at a later date.

7.1.1.2 Step-by-Step Approach

Troubleshooting a problem and is a logical, step-by-step procedure. The approach is much the same for all equipment; only the steps for implementing the approach may differ.

All maintenance personnel can use general troubleshooting procedures. The basic approach is listed below:

- Talk with the operator. Read the HMI.
- Read the Alarm and Warning messages at the TOP of the HMI screen. Faults generally fall within the following three categories:
    - Safety Faults (Safety Faults)
    - Fixture Faults (Switch Faults)
    - Communication (Profinet Faults)
- Solve the problem.
- Make final checks.
- Complete equipment logs and paperwork.
- Inform area supervision/instruct operators.

7.1.1.3 Intermittent Failures

An intermittent failure can be a much more difficult problem for the troubleshooter. It also can create havoc within a process or a system operation. However, diagnosing the fault can be accomplished using these general guidelines:

Attempt to recreate the problem. It may be:

- Electrically induced failure
- Mechanically induced failure

Isolate the fault once the problem re-occurs:

- But you have to recreate the conditions so the fault can reoccur.
- Monitor the operation if the problem does not re-occur.

If the fault does not reoccur, you need to monitor the equipment operation for an extended period of time.

7.1.1.4 Sequence Stops

Sequence stops encompass a broad range of problems, most of which only require simple repair. Most sequence stops can be traced to a limit or proximity switch that has not been tripped. A PLC network controls the sequencing of components. When an input is received, it initializes the appropriate output based on current system logic. These sensor devices are in use constantly during machine operation. Most problems with sequencing can be attributed to dirty, faulty, or maladjusted switches. In less common cases, sequence stops are due to an output device not activating. Problems here can range from failed actuators to a logic failure. Isolating either problem can be done quickly with a basic understanding of machine operation and station controls.

Problems not attributed to output device failure may be the result of a physical disconnection. Look for broken air lines, loose cable connections, or mechanical obstruction. In the event of sensor failure, examine the actuating device to determine if the stop occurred before or after the mid-range point of the actuated device. If the stop occurs before midpoint, this indicates an advance sensor failure. A stop past midpoint signifies a retract sensor failure. If the problem cannot be physically identified, use wiring diagrams to locate the output module for the actuating device.

7.1.1.5 The Root Cause

Simply fixing a problem does not necessarily solve it. One problem may merely be a symptom of another problem. Many times, the repair of a problem results in only temporary restoration of system performance. This is because the emphasis is often on getting the equipment up and running, not on fixing the real problem.

One of the easiest ways to find the real problem is to ask, “Why did this piece of equipment fail?” If the answer to that question is that another piece of equipment has failed or is out of adjustment, then ask, “Why is that piece of equipment not running correctly?” Perform this question and answer procedure enough and you will eventually find the root cause.

For example, do not just replace the fuse because the motor is drawing excessive current. The motor may have an excessive load on it because its rotor shaft bearings are bad. But it is not necessarily a bad motor because the installers may have adjusted the belt on the motor shaft to tight which causes shaft to shift causing excessive wear on one side of the bearings. This scenario could go on, but the point is that maybe the quick fix is not the real problem.

Just remember that troubleshooting is a straightforward process in automated systems. When you encounter a problem, remember that less than 10% of all system failures will be due to the PLC and between 5% and 10% of all system failures are due to anything from the PLC out to the I/O card. By far, the most failures, 80% to 90%, in a system are due to input and output devices and the hardware they control.

7.2 READ THE HMI

The HMI provides extensive diagnostic information. The particular operation can be monitored and controlled through this device. In addition, an operator can observe fault conditions and make changes to the OP through the soft-touch display screen.

This devices provides capabilities not available through pushbutton panels. Some of these features include:

- Auto/Manual Mode of control.
- Manual movement of individual tools.
- Show status of individual control devices in-station such as switches, clamps, etc.
- System and Station Fault messages will be displayed on the screen.

7.2.1 Locating the Problem

Locating the Problem	
Step	**Action**
1	When the line stops, the first thing you should do is observe the Alarm Banner on the Main Screen. The fault banner will provide a description of what caused the fault, and where the fault is located. For a complete list of fault codes, refer to your plant's filing system.
2	After determining where the fault occurred, use the HMI screens to determine the fault. Interpret the fault banner messages, the prompt message(s) and the appropriate HMI screens to further diagnose the problem.
3	If necessary, locate the appropriate drawings required to further troubleshoot the problem.

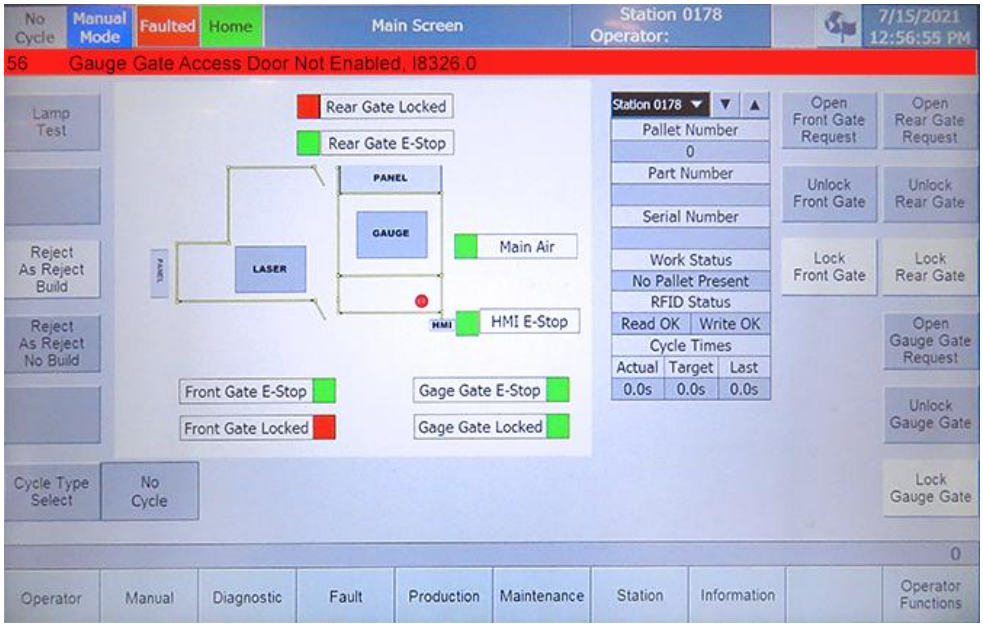


Figure 7-1: Typical Main Screen

7.2.2 Warning Messages

There are several warning messages that can occur on the system which informs the operator about a situation that needs attention but does not necessarily stop the machine from operation. If a warning is not resolved with a reasonable amount of time, the cause of the warning will eventually become a fault condition.

Faults and warning alarms are display just under the top header on the HMI screen and can be acknowledged and cleared. They can also be reviewed on the Alarm History screen which keeps an ongoing record of alarms that have occurred until the alarm history is reset or cleared. Faults appear with a red background and Warnings appear with a yellow background.

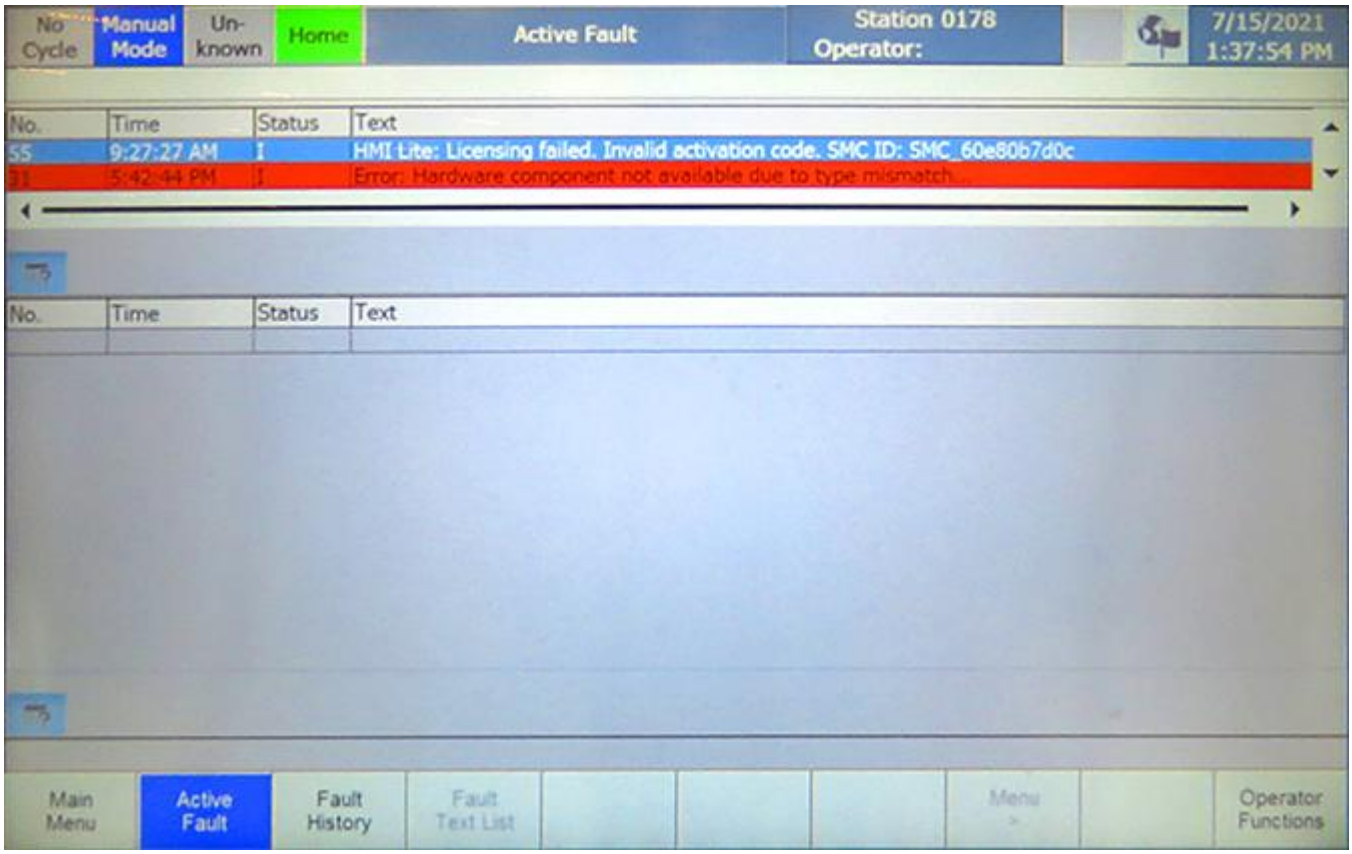
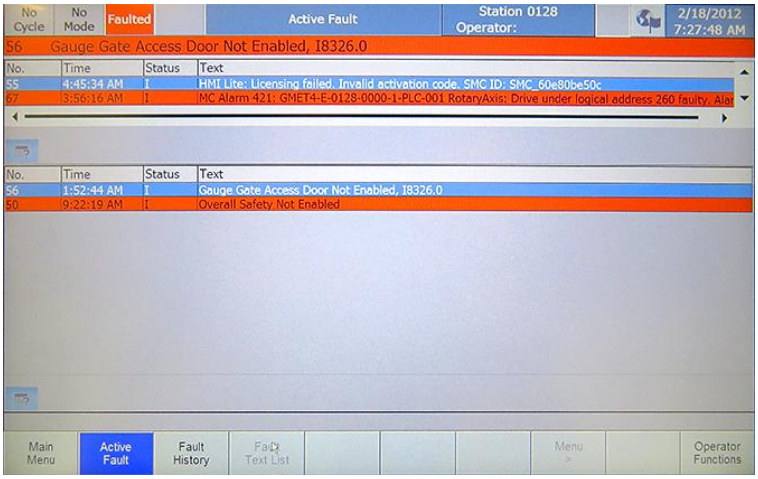


Figure 7-2: Typical Alarm Fault Screen

7.3 FAULT RECOVERY PROCEDURE

6. Access the Active Fault screen to display the active alarms (faults) and warnings for the machine. This screen displays all active alarms.



7. Diagnose and rectify the fault.

WARNING

WARNING
If rectifying a fault requires entry into a guarded area, follow all Access or Master Lockout / Tagout procedures before entering into the guarded area to perform work on the equipment. Failure to observe this precaution may result in death, severe injuries or considerable damage to property.

8. After the fault or warning is diagnosed and rectified, the fault can be cleared and the safety circuits reset by pressing the FAULT RESET pushbutton on the system HMI panel. The cleared fault will be sent and displayed on the Fault History screen.

Figure 7-3: Typical HMI Fault Rest Pushbutton

7.4 MECHANICAL TROUBLESHOOTING

Perhaps the most valuable but difficult-to-learn skill any mechanical repair person must have is the ability to troubleshoot a system. Troubleshooting, however, is a skill that can be learned like any other. Troubleshooters must be able to determine the cause or causes of a problem simply by examining its effects. Rarely does the source of a problem directly present itself for all to see. Cause/effect relationships are often complex, even for seemingly simple system. Typically, a misbehaving system is still functioning to some degree and may be stimulated and adjusted by the troubleshooter utilizing the proper diagnostic procedures.

7.5 PNEUMATIC TROUBLESHOOTING

The following tables detail general pneumatic troubleshooting tasks. These general procedures can be used to help personnel perform system troubleshooting relating to pneumatics.

7.5.1 Pneumatic Troubleshooting Chart

Pneumatic System Troubleshooting Chart		
Symptom	**Possible Cause**	**Probable Solutions**
Air leak(s).	Dirt or foreign matter in valve.	Clean or replace valve.
No air in system.	No air supply.	Ensure that the plant air system is supplying air to the machine.
	Air lockout closed.	Open air lockouts and ball valve shut off.
		Check air line for restrictions.
	Defective pressure switch.	Repair or replace as necessary.
	Improper pressure regulator setting.	Check incoming air pressure to equipment. Verify it is within the acceptable operating range.
	Dirty filter(s).	Replace element.
	Blown fuse.	Replace fuse.
Low air pressure.	Low or no pressure.	Check for broken lines, defective valves, or incorrect position of valves.
Lack of air pressure.	Verify the pneumatic lockout valve is in the open position.	Open air lockout valve.
	Verify air regulators are set to proper air pressure.	Adjust if needed. Verify it is within the acceptable operating range.
	Verify regulators are operating properly.	Repair or replace as needed. Verify regulator is within the acceptable operating range.
	Check for broken lines, loose cable connections or mechanical obstructions.	Repair or replace as needed.
No movement.	No air supply to cylinder.	Check shut off valve at incoming side.
		Check flow control valves.
		Check regulator pressure setting.
		Check for physical damage that could cause air leakage from components or line.
		Check for physical obstructions.
Component moves in a sluggish manner.	Control settings.	Check settings of flow controls.
		Check pressure setting.
		Check for incoming air restrictions.
		Check for physical damage that could cause air leakage from component or line.

7.5.2 Pneumatic Device Inspection

The following sections outline some basic pneumatic system tests that you can conduct on specific equipment components. As part of a troubleshooting test, you should mechanically inspect the devices. Also, if spare parts are available, substitute a good part for a suspect part as a quick method of returning the equipment to operation. Test the suspect part and either replace, repair, or discard it.

7.5.3 Control Valves

If the actuator and mechanical linkage have free movement and are in good operating condition, loosen or disconnect the lines to the cylinder and cycle the system. If there is no indication of airflow, the problem is either in or ahead of the control valve. The cause of trouble in a control valve can be located by performing the following tests.

Control Valve Inspection Procedure	
Step	**Action**
1	If the valve action is sluggish, check the moving parts for insufficient lubrication or swollen seals.
2	If the valves are pilot-operated, check the pilot supply pressure.
3	A clogged exhaust muffler may also result in slow actuator movement. In systems having manifold mounted control valves, the retarded exhaust flow from one valve may cause backpressure in an exhaust passage resulting in malfunction or unintentional operation of other valves or actuators.
4	Other reasons for sluggish valve movement include heat, swollen or deteriorated packings, and binding caused by excessive operating pressure. Unbalanced poppet valves are particularly sensitive to excessive supply pressure.
5	Worn packings, valve seats, and valve bodies can cause leakage within the valve. Abnormal internal leakage in one valve of a manifold valve stack can starve other valves in the stack. If the valves are internally piloted, spring-centered, or spring-returned, loss of pilot pressure may cause them to oscillate when the operating signal is received. Broken springs and valve stems are other possible causes of control valve malfunction.

7.5.4 Control Valve Actuators

Frequently, control valves will not shift because the actuating device doesn't operate. If the system malfunction is located in the control valve area, check both the valve and the actuator.

Control Valve Actuator Inspection Procedure	
Step	**Action**
1	In addition to electrical failures, mechanical failures cause solenoid actuators to be inoperative. These include broken straps or plunger blocks, sheared clevis pins, and misalignment between the solenoid and valve caused by faulty mounting.
2	Electrical failures can be determined with the aid of electrical instruments. Most solenoid coils that actuate pneumatic valves are designed for continuous duty. If a solenoid fails prematurely, take electrical resistance readings to determine if the coil is open, shorted, or grounded. Open coils result from physical damage to the coil that severs the coil wire. An open circuit in a solenoid valve can also be caused by a short circuit resulting in arcing and intense heat. The heat may be severe enough to melt the wire and open the circuit.
3	Insulation failures occur from overheating. If a solenoid coil is in operating condition but you do not have voltage, look for the source of trouble in the electrical supply system. Fuses may have blown or circuit breakers tripped.
4	Pneumatic pilot actuators on pneumatic control valves are usually very simple in construction. Most consist of a small piston or diaphragm located on the end of the main control valve. Most of the inlets to pilot actuators are very small, and can easily become clogged. This is especially true where pilot passages are within the valve body, where they do not have a direct path to the piston. Removing the obstruction almost always restores the valves to service.

7.5.5 Air Filter

Air Filter Troubleshooting Chart		
Symptom	**Possible Cause**	**Probable Solutions**
Excessive pressure drops.	Dirty filter.	Open drain cock and drain off any bowl accumulation.
Condensation appears.	Dirty filter.	Check and clean filter.
Air flow is reduced.	Filter element is clogged.	Clean or replace element.

7.5.6 Air Regulator

Air Regulator Troubleshooting Chart		
Symptom	**Possible Cause**	**Probable Solutions**
Erratic operation / loss of regulation.	Dirt in disc area.	Clean regulator parts, especially disc area with denatured alcohol.
Pressure cannot be adjusted.	Contaminants present in the valve seat and/or adjustment assembly.	Clean valve seat or replace adjustment assembly.
	Broken valve spring.	Replace valve spring.
Air leaks from small bonnet hole.	Broken diaphragm.	Replace diaphragm.
Air leaks from bonnet screws.	Loose bonnet screws.	Tighten screws.
	Broken diaphragm.	Replace diaphragm.

7.5.7 Air Exhaust Muffler

Muffler Troubleshooting Chart		
Symptom	**Possible Cause**	**Probable Solutions**
Cylinders gradually cycle more slowly.	Silencer is clogged.	Replace silencer.
Oil leak.	Cracked housing.	Replace silencer.
Increasing exhaust / noise level.	Dirty element cartridge.	Clean or replace the element cartridge.

7.5.8 Air Cylinder

Air Cylinder Troubleshooting Chart		
Symptom	**Possible Cause**	**Probable Solutions**
Air cylinder not operating properly or not at all.	Cylinder moves in the wrong direction.	Connect (switch) cylinder airlines to opposite ports.
	Foreign object or obstruction.	Check for presence of foreign object or obstruction. Clear if necessary.
	Cylinder frozen.	Check cylinder and try to manually move rod end. Rebuild with cylinder rebuild kit or replace, if necessary.
	Cylinder fails to move load.	Check incoming pressure. Correct pressure settings if necessary.
		Check flow controls. Adjust, if necessary.
		Check pressure regulator setting. Adjust, if necessary.
		Internal piston seals worn. Replace seals. Improperly lubricated cylinders lead to premature seal life.
		Piston rod is broken. Repair or replace.
		Cylinder is undersized. Re-size and replace.
		Check for body leaks. Tighten tie rods, if loose. Check for pinched seals.
		Check air hoses for cuts or leaks. Replace hose, if necessary.
		Verify all hoses are clear of obstructions. Blow out lines, if necessary.
		Check fittings.
	Cylinder moves too slowly.	Check flow controls. Adjust, if necessary.
		Check cylinder cushions. Adjust, if necessary.
		Cylinder is undersized. Re-size and replace.
	Rod seal leak.	Replace leaking rod seal. If soft or gummy, change lube used. If hard, check for excessive heat sources.
	Cylinder drifts.	Internal piston seal worn. Repair cylinder or replace.
	Solenoid valve.	Check if spool is stuck. Push manual operator (manually punch valve) to see if it moves. Dirt or foreign matter lodged in valves is major cause of breakdowns. Clean valve spool. Verify incoming air is clean. Change filter, if needed.
		Check valve spool mating surfaces. If worn, replace spool.

Air Cylinder Troubleshooting Chart		
Symptom	**Possible Cause**	**Probable Solutions**
		Check condition of return springs. Replace, if needed.
		Check valve poppet. Clean, if necessary.
		Check bonded mating surface of poppet. Replace, if worn.
	Excessive noise from valve or sluggish operation.	Dirt or foreign matter in valve. Clean valve.
	Control circuit power problem.	Manually energize solenoid, and listen for click. Absence of click indicates solenoid is not operating. Check incoming power, for loose wires, blown fuses or ungrounded circuit.
	Solenoid problem.	If above solutions is unsuccessful, replace solenoid. Note: Manually punching a valve replaces the solenoid's function. If the device moves when manually punched, it doesn't mean that the solenoid is OK; it just means that the spool is working.

7.6 ELECTRIC TROUBLESHOOTING

Electrical troubleshooting is the process of locating the cause of malfunctions in electrical circuits. The following pages contain some general troubleshooting information as well as specific tests for determining the status of specific electrical devices. Skill in troubleshooting electrical equipment and circuits requires the following expertise:

- Knowledge of electrical principles to understand how a circuit or device should function.
- Skill in reading and interpreting electrical schematics, diagrams, product data, and so forth.
- Skill in operating test equipment and interpreting test measurements.
- Ability to analyze problems in a logical manner.

Following systematic steps that narrow down the problem to a smaller area of the equipment is much more efficient than trial-and-error methods. The troubleshooting procedure detailed below can be very useful in organizing the problem-solving effort and reducing equipment downtime. The following troubleshooting procedure consists of five steps that you should perform in sequence. These steps represent the most reliable method of learning and applying a logical approach to problem solving and can be applied to any equipment, regardless of size.

7.6.1 Electrical System Troubleshooting Procedure

Electrical System Troubleshooting Procedure	
Step	**Action**
1	**Identify the symptom.** A symptom is an external indication that a circuit or device is not functioning correctly. You can identify a symptom by investigating the problem by sight, sound, smell, and touch. For example, visually inspecting the equipment may reveal that a circuit component has overheated and changed color or that an indicator lamp, which should be on, is not. A peculiar odor may lead you to discover melted insulation, or a chattering noise could indicate that a solenoid is about to fail. Moving controls or adjusting knobs may change the problem or have no effect at all. The fact that the equipment is not operating is a symptom. If someone else was operating the equipment when it failed, ask the person if he/she noticed anything unusual before it failed. Funny noises, things that do not look quite right, and improper operating sequences are symptoms that could lead to the cause of the problem. If you cannot find any immediately identifiable symptoms, try operating the equipment once you determine that it is **safe** to do so. Watch what works and what does not work. Note anything that does not seem right, no matter how small. Take the time to conduct a thorough investigation.
2	**Analyze the symptom.** In this step, you identify the functions where symptoms indicate a malfunction. Use the information you obtained during your identification, along with the schematic and functional block diagrams and knowledge of how the equipment is supposed to operate, to make logical, technical deductions. For example, after careful examination, you find that a clamp will not pressurize. Further analysis, without using test equipment, narrows the problem to clamp pressurization or pre-fill shift, any of which might contain the faulty circuit.
3	**Isolate the single faulty function.** In this step, you use test equipment to decide which faulty function is actually causing the malfunction. When making these tests, use the following guidelines: Make only those tests that are safe to make. Make the least difficult tests first. Test those functions first that will eliminate one or more of the other possible faulty functions. For example, if taking an ohmmeter reading can determine the fault; do not take a voltmeter reading, as that requires power on the equipment. If you must disassemble part of the machine to reach a test point, perform a simpler test first. Test at a midway point in the circuitry, if possible. A good reading at the midway point eliminates the preceding functions and indicates that the problem is in the remaining circuits. A faulty signal at the midway point means that the problem is in the functions that process the signal before the midway point. In the previous clamp example, test the clamp's pressurization circuits where the clamp's fully retracted signal input either eliminates that function or confirms that the cause of the problem is a clamp that is not fully returned and, therefore, cannot be pressurized. Continue testing inputs and outputs of the suspect functions until you identify and confirm the single faulty function.

Electrical System Troubleshooting Procedure	
Step	**Action**
4	**Isolate the faulty circuit.** In this step, you locate the single malfunctioning circuit within a functional group of circuits. Use the accumulated symptom and test data to close in on the single faulty circuit. Follow the guidelines from Step Three, but apply them to the circuits related to the faulty function. Use schematic and block diagrams to locate test points. In the clamp example, assume that the clamp's fully retracted signal is not present at the input to the clamp's pressurization circuits. Test within the clamp's retracted circuits until you identify a single faulty circuit. The first test may reveal that the output of the clamp's fully retracted circuit is bad. A check of the inputs to this circuit may indicate that the input from a clamp's retracted- switch is bad but that all others are good. You can now identify the problem as being associated with one of the relatively few parts contained in a single circuit.
5	**Locate / verify the cause of the malfunction.** The tests you make in this step identify the failing part within the faulty circuit. Test the circuit until you find the cause of the malfunction. Examine and test the faulty part to verify that it has caused the problem and produced the observed symptoms.

7.6.2 Sequence Stops

Sequence stops encompass a broad range of problems, most of which only require simple repair. Most sequence stops can be traced to a limit or proximity switch that has not been tripped. A logic controller network controls the sequencing of components. When an input is received, it initializes the appropriate output based on current system logic.

These sensor devices are in use constantly during machine operation. Most problems with sequencing can be attributed to dirty, faulty, or maladjusted switches. In less common cases, sequence stops are due to an output device not activating. Problems here can range from failed actuators to a logic failure. Isolating either problem can be done quickly with a basic understanding of machine operation and station controls.

Problems not attributed to output device failure may be the cause of a physical disconnection. Look for broken air lines, loose cable connections, or mechanical obstruction. Mechanical obstruction can often take the form of debris buildup on, or near sensors. In the event of sensor failure, examine the actuating device to determine if the stop occurred before or after the mid-range point of the actuated device. If the stop occurs before midpoint, this indicates an advance sensor failure. A stop past midpoint signifies a retract sensor failure. If the problem cannot be physically identified, use wiring diagrams to locate the output module for the actuating device.

7.6.3 Repairing Sensors

Prior to repairing a sensor, ensure that the related actuator has traveled full stroke to the correct physical trip position. In some cases the sensor may be fully operational but the actuator motion is limited by an obstruction.

Return the actuator to the opposite position of the failure. Manually trip the sensor and observe the indicator on the I/O card to see if the sensor is operating correctly. If no indication is observed, replace the sensor and repeat the test. If there is still no indication, the problem exists in the wiring between the controller and the sensor.

Manually operate the actuator several times to ensure proper adjustment of the sensor.

7.6.4 Non-Actuating Problems

After examining the system for obvious physical breaks, attempt to operate the device using manual controls. Manual operation may also reveal the presence of an obstruction. If it is determined that the failed component is receiving proper pneumatic pressure and there is no obstruction, the problem is controls related. If the problem is determined to be controls based, it exists somewhere between the cable system and the controller. First, determine if the controller is receiving power. If the power supplies are functional, proceed to the next step. Be aware that a malfunction of the power supply may have caused damage to other components.

7.6.5 Programmable Logic Controller (PLC)

Troubleshooting is a straightforward process in automated systems. When you encounter a problem, remember that less than one-third of all system failures will be due to the PLC. Most of the failures are due to input and output devices. Often the error checking capabilities present on the PLC modules are sufficient for fault diagnosis. The light emitting diodes (LEDs) on PLC central processing units and modules can provide immediate feedback on what is happening. PLCs are equipped with light emitting diodes (LEDs) to indicate blown fuses and other problems. Examine these indicators first.

7.6.6 PLC Inputs

If the field device connected to an input module does not seem to turn ON, a problem may exist somewhere between the L1 connection and the terminal connection to the module. An input module's status indicators can provide information about the field device, the module, and the field device's wiring to the module that will help pinpoint the problem.

PLC Input Troubleshooting Procedure	
Step	**Action**
1	The first step in diagnosing the problem is to place the PLC in standby mode, so that it is not activating the output. This allows the field device to be manually activated (e.g., a limit switch can be manually closed). When the field device is activated, the module's power status indicator should turn on, indicating that power continuity exists. If the indicator is on, then wiring is not the cause of the problem.
2	Try using the PLC's test mode, which reads the inputs and executes the program but does not activate the outputs. In this mode, the PLC's display should either show a 1 in the image table bit corresponding to the activated field device or the contact's reference instruction should become highlighted when the device provides continuity. If the PLC is reading the device correctly, then the problem is not located in the input module. If it does not read the device correctly, then the module could be faulty. The logic side of the module may not be operating correctly, or its optical isolator may be blown. Moreover, one of the module's interfacing channels could be faulty. In this case, the module must be replaced.
3	If the module does not read the field device's signal, then further tests are required. Bad wiring, a faulty field device, a faulty module, or an improper voltage between the field device and the module could be causing the problem. First, close the field device and measure the voltage to the input module. The meter should display the voltage of the signal (e.g., 120 volts AC). If the proper voltage is present, the input module is faulty because it is not recognizing the signal. If the measured voltage is 10–15% below the proper signal voltage, then the problem lies in the source voltage to the field device. If no voltage is present, then either the wiring or the field device is the cause of the problem. Check the wiring connection to the module to ensure that the wire is secured at the terminal or terminal blocks.
4	To further pinpoint the problem, check that voltage is present at the field device. With the device activated, measure the voltage across the device using a voltmeter. If no voltage is present on the load side of the device (the side that connects to the module), then the input device is faulty. If there is power, then the problem lies in the wiring from the input device to the module. In this case, the wiring must be traced to find the problem.

7.6.7 PLC Outputs

PLC output interfaces also contain status indicators that provide useful troubleshooting information. Like the troubleshooting of PLC inputs, the first step in troubleshooting outputs is to isolate the problem to the module, the field device, or the wiring.

PLC Output Troubleshooting Procedure	
Step	**Action**
1	At the output module, ensure that the source power for switching the output is at the correct level. In a 120 VAC system, this value should be within 10% of the rated value (i.e., between 108 and 132 volts AC). Also, examine the output module to see if it has a blown fuse. If it does have a blown fuse, check the fuse's rated value. Furthermore, check the output device's current requirements to determine if the device is pulling too much current.
2	If the output module receives the command to turn on from the processor yet the module's output status does not turn on accordingly, then the output module is faulty. If the indicator turns on but the field device does not energize, check for voltage at the output terminal to ensure that the switching device is operational. If no voltage is present, then the module should be replaced. If voltage is present, then the problem lies in the wiring or the field device. At this point, make sure that the field wiring to the module's terminal or to the terminal block has a good connection and that no wires are broken.
3	After checking the module, check that the field device is working properly. Measure the voltage coming to the field device while the output module is on, making sure that the return line is well connected to the device. If there is power yet the device does not respond, then the field device is faulty.
4	Another method for checking the field device is to test it without using the output module. Remove the output wiring and connect the field device directly to the power source. If the field device does not respond, then it is faulty. If the field device responds, then the problem lies in the wiring between the device and the output module. Check the wiring, looking for broken wires along the wire path.

7.6.8 PLC Processor

The PLC processor also provides diagnostic indicators that show the status of the PLC and the CPU. Such indicators include power OK, memory OK, and communications OK conditions.

PLC Processor Troubleshooting Procedure	
Step	**Action**
1	First, check that the PLC is receiving enough power from the transformer to supply all the loads. If the PLC is still not working, check for voltage supply drop in the control circuit or for blown fuses.
2	If the PLC does not come up even with proper power, then the problem lies in the CPU. The diagnostic indicators on the Rear of the CPU will show a fault in either memory or communications. If one of these indicators is lit, the CPU may need to be replaced.

In conclusion, the best method for diagnosing input/output malfunctions is to isolate the problem to the module, the field device, or the wiring. If both power and logic indicators are available for review, then module failures will become readily apparent.

The first step in solving the problem is to take a voltage measurement to determine if the proper voltage level is present at the input or output terminal. If the voltage is adequate at the terminal and the module is not responding, then the module should be replaced. If the replacement module has no effect, then field wiring may be the problem.

A proper voltage level at the output terminal while the output device is off also indicates an error in the field wiring. If an output rung is activated but the LED indicator is off, then the module is faulty.

If a malfunction cannot be traced to the I/O module, then the module connectors should be inspected for poor contact or misalignment. Finally, check for broken wires under connector terminals and cold solder joints on module terminals.

7.6.9 Control Panel

Control Panel Troubleshooting Chart		
Symptom	**Possible Cause**	**Probable Solutions**
Power will not come on.	Disconnect is off.	Verify disconnects on the main control panels are in the on position.
	Blown fuse.	Check/replace fuse.
	Circuit breaker tripped.	Check/reset circuit breaker.
	E-Stop string active.	Check/reset E-Stops and safety gate plugs.
	Incoming power fault.	Check incoming line power just before the disconnect.
		Check that the buss connection is made and condition of buss plug.
		Verify that buss has power by checking if other equipment on buss is operating.
	Disconnect faulty.	Check the disconnect operating mechanism. Repair or replace, if necessary.
		Check condition of contacts. Clean or replace, if necessary.
Control power will not come on.	E-Stop active.	Be sure that all E-Stop push buttons are reset.
	Fault present.	Correct and clear fault.
	Blown fuse.	Check/replace fuse.
Master power will not come on.	Bodyline interlock.	Check PLC signal.
	Blown fuse(s).	Check fuse(s). Replace, if required.
	Control transformer faulty.	Check for voltage present on terminals. Replace transformer, if necessary.
	Control master relay.	Check operation of master relay. Check contacts. Repair or replace, if necessary.
	E-Stop circuit active.	Check/reset E-Stops, safety gate plugs or other safety interlocks. Reset.
	Proximity or limit switch.	Check if supply voltage is present to the sensor. Check status light on input card.
		If voltage is not present, check power supply.
Master power will not come on.	Proximity or limit switch. (Continued)	Verify correct voltage is wired to device.
		Check all point to point connections.
		Check all cords and connectors. Swap out a cord to see if it's faulty.

Control Panel Troubleshooting Chart		
Symptom	**Possible Cause**	**Probable Solutions**
(Continued)		Switch devices to see if it is faulty.
		Voltage spikes or transients may cause intermittent problems. Check for fluctuations in line current. Check power supply.
		Check equipment ground. Intermittent ground will cause problems.

7.6.10 Proximity / Limit Switch

Proximity / Limit Switch Troubleshooting Chart		
Symptom	**Possible Cause**	**Probable Solutions**
Detection failure.	Debris or foreign object on fingers.	Clean fingers with damp cloth. Remove any foreign objects.
	Misalignment.	Check finger for damage or bending. Replace as needed.
	Scratch on switch contacts.	Replace proximity switch.
	Debris or foreign object obstructing wand.	Remove obstructions or foreign object from wand.

7.6.11 Solenoid Coils

Solenoid Coil Inspection Procedure	
Step	**Action**
1	Remove it from the machine (plug ports on valves if required).
2	Disassemble and visually examine the solenoid for signs of overheating or mechanical problems.
3	Test the coil by attaching an ohmmeter (set to a low resistance range) across the coil terminals. A relatively low reading (a few thousand ohms or less) should be observed on the meter if the coil is good. It should not read zero ohms as this indicates the coil windings are shorted to each other, probably as a result of melted insulation. If the ohmmeter reads infinity, it means that the coil has opened up and is defective.

7.6.12 Contact Relays

Contact Relay Inspection Procedure	
Step	**Action**
1	Remove it from the machine.
2	Carefully examine the relay for mechanical problems.
3	If none are noted, check the relay coil in the same way as a solenoid coil. The electrical contacts can be tested with an ohmmeter in the same way that any switch contacts are tested. The meter should read zero when the contacts are closed and infinity when they are open.
4	Manually actuate the relay armature to conduct these tests and remember to test both the normally open and normally closed contact.

7.6.13 Circuit Breakers

Circuit Breaker Inspection Procedure	
Step	**Action**
1	Remove dust, dirt, soot, grease, or moisture from the surface of the circuit breaker using a lint-free dry cloth, brush, or vacuum cleaner. Do not blow debris into circuit breakers. If contamination is found, look for the source and eliminate the problem.
2	Switch circuit breaker to on and off several times to be sure that the mechanical linkages are free and do not bind. If mechanical linkages are not free, replace the circuit breaker.
3	Check base, cover, and operating handle for cracks, chipping, and discoloration. The circuit breaker should be replaced if cracks or severe discoloration is found.
4	Check terminals and connectors for looseness or signs of overheating. Overheating will show as discoloration, melting, or blistering of conductor insulation, or as pitting or melting of conductor surfaces due to arcing. If there is no evidence of overheating or looseness, do not disturb or tighten the connections. If there is evidence of overheating, termination points should be cleaned or replaced. Before re-energizing the circuit breaker, all terminations and cables should be refurbished to the original condition they were in when first installed.
5	Check circuit breaker mounting hardware, and tighten if necessary.

7.7 SUPPLIER EQUIPMENT TROUBLESHOOTING

Troubleshooting procedures for supplier equipment is provided in the OEM documentation provided with the equipment.

NOTES

SECTION 8
SPARE PARTS

Table of Contents

8.1 MACHINE BUILDER / INTEGRATOR

JENOPTIK AUTOMOTIVE NORTH AMERICA LLC
1500 W Hamlin Rd,
Rochester Hills, MI 48309
Phone: 248-853-5888
Website: https://www.jenoptik.com/

JENOPTIK AG (Germany)
Carl-Zeiß-Straße 1,
07743 Jena, Germany
Phone: +49 3641 650

8.1.1 Spare Parts List

For a complete list of spare parts, refer to the V30 Spare Parts List for more information.

NOTES

SECTION 9
DRAWINGS

Table of Contents

9.1 DRAWING LIST

A complete set of drawings was delivered to Stellantis with the equipment. The following table lists all drawings provided:

Title	Drawing Number
Electrical Controls Drawings	KEP4-CRK-0178-0000-0-E-001
Pneumatics Drawings	KEP4-CRK-0178-0000-0-P-001
Machine Layout	662651-00_mechanic_op1178
Measuring Setup	662670-00_measuring_setup_cpl
Lifting Station	662671-00_lifting_station_cpl
Rotary Drive (Headstock)	662672-00_rotary_drive_cpl
Setting Master Supply	662674-00_setting_master_supply
Admission	662675-00_admission_cpl
Clamping Workpiece	662676-00_clamping_workpiece
Measuring Satellites	662677-00_measuring_satellites
Tailstock	663525-00_tailstock_cpl
Cable Duct	667611-00_cable_duct_cpl
Measuring Principle	661860-02_measuring_principle_OP178

SECTION 10
APPENDIX

Table of Contents

10.1 MANUFACTURER CONTACT INFORMATION

10.1.1 JENOPTIK Automotive North America, LLC

Website: https://www.jenoptik.com/

Document Description	Document Name
Operating manual - Gageline PS50 and PS100 - Probe Satellites	552646_BA_PS50_PS100_V1.01_en.pdf
Operation manual - Gageline Tolaris Premium - Description of the user interface	637880_OM_Tolaris_Premium_en.pdf
EU Declaration of Conformity	CE_ProbeSatellites_complete_V2_(2020)_en.pdf
Measuring Principle Crankshaft HO/SO	661860-02_measuring_principle_OP178.pdf
Calibration Master Mean SO- OP178	662501-00_em_kw_so_op_180_sheet_1.pdf
Calibration Master Mean SO- OP178	662501-00_em_kw_so_op_180_sheet_2.pdf
Calibration Master Mean HO- OP178	662504-00_em_kw_ho_op_180_sheet_1.pdf
Calibration Master Mean HO- OP178	662504-00_em_kw_ho_op_180_sheet_2.pdf

10.1.2 Balluff, Inc.

Website: www.balluff.com

Document Description	Document Name
BOS 6K/BKT 6K Photoelectric Proximity Sensor - Operating Instructions	MAN_BOS_6K_RLT_X_B17_DRW_892307_03_000.pdf
BNI IOL-802-102-Z037 - Smart Light User's Guide	MAN_BNI_IOL_802_102_Z03X_EN_K17_DOK_915906_08_000.pdf
Balluff Network Interface IO-Link - Installation Guide	MAN_MIC_BNI_IOL_802_XXX_Z037_006_DE_L17_DRW_914748_04_000.pdf

10.1.3 Cognex Corporation

Website: https://support.cognex.com/en/downloads/

Document Description	Document Name
DataMan® 370 Series - Quick Reference Guide	DM370_Series_Quick_Reference.pdf
DataMan® 370 Series - Reference Manual	DM370_Series_Reference_Manual.pdf

10.1.4 Euchner USA

Website: www.euchner-usa.com

Document Description	Document Name
Safety Information and Maintenance (Part of the Operating Instructions for Safety System MGB-L.B-EI.-… (Ethernet/IP))	393498.pdf
Transponder-Coded Safety Switch With Guard Locking - CET.-AP-… (Unicode/Multicode) - Operating Instructions	429556.pdf
MGB-L..B-EI-… (Ethernet/IP) With Data Structure Type A - Operating Instructions	432970.pdf

10.1.5 IFM Efector, Inc.

Website: www.ifm.com

Document Description	Document Name
Operating instructions - Photoelectric distance sensor - OGD592 / OGD593	80272871UK.pdf
OGD - IO Link	ifm-OGD592-20180314-IODD11-en.pdf
Operating instructions - Through-beam sensor with IO-Link - OGE / OGS	80282420UK.pdf
Operating instructions - Electronic pressure sensor - PN7xxx	80285720UK.pdf

10.1.6 Purex Incorporated

Website: www.purexinc.com

Document Description	Document Name
Digital Series Operators Manual	Manual-Digital-822005.pdf

10.1.7 Siemens, USA

Website: www.siemens.com/us/en/home.html

Document Description	Document Name
SIMATIC Automation system S7-1500, Automation system ET 200MP Manual Collection	s71500_et200mp_manual_collection_en-US.pdf
SIMATIC S7-1500 - CPU 1516-3 PN/DP (6ES7516-3AN02-0AB0)	s71500_cpu1516_3_pn_dp_manual_en-US_en-US.pdf
SIMATIC S7-1500 S7-1500/S7-1500T Motion Control alarms and error IDs V6.0, STEP 7 V17 or higher - Diagnostics Manual	s71500_s71500t_alarms_errorids_diagnostics_manual_en-US_en-US.pdf
SIMATIC HMI - HMI devices Comfort Panels - Operating Instructions	HWComfortPanelsenUS_en-US.pdf
SIMOTICS S-1FG1 servo geared motor - Operating Instructions	1FG1_op_instr_0321_en-US.pdf
Drive technology - 1FK7 G2 synchronous motors - Configuration Manual	1FK7_G2_config_man_0218_en-US.pdf
Drive technology - 1FK7 G2 synchronous motors - Operating Instructions	1FK7_G2_op_instr_0521_en-US.pdf
Drive technology - Replacing an encoder for SIMOTICS S-1FK7 G2, S-1FG1 and S-1FT7 - Service Instructions	1FK7G2_1FG1_1FT7_service_man_0118_en-US.pdf

10.1.8 SKF Lubrication Systems Germany GmbH

Website: www.skf.com/lubrication

Document Description	Document Name
Gear Pump Units of Product Series MKU, MKF, MKL Assembly instructions acc. to EC Dir. 2006/42/EC for partly completed machinery, with associated operating instructions	0901d196803bd948-951-170-223-EN_tcm_12-163150.pdf

10.1.9 Telesis Technologies, Inc.

Website: www.skf.com/lubrication

Document Description	Document Name
Maintenance Tasks	Maint task.xlsx
Spare Parts For Purchased Equipment	FCA KEP (Jenoptik) Spare Parts List.xls
Installation & Maintenance - F-series/Model 6/6SP - Laser Marking Systems	68637.pdf
Merlin® II LS - Laser Marking System Software - Operating Instructions	44836.pdf
Installation and Setup - CIFX-Profinet® Option - For Telesis Laser Marking Systems	85857.pdf

NOTES