

Adept Robot Safety Guide



adept[®]

Adept Robot Safety Guide



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Chapter 1: Alert Notation

There are six levels of alert notation used in Adept manuals. In descending order of importance, they are:



DANGER: This indicates an imminently hazardous electrical situation which, if not avoided, will result in death or serious injury.



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WARNING: This indicates a potentially hazardous electrical situation which, if not avoided, could result in serious injury or major damage to the equipment.



WARNING: This indicates a potentially hazardous situation which, if not avoided, could result in serious injury or major damage to the equipment.



CAUTION: This indicates a situation which, if not avoided, could result in minor injury or damage to the equipment.

NOTE: Notes provides supplementary information, emphasizes a point or procedure, or gives a tip for easier operation.

Chapter 2: Fixed Robots

2.1 Definition

An industrial robot is an automatically controlled, programmable, multi-purpose, manipulative machine with several degrees of freedom, for use in industrial automation applications. It may be either fixed in place or mobile.

2.2 Compliance and Intended Use

Compliance

The installation and use of Adept products must comply with all safety instructions and warnings in this guide and any user or reference guides for the equipment. Installation and use must also comply with all applicable local and national requirements and safety standards.

Intended Use

Adept equipment is not intended for use in any of the following situations:

- In hazardous (explosive) atmospheres
- In life-support systems
- In residential installations
- Where the Adept equipment will be subject to extremes of heat or humidity.



CAUTION: The instructions for operation, installation, and maintenance given in this guide and the robot user's guide must be strictly observed.

Non-intended use of Adept equipment can:

- Cause injury to personnel
- Damage the robot or other equipment
- Reduce system reliability and performance

All persons that install, commission, operate, or maintain the robot must:

- Have the necessary qualifications
- Read and precisely follow the instructions in this safety guide
- Read and precisely follow the instructions in the robot user's guide

If there is any doubt concerning the application, ask Adept to determine if it is an intended use or not.

2.3 Risk Assessment

Safety standards in many countries require appropriate safety equipment to be installed as part of the system. Safeguards must comply with *all* applicable local and national standards for the location where the robot is installed.

Adept has performed Risk Assessments for Adept robots, based on the intended applications of the robot. The conclusions are summarized below

Exposure

When Arm Power is on, all personnel must be kept out of the robot workcell by interlocked perimeter barriers. It is up to the customer to determine if teaching the robot in Manual Mode, by a skilled programmer (see See "Qualification of Personnel"), wearing safety equipment and carrying an Adept pendant, is allowable under local regulations.

Severity of Injury

Provided that skilled personnel who enter the robot workcell are wearing protective headgear, eyeglasses, and safety shoes, it is likely that injuries caused by the robot would be slight (normally reversible). The risk of severe injury increases as the size of the robot and payload increase.

Avoidance

If the customer determines that teaching the robot in Manual Mode is allowable, the programmer must always carry the pendant when inside the workcell, as the pendant provides both E-Stop and Enabling switch functions.

For *normal* operation (AUTO mode), user-supplied interlocked guarding must be installed to prevent any person entering the workcell while Arm Power is on.



DANGER: The robot system must be installed with user-supplied interlock barriers. The interlocked barriers must open the E-Stop circuit in the event of personnel attempting to enter the workcell when Arm Power is enabled. Failure to install suitable guarding or interlocks could result in injury or death.

The following circuits are all dual channel, and classified as category 3, PL-d:

- Front panel
- Adept Pendant
- Safety door (mute gate)
- External (user or line) E-Stop

The Risk Assessment for *teaching* an Adept product depends on the application. If the customer determines that teaching the robot in Manual Mode is allowable, the programmer may need to enter the robot workcell while Arm Power is enabled. Other programming methods can be used so that the programmer does not have to enter the workcell while Arm Power is on.

Examples of alternative methods of programming include:

- Programming from outside the safety barrier
- Programming with Arm Power off
- Copying a program from another (master) robot
- Off-line or CAD programming

Safety System Behavior

The standard control system is fully-hardened to all EMI influences. In addition, a software-based reduced-speed mode has been incorporated to limit speed and impact forces on an Operator and production tooling when the robot is operated in Manual Mode.

2.4 Transportation

Always use adequate equipment to transport and lift Adept products. See the Installation chapter of the robot user's guide for more information on transporting, lifting, and installing.

2.5 Safety Barriers



CAUTION: Adept Technology strictly prohibits installation, commissioning, or operation of an Adept robot without adequate safeguards. These must be compliant with applicable local and national standards.

Safety barriers must be provided that prevent personnel from entering the workcell whenever power is applied to the equipment. Adept systems are computer-controlled and may activate remote devices under program control at times or along paths not anticipated by personnel. It is critical that safeguards be in place to prevent personnel from entering the workcell whenever power to the equipment is present.

The user must ensure that adequate safeguards, safety barriers, light curtains, safety gates, safety floor mats, etc., are installed. The robot workcell must comply with applicable local and national standards.

The height and the distance of the safety barrier from the robot must ensure that personnel cannot reach the work envelope of the robot.



CAUTION: Never remove any safeguarding and never make changes in the system that will decommission a physical safeguard.

The Adept control system has features that aid the user in constructing system safeguards, including customer emergency-stop circuitry and digital input and output lines. The emergency power-off circuitry is capable of switching external power systems and can be interfaced to the appropriate user-supplied safeguards. See the Adept SmartController User's Guide for additional information.

Impact and Trapping Points

Adept robots are capable of moving at high speeds. If a person is struck by a robot (impacted) or trapped (pinched) serious injury could occur. Robot configuration, joint speed, joint orientation, and attached payload all contribute to the total amount of energy available to cause injury.

Hazards from Expelling a Part or Attached Tooling

Any tooling, fixtures, end-effectors, etc., mounted to the tool flange, or one of the other axes of the robot, must be attached by sufficient means to resist being expelled from the robot. Additionally, any payload must be held by the end-effector in a manner that prevents the payload from being expelled accidentally.

The safety barrier constructed around the robot must be designed to withstand the impact of any item expelled accidentally from the robot. Projectile energy can be calculated using the formula $E = \frac{1}{2}mv^2$.

NOTE: In the Projectile energy formula above:

E = Energy

M = Mass

V = Velocity

2.6 Robot Modifications

It is sometimes necessary to modify the robot in order to successfully integrate it into a work-cell. Unfortunately, many simple modifications can either cause a robot failure, or reduce the robot's performance, reliability, or lifetime. The following information is provided as a guideline to modifications.

Acceptable Modifications

In general, the following robot modifications do not cause problems, but may affect robot performance:

- Attaching tooling, utility boxes, solenoid packs, vacuum pumps, cameras, lighting, etc., to the robot tool flange
- Attaching hoses, pneumatic lines, or cables to the robot

These should be designed so they do not restrict joint motion or cause robot motion errors.

Unacceptable Modifications



CAUTION: For safety reasons, it is prohibited to make certain modifications to Adept robots.

The modifications listed below may damage the robot, reduce system safety and reliability, or shorten the life of the robot. The warranty of the entire robot, or certain parts, may be voided.



CAUTION: Making any of the modifications outlined below voids the warranty of any components that Adept determines were damaged due to the modification. You must contact Adept Customer Service if you are considering any of the following modifications:

- Modifying any of the robot harnesses or robot-to-controller cables
- Modifying any robot access covers or drive system components
- Modifying, including drilling or cutting, any robot surface
- Modifying any robot electrical component or printed-circuit board
- Routing additional hoses, air lines, or wires through the inside of the robot
- Modifications that compromise EMC performance, including shielding

2.7 Installation

General Precautions

Take precautions to ensure that the following situations do not occur:

- Improper installation or programming of the robot system
- Use of non-Adept supplied cables or modified components in the system

Safety Requirements for Additional Equipment

- Additional equipment used with the Adept robots (grippers, conveyor belts, etc.) must not reduce the workcell safeguards
- Emergency stop switches must be accessible at all times.
- All components in the robot workcell must comply with all local and national safety requirements

2.8 Operation

This guide and the robot user's guide must be read by all personnel who install, operate, or maintain Adept systems, or who work within or near the workcell.

A moving robot arm can cause serious injury.

- Do not enter the safety fence during automatic operation
- Push the emergency stop button before entering the workcell
- Do not defeat any aspect of the safety E-Stop system
- Do not defeat an interlock so that an operator can enter a workcell with High Power ON
- Take precautions to prevent ejection of a work piece (See "Hazards from Expelling a Part or Attached Tooling ")

Adept robots have a Manual and an Automatic (AUTO) operating mode. While in Automatic Mode, personnel are not allowed in the workcell.

If the customer determines that teaching the robot in Manual Mode is allowable under local regulations, operators with additional safety equipment may work in the robot workcell. For safety reasons the operator should, whenever possible, stay outside of the robot workcell to prevent injury. The maximum speed and power of the robot is reduced, but it could still cause injury to the operator.

The type of safety equipment required for operators working within a workcell must be determined by the user, based on industry standards and their installation. Safety glasses, protective headgear (hard hat), and safety shoes are examples to be considered.

Warning signs must be posted around the workcell to ensure that anyone working around the robot system knows they must wear safety equipment.

Qualification of Personnel

This guide assumes that all personnel have attended an Adept training course and have a working knowledge of the system. The user must provide the necessary additional training for all personnel who will be working with the system.

As noted in this guide, certain procedures should be performed only by skilled or instructed persons. For a description of the level of qualification, Adept uses the standard terms:

- **Skilled persons** have technical knowledge or sufficient experience to enable them to avoid the dangers, electrical and/or mechanical
- **Instructed persons** are adequately advised or supervised by skilled persons to enable them to avoid the dangers, electrical and/or mechanical

All personnel must observe industry-prescribed safety practices during the installation, operation, and testing of all electrically-powered equipment. To avoid injury or damage to equipment, always remove power by disconnecting the AC power from the source before attempting any repair or upgrade activity. Use appropriate lockout procedures to reduce the risk of power being restored by another person while you are working on the system.



WARNING: Before working with the robot, every entrusted person must confirm that they:

- Have received the guides (both this guide, and the robot user's guide)
- Have read the guides
- Understand the guides
- Will work in the manner specified by the guides

Protection Against Unauthorized Operation

The system must be protected against unauthorized use. The user or operator must restrict access to the keyboard and the pendant by locking them in a cabinet or using another adequate method.

2.9 Sound Emissions

The sound emission level of the Adept robots depends on the speed and payload. The maximum value is 90 dB. (This is at maximum AUTO-mode speed.)



WARNING: Acoustic emission from this robot may be up to 90 dB (A) under worst-case conditions. Typical values will be lower, depending on payload, speed, acceleration, and mounting. Appropriate safety measures should be taken, such as ear protection and display of a warning sign.

2.10 Thermal Hazard

The following warning applies to both the base and outer link for Adept Cobra robots. It applies to the base for the Adept Quattro robot, and all links for Adept Viper robots.



WARNING: You can burn yourself. Do not touch the robot after it has been running at high ambient temperatures (40-50° C, 104-122° F) or at fast cycle times (over 60 cycles per minute). The robot skin/surface temperature can exceed 85° C (185° F).

2.11 Maintenance

Before performing maintenance in the workcell of the robot, High Power must be switched off and the power supply of the robot must be switched off and locked and tagged out. After these precautions, a skilled person is allowed to perform maintenance on the robot.

Only skilled persons with the necessary knowledge about safety and operating the equipment are allowed to maintain the robot system.



CAUTION: During maintenance and repair, the power of the Adept equipment must be turned off. Lockout measures must be used to prevent unauthorized personnel from turning on power.

2.12 Risks That Cannot Be Avoided

The Adept control system includes devices that disable High Power if a system failure occurs. However, certain residual risks or improper situations could cause hazards. The following situations may result in risks that cannot be avoided:

- Failure of software or electronics that may cause high-speed robot motion in Manual Mode
- Failure of hardware associated with an enabling device or E-Stop system

2.13 What to Do in an Emergency Situation

Press any E-Stop button (a red push-button on a yellow background/field) and then follow the internal procedures of your company or organization for an emergency situation. If a fire occurs, use CO₂ to extinguish the fire.

Chapter 3: Mobile Robots

3.1 Definition

An industrial robot is an automatically controlled, programmable, multi-purpose, manipulative machine with several degrees of freedom, for use in industrial automation applications. It may be either fixed in place or mobile.

3.2 General Safety Instructions

Read the installation and operation instructions before using the equipment.

- Do not ride on the robot
- Do not exceed the maximum payload
Payload decreases as slope increases. Refer to the user's guide
- Do not drop the robot, run it off a ledge, or otherwise operate it in an irresponsible manner
- Do not get the robot wet, or expose the equipment to rain or moisture
- Do not use power extension cords unless properly rated
- Do not continue to run the robot after hair, yarn, string, or any other items have become wound around the robot's axles or wheels
- Never access the interior of the robot with the charger attached
Immediately disconnect the battery pack when removing the access cover.
- Do not use parts not authorized by Adept
- Do not use any charger not supplied by Adept
- Do not turn on the robot without the antennas in place
- Although the laser is Class 1 (eye-safe), Adept recommends you not look into it

3.3 Intended Use

The Adept equipment is not intended for use in any of the following situations:

- In hazardous (explosive) atmospheres
- In life-support systems
- In residential installations
- Where the Adept equipment will be subject to extremes of heat or humidity.
- In mobile, portable, marine, or aircraft systems

NOTE: The gyroscopic navigation used in Adept mobile robots requires a stationary environment for optimum accuracy. Therefore, Adept does not recommend them for use on a ship, train, aircraft, or other "moving" environment.



CAUTION: The instructions for operation, installation, and maintenance given in this guide and the robot user's guide must be strictly observed.

Non-intended use of Adept equipment can:

- Cause injury to personnel
- Damage the robot or other equipment
- Reduce system reliability and performance

Adept mobile robots are intended for use on level floors, in wheelchair-accessible areas.

The body of the robot must not come into contact with liquids. The drive wheels can tolerate damp floors, but the body of the robot must remain dry.

All persons that install, commission, operate, or maintain the robot must:

- Have the necessary qualifications
- Read and precisely follow the instructions in this safety guide
- Read and precisely follow the instructions in the robot user's guide

If there is any doubt concerning the application, ask Adept to determine if it is an intended use or not.

3.4 Qualification of Personnel

This guide assumes that all personnel have attended an Adept training course and have a working knowledge of the system. The user must provide the necessary additional training for all personnel who will be working with the system.

As noted in this guide, certain procedures should be performed only by skilled or instructed persons. For a description of the level of qualification, Adept uses the standard terms:

- **Skilled persons** have technical knowledge or sufficient experience to enable them to avoid the dangers, electrical and/or mechanical
- **Instructed persons** are adequately advised or supervised by skilled persons to enable them to avoid the dangers, electrical and/or mechanical

All personnel must observe industry-prescribed safety practices during the installation, operation, and testing of all electrically-powered equipment. To avoid injury or damage to equipment, always remove power by disconnecting the AC power from the source before attempting any repair or upgrade activity. Use appropriate lockout procedures to reduce the risk of power being restored by another person while you are working on the system.



WARNING: Before working with the robot, every entrusted person must confirm that they:

- Have received the guides (both this guide, and the robot user's guide)
- Have read the guides
- Understand the guides
- Will work in the manner specified by the guides

3.5 Safety Aspects While Performing Maintenance



DANGER: During maintenance of the charging station, disconnect the AC power cord to the charging station. Keep it locked up until you are done with maintenance.



DANGER: During maintenance and repair, disconnect the batteries of the robot as soon as possible. Avoid shorting the terminals of the batteries.

3.6 What to Do in an Emergency Situation

Press any E-Stop button (a red push-button on a yellow background/field) and then follow the internal procedures of your company or organization for an emergency situation. If a fire occurs, use CO₂ to extinguish the fire.



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