华数机器人

HSR-MD410-1500

机械操作维护手册

Mechanical Operation Maintenance Manual

V24.1.0

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在本说明书中，我们将尽力叙述相关内容。由于篇幅限制及产品开发定位等原因，不能也不可能对所有不必做或不能做的事件进行详细的叙述。因此，本说明书中没有特别描述的事件均可视为“不可能”或“不允许”的事件。

In this manual, we will do our best to describe the relevant contents. Due to space constraints and product development positioning, it is not possible or possible to describe in detail all the events that do not have to be done or cannot be done. Therefore, events not specifically described in this specification can be regarded as "impossible" or "impermissible".

我们已就印刷品的内容与描述的硬件和软件内容是否一致进行了校对，不排除存在不一致的情况。我们会定期校对印刷品的内容，并在之后的版本中作必要的更改。

We have proofread whether the content of the printed material is consistent with the hardware and software content described, and inconsistencies cannot be ruled out. We regularly proofread the contents of the printed material and make necessary changes in subsequent editions.

中国

China

目录

Content

引言 Introduction 1

1 安全 Safety 3

1.1 机器人安全须知 Robot Safe Use Instructions 3

1.1.1 调整、操作、保全等作业时的安全注意事项 Safety precautions during Adjustment, Operation, Preservation, etc. 3

1.1.2 机器人本体的安全对策 Security Countermeasures of Robot Body 7

1.2 机器人的转移、转让、变卖 Transport, Transfer or Sell the Robot 13

1.3 机器人的废弃 Discard Robot 14

2 基本说明 Basic Explanation 16

2.1 型号规格说明 Explanation of Type and Specification 16

2.2 机械系统的组成 Mechanical System Composition 17

2.3 机械性能参数 Mechanical Performance Parameter 17

2.3.1 相关性能参数 Performance Parameter 18

2.3.2 工作半径及运动范围 Working Radius and Motion Range 19

2.4 搬运和存放 Handling and Storage 20

2.4.1 开箱 Unpacking 20

2.4.2 搬运 Handling 22

2.5 安装 Installation 26

2.5.1 安全围栏 Safety Switch 27

2.5.2 安装环境 Installation Environment 29

2.5.3 机器人安装及固定尺寸 Robot Installation and Fixing Dimension 31

2.5.4 安装举例 Installation Practice 33

2.6 机器人负荷允许值 Allowable robot load 35

2.7 电气连接 Electrical connections....36
2.7.1 本体与控制柜连接 Connection between the main body and the control cabinet....37
2.7.2 本体接地 grounding....37
2.7.3 信号线和气管 Signal line and trachea....38

3 检修及维护 Overhaul and Maintenance....39
3.1 维修检验项目及周期....40
3.2 主要螺栓的检修 Overhaul of Main Bolt....42
3.3 润滑油的检查及更换 Check and replacement of Lubricant....42
3.3.1 润滑油检查 Check for Lubricant....43
3.3.2 润滑油供给量 Lubricant Supply Amount....44
3.3.3 润滑油添加时机器人位姿 Robot pose during lubricant addition....44
3.3.4 润滑油更换 Replacement of lubricant....45
3.4 鱼眼轴承的维护保养 Maintenance and upkeep of fisheye bearings....51
3.5 电池更换 Replace Battery....52
3.6 零点校对 Zero calibration....54

4 故障处理 Failure Treatment....56
4.1 调查故障原因的方法 Methods to Investigate Reasons of Failure....56
4.2 故障现象和原因 Failure Phenomenon and Causes....58
4.3 各个零部件的检查方法及处理方法 Check Method and Treatment for Each Part....59
4.3.1 减速机 Reducer....59
4.3.2 电机 Motor....60

5 附录 Appendix....61
5.1 机器人备件目录 Spare parts of the robot....61
5.2 螺钉拧紧说明 Screw Tightening Instructions....61
5.3 密封胶应用 Application of Sealant....63

引言 Introduction

前言

Preface

感谢贵公司购买华数机器人。

Thank you for purchasing Huashu Robot.

本说明书介绍了 HSR-MD410-1500 工业机器人的机械操作维护，是用户快速学习和使用的基本说明书。

This manual introduces the mechanical operation and maintenance of HSR-MD410-1500 industrial robot, which is a basic manual for users to learn and use quickly.

在使用机器人之前，请仔细阅读本手册及其他相关手册，务必理解并熟悉手册中所说明的内容。

Before using the robot, please read this manual and other relevant manuals carefully, and be sure to understand and familiarize yourself with the content described in the manual.

阅读对象

object of reading

本说明书主要面向使用华数工业机器人的用户，请务必保证用户具备对工业机器人的基本知识。

This manual is mainly for users who use Huashu industrial robots, please be sure to ensure that users have basic knowledge of industrial robots.

图示说明

graphic illustration

在本说明书中可能出现下列图示，它们所代表的含义如下：

The following illustrations may appear in this manual, and their meanings are as follows：

图示 graphic	说明 illustration
 危险	表示处理有误时，会导致使用者死亡或者负重伤，危险性非常高的情形。 It indicates that improper handling can cause death or serious injury to the user, and the risk is very high.

	表示处理有误时，会导致使用者死亡或者负重伤的情形。 It indicates that improper handling can cause death or serious injury to the user, and the risk is very high.
	表示处理有误时，会导致使用者轻伤或发生财产损失的情形。 It indicates that improper handling will cause minor injury or property loss to the user.
	表示其他重要的情形。 Other important situations.

1 安全 Safety

工业机器人符合现行安全技术规定。尽管如此，违规操作可能会造成人身伤害，机器人或其他设备损坏。

The industrial robot complies with current safety technical regulations. Even though, operations against these regulations can result in personal injury, damage to the robot or other equipment.

只允许在机器人完好的状态下按规定且有安全意识地使用工业机器人。必须遵守本说明书使用机器人，必须及时排除有安全隐患的故障。

It is only allowed to use the industrial robot in intact status and in a prescribed and safe-conscious manner. To use this robot, this manual must be followed, so as to clear the failure with safety hazards in a timely manner.

华数机器人有限公司致力于提供可靠的安全信息，但不对此承担责任。即使一切操作都按安全操作说明进行，也不能确保机器人不会造成人身伤害及财产损失。

It is only allowed to use the industrial robot in intact status and in a prescribed and safe-conscious manner. To use this robot, this manual must be followed, so as to clear the failure with safety hazards in a timely manner.

1.1 机器人安全须知 Robot Safe Use Instructions

实施安装、运转、维修保养、检修作业前，请务必熟读本书及其它附属文件，正确使用本产品。请在充分掌握设备知识、安全信息以及全部注意事项后，再使用本产品。

Before installing, operating, repairing, and overhauling, please be sure to familiarize yourself with this book and other accompanying documents and use this product correctly. Please fully understand the equipment knowledge, safety information, and all precautions before using this product.

1.1.1 调整、操作、保全等作业时的安全注意事项 Safety precautions during Adjustment, Operation, Preservation, etc.

(1) 作业人员须穿戴工作服、安全帽、安全鞋等。

Operators should wear work clothes, safety helmets, safety shoes, etc.

(2) 投入电源时，请确认机器人的动作范围内没有作业人员。

Before connecting power supply, please make sure that there is no operator within robot's motion range.

(3) 机器人处于自动模式时，不允许任何人员进入机器人运动所及范围。

When the robot is in Automatic Mode, no personnel should enter the robot's motion range.

(4) 必须切断电源后，方可进入机器人的动作范围内进行作业，并且必须随身携带示教器，避免他人误操作。

Must cut off power supply before operators enter the robot's motion range. The teaching device should also be carried with in case mis operation by others.

(5) 检修、维修保养等作业必须在通电状态下进行时，应 2 人 1 组进行作业。1 人保持可立即按下紧急停止按钮的姿势，另 1 人则在机器人的动作范围内，保持警惕并迅速进行作业。此外，应确认好撤退路径后再行作业。

Where operations like overhaul, maintenance, etc. must be operated with power supply, and these should be operated in pairs. One is prepared to press the Emergency Stop button and another operates within the robot's motion range quickly with caution. Besides, the retreat path should be confirmed before operating.

(6) 手腕部位及机械臂上的负荷必须控制在允许搬运重量以内。如果不遵守允许搬运重量的规定，会导致异常动作发生或机械构件提前损坏。

The load on wrist part and manipulator arm must be controlled within the allowable load limit. Failure to comply with the rules of allowable load limit will cause abnormal action or premature damage of mechanical components.

(7) 万一发生火灾，请使用二氧化碳灭火器。

In case of fire, use a carbon dioxide fire extinguisher.

(8) 急停开关不允许短接。

The Emergency Stop mustn't be short-circuited.

(9) 请仔细阅读使用说明书《机械操作维护手册》的“安全注意事项”章节的说明。

Please read instructions in chapter "Precautions" in Mechanical Operation Maintenance Manual.

(10) 禁止进行维修手册未涉及部位的拆卸和作业。

Disassembling or operating components not mentioned in service manual is prohibited.

机器人配有各种自我诊断功能及异常检测功能，即使发生异常也能安全停止。即便如此，因机器人造成的事故仍然时有发生。

The robot is equipped with various self-diagnosis and abnormal detection functions, so it can stop safely after an abnormal occurs. Even so, accidents caused by robots still happen.

机器人事故以下列情况居多：

Those conditions prevail in robot accidents:

(1) 未确认机器人的动作范围内是否有人，就执行了自动运转。

Execute automatic running without ensuring there's no one within the robot's motion range.

(2) 自动运转状态下进入机器人的动作范围内，作业期间机器人突然起动。

Enter the robot's motion range in its automatic run mode, and the robot moves unexpectedly.

(3) 只注意到眼前的机器人，未注意别的机器人。

Focuses only on the robot in the front and pays no attention to other robots.

上述事故都是由于“疏忽了安全操作步骤”、“没有想到机器人会突然动作”的相同原因而造成的。换句话说，都是由于“一时疏忽”、“没有遵守规定的步骤”等不安全行为而造成的事故。

All the above accidents are caused by "neglecting safe operation steps", "unexpecting the abrupt action of robot" and other reasons similar to them. In other words, all caused by unsafe acts like"lapse of attention", "not following the prescribed steps".

“突发情况”使作业人员来不及实施“紧急停止”、“逃离”等行为避开事故，极有可能导致重大事故发生。“突发情况”一般有以下几种：

"Emergencies" are likely to cause major accidents because its abruptness allows no time for operators to press "Emergency Stop" or "'Escape". Generally, "Emergencies" include the following cases:

(1) 低速动作突然变成高速动作。

The low-speed action turn into high-speed abruptly.

(2) 其他作业人员执行了操作。

Other operators operates.

(3) 因周边设备等发生异常和程序错误，启动了不同的程序。

Another program starts due to peripheral equipment abnormality and program error.

(4) 因噪声、故障、缺陷等原因导致异常动作。

Abnormal actions due to noise, failure, defects, etc.

(5) 误操作。

Mis-operation.

(6) 原想以低速再生执行动作，却执行了高速动作。

Has intended to perform the action at a low speed, but execute the high speed action.

(7) 机器人搬运的工件掉落、散开。

The workpiece carried by the robot fall and fall apart.

(8) 工件处于夹持、联锁待命的停止状态下，突然失去控制。

The robot runs out of control when the workpiece in clamping, interlock standby stop state.

(9) 相邻或背后的机器人执行了动作。

Robots next to or behind this robot perform the action.

上述仅为一部分示例，还有很多形式的“突发情况”。大多数情况下，不可能“停止”或“逃离”突然动作的机器人，因此应执行下列最佳对策，避免此类事故发生。

The above is just part of examples and there still are "Emergencies" in many other forms. In most cases, it's impossible to "stop" or "escape" the sudden-action robots, so the following countermeasures should be executed to avoid accidents of this kind.

小心，勿靠近机器人。

Caution, keep off the robot.

不使用机器人时，应采取“按下紧急急停止按钮”、“切断电源”等措施，使机器人无法动作。

When non-use the robot, make it unable to act by pressing "Emergency Stop" button or "Power Cut", etc.

机器人动作期间，请配置可立即按下紧急停止按钮的监视人（第三者），监视安全状况。

During robot action, please configure a monitor (a third party) who can immediately press the Emergency Stop button to monitor the security situation.

机器人动作期间，应以可立即按下紧急停止按钮的态势进行作业。

The robot must be operated in a condition that the Emergency Stop button can be pressed at any time during its action.

为了遵守这些原则，必须充分理解下列注意事项，并切实遵行。

To comply with these principles, the latter precautions must be fully understood and observed.

1.1.2 机器人本体的安全对策 Security Countermeasures of Robot Body

机器人的设计应去除不必要的突起或锐利的部分，使用适应作业环境的材料，采用动作中不易发生损坏或事故的故障安全防护结构。

When designing the robot, remove unnecessary protrusion or sharp part, use materials suitable for the working environment, and adopt the fail-safe protection structure which is not damage-prone or accident-prone in robot action.

此外，应配备在机器人使用时的误动作检测停止功能和紧急停止功能，以及周边设备发生异常时防止机器人危险性的联锁功能等，保证安全作业。

Besides, to ensure safety, should equip the robot with mis-action detect-stop function and emergency stop function, also interlocking function to prevent risk caused by peripheral equipment.

在安全功能或防护装置取消激活或被拆下的情况下，禁止运行机器人。

Where the safety function or protective device is deactivated or removed, the robot is

not allowed to be operated.

在末端执行器及机械臂上安装附带机器时，应严格遵守本书规定尺寸、数量的螺栓，使用扭矩扳手按规定扭矩紧固。

When install the attached machine to the end effector or manipulator arm, please strictly comply with this manual and use bolt of the size and quantity exactly specified in this manual and tighten it with torque wrench at specified torque.

此外，不得使用生锈或有污垢的螺栓。

In addition, the rusty or soiled bolt should not be used.

规定外的紧固和不完善的方法会使螺栓出现松动，导致重大事故发生。

Not tightening through specified or improper method will cause the bolt looseness leading to major accident.

设计、制作末端执行器时，控制在机器人手腕部位的负荷容许值范围内。

When design, fabricate the end effector, keep the relevant data subject to allowable load value of the robot wrist part.

应采用故障安全防护结构，即使末端执行器的电源或压缩空气的供应被切断，也不致发生把持物被放开或飞出的事故，并对边角部或突出部进行处理，防止对人、对物造成损害。

Adopt fail-safe protection structure, so when the power of end effector or supply of compressed air is cut, the holding thing will not be released or threw away. Tend to the edges and protrusions to avoid damaging person or things.

严禁供应规格外的电力、压缩空气、焊接冷却水，会影响机器人的动作性能，引起异常动作或故障、损坏等危险情况发生。

Supplying off-specification power, compressed air, welding cooling water is forbidden because this will affect the motion performance, cause abnormal action or dangerous situations like failures, damages, etc.

电磁波干扰虽与其种类或强度有关，但以当前的技术尚无完善对策。机器人操作中、通电中等情况下，应遵守操作注意事项规定。由于电磁波、其它噪声以及基板缺陷等原因，会导致所记录的数据丢失。

lthough electromagnetic wave interference is related to its kind or intensity, there is no perfect countermeasure with current technology. Comply with the operation cautions when the robot is being operated or energized. The recorded data may get lost due to the electromagnetic wave, other noise, baseplate defects, etc.

因此请将程序或常数备份到闪存卡（Compact flash card）等外部存储介质内。

So please backup the program or constant to the external storage media like compact flash card.

大型系统中由多名作业人员进行作业，必须在相距较远处作交谈时，应通过使用手势等方式正确传达意图。

In a large scale system with multiple operators working simultaneously, when operators need the communicate over long distance, they should use manners like gestures to convey their real intention.

环境中的噪音等因素会使意思无法正确传达，而导致事故发生。

Factors like noise in the environment will undercut the communication, and cause accidents.

产业用机器人手势法（示例）

Industrial Robot Gestures (Sample)

	1.接通 Power on 做出接通开关的动作。 Make a posture to switch on.
	2.不行！断开 No! Power-off 右手高举，左右大力地挥动。 Raise your right hand high and wave it vigorously.
	3.可以吗（确认） Is that OK? (to confirm) 右手向前高高地举起。 Raise your right hand high, palms forward.
	4.可以（OK） 右手向前高高地举起，拇指和食指合成一个圈。 Raise your right hand high, palms forward, make a circle with the thumb and forefinger.
	5.稍等 Hold on 右手朝向对方的方向，手臂水平伸展。 Extend your right arm in the other person's direction, palm forward.
	6.离开 Left 右手臂水平伸展，并向左侧挥动。 Extend your right arm horizontally and wave it to your left.

注意

作业人员在作业中，也应随时保持逃生意识。

Operators should always be ready to escape from danger during operation.

必须确保在紧急情况下，可以立即逃生。

So they can escape from danger in case of emergency.

时刻注意机器人的动作，不得背向机器人进行作业。

Always focus on the action of robot and can't operate back to the robot.

对机器人的动作反应缓慢，也会导致事故发生。

Slow reaction to the robot action can also cause accidents.

发现有异常时，应立即按下紧急停止按钮。

Press Emergency Stop as soon as the abnormality occurs.

必须彻底贯彻执行此规定。

This clause must be strictly carried out all the time.

应根据设置场所及作业内容，编写机器人的起动方法、操作方法、发生异常时的解决方法等相关的作业规定和核对清单。并按照该作业规定进行作业。

Take setting place and operation content into consideration, and compile operation regulations and check lists of starting methods, operating methods, solutions to abnormality, etc. of the robot. And operate according to the regulations.

仅凭作业人员的记忆和知识进行操作，会因遗忘和错误等原因导致事故发生。

Operating only by memories or knowledges of operators will lead to accidents due to their forgetting and mistakes.

不需要使机器人动作和操作时，请切断电源后再执行作业。

When the robot is not required to move or act, please cut off power supply to continue the operation.

示教时，应先确认程序号码或步骤号码，再进行作业。

Before teaching, confirm the number of program or steps, then continue the operation.

错误地编辑程序和步骤，会导致事故发生。

Wrongly edit the program or steps will cause accidents.

对于已经完成的程序，使用存储保护功能，防止误编辑。

Use storage protection function to protect the completed program and avoid mis-editing.

示教作业完成后，应以低速状态手动检查机器人的动作。

After the teaching operation completed, check the robot state manually in low speed state.

如果立即在自动模式下，以 100%速度运行，会因程序错误等因素导致事故发生。

If run the robot immediately in automatic mode at 100% speed, factors like program error may cause accidents.

示教作业结束后，应进行清扫作业，并确认有无忘记拿走工具。作业区被油污染，遗忘了工具等原因，会导致摔倒等事故发生。

After the teaching operation completed, should operate cleaning and make sure all tools have been taken. Oil pollution in operation area or left tools will cause accidents like slipping.

确保安全首先从整理整顿开始。

Ensure safety from cleaning up.

没有固定机械臂便拆除马达，机械臂可能会掉落，或前后移动。请先固定机械臂，然后再拆卸马达。

Please fix the manipulator arm before detaching the motor. Please fix the manipulator arm before detaching the motor.

1.2 机器人的转移、转让、变卖 Transport, Transfer or Sell the Robot

机器人转移、转让、变卖到国外时，最初出售时的合同条项若无特别规定，则包含与安全有关的条项不得由新承受人继承。

When transport, transfer, sell the robot abroad, without special regulations in the original sales contract, the safety-related clauses will not be inherited by the new inheritor.

原客户与新承受人之间，必须重新签订合同。

The original client should sign a new contract with new inheritor.

机器人转移、转让、变卖时，必须确保操作说明书、维修保养说明书等机器人附属文件类移交给新的使用者。

When transport, transfer or sell the robot, make sure the operation manual, maintenance manual and other documents attached to this robot is transferred to new user.

转移、转让、变卖到国外时，客户必须负责准备适当语言的操作维修保养说明书，修改显示语言，并保证符合当地法律规定。

When transport, transfer or sell the robot abroad, the client must take the responsibility to prepare operation and maintenance manuals in proper language and alter the display language, and make sure to comply with local regulations.

新使用者由于没有阅读使用说明书而进行错误操作或不安全作业，会导致事故发生。

New user may conduct improper or unsafe operations without reading operation manual, which may cause accidents.

1.3 机器人的废弃 Discard Robot

请勿分解、加热、焚烧用于控制装置、机器人主体的电池，否则会发生起火、破裂、燃烧事故。

Do not decompose, heat or incinerate batteries used for control devices and robot bodies, or the fire, rupture, or combustion can be caused.

请勿将控制装置的基板、组件等分解后再废弃，破裂或切口等尖锐部分及电线等可能会造成伤害。

Don’t discard the baseplate and components of the control device directly after decomposition, sharp parts such as rupture or incision and electrical wires may cause injury.

电缆线、外部接线从连接器、接线盒拆除后，请勿做进一步分解再废弃。否则可能因导体等导致手或眼受伤。

Detach the cable, external circuit connection from connector and junction box, then discard them directly without further decomposition. Or the hand or eyes may get injured by conductor, etc.

进行废弃作业时，请充分注意不要被夹伤、受伤。

Please pay full attention to avoiding clamping or injury during discarding operation.

废弃品应在安全状态下废弃。

The discarded article should be discarded in a safe condition.

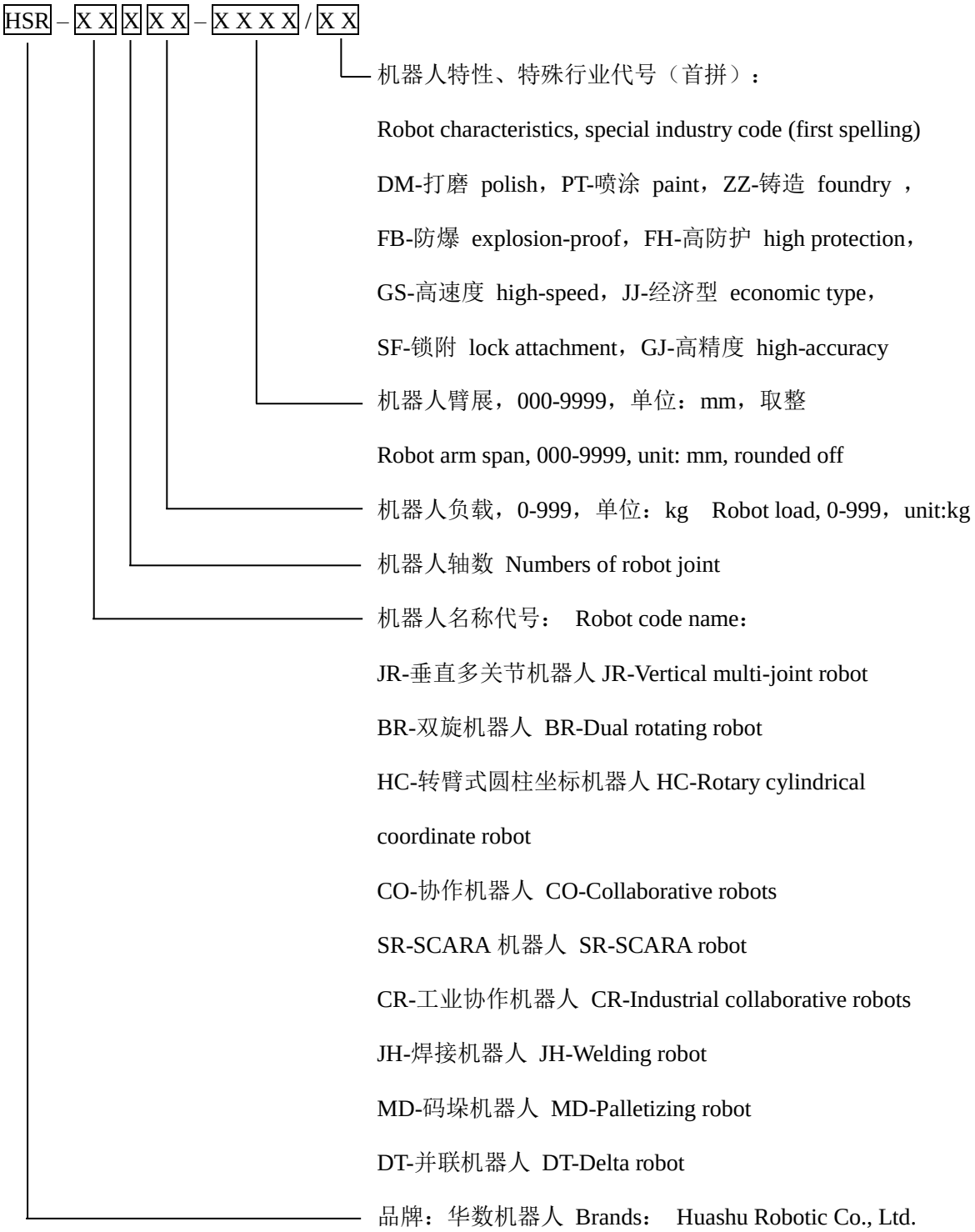
废旧电池和废旧润滑脂等有害环境的废旧物请按当地环保要求处理，避免造成环境污染。

To avoid environmental pollution, waste materials such as used batteries and used grease should be disposed according to local environmental protection requirements.

2 基本说明 Basic Explanation

2.1 型号规格说明 Explanation of Type and Specification

公司机器人型号说明如下 Explanation of Type：



2.2 机械系统的组成 Mechanical System Composition

本节介绍华数机器人本体的组成部分。

This section focuses on the composition of Huashu robot.

机器人机械系统是指机械本体组成，机器人本体主要由底座、大臂、小臂等构成，其相关关系见图 2.1 机器人系统组成图。

Robot mechanical system refers to the basic machine composition of the robot body, including pedestal, big arm, forearm, etc., see Diagram 2.1 for its system composition relations.

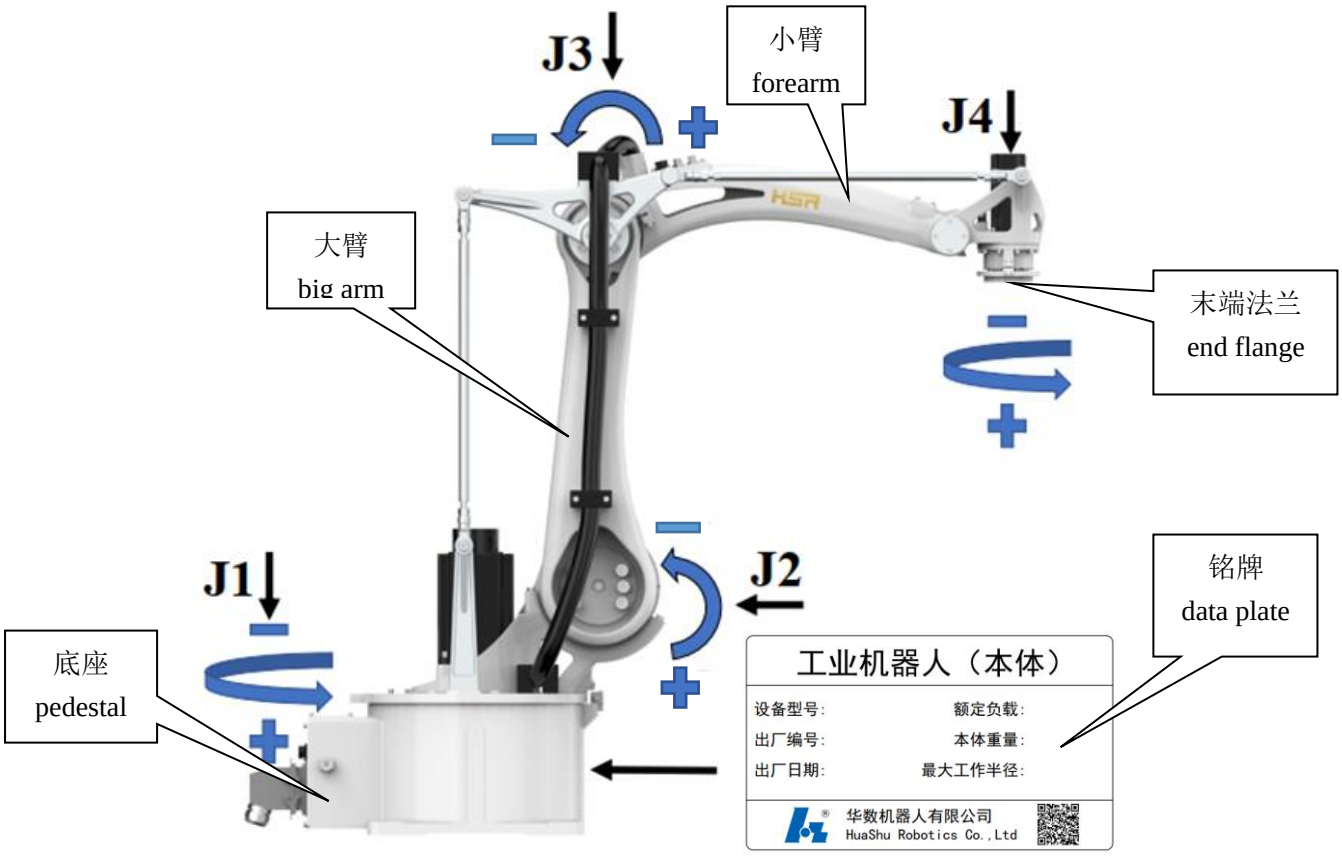


图 2-1 机器人机械系统组成 Diagram 2.1 Robot mechanical system composition

2.3 机械性能参数 Mechanical Performance Parameter

本节介绍机器人的性能参数，如机器人运动范围、速度、可达空间等。

This section introduces the performance parameters of the robot, such as motion range, speed, reachable space, etc.

2.3.1 相关性能参数 Performance Parameter

表 2-1 机器人性能参数 Table 2.1 Robot Performance Parameter

型号 Type		HSR-MD410-1500
控制轴 control joint		4
最大负载 Maximum load		10Kg
最大运动半径 Maximum motion radius		1510mm
重复定位精度 Repositioning resolution		±0.08mm
运动范围 Motion range	J1	±170°
	J2	-140 ?0 °
	J3	-30 ?155 °
	J4	±360 °
运行最大速度 Maximum speed	J1	379°/s，6.61rad/s
	J2	379°/s，6.61rad/s
	J3	267°/s，4.66rad/s
	J4	578°/s，10.09rad/s
容许惯性矩 Allowable inertia torque	J4	0.25kg ㎡
容许最大静态负荷扭矩 Allowable Maximum Static Load Torque	J4	42Nm
适用环境 Applicable conditions	温度 Temperature	0~45 °
	湿度 Humidity	20%~80%
	其他 Others	避免与易燃易爆或腐蚀性气体、液体接触，远离电子噪声源（等离子） Avoid contact with flammable, explosive or corrosive gases or liquids and stay away from electronic noise sources (plasma)
本体防护等级 Level of protection		IP54
安装方式 Assembly position		地面安装 Ground
本体重量 weight		140kg

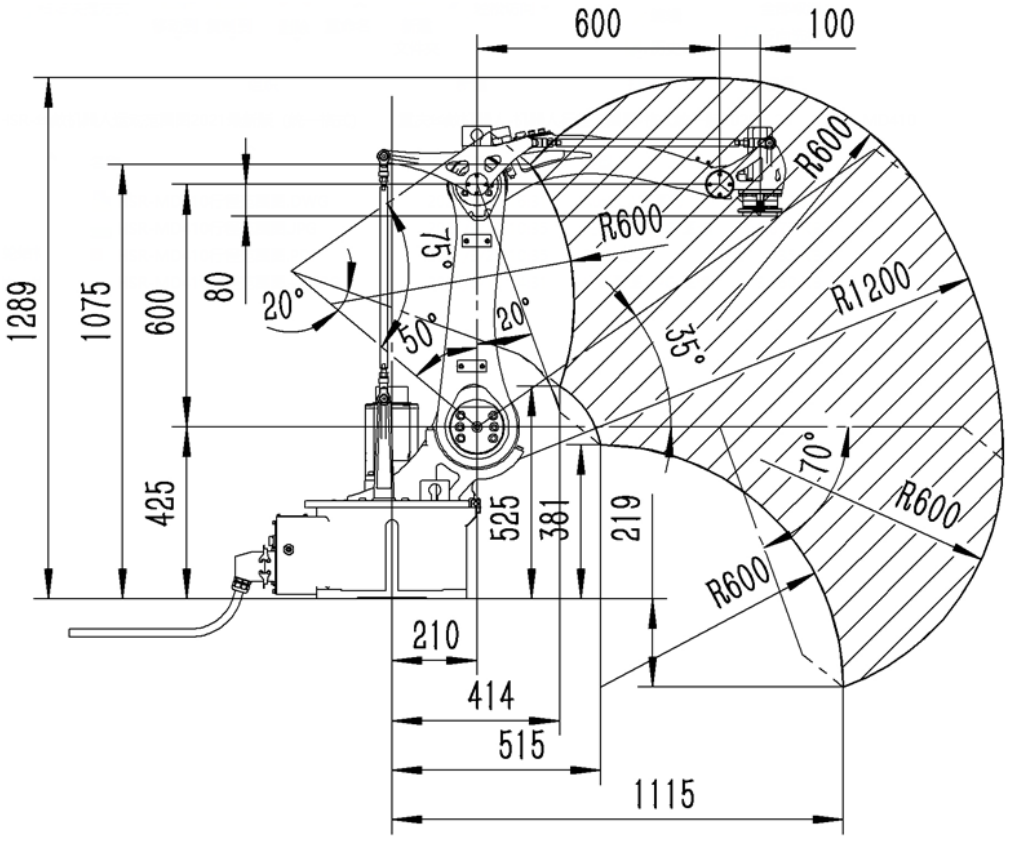
2.3.2 工作半径及运动范围 Working Radius and Motion Range

表 2.2 HSR-MD410-1500 单轴运动范围 Table 2.2 HSR-MD410-1500 motion range for each joint

	零点（°） Zero （°）	HSR-MD410-1500
J1	0 °	±170°
J2	-90 °	-140 ⁰/0 °
J3	90 °	-30 ⁰/155 °
J4	0 °	±360 °

注：机器人不能超行程使用。

Note: Robots cannot be used beyond their travel range.



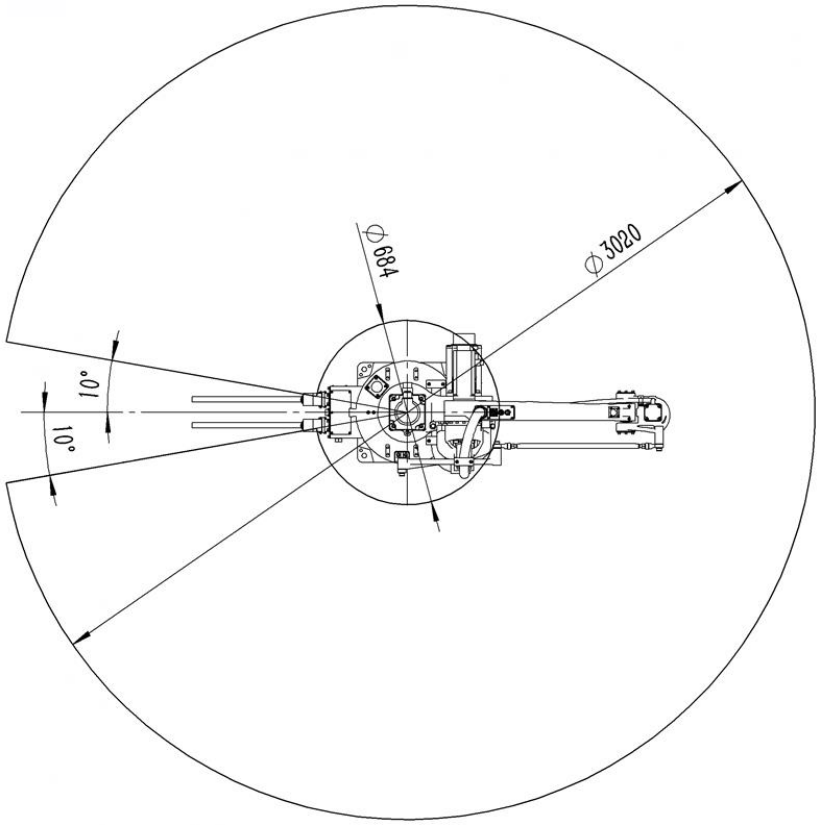


图 2.2 HSR-MD410-1500 机器人工作空间　Diagram 2.2 HSR-MD410-1500 robot work space

2.4 搬运和存放 Handling and Storage

本节介绍机器人开箱、搬运及相关注意事项，原则上应使用起重机或叉车进行机器人的搬运作业。在对 HSR-MD410-1500 工业机器人实施运输和存放过程中，应采取适当的预防措施；应在 0℃到 45℃温度范围内运输和存放，并能经受温度高达 70℃、时间不超过 24h 的短期运输和存放。不得强烈颠簸、振动、冲击和碰撞并应采取防潮措施，以免损坏电气设备。

This section introduces unpacking, handling and related precautions of the robot, and in principle, crane or forklift should be used for robot handling. During the transport and storage of HSR-MD410-1500 industrial robot, proper preventive measures should be taken; it should be transported and stored within the temperature range of -25℃ to 55℃, and can endure short-term (less than 24h) transport and storage at up to 70℃. To avoid damage to the electrical equipment, please take anti-moisture measures and prevent strong bumps, vibrations, shocks and bumps.

2.4.1 开箱 Unpacking

到货后请确认装箱内容及包装是否损坏。

Upon receipt, please check the packing contents and the package for any damage.

开箱过程中注意不要损伤机器人，开箱后请不要强制扳动、悬吊、骑坐机器人。

Please carefully unpack to keep the robot intact; after unpacking, please don't wrench, suspend or sit on the robot.

开箱后若要拆除机器人底座固定螺钉，过程中注意扶住机器人保持平衡以防机器人倾倒。

Where the fixing screw of the robot pedestal needs to be removed after unpacking, please support the robot to keep it balanced so as to prevent any falling.

注意

不要强制扳动、悬吊、骑坐机器人。

Don't wrench, suspend or sit on the robot.

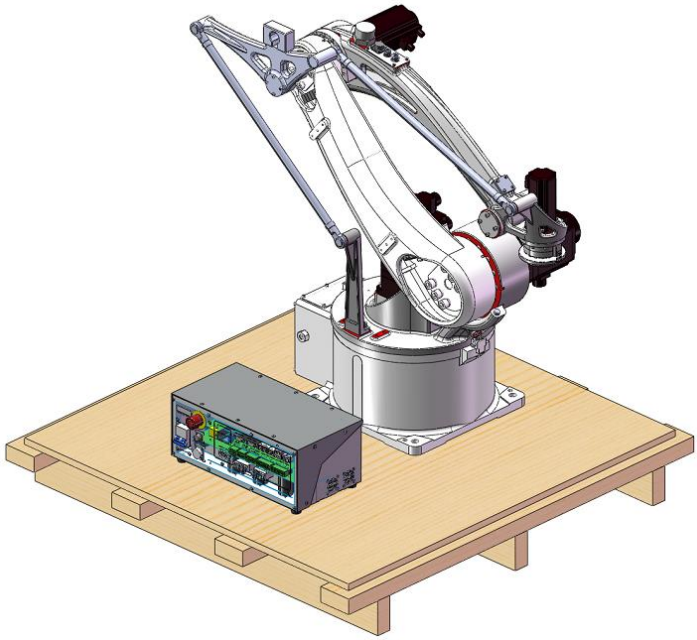


图 2.3 机器人包装状态示意图 Diagram 2.3 Robot packaging status diagram

2.4.2 搬运 Handling

起吊重量约 140kg（不含外设、搬运固定夹具及托盘），请选用承重能力足够大的叉车或起重机及足够强度的吊绳。

The lifting weight is about 185kg (excluding peripherals, handling fixtures and pallets), please choose a forklift or crane with a large enough load-bearing capacity and a lifting rope with sufficient strength.

在搬运机器人过程中，请务必避免让机器人受到过分冲击及振动。

When handling the robot, be sure to avoid exposing the robot to excessive shock and vibration

用叉车及起重机搬运机器人时，请事先清除障碍物等，确保机器人安全地搬运到安装位置。

When transporting the robot with a forklift or crane, remove obstacles and other obstacles in advance to ensure that the robot is safely transported to the installation position.

当使用起重机或叉车搬运机器人时，绝对不能人工支撑机器人机身。

When using a crane or forklift to move a robot, the robot body must never be supported manually.

请由具有资格的作业人员进行司索、起重机起吊作业或叉车驾驶等搬运作业。如果由没有资格的作业人员进行作业，则可能会导致重伤或重大损害，非常危险。

Please engage eligible operators to carry out sling, crane lifting, forklift driving and other handling operations. Operations by the ineligible can cause serious injury or major damage, it is very dangerous.

吊起机器人时，请确保机器人平衡。起吊不稳则可能会因机器人掉落而导致重伤或重大损害，非常危险。

When lift the robot, hold it with hands to ensure balance. Robot may fall due to unstable lifting can cause serious injury or major damage, it is very dangerous.

使用用搬运固定夹具搬运时使用完成后务必将其拆卸。

When using the carry-on fixture, be sure to disassemble it after use.

注意

在使用搬运固定夹具安装的螺纹孔安装其它附属设备时，机器人运动范围将受限制，请充分考虑使用条件。

When installing other ancillary equipment using the threaded holes installed by the handling fixture, the range of motion of the robot will be limited, so please fully consider the conditions of use.

原则上应使用起重机或叉车进行机器人的搬运作业。

In principle, should use crane or forklift for robot handling.

叉车搬运时机器人和底板（托盘）应固定牢固，采用螺钉紧固时配弹垫及平垫，叉车搬运前，机器人搬运姿势各轴角度如表 2.3 所列，示意如图 2.4-图 2.5。

Before the forklift handling, fix the robot and baseboard (pallet); including adopting fixing screws(if any) with spring pad and flat pad, Before the forklift is moved, The angles of each axis in the robot's handling posture are listed in Table 2.3, and the schematic diagram of the robot's posture during handling is shown in Figure 2.4.

表 2.3 搬运时机器人各轴角度 Table 2.3 Robot posture during handling

J1	J2	J3	J4
0°	-129°	155°	任意

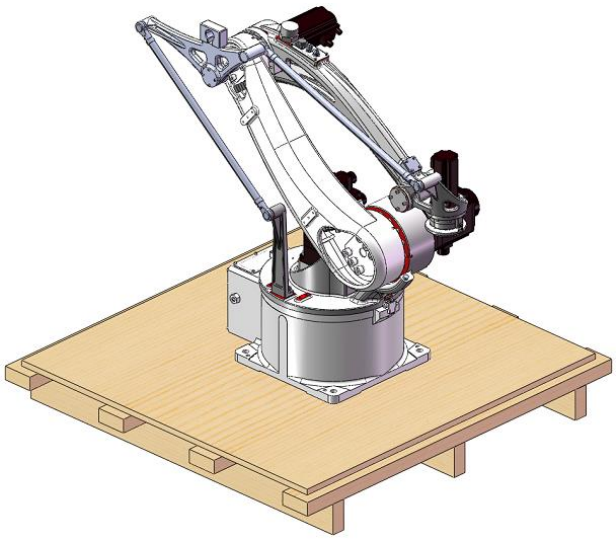


图 2.4 搬运时机器人姿势 Diagram 2.4 Robot posture during handling

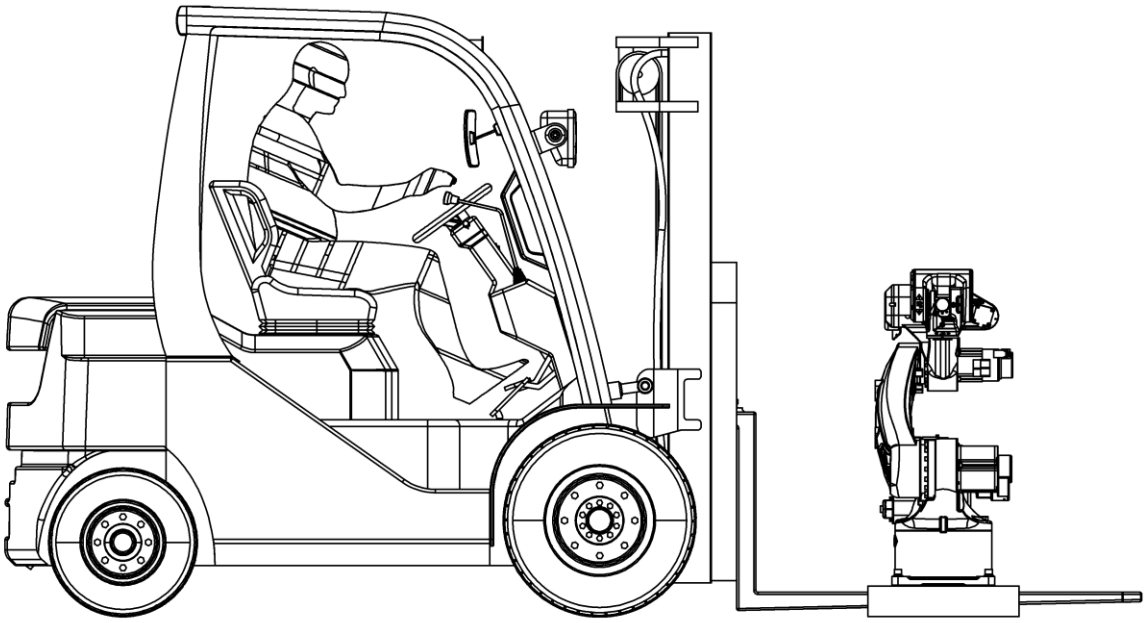


图 2.5 使用叉车搬运 Diagram 2.5 Handle by a forklift

使用行车（起重机）搬运，先设置机器人姿势（同表 2.3），然后在机器人底座上安装 4 只吊环螺栓（M12），用钢索起吊，应在钢索与机器人主体接触的部位套上橡胶软管等进行保护，并注意钢索不能与电机及管线包接触，如图 2.6。吊装时注意机器人重心靠上或者不平倾覆问题。

When handling by a crane, first adjust the position of robot（Diagram 2.3）, then fix 4 eyebolts (M12) at the pedestal of the robot, and protect the connecting part of the tightwire and robot with rubber hoses and foam blocks; note that the tightwire can't connect the motors or pipeline packages, see Diagram 2.6. When hoisting, pay attention to the robot center of gravity above halfway or robot tumbling due to inbalance.

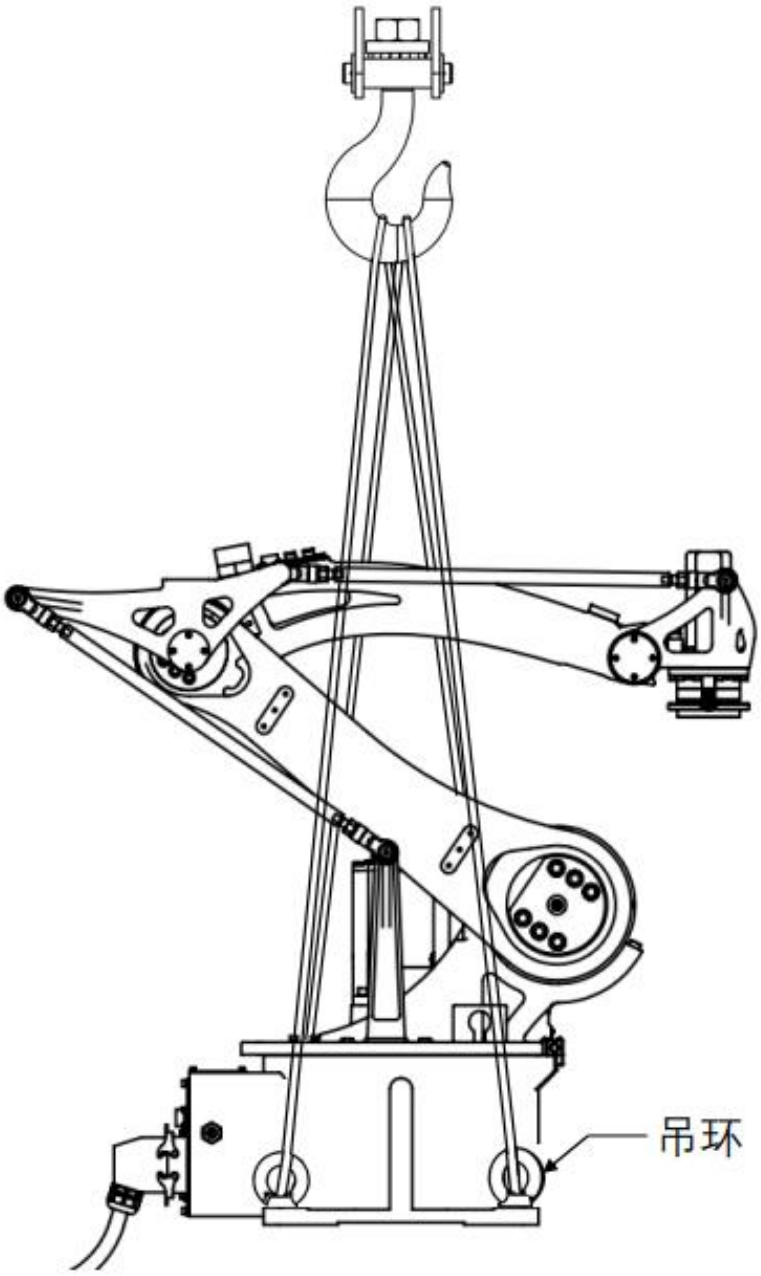


图 2.6 使用起重机搬运 Diagram 2.6 Handle by a crane

2.5 安装 Installation

本节介绍机器人的安装及其注意事项、机器人的安装示例、安装环境等。

The section introduces the installation and related notices, practices for installation, the installation environment, etc.

机器人使用设置安全围栏，否则可能发生人身伤害、设备损坏等事故。

Set safety fence for robot operation, or accidents like body injury, equipment damage may occur.

机器人未固定严禁进行通电和运转，否则可能发生设备倾倒、人身伤害、设备损坏等事故。

Energizing or operating the robot without fixing is forbidden, or accidents such as equipment dumping, personal injury and equipment damage may occur.

选择倒挂、壁挂安装方式时，要固定在有足够强度天花板或墙壁上，还应考虑防止坠落的处理方案。否则可能发生人身伤害、设备损坏等事故。

To hang the robot upside down or on the wall, please ensure the ceiling or wall has enough strength; please also consider solutions to prevent the robot from falling. Or accidents like body injury, equipment damage may occur.

不要安装或运转有损坏或者缺少零件的机器人。

Do not install or operate robots with damaged or missing parts.

设置完成后，在最初通电前务必取下相关附件及放置在机器人上的物品并且人员远离机器人可达最大运动范围。

After completing the setting, be sure to remove all relevant accessories and tools on robot, and stay away from the maximum robot reach before its initial power on.

2.5.1 安全围栏 Safety Switch

应该遵守中华人民共和国国家标准 GB11291.2-2013 《机器人与机器人装备 工业机器人的安全要求 第 2 部分：机器人系统与集成》中 5.4 机器人运动限制规定“机器人设备的设计和集成，应减少人员可能暴露于危险中的情况”。5.4.2 建立安全防护空间和限定空间规定“应通过周边防护来建立安全防护空间。建立安全防护空间应充分考虑机器的位置和布局以及安全防护空间内的危险”。5.5.2 干预通道“需要手动高速方式的任务，提供的最小间隙应为 0.5m”。5.10 安全防护规定“当设计不能去除危险或不能充分降低危险时，那么应应用安全防护。到危险区域的通道应被安全防护装置保护，如防护装置和保护装置”。

It should comply with the National Standard of the People's Republic of China GB11291.2-2013 "Robots and Robot Equipment - Safety Requirements for Industrial Robots Part 2: Robot Systems and Integration" in 5.4 Robot Movement Restriction stipulates that "the design and integration of robotic equipment should reduce the possible exposure of personnel to hazards". 5.4.2 Establish a safety protection space and limit the space, stipulating that "a safety protection space should be established through perimeter protection." The location and layout of the machine and the hazards within the safe space should be fully considered in the establishment of the safety protection space". 5.5.2 Intervention channels "For tasks that require a manual high-speed mode, the minimum clearance provided shall be 0.5m". 5.10 Safety protection stipulates that "when the design does not remove the hazard or does not sufficiently reduce the hazard, then the safety protection shall be applied." Access to the danger zone should be protected by safety guards, such as guards and protective devices".

工业机器人在自动运行过程中，操作者及周围人员有接触机器人的危险，为避免机器人运行过程中造成人员伤害、设备损坏，请务必设置安全围栏或采用相关防护装置。

During automatic running of industrial robot, operators and the surrounding staff may get injured by touching the robot. To avoid staff injury and equipment damage in robot operation, please be sure to set safety switch or relevant protections.

(1) 安全围栏应足以保证机器人最大运动空间，即使安装好所需夹具并夹取工件后，也不会和周围环境产生干扰；

The safety fence should be sufficient to ensure the maximum movement space of the robot, and even after installing the required fixtures and clamping the workpiece, it will not interfere with the

surrounding environment;

(2) 安全围栏的出入口尽量少，有可能的情况下尽量只留一个，并设置带锁的安全门，防止无关人员随意进入，造成人身伤害；

The entrances and exits of the safety fence should be as few as possible, and only one should be left as much as possible if possible, and a locked safety door should be set up to prevent unrelated personnel from entering at will and causing personal injury;

(3) 安全围栏范围可参考如图 2.8，机器人运动范围参考图 2.2，夹具及工件根据客户实际情况。

The range of the safety fence can be referred to as shown in Diagram 2.8, the range of motion of the robot is referred to Diagram 2.2, and the fixture and workpiece are according to the actual situation of the customer.

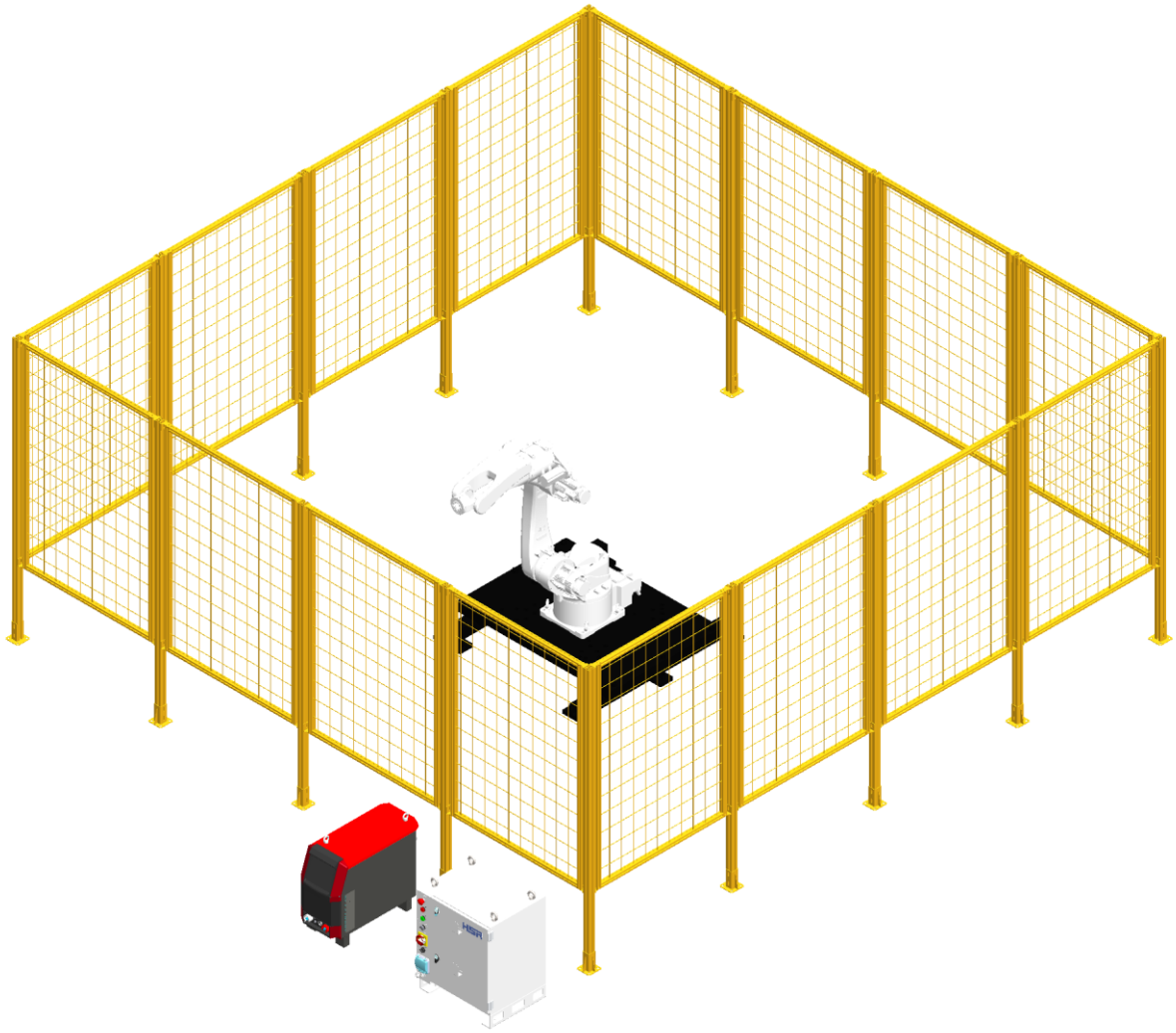


图 2.7 安全围栏 Diagram 2.7 Security fence

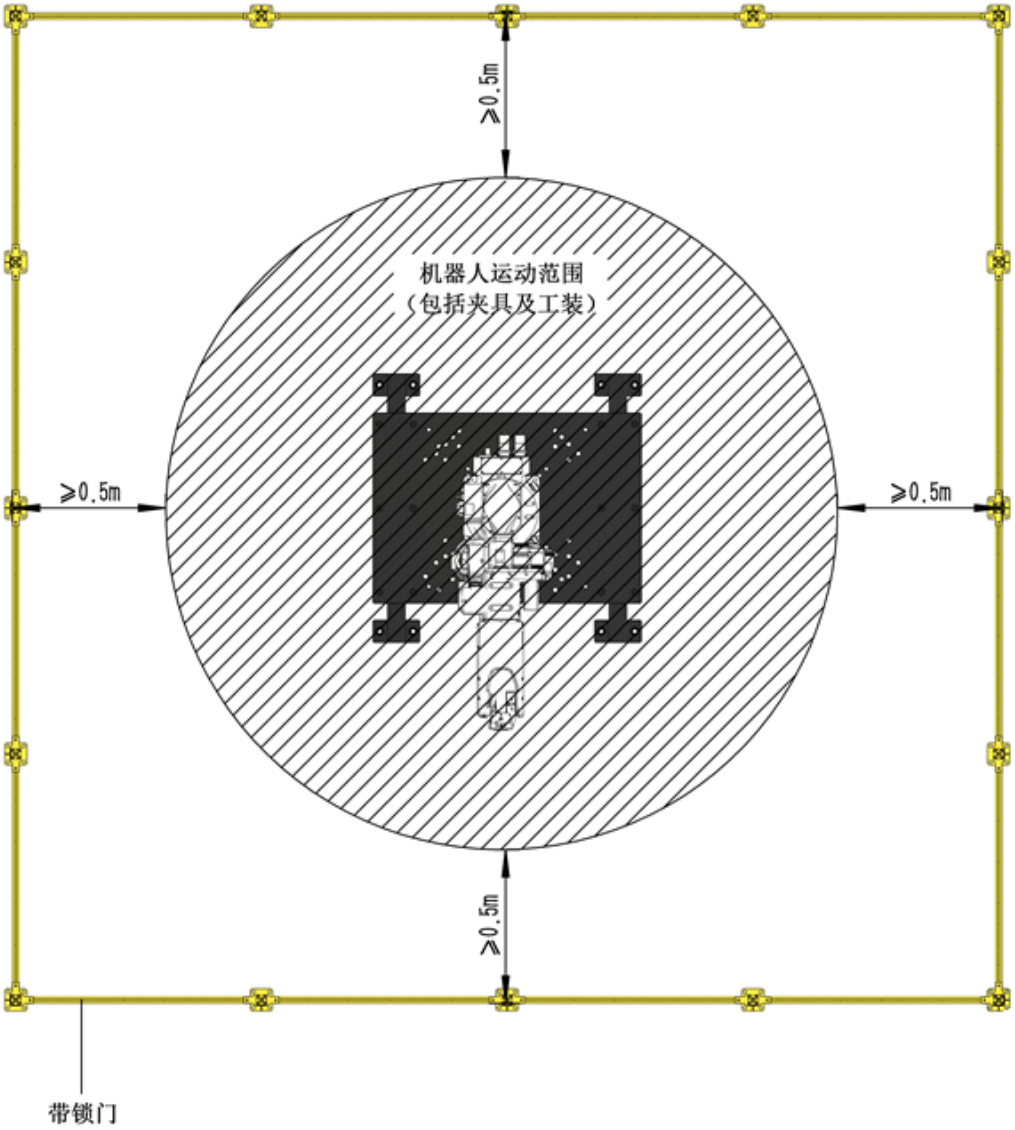


图 2.8 安全范围 Diagram 2.8 Safe range

2.5.2 安装环境 Installation Environment

机器人的安装对其功能的发挥十分重要，机器人安装环境如下：

Installation environment is of great importance to robot performance, and the installation environment is as follows:

(1) 安装面的平面度在 0.5mm 以内；

Flatness deviation of installation surface subject to 0.5mm;

(2) 环境温度 0°～45°；

Installation temperature between 0° and 45°；

(3) 环境湿度 20%～80%，不结露；

Installation humidity between 20%～80%, no dewing;

(4) 安装地点的海拔不超过 1000m；

The altitude of installation should not exceed 1000m;

(5) 污染等级为 3 级；

The class of pollution is Class III;

(6) 不存在易燃、腐蚀性液体及气体的场合；

Places of no flammable, corrosive fluids or gases;

(7) 远离大的电器噪音源的场所；

Places away from loud electric noise source;

(8) 不受大的冲击、振动的场所。

Places suffering no great impact or vibration.

2.5.3 机器人安装及固定尺寸 Robot Installation and Fixing Dimension

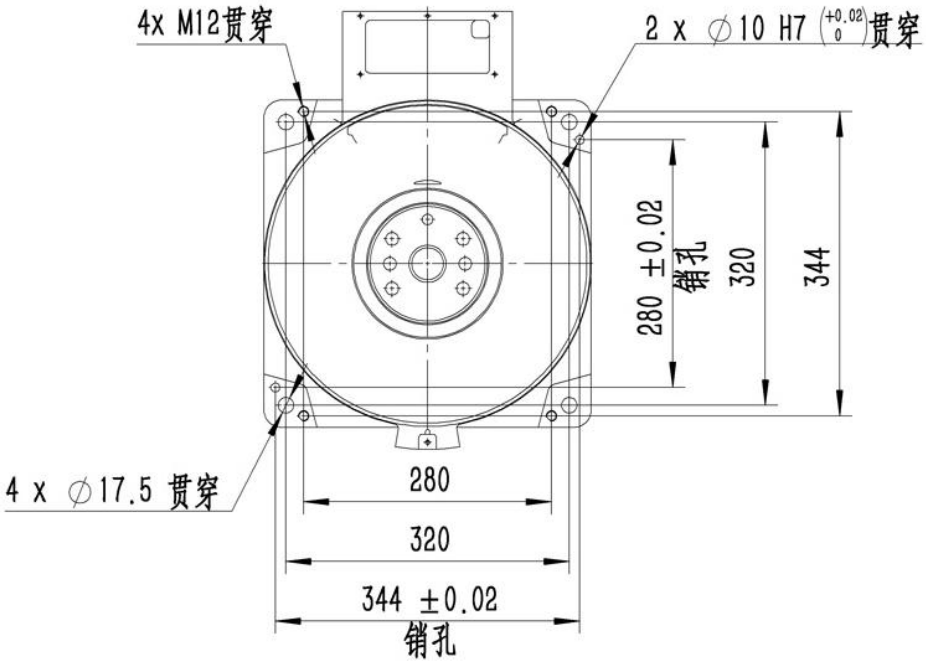


图 2.9 机器人底座安装尺寸 Diagram 2.9 Installation dimension for robot pedestal

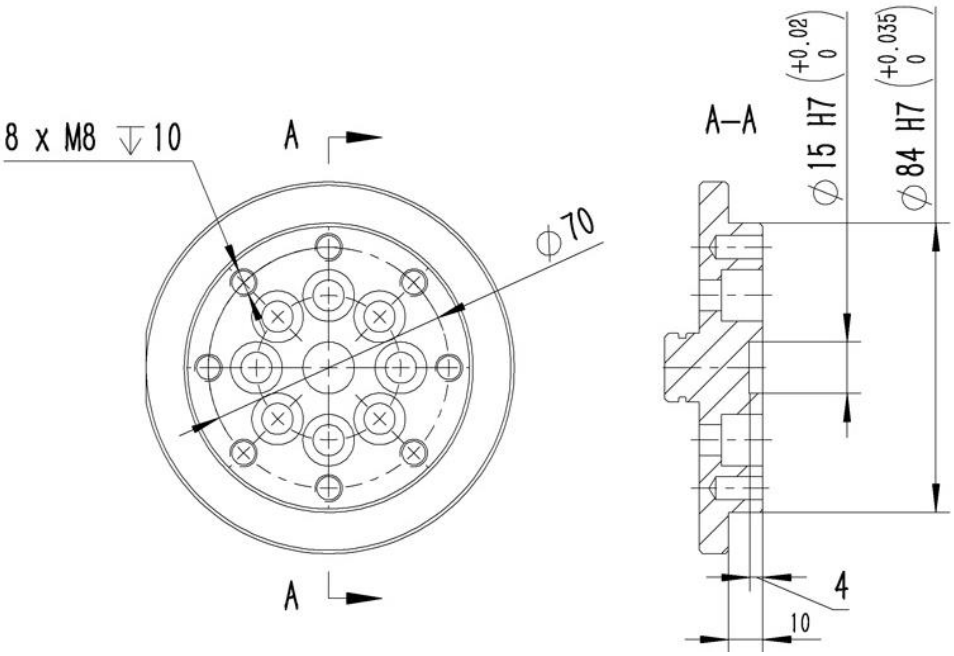


图 2.10 末端法兰尺寸 Diagram 2.10 Dimension of end flange

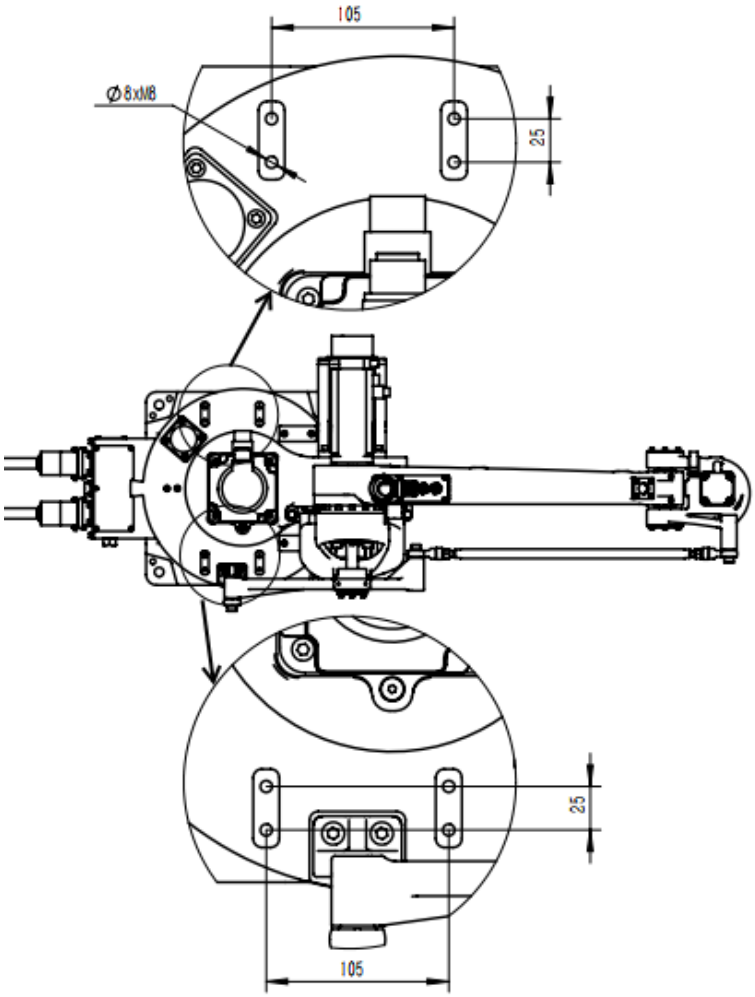


图 2.11 附属设备管线包安装固定区域 A Diagram 2.11 Installation area A for accessory equipment

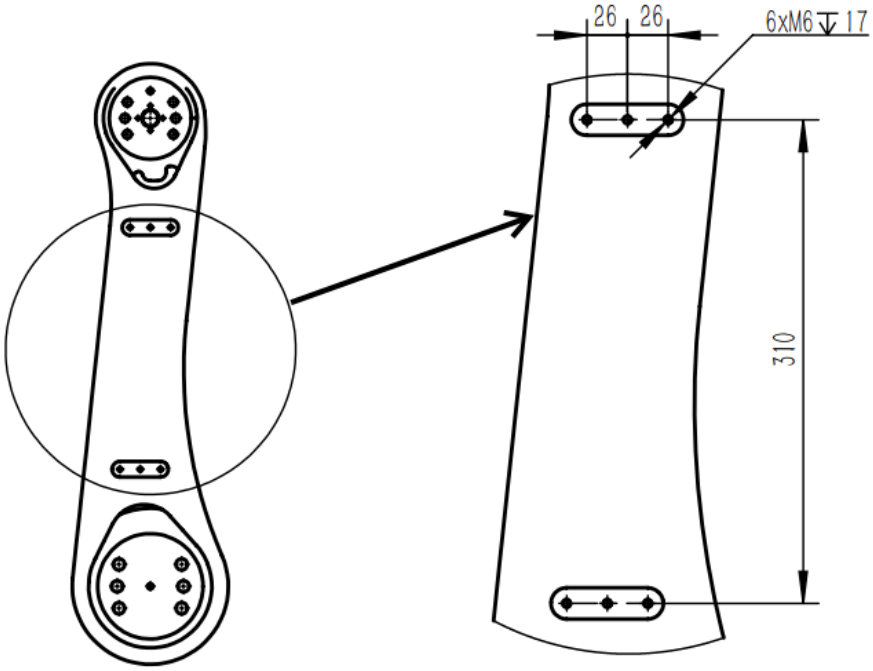


图 2.12 附属设备管线包安装固定区域 B Diagram 2.12 Installation area B for accessory equipment

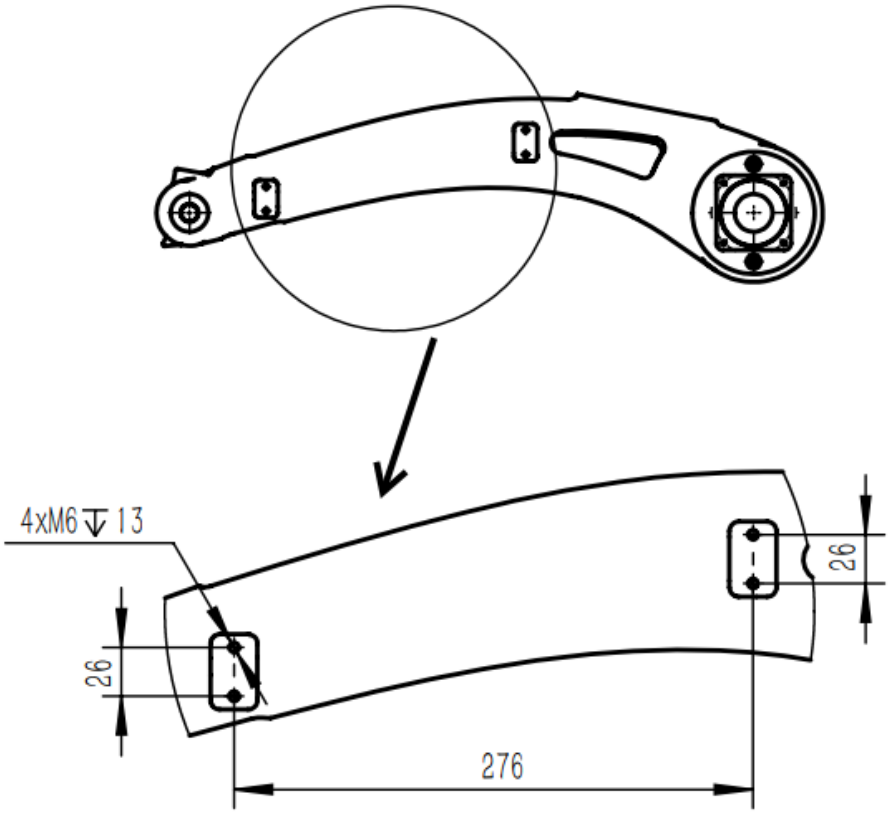


图 2.13 附属设备管线包安装固定区域 C Diagram 2.13 Installation area C for accessory equipment

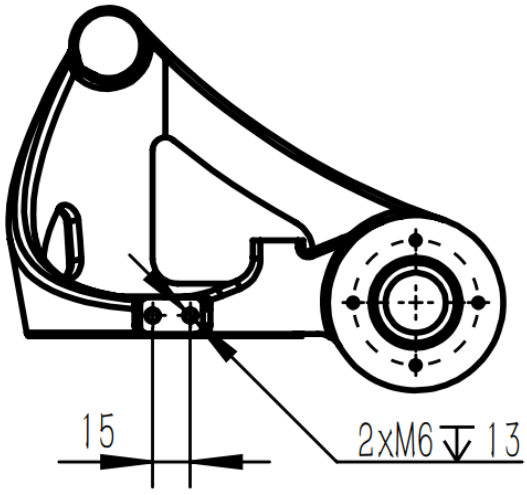


图 2.14 附属设备管线包安装固定区域 D Diagram 2.14 Installation area D for accessory equipment

2.5.4 安装举例 Installation Practice

机器人的安装固定

Installation and fixing of robot

机器人加减速时，在底座的所有方向都会产生较大的反作用力。因此安装机器人时基座必须具有足够的强度和刚度。

Robot acceleration or deceleration will generate a large reacting force in all directions of the pedestal. So the pedestal must possess sufficient intensity and rigidity during the robot installation.

机器人的底座应通过其上四个安装孔用 M16 螺钉（12.9 级）固定在底板上。机器人底座安装尺寸参照图 2.9，机器人安装举例如图 2.15。

The base of the robot should be fixed to the bottom plate with M16 screws (grade 12.9) through its four mounting holes. The installation dimensions of the robot base refer to Figure 2.9, and an example of robot installation is shown in Figure 2.15.

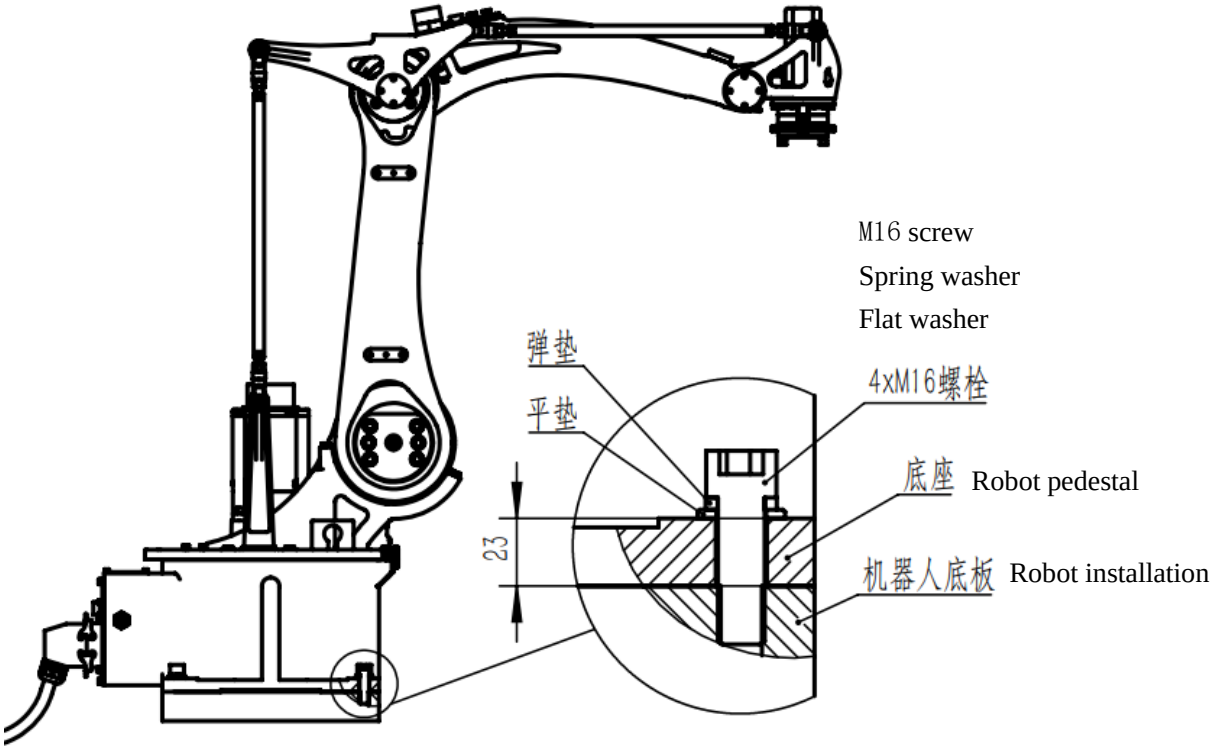


图 2.15 机器人安装举例 Diagram 2.15 Installation practice for robot

机器人安装在安装座上，安装座应具有足够的强度，同时安装座与地面连接时地面应平整无凹凸不平和龟裂。安装时应注意自身安全及机器人倾覆。

Install the robot on the installation seat, which should possess sufficient intensity, and the ground connecting the seat should be flat, without bumps or cracks. During installation, pay attention of personal safety and prevent the robot from tumbling.

若有不明处或需相关技术支持请用户联系我司。

Please contact us for any doubt or technical supports.

2.6 机器人负荷允许值 Allowable robot load

本节重点介绍机器人载荷。在选用机器人时若相关负载、转矩、惯量超过容许值请选用更大负载机器人或咨询我司。

This section focuses on robot load. Where the relevant robot, torque, inertia exceeds the allowable value, please choose robot with larger load or consult our company.

在机器人本体上安装设备尺寸及示例参照章节 2.5.3 和 2.5.4。

Refer to Chapter 2.5.3 and 2.5.4 for installation dimension of robot body.

机器人手腕前端的安装负荷受手腕容许可搬重量、容许负荷扭矩值、容许惯性矩值影响，容许负荷扭矩值根据实际负荷惯性矩的不同而发生变化。

The installation load of robot front wrist is affected by wrist allowable weight capacity, allowable load torque value and allowable inertia torque value, and the allowable load torque value varies with the actual load inertia torque value.

手腕负荷应严格控制在各容许值以内。在容许值以外的手腕负荷使用机器人时，不能保证正常动作。

The wrist load should be strictly controlled under each allowable value. The robot cannot work normally with the wrist load beyond allowable value.

（1） 机器人允许搬运重量

Allowable carrying weight of the robot

表 2.4 容许搬运重量 Table 2.4 Allowable carrying weight

机器人型号 Robot Type	HSR-MD410-1500
容许搬运重量 allowable carrying weight	10KG

注：机器人容许搬运重量为机器人在额定配置下容许的额定载荷，若超出该值机器人可能出现性能下降、损坏等情况。用户负载超出该值使用时请与我司联系，我司可根据工况进行评估降低风险，防止出现不必要的损失。

Note: the allowable carrying weight is the allowable rated load of the robot under the rated

configuration; if the value is exceeded, the robot may suffer from performance degradation or damage, etc. Contact us when the user load exceeds that value, and we can evaluate and mitigate the risks according to the working condition, so as to prevent unnecessary losses.

（2）机器人容许最大静态负荷扭矩

Allowable Maximum Static Load Torque of the Robot

表 2.5 容许最大静态负荷扭矩　Table 2.5 Allowable Maximum Static Load Torque

机器人型号 Robot Type		HSR-MD410-1500
容许最大静态负荷扭矩 Allowable Maximum Static Load Torque	J4 轴 J4 joint	42Nm

（3）机器人容许最大惯性矩

Allowable Maximum Inertia torque

表 2.6 容许最大惯性矩　Table 2.6 Allowable maximum inertia torque

机器人型号 Robot Type		HSR-MD410-1500
容许最大惯性矩 Allowable maximum inertia torque	J4 轴 J4 joint	0.25kg.m^2

2.7 电气连接 Electrical connections

本节重点介绍机器人的电气连接准备工作，包括机器人本体与控制柜之间的连接，机器人本体接地，机器人的外部 I/O 和气管说明等。

This section focuses on the preparation of the electrical connection of the robot, including the connection between the robot body and the control cabinet, the grounding of the robot body, the external I/O and trachea description of the robot, etc.

2.7.1 本体与控制柜连接 Connection between the main body and the control cabinet

机器人本体铭牌号务必与控制柜铭牌号匹配，铭牌号匹配错误将导致机器人精度偏差。

The nameplate number of the robot body must match the nameplate number of the control cabinet, and the wrong matching of the nameplate number will lead to the deviation of the robot's accuracy.

机器人本体与控制柜之间通过动力编码线连接，该线缆两端重载连接器需要与机器人和控制柜连接好。

The robot body is connected to the control cabinet through a power coding cable, and the heavy-duty connectors at both ends of the cable need to be connected to the robot and the control cabinet.

2.7.2 本体接地 grounding

机器人底座位置有 M8 接地螺丝孔，用于连接地线接地端子。

There is an M8 grounding screw hole at the base of the robot for connecting the grounding terminal.

接通控制柜电源之前，请将本体可靠接地。尚未连接地线的情况下，有触电危险。

Before turning on the power supply of the control cabinet, please reliably ground the main body. If the ground wire is not connected, there is a risk of electric shock.

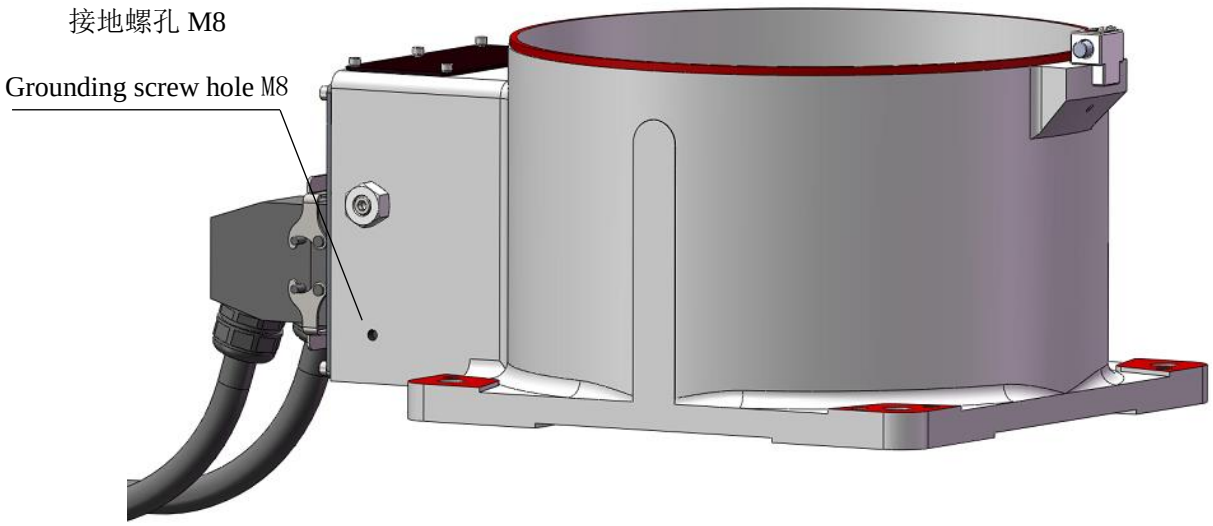


图 2.16 机器人接地螺丝孔 Diagram 2.16 Robot grounding screw hole

2.7.3 信号线和气管 Signal line and trachea

机器人提供了从底座通往小臂的电气信号和气管通路，用于供应末端执行机构的使用。

The robot provides an electrical signal from the base to the forearm and tracheal access for the use of the end-effector.

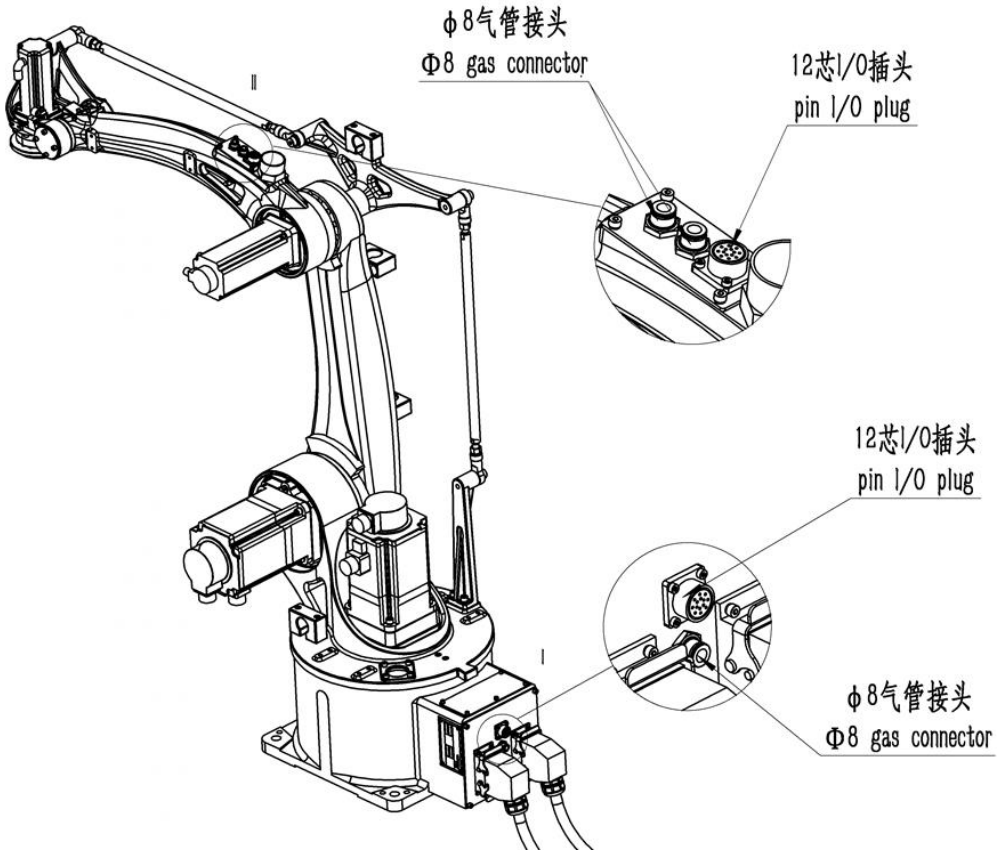


图 2.17 机器人外部电路、气路连接 Diagram 2.17 External circuits and gas connections of robots

3 检修及维护 Overhaul and Maintenance

本章介绍机器人的检修、维护，为客户对机器人的维护提供指导。

This section focuses on the overhaul and maintenance of the robot and provide guidance for clients.

为了使机器人能够长期保持较高的性能，必须进行维修检查。

In order to maintain the effective performance of the robot in the long term, maintenance and overhaul must be carried out.

检修分为日常检修和定期检修，检查人员必须编制检修计划并切实进行检修。关于检修项目请参阅表 3.1。

Overhaul includes daily overhaul and regular overhaul, the overhaul personnel must compile overhaul plan and execute it. Refer to Figure 3.1 for overhaul items.

保养、检修及配线作业必须切断电源，否则有可能发生触电、人生伤害等事故。

Before maintenance, overhaul and wiring, the power must be cut off, or accidents like electric shock, personal injury may happen.

拆卸、修理请建议与我司联系。

Please consult our company for detach and maintenance advice.

维修、检修、保养作业和部件更换作业时需切断电源进行，为防止其他作业者不小心接通电源，请在一级电源等位置上挂上“禁止接通电源”的警示牌。

Before repairing, overhaul, maintenance and replacement of parts, the power must be cut off; Besides, to avoid accidental power connecting by other operators, please hang "Power-On Forbidden" next to the primary power supply.

警告

维修、检修、保养作业必须在确认周围安全、确保躲避危险所必须的通道和场所的前提下安全地进行作业。

Repairing, overhaul and maintenance must be operated after confirming the surrounding safety, ensuring the necessary escape-way and shelter clear to escape from danger.

警告

进行维修检修的人员必须是由接受过特殊指导教育或法律规定时间的教育，熟知相关内容的人员担任。

Repairing and overhaul personnel must have received special instruction and education or be familiar with the relevant contents within the time specified by law.

3.1 维修检验项目及周期

本节介绍机器维修检验、保养项目及周期。

This section introduces the items and cycles of overhaul and maintenance.

为了使机器人能够长期保持较高的性能降低故障确保安全，必须进行检修检查。

In order to maintain the effective performance of the robot in the long term and prevent failures to ensure safety, maintenance and overhaul must be carried out.

检修分为日常检修和定期检修，检查人员必须编制检修计划并切实进行检修，其检修项目及周期参考表 3.1。

Overhaul includes daily overhaul and regular overhaul, the overhaul personnel must compile overhaul plan and execute it, refer to Figure 3.1 for overhaul items and cycles.

此外，检修或调整方法不明时，请与我司联系。

Beside, connect us when the overhaul or adjustment method is not clear.

表 3.1 维修检验项目及周期 Table 3.1 Overhaul Items and Cycle

检修部位 Overhaul Part		检修间隔 Overhaul Interval						方法 Method	检修处理内容 Overhaul Content
		日常 Daily	间隔 Interval 1000h	间隔 Interval 6000h	间隔 Interval 12000h	间隔 Interval 24000h	间隔 Interval 36000h		
1	原点标记 Origin Marker	●						目测 Visual inspection	零点是否丢失 Check the existence of origin marker
2	外部线缆 External cable	●						目测 Visual inspection	检测是否有污迹、损伤 Check for stain or damage
3	整体外观 Overall appearance	●						目测 Visual inspection	清理尘埃、污迹，检测各部分有无龟裂 Clean dirt and stains, check all parts for any chap.
4	底座螺栓 Pedestal bolt		●					扳手 Wrench	检测有无缺少、松动 Check if there's any miss or looseness
5	盖类螺栓 Cover bolt		●					扳手 Wrench	检测有无缺少、松动 Check if there's any miss or looseness
6	主要螺栓 Main bolt		●					扳手 Wrench	检查有无缺少、松动 Check if there's any miss or looseness
7	航插 Aviation Plug		●					手触 Hand touch	检查有无松动插紧 Check if there's any looseness and plug in tightly
8	同步带 Synchronous belt			●				手触 Hand touch	检查皮带张紧力及摩擦程度 Check belt tension and friction
9	电池组*1 Battery pack*1			●					示教器显示报警 Teaching device display alarm
10	各轴减速机 Each joint reducer			●					检测有无异常（异响、震动等） Check for any

									abnormality (abnormal sound or shake, etc.)
11	线缆 Cable			●				目测 Visual inspection	检查有磨损，扭断 Check if there's any abrasion or breakage
12	终端夹具 End clamp	●						目测、手触 Visual inspection, hand touch	检查有无缺少、松动 Check if there's any miss or looseness

*1 电池组更换参照章节 3.5

*1 Refer to chapter 3.5 for battery pack replace

3.2 主要螺栓的检修 Overhaul of Main Bolt

表 3.2 主要螺钉检查部位 Table 3.2 main screw part to check

序号 No.	检查部位 Check Part	序号 No.	检查部位 Check Part
1	机器人安装用 for robot installation	4	J3 轴马达安装用 for J3 joint motor installation
2	J1 轴马达安装用 for J1 joint motor installation	5	J4 轴马达安装用 for J4 joint motor installation
3	J2 轴马达安装用 for J2 joint motor installation	6	末端负载安装用 for end load installation

注意

螺钉的拧紧和更换，必须用扭矩扳手以正确扭矩紧固后，再行涂漆固定，此外，应注意未松动的螺栓不得以所需以上的扭矩进行紧固。

For screw tightening and replacement, must use torque wrench to tighten the bolt properly before painting and fixing. Besides, the unloosened bolts cannot be tightened at the above torque.

3.3 润滑油的检查及更换 Check and replacement of Lubricant

本说明书所叙述的润滑油检查及更换均是在机器人地面安装时所进行的，若机器人是侧挂或倒挂方式安装，润滑油具体更换操作详情请咨询我司服务部门。

The check and replacement of lubricant described in this manual applies to the robot installed on the ground; for replacement procedures of lubricant applicable to for robots side-hung or inverted, contact service department of us.

3.3.1 润滑油检查 Check for Lubricant

每运转 5000 小时或每隔 1 年，请测量减速机的润滑油铁粉浓度。超出标准值时，有必要更换润滑油或减速机，请联系我司。必需的工具：润滑油铁粉浓度计（推荐润滑油铁粉浓度计出光兴产制造 型号 OM-810）、润滑油枪（带供油量确认计数功能）

Please measure concentration of iron powder in reducer lubricant at the interval of every 5000-hour or 1-year operation. It is necessary to alter lubricant or reducer when the measuring result exceeds the standard value, please contact us. Necessary tools: iron powder concentration meter for lubricating oil (recommend iron powder concentration meter for lubricating oil made by IDEMITSU KOSAN, type OM-810), lubricating gun (with oil confirming and counting function)

J1 轴油口位置，参考章节 3.3.4，图 3.1

J1 port position, refer to Chapter 3.3.4, see Diagram 3.1

J2 轴油口位置，参考章节 3.3.4，图 3.2

J2 port position, refer to Chapter 3.3.4, see Diagram 3.2

J3 轴油口位置，参考章节 3.3.4，图 3.3

J3 port position, refer to Chapter 3.3.4, see Diagram 3.3

检修时，如果必要数量以上的润滑油流出了机体外，请使用润滑油枪对流出部分进行补充。补充润滑油量比流出量更多时，可能会导致润滑油渗漏或机器人运作时的轨迹不良等，应加以注意。

During overhaul, if redundant lubricating oil flows out of the body, please use the lubricating gun to supplement. Supplementing more amount than the outflow can cause the leakage of lubricating oil or the poor trajectory of robot movement, etc., please pay attention to this.

注意

检修或加油完成后，为防止漏油，在油口堵头螺纹上务必缠绕密封胶带再进行安装。

After the overhaul or refueling, to prevent oil leakage, be sure to wrap sealing tape around the thread of plug for port before installation.

3.3.2 润滑油供给量 Lubricant Supply Amount

正常使用情况下，机器人每运转 20000 小时或每隔 4 年应更换减速机润滑油，每运转 5000 小时或 1 年应添加平衡缸轴承润滑油。表 3.3 示出指定润滑油和供油量。

In normal use, the lubricant, must be replaced every 20, 000-hour or 4-year operation. Figure 3.3 gives the specified lubricant and lubricant flow.

表 3.3 更换润滑油油量表 Table 3.3 Lubricant amount replace sheet

位置 Position	油量 Oil Amount	堵头规格 Plug specifications	润滑油名称 Lubricant name	备注 Remarks
J1 轴减速机 J1 joint reducer	320CC	带 ED 圈密封堵头 M8x1	得润宝灵威 9101 机器人减速机润滑脂 Derunbao Lingwei 9101 robot reducer lubricating grease	急速上油会引起油仓内压力上升，使密封圈开裂，而导致润滑油渗漏，供油速度应控制在 40cc/10 秒以下。 The oil supply speed should be controlled below 40cc/10 seconds, because rapid oiling can increase pressure in the oil tank, causing the seal ring to crack and oil leakage.
J2 轴减速机 J2 joint reducer	315cc	带 ED 圈密封堵头 M8x1		
J3 轴减速机 J3 joint reducer	185cc	带 ED 圈密封堵头 M8x1		

3.3.3 润滑油添加时机器人位姿 Robot pose during lubricant addition

对于润滑油更换或补充操作，建议使用给出的机器人位姿。表 3.4 所示为润滑时机器人位姿。

For lubrication change or replenishment operations, it is recommended to use the robot position given. Table 3.4 shows the robot posture during lubrication.

表 3.4 润滑时机器人位姿　Table3.4 Robot pose

供给位置 Supply to	方位 Position			
	J1	J2	J3	J4
J1 轴减速机 J1 joint reducer	任意 Any	任意 Any	任意 Any	任意 Any
J2 轴减速机 J2 joint reducer		−90°	任意 Any	
J3 轴减速机 J3 joint reducer		任意 Any	+90°	

3.3.4　润滑油更换 Replacement of lubricant

注意

该机器人保养需按照以下规定定期进行润滑油和检修以保证效率。

To ensure efficiency, the regular lubricating and overhaul of the robot should be complemented by the following regulations.

注意

混用不同油品可能导致减速机严重受损。加注减速机润滑油时，请勿混用不同油品，说明中另有规定的除外。只能使用制造商指定油品类型。

Mixing different lubricant can cause serious damage to reducer. When fill lubricant to the reducer, do not mix different oil products, unless otherwise specified in the instructions. Use only the type of oil specified by the manufacturer.

注意

当注油量超出排出量油脂时，可能会导致油脂过度填充使内部气压升高而导致漏油，在注油后机器人进行热机后打开油口进行释放压力可降低漏油风险。

Note: If the amount of oil injected exceeds the amount of oil drained, the excessive oil filling may increase the internal pressure and lead to oil leakage. In this case, open the port to release pressure after the robot has heated to reduce the risk of oil leakage.

重要

若未能正确执行润滑操作，润滑腔体内的压力可能会突然增加，有可能损坏密封部分，而导致润滑油泄露和操作异常。

If replenish lubricant by improper steps, the pressure inside the lubricant cavity can increase suddenly, and this can damage the seal part, then cause the leakage of lubricant and abnormal operations.

注意

润滑油补充或更换后，应将地面和机器人上的多余润滑油彻底清除，防止工作人员因滑到而导致意外。

After the refilling or replacement, the excess oil on the ground and the robot should be completely removed to prevent accidents caused by the workers' sliding.

减速机润滑油更换油口位置及步骤：

Port position and steps to replace the reducer lubricant

J1 轴油脂补充与更换（参考图 3.1）

Joint J1 lubricant feed and replacement (refer to Diagram 3.1)

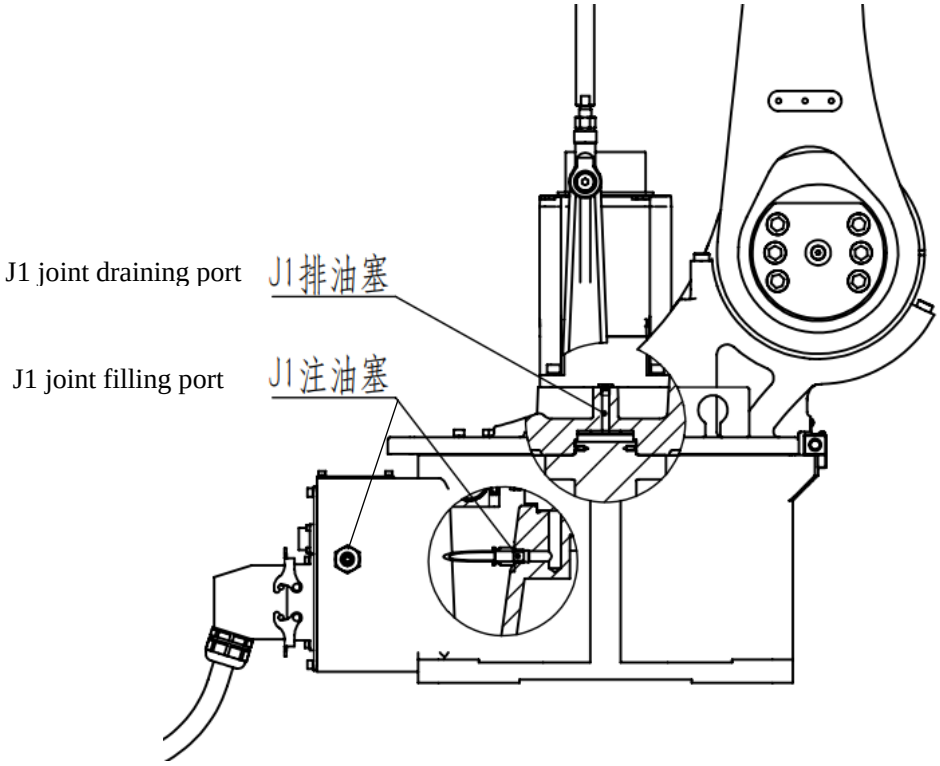


图 3.1 J1 轴油口示意图　Diagram 3.1 port position of Joint J1

(1) 将机器人移动到表 3.4 所示位置，切断电源或急停处于激发状态，取下注油口和排油口的堵头。（注：严禁在未取排油口的堵头下进行注油，未取排油口的堵头下进行注油可能引起电机故障或漏油。）

Move the robot to the position shown in Figure 3.4, cut off power supply, remove the plug of the filling port and the draining port. (Note: It is forbidden to feed oil before the plug of draining port is removed, or it may cause motor failure or oil leakage.)

(2) 安装油管及接头（M8X1），准备注油及排油。

Install the filling pipe and connector(M8X1), prepare for the oil filling and draining.

(3) **采用油枪从注油口注油，注油油量与排出油量相等（排出的润滑油用废油桶接住并装好），注射压力不得超过 0.03Mpa，不能直接使用工厂气源作为油枪动力。**若注油油量大于排油油量，可在未安装堵头情况下运动 J1 轴排除多余油脂。

Use the oil gun to fill oil from the filling port, the amount of oil injected equals the amount of oil drained(the drained oil should be caught and collected in the waste oil tank),The injection pressure shall not exceed 0.03Mpa, and the factory air source shall not be directly used as the fuel gun power. If the amount of oil injected exceeds the amount of oil drained, the extra oil can be

remove by moving joint J1 with the plug removed.

(4) 清理多余油脂，安装堵头（M8X1）。**（堵头螺纹处涂乐泰 5699 密封胶或者缠绕生胶带）**

Clear the extra oil and install the plug（M8X1）. (**Apply Loctite 5699 sealant or wrap adhesive tape to plug thread**)

J2 轴油脂补充与更换（参考图 3.2）

Joint J2 lubricant feed and replacement (refer to Diagram 3.2)

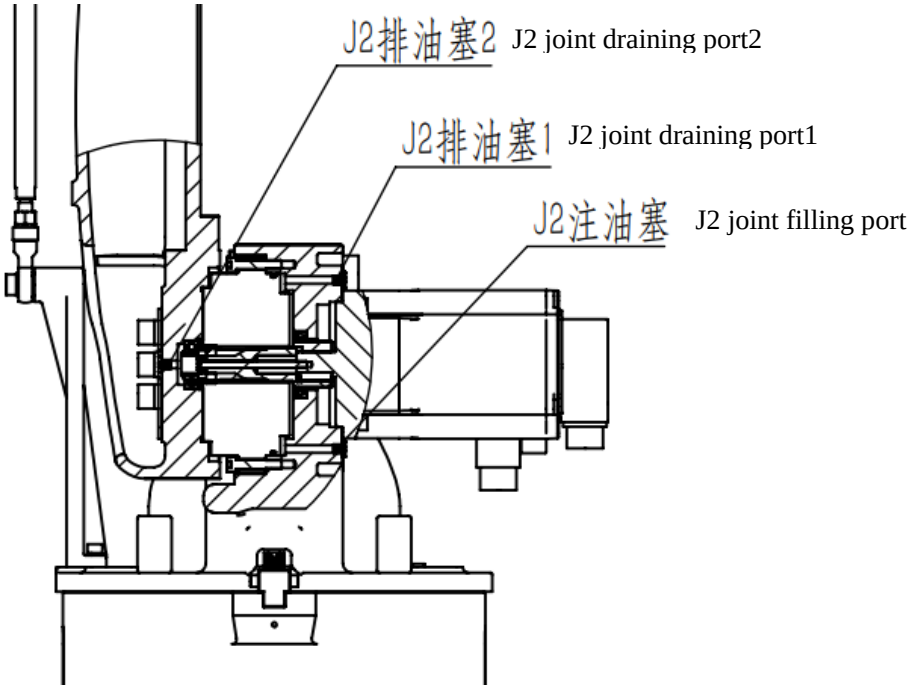


图 3.2 J2 轴油口示意图　Diagram 3.2 port position of Joint J2

(1) 将机器人移动到表 3.4 所示位置，切断电源或急停处于激发状态，取下注油口和排油口的堵头。（注：严禁在未取排油口的堵头下进行注油，未取排油口的堵头下进行注油可能引起电机故障或漏油。）

Move the robot to the position shown in Figure 3.4, cut off power supply, remove the plug of the filling port and the draining port. (Note: It is forbidden to feed oil before the plug of draining port is removed, or it may cause motor failure or oil leakage.)

(2) 安装油管及接头（M8X1），准备注油及排油。

Install the filling pipe and connector(M8X1), prepare for the oil filling and draining.

(3) **采用油枪从注油口注油，注油油量与排出油量相等（排出的润滑油用废油桶接住并装好），注**

射压力不得超过 0.03Mpa，不能直接使用工厂气源作为油枪动力。若注油油量大于排油油量，可在未安装堵头情况下运动 J2 轴排除多余油脂。

Use the oil gun to fill oil from the filling port, the amount of oil injected equals the amount of oil drained(the drained oil should be caught and collected in the waste oil tank),The injection pressure shall not exceed 0.03Mpa, and the factory air source shall not be directly used as the fuel gun power. If the amount of oil injected exceeds the amount of oil drained, the extra oil can be remove by moving joint J2 with the plug removed.

(4) 清理多余油脂，安装堵头(M8X1)。**（堵头螺纹处涂乐泰 5699 密封胶或者缠绕生胶带）**

Clear the extra oil and install the plug（M8X1）. (**Apply Loctite 5699 sealant or wrap adhesive tape to plug thread**)

J3 轴油脂补充与更换（参考图 3.3）

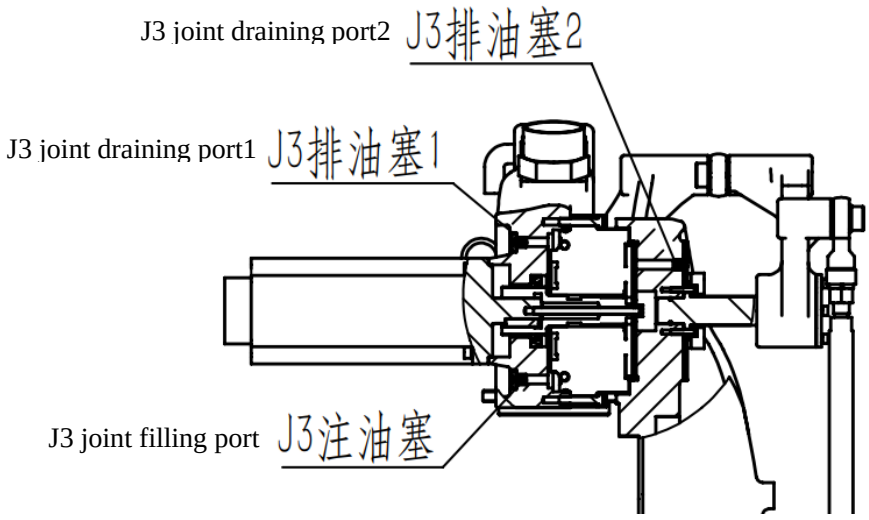


图 3.3 J3 轴油口示意图　Diagram 3.3 port position of Joint J3

(1) 将机器人移动到表 3.4 所示位置，切断电源或急停处于激发状态，取下注油口和排油口的堵头。（注：严禁在未取排油口的堵头下进行注油，未取排油口的堵头下进行注油可能引起电机故障或漏油。）

Move the robot to the position shown in Figure 3.4, cut off power supply, remove the plug of the filling port and the draining port. (Note: It is forbidden to feed oil before the plug of draining port is removed, or it may cause motor failure or oil leakage.)

(2) 安装油管及接头（M8X1），准备注油及排油。

Install the filling pipe and connector(M8X1), prepare for the oil filling and draining.

(3) **采用油枪从注油口注油，注油油量与排出油量相等（排出的润滑油用废油桶接住并装好），注射压力不得超过 0.03Mpa，不能直接使用工厂气源作为油枪动力。**若注油油量大于排油油量，可在未安装堵头情况下运动 J3 轴排除多余油脂。

Use the oil gun to fill oil from the filling port, the amount of oil injected equals the amount of oil drained(the drained oil should be caught and collected in the waste oil tank The injection pressure shall not exceed 0.03Mpa, and the factory air source shall not be directly used as the fuel gun power. If the amount of oil injected exceeds the amount of oil drained, the extra oil can be remove by moving joint J3 with the plug removed.

(4) 清理多余油脂，安装堵头（M8X1）。**（堵头螺纹处涂乐泰 5699 密封胶或者缠绕生胶带）**

Clear the extra oil and install the plug（M8X1）. (**Apply Loctite 5699 sealant or wrap adhesive tape to plug thread**)

释放润滑脂槽内残余压力的步骤：

Steps to release residual pressure in the grease tank:

请按照如下所示步骤释放残余压力：

Follow these steps to release residual pressure:

(1) 打开需要释放润滑脂槽内残余压力轴的注油口堵头，在出油口下安装回收袋，以避免流出来的润滑脂飞散。

Open the oil inlet plug of the residual pressure shaft in the grease tank to be released, and install a recovery bag under the oil outlet to prevent the outgoing grease from scattering.

(2) 启动机器人，调入机器人跑单轴最大运动范围的单轴运动程序，使其在满载、100%速度的工况下连续运行 1h；

Start the robot and call in the single-axis motion program of the robot to run the maximum range of motion of a single axis, so that it can run continuously for 1h under full load and 100% speed;

(3) 停止机器人运行程序，使机器人停在原点位置，关掉示教器上的使能；

Stop the robot from running the program, stop the robot at the origin position, and turn off the enable

on the teach pendant;

(4) 确认安全后，拆除各轴注油口处的堵头（堵头需涂抹密封胶），拆卸堵头时，请勿直接面对堵头，防止高压、高温油液喷射对人员造成伤害。

After confirming the safety, remove the plug at the oil injection port of each shaft (the plug needs to be coated with sealant), and when disassembling the plug, do not face the plug directly to prevent injury to personnel caused by high-pressure and high-temperature oil injection.

(5) 螺塞拆开后 3~5 秒后重新拧紧，用干净的抹布清理螺塞周围油液。

Re-tighten the plug after 3~5 seconds after disassembly, and clean the oil around the plug with a clean rag.

3.4 鱼眼轴承的维护保养 Maintenance and upkeep of fisheye bearings

图 3.4 机器人本体鱼眼轴承维护部位　Diagram 3.4 Robot body fisheye bearing maintenance parts

码垛机器人的鱼眼轴承需要定期进行鱼眼轴承维护保养，需要进行常规保养来确保其能够顺利工作并提高其耐用性。保养内容如下：

The fisheye bearings of the palletizing robot require regular maintenance to ensure their smooth operation and improve their durability. The maintenance content is as follows:

a.清洁鱼眼轴承表面以及周围的环境。清洁表面可以去除灰尘和杂物，从而避免进入杂质和腐

蚀磨损等问题。

a. Clean the surface of the fisheye bearing and the surrounding environment. Cleaning the surface can remove dust and debris, thereby avoiding issues such as impurities and corrosion wear.

b.添加润滑油。在鱼眼轴承中使用润滑油可以帮助减少摩擦和磨损，并保持其正常工作状态。一般来说，润滑油添加周期为每月一次。也可在鱼眼轴承球光洁面涂抹锂基润滑脂。

b. Add lubricating oil. The use of lubricating oil in fisheye bearings can help reduce friction and wear while maintaining their normal working condition. Generally speaking, the lubrication oil addition cycle is once a month. Lithium based grease can also be applied to the smooth surface of the fisheye bearing ball.

c.检查鱼眼轴承。定期检查鱼眼轴承的状态，如果发现出现裂纹，损坏等情况，应立即更换。

c. Check the fisheye bearings. Regularly inspect the condition of the fisheye bearings. If cracks, damage, or other issues are found, they should be replaced immediately.

3.5 电池更换 Replace Battery

本节主要介绍机器人本体电机编码器电池位置及更换步骤。

This section focus on the battery position of the robot motor encoder and the replacement steps.

机器人本体内电池，应每一年进行更换；此外机器人出现编码器电池报警时也应更换电池。若需更换电池或有不明处可与我司联系。

The battery in the robot body should be replaced every year; In addition, the battery should also be replaced when the encoder battery alarm occurs in the robot. Contact us for replacement of battery or any doubt.

更换电池前请将机器人回零，防止更换电池后零点丢失。

To avoid zero loss, please return the robot to zero before replacing battery.

安装盖板时，注意不要挤压电缆。

Be care not to squeeze the cable when install the cover plate.

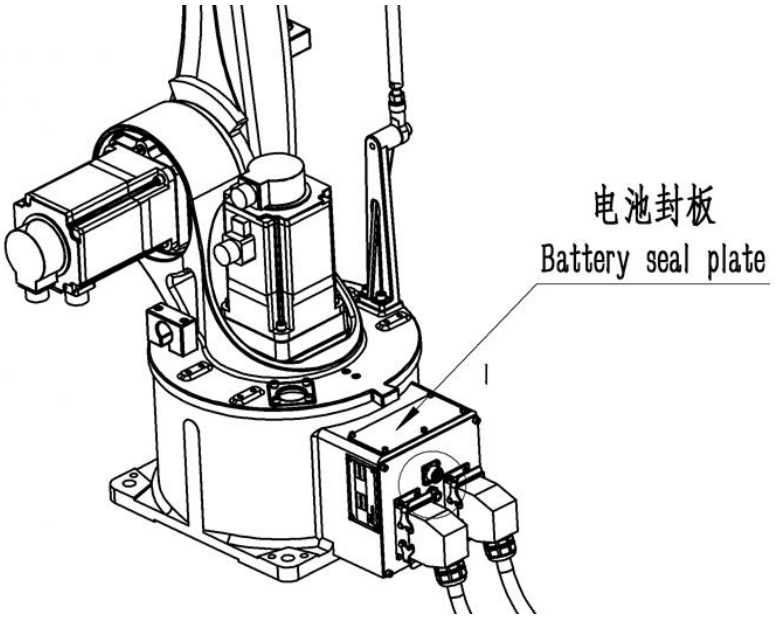


图 3.5 电池位置 Diagram 3.5 Position of battery

更换步骤：

Replace steps:

(1) 机器人回零点，按下机器人急停按钮，**不要切断电源**；

Return the robot to zero and press the Emergency Stop button, **don't cut off the power supply**;

(2) 拆下电池封板，拉出电池；

Remove the battery seal plate and pull out the battery;

(3) 拔下旧电池；

Unplug the old battery;

(4) 将新电池插入插头，放入机器人底座电池槽中；

Insert the new battery into the plug and put it into the battery jar of robot pedestal;

(5) 重新安装好电池封板；

Reinstall the battery seal plate;

(6) 检查机器人零点是否丢失；

Check the existence of zero；

(7) 若断电更换机器人电池或者零点丢失请重新校对零点。

Where the battery is replaced during power-off, or the zero is lost after replacement of battery, please re-check the zero.

更换电池前机器人如果未回至零点或者更换电池后其它原因导致机器人零点丢失，请参照章节 3.6 进行校对。电池型号规格请联系我司。

Where the zero is not returned before battery replacement or the robot loses zero due to other reasons after battery replacement, please refer to section 3.6 for proofreading. Please contact us for the battery model and specification.

3.6 零点校对 Zero calibration

本节主要介绍机器人零点丢失情况下零位参考位置，机器人在出厂前，已经做好机械零点校对，当机器人因故障丢失零点位置，需要对机器人重新进行机械零点的校对。HSR-MD410-1500 机器人标准品零点校对参照图 3.6。

This section focuses on the zero reference position in case of zero loss of robot, The robot has done the mechanical zero proofreading before it leaves the factory. In case the robot loses zero position due to fault, the robot needs to be re-calibrated to the mechanical zero. For zero calibration of standard robot HSR-MD410-1500, Refer to Diagram 3.6.

注意

零点校对时请将速度调至低速。

Please set the speed to low speed during zero calibration.

校零时请注意机器人运动过程中压到手。

During zero calibration, please prevent the hand from being pressed by robot motion.

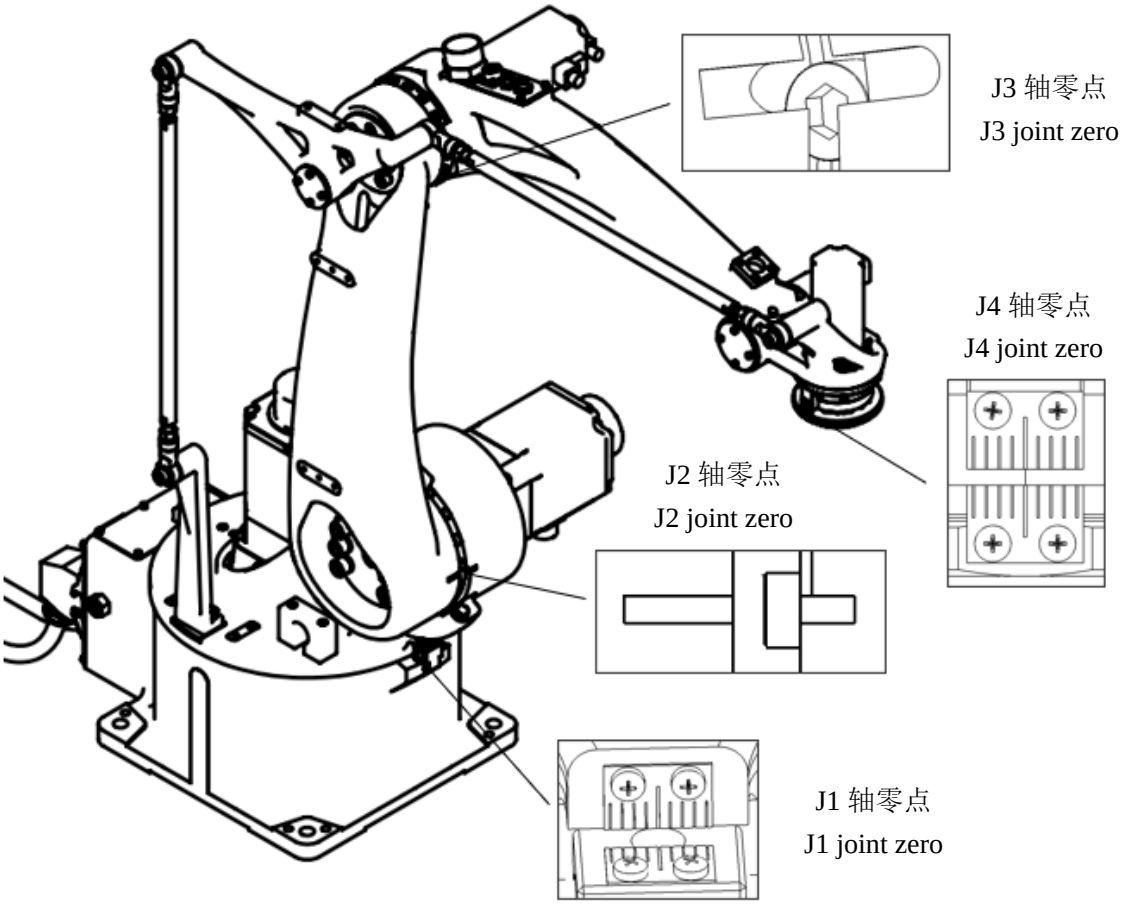


图 3.6 校零图 Diagram 3.6 zero calibration

4 故障处理 Failure Treatment

4.1 调查故障原因的方法 Methods to Investigate Reasons of Failure

机器人设计上必须达到即使发生异常情况，也可以立即检测出异常，并立即停止运行。即便如此，由于仍然处于危险状态下，绝对禁止继续运行。

The robot design must meet the following requirement: the abnormality can be detected immediately as it occurs and the robot is stopped. Even so, running is forbidden because the robot is still in danger.

机器人的故障有如下各种情况：

Robot failures fall into several conditions as follows:

（1）一旦发生故障，直到修理完毕不能运行的故障。

Once this failure occurs, the robot can't operate until it has been repaired.

（2）发生故障后，放置一段时间后，又可以恢复运行的故障。

Once this failure occurs, the robot can continue to operate after some time.

（3）即使发生故障，只要使电源 OFF，则又可以运行的故障。

Once this failure occurs, turn off the power, then robot can operate.

（4）即使发生故障，立即就可以再次运行的故障。

Once this failure occurs, the robot can operate again immediately.

（5）非机器人本身，而是系统侧的故障导致机器人异常动作的故障。

Failure on robot abnormality caused by system-side failure.

（6）因机器人侧的故障，导致系统侧异常动作的故障。

Failure on system-side abnormality caused by robot-side failure.

尤其是(2) (3) (4)的情况，肯定会再次发生故障。而且，在复杂的系统中，即使老练的工程师也经常不能轻易找到故障原因。因此，在出现故障时，请勿继续运转，应立即联系接受过规定培训的保全作业人员，由其实施故障原因的查明和修理。此外，应将这些内容放入作业规定中，并建立可以切实执行的完整体系。否则，会导致事故发生。

In condition (2), (3) and (4), those failures will recur definitely. Besides, even the experienced engineer cannot find the failure cause easily in complex system. There, please stop the robot when failure

occurs, and contact security operator with prescribed training, and let them to investigate reason and repair. Besides, these content should be added into the operation regulations, and establish a complete system that can be effectively implemented. Or the accidents can occur.

机器人动作、运转发生某种异常时，如果不是控制装置出现异常，就应考虑是因机械部件损坏所导致的异常。为了迅速排除故障，首先需要明确掌握现象，并判断是因什么部件出现问题而导致的异常。

When abnormality occurs in robot motion or operation, if not caused by controlling device, check if it is caused by mechanism fails. In order to clear the trouble quickly, first need to investigate the situation, and define the failure is caused by which part.

第 1 步 哪一个轴出现了异常？

Step 1 Abnormality occurs to which joint?

首先要了解是哪一个轴出现异常现象。如果没有明显异常动作而难以判断时，应对

First need to know the abnormality occurs to which part. If cannot decide by apparent abnormality, should investigate

有无发出异常声音的部位；

the part with abnormal sound;

有无异常发热的部位；

the part with abnormal heating;

有无出现间隙的部位等情况进行调查。

the part with gaps, etc.

第 2 步 哪一个部件有损坏情况？

Step 2 Abnormality occurs to which part?

判明发生异常的轴后，应调查哪一个部件是导致异常发生的原因。一种现象可能是由多个部件导致的。故障现象和原因如下页表 4.1 所示。

After defining the abnormal joint, investigate the abnormality occurs to which part. One phenomenon may be caused by multiple parts. The figure 4.1 presents failures and causes.

第 3 步 问题部件的处理！

Step 3 Treatment to Failure Part

判明出现问题的部件后，按 4.3 所示方法进行处理。当弄不清原因，又不知道如何采取对策时，请联系本公司服务部门。

After define the failure part, process it with methods in figure 4.3. When the cause is unclear and it is unclear how to take countermeasures, please contact our company's service department.

4.2 故障现象和原因 Failure Phenomenon and Causes

如表 4.1 所示，一种故障现象可能是因多个不同部件导致。因此，为了判明是哪一个部件损坏，请参考此后所示的内容。

As table 4.1 shows, one failure phenomenon can be caused by several parts. So, please refer to the following content to define the failure part.

表 4.1 故障现象和原因 Table 4.1 Failure Phenomenon and Causes

原因部件 Failure Part 故障说明 Failure Explanation	减速机 Reducer	电机 Motor
过载 [注 1] Overload [Note 1]	●	●
位置偏差 Positional deviation	●	●
发生异响 Abnormal Sound	●	●
运动时振动 [注 2] Vibration in motion [Note 2]	●	●
停止时晃动 [注 3] Shake when stopping [Note 3]		●
轴自然掉落 Joint fall naturally	●	●
异常发热 Abnormal Heating	●	●
误动作、失控 Mis-action, out of control		●

[注 1]：负载超出电机额定规格范围时出现的现象。

[Note 1]: This phenomenon occurs when the load exceeds the rated specification range of the motor.

[注 2]：动作时的振动现象。

[Note 2]: This phenomenon means vibration during action.

[注 3]：停机时在停机位置周围反复晃动数次的现象。

[Note 3]:This phenomenon means repeated shaking at stop position.

4.3 各个零部件的检查方法及处理方法 Check Method and Treatment for Each Part

4.3.1 减速机 Reducer

减速机损坏时会产生振动、异常声音。此外，会妨碍正常运转，导致过载、偏差异常，出现异常发热现象，还会出现完全无法动作及位置偏差。

Reducer will produce vibration or abnormal sound after damaged. And this may impede normal running, and cause overload, abnormal deviation and heating, and complete inability to move and position deviation.

（1）检查方法 Check Method

检查减速机中润滑脂中铁粉量：润滑脂中铁粉量增加浓度在 **1000ppm** 以上时则有内部破损的可能性。（每运转 5，000 小时或每隔一年，请测量减速机的润滑脂铁粉浓度。超出标准值时，有必要更换润滑脂或者减速机，请联系本公司服务部门。）

Check the concentration of iron powder in reducer grease: where the increased concentration of iron powder exceeds 1000ppm, the internal damage may occur. (Please measure concentration of iron powder in reducer grease at the interval of every 5,000-hour or 1-year operation. It is necessary to alter grease or reducer when the measuring result exceeds the standard value, please contact service department of our company.)

检查减速机运转状态：拆下减速机，用手转动减速的输入一端，观察减速机是否产生卡顿、异常的声音。

Check the operating condition for the reducer: detach the reducer, turn the input end of reducer by your hand, check the reducer for any jam or abnormal sound.

检查减速机温度：温度较通常运转上升 10° 时基本可判断减速机已损坏。

Check the temperature of reducer: where the temperature is 10° higher than the normal

operation, it can be basically judged that the reducer has been damaged.

（2）处理方法 Handling Method

请更换减速机。由于更换减速机比较复杂，需更换时请联系本公司服务部门。

Please replace the reducer. Due to the complexity of replacing reducer, please contact our company's service department if needed.

4.3.2 电机 Motor

电机异常时，会出现停机时晃动、运转时振动等动作异常现象。此外，还会出现异常发热和异常声音等情况。由于出现的现象与减速机损坏时的现象相同，很难判定原因在哪里，因此，应同时进行减速机和平衡缸部件的检查。

Abnormal motions like shaking when stopping or vibration during motion can be defined as motor abnormality. Beside, abnormal heating or sound can also occur. Because the phenomenon is the same as that when the reducer is damaged, it's difficult to define the real cause. So please check the reducer and balance cylinder components simultaneously.

(1) 调查方法 Check Method

检查有无异常声音、异常发热现象。

Check for any abnormal sound or heating, etc.

(2) 处理方法 Handling Method

请更换电机。由于更换电机比较复杂，需更换时请联系本公司服务部门。

Please replace motor. Due to the complexity of replacing motor, please contact our company's service department if needed.

5 附录 Appendix

5.1 机器人备件目录 Spare parts of the robot

名称 Name	规格 Specification	单位 Unit	数量 Number	参考章节 Referred chapter
编码器电池 encoder battery		个 single	4	3.4
减速机润滑脂 grease	得润宝灵威 9101 机器人减速机润滑脂 Derunbao Lingwei 9101 robot reducer lubricating grease	Cc	500	3.3
密封胶 sealant	乐泰 5699 Loctite 5699	支 single	1	
螺纹胶 threadlocker	乐泰 243 Loctite 243	支 single	1	

5.2 螺钉拧紧说明 Screw Tightening Instructions

在维护检修机器人时，螺钉拧紧应采用力矩扳手按十字交叉法进行紧固，螺钉拧紧的力矩应严格参照表 5.1 所列数据。

During overhaul and maintenance, should use torque wrench to tighten screws by cross method; the tightened torque for screws must comply with data shown in Figure 5.1.

十字交叉法：螺钉紧固呈十字交叉的形式紧固，如图 5.1 所示。拧紧时应分多阶段逐步进行。初固：拧紧力矩的 30%左右，第二次紧固：拧紧力矩的 80%左右，第三次紧固：拧紧力矩的 100%。

Cross method: tighten the screw in the cross, as shown in the below. Tightening should be carried out in multiple stages. Initial tightening, tighten by 30% torque; second tightening, by 80% torque; third tightening, by 100% torque.

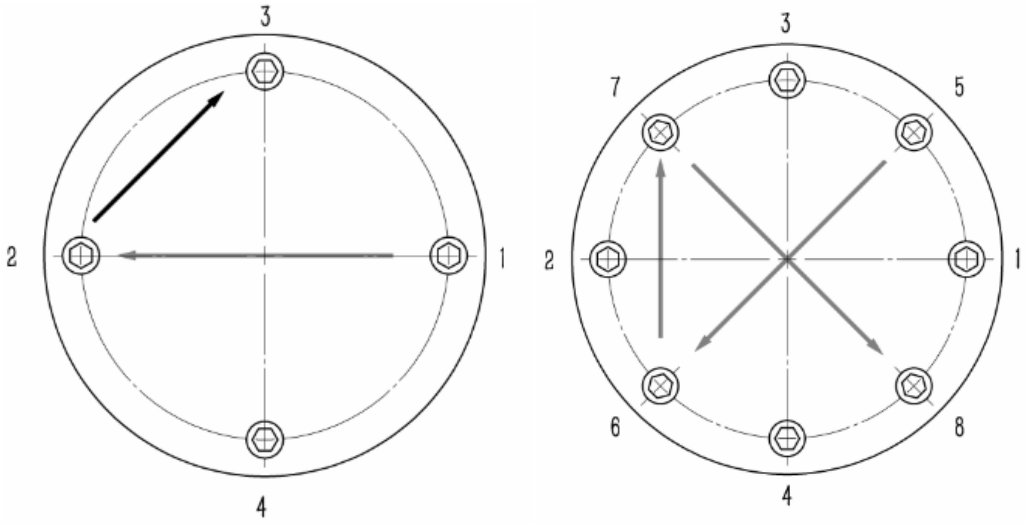


图 5.1 十字交叉法示意图 Diagram 5.1 Schematic diagram of the cross method

螺钉安装及注意事项：

Screw Installation and Precautions:

(1) 安装前观察螺钉外观是否合格，按要求领取螺钉。

Obtain the screw as required and check their appearance before installation.

(2) 螺钉紧固时可在螺钉上做好标记区分紧固与未紧固的螺钉，紧固完成后在螺钉及紧固件上皆做上标记，如下图 5.2 所示。

When tighten the screws,make marks to distinguish the tightened and not-tightened screws. After tightening, mark both the screws and fastener, as shown in the below picture.

图 5.2 防松标记示意图 Diagram5.2 Schematic diagram of anti loosening markings

(3) 对于拆卸多次的垫圈（弹簧垫圈及碟形弹簧垫圈）拆卸紧固多次后已无弹性变形力应将其废弃，固定减速机的垫圈（弹簧垫圈及碟形弹簧垫圈）应在拆卸 2 次后即废弃更换新的垫圈。

Discard the washer (spring washer and disc spring washer) after it has lost its elasticity after lots of removal and fastening, and replace the fixing washer of reducer (i.e., spring washer and disc spring washer) after it has been disassembled for 2 times.

(4) 螺钉在拆卸使用多次后已出现螺钉螺纹损坏应废弃。

Discard the thread-damaged screw after repeated use

(5) 用螺钉紧固零部件的过程中，如果出现螺钉被螺孔卡紧，无法继续打进的情况，为防止螺钉打滑或拧断螺钉，必须将螺钉退出，换用另外一颗。

When fasten the parts with screws, if the screw get stuck in the hole and cannot move forward, to prevent the screw from slipping or breaking, must unplug this screw and use another one.

表 5.1 螺钉拧紧力矩 Table 5.1 screw tightening torques

规格 Specification	螺钉等级 8.8 级 screw of grade 8.8		螺钉等级 12.9 级 screw of grade 12.9	
	标准扭矩值 Nm Standard Torque Value	扭矩范围 Nm Torque Range	标准扭矩值 Nm Value	扭矩范围 Nm Torque Range
M3	1.2	1.1～1.5	2	1.6～2.2
M4	2.5	2.2～3.5	4.8	3.8～5.7
M5	5	3.2～4.4	9.3	8.4～10.2
M6	8	7.4～11.2	16	15～18
M8	20	16～26	42	35～53
M10	40	36～52	80	74～88
M12	75	61～94	129	120～138
M14	120	97～150	205	195～220
M16	200	170～230	380	320～425
M20	370	310～430	550	490～610

注：若螺钉连接件为铝件，拧紧力矩统一按 8.8。

Attention: If the screw connector is made of aluminum, tighten by the torque required in 8.8 grade.

5.3 密封胶应用 Application of Sealant

(1) 对要密封的表面进行清洗和干燥

Clean and dry the surface to be sealed

① 用气体吹要密封的表面，除去灰尘。

Blow away the dust on the surface to be sealed.

② 为要密封的安装表面脱脂，可使用蘸有清洗剂的布或直接喷清洗剂。

Degrease the mounting surface to be sealed, use the cloth with detergent or directly spray the detergent.

③ 用气体吹干。

Blow dry the surface with gas.

(2) 施加密封胶

Apply sealant

① 确保安装表面是干燥的（无残留的清洗剂，如果有，将其擦干或吹干）。

Make sure the mounting surface is dry and with no residual detergent (if any, wipe it out or dry it).

② 在表面上施加密封胶，密封胶涂抹均匀，需密封地方密封胶不能存在断线情况。

Apply sealant to the surface and waiting for it to soften (about 10 minutes). Using the spatula to remove the softened sealant.

(3) 装配

Assemble

① 为了防止灰尘落在施加密封胶的部分，在密封胶应用后，应尽快安装零部件。注意，不要接触施加的密封胶。如果不慎擦掉了密封胶，需重新涂抹。

To avoid any dust on the surface applied with sealant, the components and parts should be installed as soon as possible after application of sealant. Please don't touch the sealant. Any destroyed sealant should be applied again.

② 安装完零部件后，用螺钉和垫圈快速固定它，使密封表面更贴合。

After the parts and components are installed, fix them quickly with screws and washers to push the them closer to the surface.

③ 未施加密封胶，不要上润滑油，这是因为无密封措施润滑油可能会泄漏。应在施加密封胶后等待至少 2 小时后进行润滑。

Before applying the sealant, please don't use the lubricant because it can lead to leakage. Lubricate the reducer at least 1 hour after installation.

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