



## KSS 8.6 操作及程式編輯技術手冊 (台灣版)

卓智機器人編譯

卓智機器人內部技術文件 台灣版

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Kuka KSS 8.6 SI V5

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# 1 Introduction 導引

## 1.1 Target group 目標族群

This documentation is aimed at users with the following knowledge and skills: 本文件目標族群為具有下列知識和技能的使用者：

- Advanced knowledge of the robot controller system 機器手臂控制系統的進階知識
- Advanced KRL programming skills 機器手臂程式撰寫的進階技能



For optimal use of KUKA products, we recommend the training courses offered by KUKA College. Information about the training program can be found at [www.kuka.com](http://www.kuka.com) or can be obtained directly from our subsidiaries.

為利KUKA產品達到最佳的使用效果，我們推薦由KUKA學院所提供的訓練課程，相關的訓練課程資訊可在[www.kuka.com](http://www.kuka.com) 或是由KUKA所屬各區原廠部門取得。

## 1.2 Industrial robot documentation 工業手臂文件

The industrial robot documentation consists of the following parts: 工業機器手臂文件涵蓋有下列部分：

- Documentation for the robot arm 機器手臂文件
- Documentation for the robot controller 控制器文件
- Documentation for the smartPAD-2 (if used) 教導器smartPAD-2文件
- Operating and programming instructions for the System Software 系統軟體的操作及撰寫程式指引說明
- Instructions for options and accessories 選項及配件的指引說明
- Spare parts overview in KUKA Xpert 於KUKA Xpert的零附件總覽

Each of these sets of instructions is a separate document. 每一個部分都是分開的個別文件

### 1.3 Representation of warnings and notes 警告及注意的代表符號

#### Safety

These warnings are provided for safety purposes and **must** be observed. 為利使用安全，必須注意這些警告



#### DANGER

These warnings mean that it is certain or highly probable that death or severe injuries **will** occur, if no precautions are taken. 這個危險警告代表，如果沒有採取安全預防措施，勢必或有極高的可能性，將導致傷亡事故。



#### WARNING

These warnings mean that death or severe injuries **may** occur, if no precautions are taken. 這個警告代表，如果沒有採取安全預防措施，可能導致傷亡事故。



#### CAUTION

These warnings mean that minor injuries **may** occur, if no precautions are taken. 這個小心警告代表，如果沒有採取安全預防措施，可能導致輕度傷害事故。



#### NOTICE

These warnings mean that damage to property **may** occur, if no precautions are taken. 這個提醒警告代表，如果沒有採取安全預防措施，可能導致設備財產的損壞。

These warnings contain references to safety-relevant information or general safety measures. 這些警告包含了安全相關的參考資訊或安全規範

These warnings do not refer to individual hazards or individual precautionary measures. 這些警告不會提示個別的危險或個別的安全預防規範

This warning draws attention to procedures which serve to prevent or remedy emergencies or malfunctions: 這個警告提醒注意免除緊急狀況或設備損壞的程序及步驟

#### SAFETY INSTRUCTION

The following procedure must be followed exactly!  
下列程序必須確實被執行

Procedures marked with this warning **must** be followed exactly. 標示有此警告的程序，必須確實遵照執行

### Notices 注意

These notices serve to make your work easier or contain references to further information. 這個提醒標示可讓作業更簡易或是包含更進一步的參考資訊



Tip to make your work easier or reference to further information.

### 1.4 Trademarks 商標

**Windows** is a trademark of Microsoft Corporation. **Windows** 是微軟的商標

**WordPad** is a trademark of Microsoft Corporation. **WordPad** 是微軟的商標

### 1.5 Licenses 授權

The KUKA license conditions and the license conditions of the open-source software used can be found here: KUKA授權規定及使用的開源軟體授權規定，都可以到下列位址取得

- Under .\LICENSE on the data storage medium with the installation files of the KUKA software Under .\LICENSE 在 KUKA 軟體安裝檔案的資料儲存裝置內
- On the KUKA smartHMI, in the main menu under **Help > Info**, tab **Li-censes** 在 KUKA 人機主畫面下 **Help > Info**, 標籤 **Li-censes**



Further information about open-source licenses can be requested from the following address: [opensource@kuka.com](mailto:opensource@kuka.com)

更多的有關開源授權資訊，可以到下面網址提出：[opensource@kuka.com](mailto:opensource@kuka.com)

## 2 Product description 產品說明

### 2.1 Product description 產品說明

#### Description

##### 說明

The KUKA System Software (KSS) provides all the functions required for operator control of KUKA robot systems.

KUKA系統軟體(KSS) 提供KUKA機器手臂系統操作控制所需的所有功能

#### Functions

##### 功能

- Path planning 路徑規劃
  - I/O management I/O管理
  - Touchscreen user interface KUKA.smartHMI 人機介面觸控螢幕
  - Simple programming with inline forms 在線格式簡易程式編輯
  - Expert programming with KRL (KUKA Robot Language) 使用KRL做專家程式編輯
  - Data and file management 數據資料及檔案管理
  - Diagnostic function 診斷功能
  - User rights management 使用權限管理
  - Integrated safety PLC 整合安全PLC模組
  - Safety-oriented functions and safety-oriented communication in discrete dual-channel technology 分離式雙迴路技術之安全導向功能、安全導向通訊
- Or direct safety-oriented communication to the safety PLC via Ether-Net-based protocols 透過乙太網路為基底的通訊協定，對安全PLC直接的安全導向通訊功能
- Numerous other function 許多其他功能

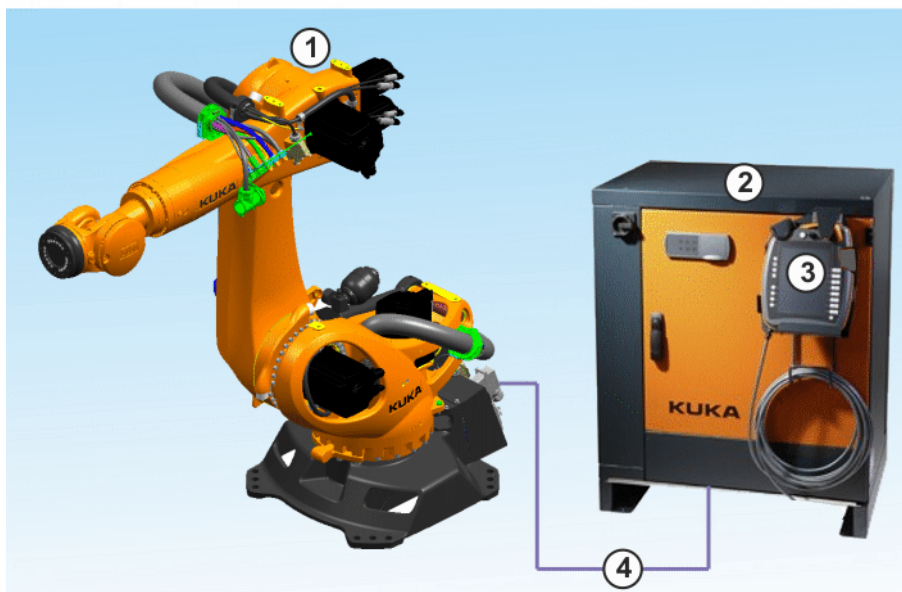
### 2.2 Overview of the industrial robot 工業機器手臂總覽

The industrial robot consists of the following components:

工業機器手臂包含下列組成：

- Manipulator 手臂
- Robot controller 控制器
- Teach pendant 教導器
- Connecting cables 連接電纜線
- Software 軟體
- Options, accessories 選項、配件





**Fig. 2-1: Example of an industrial robot 工業電腦範例**

- |                        |                           |
|------------------------|---------------------------|
| 1 Manipulator 手臂       | 3 KUKA smartPAD KUKA教導器   |
| 2 Robot controller 控制器 | 4 Connecting cables 連接電纜線 |

### 2.3 System requirements 系統要求

The System Software 8.6 can be run on the following robot controller: 系統軟體版本 8.6可在下列控制器執行

- KR C4 or VKR C4
- With Windows 10 IoT, V5.x 微軟 Windows 10 IoT, V5.x
- Motherboard D3445-K (MCC-40S) or later 主機板 D3445-K (MCC-40S)或更新版本

### 2.4 KUKA USB sticks/ KUKA USB

Special USB sticks from KUKA are available for the KR C4 and VKR C4 robot controllers. The sticks are available in the following variants:

KUKA USB 有下列形式可供使用

- Bootable variant, exclusively in conjunction with the software KUKA.RecoveryUSB

開機用的USB · 具有獨特與KUKA.RecoveryUSB軟體結合的USB

Color: Gray 顏色：灰色

- Non-bootable variant for data backup

不可開機用的U S B · 僅供資料備份

Color: Orange 顏色：橘

**NOTICE****Data loss due to USB sticks from third-party manufacturers**

由第三方製造商所生產之USB所造成的資料遺失

Data may be lost if USB sticks from manufacturers other than KUKA are used for activities on the robot controller. 非KUKA原廠的USB可能造成資料流失

- For activities on the robot controller requiring a USB stick, use a KUKA stick. 在機器手臂控制器使用時，使用KUKA原廠USB

The KUKA sticks are validated for use with the robot controller.  
KUKA USB是經驗證過，可用於KUKA機器手臂控制器的。

For further information about the USB sticks, please contact KUKA. 有關更多的USB資訊，請洽 K U K A

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## 2.5 Intended use and misuse 專用與誤用

### Use

The KUKA System Software is intended exclusively for the operation of a KUKA industrial robot or customer-specific kinematic system.

KUKA 系統軟體是專為KUKA工業手臂或客制運動系統之操作使用。

Each version of the KUKA System Software may be operated exclusively in accordance with the specified system requirements.

每一個版本的KUKA系統軟體，專用於所規範的系統要求下來操作

### Misuse

#### 誤用

Any use or application deviating from the intended use is deemed to be misuse and is not allowed. KUKA Deutschland GmbH is not liable for any damage resulting from such misuse. The risk lies entirely with the user.

任何偏離專用的使用，都被視為誤用，KUKA公司不負責任何誤用的損失，使用者必須自負風險

Examples of such misuse include: 誤用的範例

- Operation of a kinematic system that is neither a KUKA industrial robot nor a customer-specific kinematic system 在非KUKA 工業機器手臂或客製化運動系統下操作使用
- Operation of the KSS not in accordance with the specified system requirements KSS並未在規範的系統要求下操作使用

卓智機器人內部技術文件 台灣版

### 3 Safety 安全性

#### 3.1 General 通則

##### 3.4.5. Liability 可靠度

The device described in this document is either an industrial robot or a component thereof. 本文件所稱的裝置不是指工業機器手臂就是指組成元件

Components of the industrial robot: 工業機器手臂組成的元件計有：

- Manipulator 手臂
- Robot controller 控制器
- Teach pendant 教導器
- Connecting cables 連接纜線
- External axes (optional) 外部軸(選項)

e.g. linear unit, turn-tilt table, positioner 例如限性單元、旋轉偏傾平台、定位器

- Software 軟體
- Options, accessories 選項、配件

The industrial robot is built using state-of-the-art technology and in accordance with the recognized safety rules. Nevertheless, misuse of the industrial robot may constitute a risk to life and limb or cause damage to the industrial robot and to other material property.

工業機器手臂係使用最新的技術及依據公認的安全規範下，所製造生產的，雖然如此，機器手臂的誤用可能造成人員傷亡，或機器手臂及其他財產的損失。

The industrial robot may only be used in perfect technical condition in accordance with its intended use and only by safety-conscious persons who are fully aware of the risks involved in its operation. Use of the industrial robot is subject to compliance with this document and with the declaration of incorporation supplied together with the industrial robot. Any functional disorders, especially those affecting safety, must be rectified immediately.

工業機器手臂僅可在完善的技術條件下，依據其專用目的，由安全意識性高、了解作業風險的使用者操作使用，機器手臂的使用者必須遵守本文件規範及隨機出貨時的聲明文件。任何功能異常，尤其是影響安全的功能異常，必需立即修正。

#### Safety information

##### 安全資訊

Information about safety may not be construed against KUKA Deutschland GmbH. Even if all safety instructions are followed, this is not a guarantee that the industrial robot will not cause personal injuries or material damage. 有關安全的說明，不可拿來當成KUKA的負面訊息，即使是遵照所有安全指引，亦不能確保工業機器手臂不會造成意外的人員傷害或財物損毀。

No modifications may be carried out to the industrial robot without the authorization of KUKA Deutschland GmbH. Unauthorized modifications will result in the loss of warranty and liability claims. 未經KUKA原廠授權，不得對機器手臂進行改裝工程，未經授權的改裝作業，將喪失產品保固及KUKA對機器手臂的保證聲明。

Additional components (tools, software, etc.), not supplied by KUKA Deutschland GmbH, may be integrated into the industrial robot. The user is liable for any damage these components may cause to the industrial robot or to other material property.

附加的部分（工具，軟體等），非KUKA原廠所提供者，可被整合進機器手臂內，惟使用者必須承擔這些附加部分所造成的機器手臂損壞或財物損失。

In addition to the Safety chapter, this document contains further safety instructions. These must also be observed. 除了安全章節以外，本文件涵蓋了更近一步的安全指引。

### 3.4.5. EC declaration of conformity and declaration of incorporation

#### 合格的EC聲明及整合聲明

The industrial robot constitutes partly completed machinery as defined by the EC Machinery Directive. The industrial robot may only be put into operation if the following preconditions are met: 工業機器手臂係依據EC機器規範所生產的待整合機具，工業機器手臂在符合下列前置條件下，才能列入作業：

- The industrial robot is integrated into a complete system. 工業機器手臂被整合到一個完整的系統  
 or: The industrial robot, together with other machinery, constitutes a complete system. 或是 機器手臂與其他機器組成一個完整的系統  
 or: All safety functions and safeguards required for operation in the complete machine as defined by the EC Machinery Directive have been added to the industrial robot. 或是 EC機器規範所定義的完整機具操作所需安全功能及安全保護，已經加入工業機器手臂內
- The complete system complies with the EC Machinery Directive. This has been confirmed by means of a conformity assessment procedure. 一個符合EC機器規範的完整系統，且經過合格評鑑程序的確認。

## EC declaration of conformity 合格的EC聲明

The system integrator must issue an EC declaration of conformity for the complete system in accordance with the Machinery Directive. The EC declaration of conformity forms the basis for the CE mark for the system. The industrial robot must always be operated in accordance with the applicable national laws, regulations and standards. 系統整合商必須對整套系統，依據EC規範提出合格的歐盟EC聲明，這EC聲明是全系統CE標章的基本。工業機器手臂必須在符合國家現行使用的法令、規定及標準下操作。

The robot controller has a CE mark in accordance with the EMC Directive and the Low Voltage Directive. 機器手臂控制器依據EMC規範及低電壓規範，已經具有CE標章。

## Declaration of incorporation 整合聲明

The partly completed machinery is supplied with a declaration of incorporation in accordance with Annex II B of the Machinery Directive 2006/42/EC. The assembly instructions and a list of essential requirements complied with in accordance with Annex I are integral parts of this declaration of incorporation. 待整合機具隨機付有依據Annex II B of the Machinery Directive 2006/42/EC 的規範聲明。符合 Annex I 的組合說明及核心需求清單，為整合聲明的核心。

The declaration of incorporation declares that the start-up of the partly completed machinery is not allowed until the partly completed machinery has been incorporated into machinery, or has been assembled with other parts to form machinery, and this machinery complies with the terms of the EC Machinery Directive, and the EC declaration of conformity is present in accordance with Annex II A.

整合聲明：在待整合機具與全系統尚未整合前，是不准啟動的，直到待整合機具與其他部分組合後已經成為符合 EC Machinery Directive規範、符合EC合格聲明（依據Annex II A）。

### 3.4.5. Terms in the “Safety” chapter 在安全章節裡面的專用用語

STOP 0, STOP 1 and STOP 2 are the stop definitions according to EN 60204-1:2006. 依據 EN 60204-1:2006 定義 STOP 0, STOP 1 and STOP 2

Term	Description
Axis range 軸範圍	Range of each axis, in degrees or millimeters, within which it may move. The axis range must be defined for each axis. 各軸可以移動的範圍 (以角度或mm為單位) · 軸範圍一定是以各軸做為定義
Stopping distance 停止距離	<p>Stopping distance = reaction distance + braking distance 停止距離 = 反應距離 + 煞車距離</p> <p>The stopping distance is part of the danger zone. 停止距離屬危險區域的一部分</p>
Workspace 作業區域	Area within which the robot may move. The workspace is derived from the individual axis ranges. 作業區域是手臂被限定的工作範圍 · 係依照各軸限定的旋轉範圍所推導出來
User 使用者	The user of the industrial robot can be the management, employer or delegated person responsible for use of the industrial robot. 工業機器手臂的使用者可以是管理部門 · 使用單位 · 或是負責使用機器手臂的人員
Service life	<p>The service life of a safety-relevant component begins at the time of delivery of the component to the customer. 安全相關的元件服務壽限從元件運送時起算</p> <p>The service life is not affected by whether the component is used or not, as safety-relevant components are also subject to aging during storage.</p> <p>安全相關元件服務壽限並不只是受元件是否使用影響 · 因為安全有關的元件 · 儲藏時間所造成老化亦會影響產品壽命</p>

Danger zone 危險區域	The danger zone consists of the workspace and the stopping distances of the manipulator and external axes (optional). 危險區域涵蓋了手臂、外部軸的作業區域及停止距離所及區域
KUKA smartPAD 教導器	see “smartPAD”
KUKA smartPAD-2教導器	see “smartPAD”
Manipulator 手臂	The robot arm and the associated electrical installations 機器手臂手軸及電機設備
Safety zone 安全區域	The safety zone is situated outside the danger zone. 在危險區域外的空間，皆屬安全區域
Safe operational stop 安全作業停止功能	<p>The safe operational stop is a standstill monitoring function. It does not stop the robot motion, but monitors whether the robot axes are stationary. If these are moved during the safe operational stop, a safety STOP 0 is triggered. 安全作業停止功能是一個機器手臂靜止監測的機制，這機制並不會去停止手臂運動，而是監測手臂是否處於靜置狀態，如果在監測的期間手臂有移動，則觸發 safety STOP 0</p> <p>The safe operational stop can also be triggered externally. 安全作業停止功能也可以透過外部來觸發使用，如在使用者介面X11上，由外部觸發。</p> <p>When a safe operational stop is triggered, the robot controller sets an output to the field bus. The output is set even if not all the axes were stationary at the time of triggering, thereby causing a safety STOP 0 to be triggered. 當安全作業停止功能觸發使用時，控制器設定輸出到匯流排，即使在並非所有各軸都處於靜止狀態下，控制器一樣進行輸出設定，並觸發safety stop 0.</p>
Safety STOP 0	<p>A stop that is triggered and executed by the safety controller. The safety controller immediately switches off the drives and the power supply to the brakes. 這是由一個安全控制單元器所觸發執行的停止動作，安全控制會立即關閉驅動器及煞車器電源（供電時，手臂軸馬達煞車墊片開啟，無煞車作用，停止送電時，內建機械彈簧作動煞車片進行煞車）</p> <p><b>Note:</b> This stop is called safety STOP 0 in this document.</p> <p>注意：在本文件內這樣的停機稱為 safety STOP 0</p>



## Safety STOP 1

A stop that is triggered and monitored by the safety controller. The braking operation is carried out by the non-safety-oriented section of the robot controller and monitored by the safety controller. As soon as the manipulator has stopped, the safety controller deactivates the drives and the power supply of the brakes.

觸發停止並由安全控制單元監測，停機運作由非關安全的控制器部門執行，並由安全控制單元負責監測，一旦手臂停止運動，安全控制單元關閉驅動器及煞車電源（供電時，手臂軸馬達煞車墊片開啟，無煞車作用，停止送電時，內建機械彈簧作動煞車片進行煞車）

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When a safety STOP 1 is triggered, the robot controller sets an output to the field bus. 當safety stop 1 被觸發，手臂控制器輸出設定給匯流排

The safety STOP 1 can also be triggered externally. 外部可以進行 safety STOP 1 觸發

**Note:** This stop is called safety STOP 1 in this document.

提示：本文件稱此停機為safety stop 1

## Safety STOP 2

A stop that is triggered and monitored by the safety controller. The braking operation is carried out by the non-safety-oriented section of the robot controller and monitored by the safety controller. The drives remain activated and the brakes released. As soon as the manipulator is at a standstill, a safe operational stop is triggered.

觸發停止並由安全控制單元監測，停機運作由非關安全的控制器部門執行，並由安全控制單元負責監測，驅動器保持運作，且煞車釋放，一旦手臂停止運動，觸發安全作業停止功能。

When a safety STOP 2 is triggered, the robot controller sets an output to the field bus. 當safety stop 2 被觸發，手臂控制器輸出設定給匯流排

The safety STOP 2 can also be triggered externally. 外部可以進行 safety STOP 2 觸發

**Note:** This stop is called safety STOP 2 in this document.

提示：本文件稱此停機為safety stop 2

## Safety options 安全選配

Generic term for options which make it possible to configure additional safe monitoring functions in addition to the standard safety functions，這個安全選配裡的通用術語“選配”，代表可以設定額外的安全監視功能（除了標準安全功能外）

Example: SafeOperation 例如: SafeOperation

## smartPAD

Programming device for the robot controller

機器手臂程式撰寫的設備

The smartPAD has all the operator control and display functions required for operating and programming the industrial robot. 2 models exist: 教導器具有操作手臂、程式撰寫所需的操作控制及顯示功能，目前有兩種款式

- smartPAD
- smartPAD-2

In turn, for each model there are variants, e.g. with different lengths of connecting cables. 每種款式也有不同差異，如不同長度的纜線

The designation “KUKA smartPAD” or “smartPAD” refers to both models unless an explicit distinction is made.

Stop category 0  
STOP 0

The drives are deactivated **immediately** and the brakes are applied. The manipulator and any external axes (optional) perform path-oriented braking.

驅動器立刻關機，煞車立刻啟用，手臂和外部軸在路徑方向停機，

**Note:** This stop category is called STOP 0 in this document.

提示：Stop category 0 在本文件內就是 Stop 0

Stop category 1  
STOP 1

The manipulator and any external axes (optional) **perform path-maintaining braking**. 手臂和外部軸進行路徑維持停機

- Operating mode T1: The drives are deactivated as soon as the robot has stopped, but no later than after 680 ms.

T1模式：只要機器手臂停機，驅動器立即關閉，但不會超過680 ms

- Operating modes T2, AUT (KR C controller), AUT EXT (KR C controller), EXT (VKR C controller):

The drives are switched off after 1.5 s.

T2 · AU · AU EXT模式：驅動器在1.5s後關閉

**Note:** This stop category is called STOP 1 in this document.

提示：Stop category 1 在本文件內就是 Stop 1

Stop category 1 –  
Drive Ramp Stop  
STOP 1-DRS

The manipulator and any external axes (optional) perform **path-oriented** braking. 手臂和外部軸在路徑方向停機，

- Operating mode T1: The drives are deactivated as soon as the robot has stopped, but no later than after 680 ms.

T1模式：只要機器手臂停機，驅動器立即關閉，但不會超過680 ms

- Operating modes T2, AUT (KR C controller), AUT EXT (KR C controller), EXT (VKR C controller):

The drives are switched off after 1.5 s.

T2 · AU · AU EXT模式：驅動器在1.5s後關閉

- 4 **Note:** This stop category is called STOP 1 - DRS in this document.  
提示：Stop category 1 Drive Ramp Stop在本文件內就是 Stop 1-DRS

## Stop category 2

### STOP 2

The drives are not deactivated and the brakes are not applied. The manipulator and any external axes (optional) are braked with a path-maintaining braking ramp.

驅動器維持作動且未煞車，機器手臂及外部軸維持路徑緩慢停機

**Note:** This stop category is called STOP 2 in this document.

提示：Stop category 2 在本文件內就是 Stop 2

## System integrator (plant integrator)

系統整合商

The system integrator is responsible for safely integrating the industrial robot into a complete system and commissioning it.

系統整合商必須負責把機器手臂安全的整合到完整系統內並交接給客戶。

## T1

Test mode, Manual Reduced Velocity ( $\leq 250$  mm/s)

測試模式，手動低速（速度 $\leq 250$  mm/s）

## T2

Test mode, Manual High Velocity ( $> 250$  mm/s permissible)

測試模式，手動高速（速度 $>250$  mm/s）

## External axis

Axis of motion that does not belong to the manipulator, yet is controlled with the robot controller. e.g. KUKA linear unit, turn-tilt table, Posiflex

不屬於機器手臂本身，但接受手臂控制器控制，都稱為外部軸，例如直線滑軌、旋轉傾斜平台

## 3.2 Personnel 人員

The following persons or groups of persons are defined for the industrial robot: 下列機器手臂人員或群組分別定義如下：

- User 使用者
- Personnel 人員



### Qualification of personnel 合格人員

Work on the system must only be performed by personnel that is able to assess the tasks to be carried out and detect potential hazards. 系統工作必須由能夠評估任務且找出潛在風險的人員來實施。

Death, severe injuries or damage to property may otherwise result. The following qualifications are required: 否則會造成人員死亡、重傷或是財產損失，因此必須符合下列條件：

- Adequate specialist training, knowledge and experience  
足夠的專業訓練，知識及工作機經驗
- Knowledge of the relevant operating or assembly instructions, knowledge of the relevant standards  
相關的操作或整合指導專業知識，相關的標準規範知識
- All persons working with the industrial robot must have read and understood the industrial robot documentation, including the safety chapter.

所有與機器手臂工作的人員必須詳讀並了解機器手臂文件，包含安全規定之章節

### User 使用者

The user must observe the labor laws and regulations. This includes e.g. 使用者必須遵照勞工法令及規定，這包含：

- The user must comply with his monitoring obligations.  
使用者必須遵守監測的義務
- The user must carry out briefing at defined intervals.  
每隔一段時間，必須進行系統檢查作業

### Personnel 人員

Personnel must be instructed, before any work is commenced, in the type of work involved and what exactly it entails as well as any hazards which may exist. Instruction must be carried out regularly. Instruction is also required after particular incidents or technical modifications.

在任務執行前，都必須對人員所涉及的工作型態及可能存在的風險，做任務指導及說明，指導與說明必須是經常性的實施，在特殊的意外事件及技術修改之後，都必須執行

Personnel includes: 人員包含

- System integrator 系統整合人員
- Operators, subdivided into: 操作者，分為
  - Start-up, maintenance and service personnel 開機啟動、維修服務人員
  - Operating personnel 操作人員
  - Cleaning personnel 清潔人員

### System integrator

#### 系統整合商

The industrial robot is safely integrated into a complete system by the system integrator. 工業機器手臂必須由系統整合商，把手臂安全的整合成一個完整的系統

The system integrator is responsible for the following tasks: 系統整合商負有下面任務的責任

- Installing the industrial robot 機器手臂現場安裝
- Connecting the industrial robot 機器手臂與控制器、教導器連結組裝
- Performing risk assessment 執行風險評估
- Implementing the required safety functions and safeguards 完成所需的安  
全設定及防護
- Issuing the EC declaration of conformity 發布符合歐洲EC規範的聲明
- Attaching the CE mark 張貼CE 標誌
- Creating the operating instructions for the system 提供系統操作指導及說明書

## Operators

The operator must meet the following preconditions:

操作人員必須符合下列先決條件：

- The operator must be trained for the work to be carried out. 操作者必須接受過所要執行工作的訓練
- Work on the system must only be carried out by qualified personnel. These are people who, due to their specialist training, knowledge and experience, and their familiarization with the relevant standards, are able to assess the work to be carried out and detect any potential hazards. 系統工作必須由合格的人員來執行，這些合格人員是經過專業訓練、具有專業知識和經驗、熟悉相關的標準規範，而能夠評估作業，並且找出任何潛在危險的人。

### 3.3 Workspace, safety zone and danger zone 手臂作業區域、安全區域、危險區域

Workspaces are to be restricted to the necessary minimum size. A workspace must be safeguarded using appropriate safeguards. 手臂作業區域應該是被限縮於最小需求的空間範圍內，這個空間必須使用適當的防護。

The safeguards (e.g. safety gate) must be situated inside the safety zone. In the case of a stop, the manipulator and external axes (optional) are braked and come to a stop within the danger zone. 安全防護（如安全門）必須設置於安全區域內，在執行停機的狀況下，手臂及外部軸在危險區域內能夠煞車、靜止。

The danger zone consists of the workspace and the stopping distances of the manipulator and external axes (optional). It must be safeguarded by means of physical safeguards to prevent danger to persons or the risk of material damage. 危險區域涵蓋機器手臂作業區域及手臂、外部軸停止所需空間，危險區域必須使用實體的防護，避免造成人員危險及財產損失。

#### 3.4.5. Determining stopping distances 手臂停止距離的設定

The system integrator's risk assessment may indicate that the stopping distances must be determined for an application. In order to determine the stopping distances, the system integrator must identify the safety-relevant points on the programmed path. 系統整合商的風險評估有包含應用機器手臂時，手臂停止所需距離的設定，為了把停止距離給考慮進來，系統整合商必須清楚辨識在程式路徑上的相關安全點位

When determining the stopping distances, the robot must be moved with the tool and loads which are also used in the application. The robot must be at operating temperature. This is the case after approx. 1 h in normal operation. 手臂停止距離的設定，必須在手臂安裝有Tool及承載工件情況下設定，手臂必須在工作溫度下操作（大約一小時正常工作後的溫度）

During execution of the application, the robot must be stopped at the point from which the stopping distance is to be calculated. This process must be repeated several times with a safety stop 0 and a safety stop 1. The least favorable stopping distance is decisive.

在執行應用程式時，手臂必須停在開始要計算停止距離的點位上，這個過程使用safety stop 0 及 safety stop 1 反覆操作數次，並用最長的停止距離作為設定。

A safety stop 0 can be triggered by a safe operational stop via the safety interface, for example. If a safety option is installed, it can be triggered, for instance, by a space violation (e.g. the robot exceeds the limit of an activated workspace in Automatic mode).

舉例，透過安全介面，使用安全作業停止功能去觸發safety stop 0，如果有安裝安全選配，也可藉由手臂超出限定工作空間來觸發safety stop 0。

A safety stop 1 can be triggered by pressing the EMERGENCY STOP device on the smartPAD, for example. 另外，也可以使用教導器上的急停開關來觸發Safety stop 1

### 3.4 Triggers for stop reactions 停止觸發

Stop reactions of the industrial robot are triggered in response to operator actions or as a reaction to monitoring functions and error messages. The following table shows the different stop reactions according to the operating mode that has been set. 工業機器手臂會依據使用者的觸發停止方式，或依據對監測功能及錯誤訊息，來做不同方式的觸發停止，以下表格顯示依據所使用的觸發方式，其所造成的停止模式

Trigger	T1, T2	AUT, AUT EXT
Start key released 釋放開始鍵	STOP 2	-
STOP key pressed 按下停止鍵	STOP 2	
Drives OFF 關閉驅動器	STOP 1	

Trigger	T1, T2	AUT, AUT EXT
\$MOVE_ENABLE input drops out 輸入、退出	STOP 2	
Power switched off via main switch or power failure 主電源關閉或電源中斷	STOP 0	
Internal error in non-safety-oriented part of the robot controller 與安全無關的手臂控制器內部錯誤訊息	STOP 0 or STOP 1 (dependent on the cause of the error) (視錯誤原因)	
Operating mode changed during operation 作業期間改變操作模式	Safety stop 2	
Safety gate opened (operator safety) 安全門開啟 (作業人員安全)	-	Safety stop 1
Enabling switch released 釋放啟動開關	Safety stop 2	-
Enabling switch pressed fully down or error 啟動開關完全按壓到底或出錯	Safety stop 1	-
E-STOP pressed 按下急停開關	Safety stop 1	
Error in safety controller or periphery of the safety controller 安全控制單元出錯或安全控制單元周邊出錯	Safety stop 0	



## 3.5 Safety functions 安全功能

### 3.4.5. Overview of the safety functions 安全功能概述

The following safety functions are present in the industrial robot: 工業機器手臂具備下列安全功能

- Operating mode selection 操作模式選擇
- Operator safety (= connection for the monitoring of physical safe-guards) 操作人員安全 (實體安全防護的監控連結)
- EMERGENCY STOP device 急停開關
- Enabling device 啟動裝置
- External safe operational stop 外部安全作業停止
- External safety stop 1 外部安全停止 safety stop 1
- External safety stop 2 外部安全停止 safety stop 2
- Velocity monitoring in T1 T1模式速度監測

The safety functions of the industrial robot meet the following requirements: 工業機器手臂安全功能符合下列要求：

- **Category 3 and Performance Level d** in accordance with EN ISO 13849-1, EN ISO 13849-1 第三類及性能等級 d

The requirements are only met on the following condition, however: 但僅在下列條件下，符合要求：

- The EMERGENCY STOP device is pressed at least once every 12 months. 急停開關至少每12個月按壓檢查一次
- The enabling device is checked at least once every 12 months.  
(>>> *"Function test" Page 36*) 啟動裝置至少每12個月按壓檢查一次  
(功能測試第 P.36)

**DANGER****Risk of fatal injury due to non-operational safety functions or external safeguards** 由於不具作業安全功能或外部安全防護的致命傷害風險

In the absence of operational safety functions or safeguards, the industrial robot can cause death, severe injuries or damage to property.

Fm, 缺乏作業安全功能或安全維護，工業機器手臂可能造成死亡、嚴重傷害或財產損失

- If safety functions or safeguards are dismantled or deactivated, do not operate the industrial robot. 如果安全功能或安全防護被拆除或解除功能，不可對機器手臂進行操作

**Integrate industrial robot into safety system of the overall system**

整合工業機器手臂到全系統的安全體系內

During system planning, the safety functions of the overall system must be planned and designed. Death, severe injuries or damage to property may otherwise result. 在系統規劃期間，整體安全功能必須列入規劃及設計，否則將造成造成死亡、嚴重傷害或財產損失

The industrial robot must be integrated into the safety system of the overall system. 工業機器手臂必須整合到全系統的安全體系內

### 3.4.5. Safety controller 安全控制單元

The safety controller is a unit inside the control PC. It links safety-relevant signals and safety-relevant monitoring functions. 安全控制單元是一個位在控制PC內的一個單元，這個單元連結與安全有關的訊號，且連結與安全有關的監測功能。

Safety controller tasks: 安全控制單元的任務

- Switching off the drives; applying the brakes 關閉驅動器; 執行煞車
- Monitoring the braking ramp 監測煞車減速過程
- Standstill monitoring (after the stop) 靜止監測 (停止後)
- Velocity monitoring in T1 T1模式時，速度監測
- Evaluation of safety-relevant signals 評判安全有關訊號
- Setting of safety-oriented outputs 設定有關安全的輸出

### 3.4.5. Selecting the operating mode 選擇操作模式

#### Operating modes 操作模式

The industrial robot can be operated in the following modes: 工業機器手臂可以以使用下列模式操作

- Manual Reduced Velocity (T1) 手動減速模式 ( T1 )
- Manual High Velocity (T2) 手動高速模式 ( T2 )
- Automatic (AUT) 自動模式
- Automatic External (AUT EXT) 外部自動



Do not change the operating mode while a program is running. If the operating mode is changed during program execution, the industrial robot is stopped with a safety stop 2. 當程式正在執行時，不要切換操作模式，如果在程式執行時切換操作模式，工業機器手臂會以安全停止safety stop 2停機

Operating mode	Use	Velocities
T1	For test operation, programming and teaching 測試、程式編輯、教導時使用	<ul style="list-style-type: none"> <li>Program verification: 驗證程式 Programmed velocity, maximum 250 mm/s 程式執行速度最大250mm/s</li> <li>Jog mode: 寸動模式 Jog velocity, maximum 250 mm/s 寸動最大速 250mm/s</li> </ul>
T2	For test operation 測試使用	<ul style="list-style-type: none"> <li>Program verification 程式驗證: Programmed velocity 程式設定速度</li> <li>Jog mode: Not possible 無法使用寸動</li> </ul>
AUT	For industrial robots without higher-level controllers 工業機器手臂無上位控制	<ul style="list-style-type: none"> <li>Program operation: 程式執行操作 Programmed velocity 程式設定速度</li> <li>Jog mode: Not possible 無法使用寸動</li> </ul>
AUT EXT 外部自動	For industrial robots with higher-level controllers, e.g. PLC 業機器手臂接受上位控制，如PLC	<ul style="list-style-type: none"> <li>Program operation: 程式執行操作 Programmed velocity 程式設定速度</li> <li>Jog mode: Not possible 無法使用寸動</li> </ul>

### Mode selector switch 模式選擇開關

The user can change the operating mode via the connection manager. The connection manager is a view that is called by means of the mode selector switch on the smartPAD. 使用者可透過介接管理員視窗來切換作業模式，介接管理視窗使用smartPAD上的模式選擇開關來打開

The mode selector switch may be one of the following variants: 模式選擇開關可能有下列的形式：

- With key 使用鑰匙  
It is only possible to change operating mode if the key is inserted.  
只有在鑰匙插入使用狀況下，可以改變操作模式
- Without key 無鑰匙



## WARNING

### **Danger to life and limb due to mode selector switch without access restriction 無取得模式選擇開關的限制，恐致傷亡意外**

If the smartPAD is equipped with a mode selector switch without a key, all persons can operate the mode selector switch, irrespective of their field of activity or qualifications. Death, severe injuries or damage to property may result. 如果smartPAD配用無需鑰匙的模式選擇開關，所有人員，無論他們的活動區域或資格，都可以進行模式選擇，這可能造成死亡、嚴重傷害或財產損失

- An additional device must be installed to ensure that the mode selector switch can only be operated by a restricted group of people. 必須建立額外的安全措施，確保只有限定的人員可以做模式選擇開關的操作
- The device itself must not trigger motions of the industrial robot or other hazards. 這額外增加的裝置本身，不可觸發手臂作動或其他風險

### 3.4.5. “Operator safety” signal “操作者安全” 訊號

The “operator safety” signal is used for monitoring physical safeguards, e.g. safety gates. Automatic operation is not possible without this signal. In the event of a loss of signal during automatic operation (e.g. safety gate is opened), the manipulator stops with a safety stop 1. 操作者安全訊號是用來監測實體安全防護，例如安全門，自動作業時，不可沒有這個訊號，一旦自動作業時失去訊號，手臂會立即以safety stop 1停機(例如安全門被打開)。

Operator safety is not active in modes T1 (Manual Reduced Velocity) and T2 (Manual High Velocity). 在T1，T2作業模式下，操作者安全功能並不啟用。



## WARNING

**Danger to life and limb due to resumed automatic operation without adequate acknowledgement** 在手臂停機時，沒有進行充分的確認就繼續執行自動化運行，恐致傷亡意外

Following loss of the “Operator safety” signal, it must not be possible to restart automatic operation by merely closing the safeguard. Otherwise, for example, the safety gate could close unintentionally, thereby causing automatic operation to resume while there are persons in the danger zone. Death, severe injuries or damage to property may result.

在失去操作者安全訊號後，絕不可只是關上安全防護，就繼續執行手臂運動，否則，很可能造成無心的關上安全防護，讓機器手臂繼續做動，萬一還有人員處在手臂危險區域內，將造成人員傷亡。

- Automatic operation must not be resumed until the safeguard has been closed and the closing has been acknowledged.

自動作業必須在安全防護關閉及做充分關閉確認後，才能繼續執行

- The acknowledgement must be designed in such a way that an actual check of the danger zone can be carried out first. Other acknowledgement functions (e.g. an acknowledgement which is automatically triggered by closure of the safeguard) are not permitted.

關閉的確認動作必須是危險區域先做確實檢查，其他確認功能（例如關閉安全門後自動觸發的確認）都是不被允許！

### 3.4.5. EMERGENCY STOP device 急停開關裝置

The EMERGENCY STOP device for the industrial robot is the EMERGENCY STOP device on the smartPAD. The device must be pressed in the event of a hazardous situation or emergency. 工業機器手臂的急停開關位於教導器上，遇到危險及緊急狀況時，必須按下急停開關。

Reactions of the industrial robot if the EMERGENCY STOP device is pressed: 急停開關按下後，工業機器手臂的反應：

- The manipulator and any external axes (optional) are stopped with a safety stop 1. 手臂及任何外部軸皆以safety stop 1定止作動

Before operation can be resumed, the EMERGENCY STOP device must be turned to release it. 在重新啟動手臂前，急停開關必須旋轉至釋放位置。



### WARNING

#### **Danger to life and limb due to tools and equipment without EMERGENCY STOP 無急停開關，恐致傷亡意外及財產損失**

If tools and other equipment connected to the robot are not integrated into the EMERGENCY STOP circuit, this can result in death, severe injuries or damage to property. 如果手臂工具或其他與手臂連接的設備，若沒有整合到急停開關的停機迴路，恐造成傷亡意外或財產損失

- Integrate tools and other equipment into the EMERGENCY STOP circuit if they could constitute a potential hazard. 如果手臂工具及其他設備具有潛在的危險，需整合到急停開關迴路。

There must always be at least one external EMERGENCY STOP device installed. This ensures that an EMERGENCY STOP device is available even when the smartPAD is disconnected. 至少要有一組外部的急停開關被安裝在現場，提供使用，以免教導器未連接使用時，上面的急停開關失效無法作動。

(>>> [3.5.7 "External EMERGENCY STOP device" Page 35](#))

## 卓智機器人內部技術文件 台灣版

### 3.4.5. Logging off from the higher-level safety controller 從較高層的安全控制單元登出

If the robot controller is connected to a higher-level safety controller, this connection will inevitably be terminated in the following cases: 如果機器手臂控制器有連接到較高層安全控制單元，這個連接將在下面狀況發生時失效：

- Switching off the voltage via the main switch of the robot Or power failure 關掉機器手臂主電源供應開關，或電力中斷
- Shutdown of the robot controller via the smartHMI 使用教導器關閉控制器
- Activation of a WorkVisual project in WorkVisual or directly on the robot controller 在WorkVisual啟動專案或由控制器啟動專案
- Changes to **Start-up > Network configuration** 改變網路組態
- Changes to **Configuration > Safety configuration** 改變安全組態
- **I/O drivers > Reconfigure** 改變 I/O組態
- Restoration of an archive 恢復備份檔案

## Effect of the interruption: 中斷處理的影響

- If a discrete safety interface is used, this triggers an EMERGENCY STOP for the overall system. 如果使用的是一個分散式的安全介面，中斷處理會觸發整個系統的急停。
- If the Ethernet interface is used, the KUKA safety controller generates a signal that prevents the higher-level controller from triggering an EMERGENCY STOP for the overall system. 如果使用網路介面，KUKA 安全控制單元會產生一個訊號，避免高層控制器對整個系統觸發急停。


**Take Ethernet safety interface into consideration in risk assessment 把網路安全介面下入風險評估考量**

Failure to take the Ethernet safety interface into consideration in the risk assessment may result in death, severe injuries or damage to property.

未把網路安全介面列入風險評估考量，教導致生命、財產損失

- In his risk assessment, the system integrator must take into consideration whether the fact that switching off the robot controller does not trigger an EMERGENCY STOP of the overall system could constitute a hazard and, if so, how this hazard can be countered.

在風險評估時，系統整合商必須把關閉機器手臂控制器，並不會觸發整個系統的急停而可能造成的危險列入考慮，並設法防止。

# 卓智機器人內部技術文件 台灣版


**WARNING 警告**
**Danger to life and limb due to smartPAD on controller that has been switched off 沒有作用的教導器，可導致生命、財產損失**

If a robot controller is switched off, the EMERGENCY STOP device on the smartPAD is not operational. There is a risk of operational and non-operational EMERGENCY STOP devices becoming interchanged. Death, severe injuries or damage to property may result.

如果機器手臂控制器被關閉，手臂教導器上的急停開關將無任作用，如果把一個可以作動的教導器和一個不能作動的教導器做交換，恐造成傷亡意外或財產損失。

- Cover smartPADs on controllers that have been switched off or remove them from the system. 遮蓋沒有作用的教導器或從作業現場移除。



### 3.4.5. External EMERGENCY STOP device 外部急停開關

Every operator station that can initiate a robot motion or other potentially hazardous situation must be equipped with an EMERGENCY STOP device. The system integrator is responsible for ensuring this. 每一個可以啟動手臂的操作者工作站，或是其他有危險的區域，都必須配置一個急停開關，系統整合商必須負責確認此事。

There must always be at least one external EMERGENCY STOP device installed. This ensures that an EMERGENCY STOP device is available even when the smartPAD is disconnected. 至少要安裝一個外部的急停開關，以確保當教導器離線時，還有一個急停開關可供使用。

External EMERGENCY STOP devices are connected via the customer interface. External EMERGENCY STOP devices are not included in the scope of supply of the industrial robot. 外部急停開關可以透過客戶介面（customer interface · X11）連結，且外部急停開關，並不包含在機器手臂交運清單內。

### 3.4.5. Enabling device 啟動裝置

The enabling devices of the industrial robot are the enabling switches on the smartPAD. 機器手臂的啟動裝置即是教導器背後的啟動開關

- **smartPAD:** 3 enabling switches 3個啟動開關
- **smartPAD-2:** 4 enabling switches 新型教導器有4個啟動開關

The enabling switches have 3 positions 啟動開關有3個按壓狀態

- Not pressed 未按壓
- Center position 中心位置
- Fully pressed (panic position) 完全下壓（恐慌位置）
- In the test modes, the manipulator can only be moved if at least one of the enabling switches is held in the center position. 在測試模式下，只有至少一個啟動開關被按壓在中心位置，才能作動手臂

It is possible to hold several enabling switches in the center position simultaneously. This makes it possible to adjust grip from one enabling switch to another one. 可同時按壓數個啟動開關在中心位置，藉此進行啟動開關間的切換。

In the test modes, the manipulator can be stopped in the following ways: 測試模式下，手臂可以用下列方式停止：

- Press at least one enabling switch down fully. 按壓其中一個啟動開關到底  
Pressing an enabling switch down fully triggers a safety stop 1. 按壓其中一個啟動開關到底，會觸發safety stop 1
- Or release all enabling switches. 釋放所有啟動開關  
Releasing all (!) enabling switches held in the center position triggers a safety stop 2. 釋放所有按壓在中心位置的啟動開關，會觸發safety stop 2



#### WARNING

**Danger to life and limb due to lack of reaction when an enabling switch is released** 釋放啟動開關後，機器手臂並未停止作動，恐造成生命財產損失

Releasing one of multiple enabling switches held in the center position does not trigger a stop reaction. 釋放一個啟動開關，但其他啟動開關仍按壓在中心位置，這將不會觸發機器手臂停止

If multiple switches are held in the center position, the robot controller cannot distinguish whether one of them was intentionally released or if it was unintentionally released as the result of an accident. 如果多個啟動開關被按壓在中心位置，機器手臂控制器無法辨識其中一個被釋放掉，是有意或被釋放，或者是因為意外而無意的被釋放，因此手臂不會觸發停止。

- Create awareness for the hazard. 對此，必須保有這種風險警覺

If an enabling switch malfunctions (e.g. jams in the center position), the industrial robot can be stopped using one of the following methods: 如果啟動開關故障（例如，中心位置被卡住），手臂可以下列方式停止：

- Press another enabling switch down fully. 按壓另外一個啟動開關到底
- Actuate the EMERGENCY STOP device. 按壓急停開關
- Release the Start key. 釋放開始按鍵

**WARNING****Danger to life and limb due to manipulation of enabling switches**

The enabling switches must not be held down by adhesive tape or other means or tampered with in any other way. Death, severe injuries or damage to property may result.

**操弄啟動開關可能造成的傷亡意外**

啟動開關不可以用膠帶黏住方式按壓，或者使用其他任何不當的方法按壓，否則將導致傷亡及財產損失

- Carry out a visual inspection of the enabling switches. 對啟動開關執行目視檢查
- Rectify tampering or remove any foreign bodies. 修正不當按壓或移除任何異物

**Function test****功能測試**

The function of the enabling switches must be tested in the following cases: 啟動開關在下列情況下，必須做功能測試：

- Following initial start-up or recommissioning of the industrial robot 在初次啟動或工業機器手臂交機時
- After a software update 在軟體更新後
- After disconnecting and reconnecting a smartPAD (the same smart-PAD or another one) 在教導器離線且重新連線後（使用原有教導器或另外的教導器）
- The test must be carried out at least once every 12 months. 每12個月至少做一次測試

To test, perform the following steps separately for each enabling switch: 對每一個啟動開關各別執行下面的測試執行步驟：

1. Move the manipulator in a test mode. 在測試模式下，移動手臂
2. While the manipulator is moving, press the enabling switch down fully and hold it down for 3 seconds. 當手臂移動時，下壓啟動開關到底，並持續3秒

The test is passed in the following case: 下面的狀況下，表示測試通過：

- The manipulator stops. 機器手臂停止作動
- And: No error message for the enabling device is displayed (*Enabling switch error* or similar). 且 沒有任何有關啟動開關的錯誤訊息顯示 (*Enabling switch error* 或類似訊息)

If the test has not been passed for one or more enabling switches, the smartPAD must be exchanged and the test must be performed again. 如果其中任何一個啟動開關測試未通過，必須更換教導器，而且重做測試

### 3.4.5. External enabling device 外部啟動裝置

External enabling devices are required if it is necessary for more than one person to be in the danger zone of the industrial robot. 如果需要超過1個人在手臂危險區域內，必須裝設外部啟動裝置

The function of the external enabling switches must be tested at least once every 12 months. 外部啟動開關必須每12個月至少測試一次。



Which interface can be used for connecting external enabling devices is described in the "Planning" chapter of the robot controller operating instructions and assembly instructions. 外部啟動裝置的連接介面，可參考機器手臂操作及組裝說明的“計畫”章節

External enabling devices are not included in the scope of supply of the industrial robot. 外部啟動裝置並不包含在機器手臂交運的項目內。

### 3.4.5. External safe operational stop 外部安全作業停止

The safe operational stop can be triggered via an input on the customer interface. The state is maintained as long as the external signal is FALSE. If the external signal is TRUE, the manipulator can be moved again. No acknowledgement is required. 安全作業停止可以透過客戶介面 (customer interface, 如X11) 輸入訊號來觸發，當外部輸入訊號為FALSE時，機器手臂觸發停止，但若輸入為TRUE，機器手臂可以繼續移動，且不需按確認。

( Acknowledgement )

### 3.4.5. External safety stop 1 and external safety stop 2 外部safety stop 1 及外部 safety stop 2

Safety stop 1 and safety stop 2 can be triggered via an input on the customer interface. The state is maintained as long as the external signal is FALSE. If the external signal is TRUE, the manipulator can be moved again. No acknowledgement is required.

安全safety stop 1及safety stop 2可以透過客戶介面 (customer interface, 如X11) 輸入訊號來觸發，當外部輸入訊號為FALSE時，機器手臂觸發停止，但若輸入為TRUE，機器手臂可以被再移動，且不需按確認。

If interface X11 is selected as the customer interface, only the signal **Safety stop 2** is available. 如果是使用X11作為客戶端介面，則僅有Safety stop 2可以被觸發。

### 3.4.5. Velocity monitoring in T1 在T1模式下的速度監測

In T1 mode, the velocity is safely monitored on both an axis-specific and Cartesian basis. 在T1模式下，機器手臂的各軸軸速度和世界座標下的空間移動速度，均被安全的監測著。



- Applicable up to and including System Software 8.5.7:  
For customer kinematic systems (CKs), only the axis-specific velocity is safely monitored in T1 mode. The Cartesian position on the flange is only available for KUKA kinematic systems using safe technology.

KSS 8.5.7 (含) 以下版本適用：

在T1模式下，CKS (customer kinematic systems) 僅作各軸軸速度的安全監測，世界座標系下的法蘭速度僅有使用安全技術下的 KUKA kinematic system 可以提供監測功能

- Applicable for System Software 8.5.8 or higher:  
For all kinematic systems, the axis-specific velocity is safely monitored in T1 mode. The Cartesian velocity is safely monitored in T1 if the associated setting is activated in the safety configuration.

KSS 8.5.8 (含) 以上版本適用：

在T1模式下，所有運動學系統，各軸軸速度均被安全監測，世界座標系下的法蘭速度，在安全組態內的相關設定被啟用時，可以被安全監測。

#### Axis-specific monitoring 軸速度監測

If an axis exceeds its velocity limit, a safety stop 0 is triggered. 如果有一軸超過速度限制，則觸發 safety stop 0

- Default limit value for rotational axes: 30°/s 內建旋轉軸速度上限為 30°/秒
- Default limit value for linear axes: 250 mm/s 線性軸內建速度上限為 250mm/s



From System Software 8.3 onwards, the axis-specific monitoring can be configured using the **Maximum velocity T1** parameter. Further information about this can be found in the **Operating and Programming Instructions for System Integrators** documentation for the System Software. 自KSS 8.3之前，軸速度監測可以使用最大速度T1參數設定，更多的資訊及說明，可參閱系統整合商的操作與程式撰寫指導KSS文件

## Cartesian monitoring 世界座標速度監測

The Cartesian monitoring refers to the velocity at the flange. If a limit value is exceeded, a safety stop 0 is triggered. 世界座標系下的速度監測係用在法蘭上的速度作為監測，當速度超過設定，則、觸發 safety stop 0

- Default limit value: 250 mm/s 內建速度上限為 250mm/s

If an additional safety option (e.g. SafeOperation) is used, the limit value can be configured. It can be reduced, but not increased. 如果有選配安全選項(例如, SafeOperation)，上限速度可以被修改，但只能向下修改，而不能增加上限速度。

## 3.6 Additional protective equipment 額外的防護設備

### 3.4.5. Jog mode 寸動

In the operating modes T1 (Manual Reduced Velocity) and T2 (Manual High Velocity), the robot controller can only execute programs in jog mode. This means that it is necessary to hold down an enabling switch and the Start key in order to execute a program. 在測試模式T1（手動減速速度），及T2（手動高速）模式下，手臂控制器僅能用寸動方式執行程式，也就是說，在這兩種模式下執行程式，都必須按壓啟動開關及開始鍵，才能執行程式。

- Releasing the enabling switch triggers a safety stop 2. 釋放啟動開關，則觸發safety stop 2停止
- Pressing the enabling switch down fully (panic position) triggers a safety stop 1.  
按壓啟動開關到底，則觸發safety stop 1停止
- Releasing the Start key triggers a STOP 2.  
釋放開始鍵觸發stop2停止

### 3.4.5. Software limit switches 軟體限制開關

The axis ranges of all manipulator and positioner axes are limited by means of adjustable software limit switches. These software limit switches only serve as machine protection and must be adjusted in such a way that the manipulator/positioner cannot hit the mechanical end stops.

The software limit switches are set during commissioning of an industrial robot. 機器手臂各軸及定位軸，可以藉由軟體限制開關去調整運動範圍，軟體限制開關僅提供機械的保護，其設定範圍不可超過機構終點擋塊位置。軟體限制開關在機器手臂交機時，設定完成。



Further information is contained in the operating and programming instructions. 更多的資訊及說明，可參閱操作與程式撰寫指導文件

### 3.4.5. Mechanical end stops 機構終端阻擋器

Depending on the robot variant, the axis ranges of the main and wrist axes of the manipulator are partially limited by mechanical end stops. 依據不同形式的機器手臂，部分主關節及腕關節，有設置機構終端阻擋器，以限制動作範圍。

Additional mechanical end stops can be installed on the external axes. 外部軸也可以加裝額外的機構終端阻擋器



#### WARNING

**Danger to life and limb following collision with obstacle 與障礙物撞擊後，恐導致造成傷亡意外**

If the manipulator or an external axis hits an obstruction or a mechanical end stop or mechanical axis limitation, the manipulator can no longer be operated safely. Death, injuries or damage to property may result. 如果機器手臂與外部軸撞擊障礙物，或是機構終端阻擋器，或是機構軸限器，機器手臂可能不再能夠被安全操作，並可能導致傷亡意外或財物損失。

### 3.4.5. Mechanical axis limitation (optional) 機構軸限器 (選配)

卓智機 Some manipulators can be fitted with mechanical axis limitation systems in axes A1 to A3. The axis limitation systems restrict the working range to the required minimum. This increases personal safety and protection of the system. 一些機器手臂可以在A1到A3軸加裝機構軸限器系統，以限制機器手臂作業區域到最小需求範圍內，以增加人員安全並保護系統。

In the case of manipulators that are not designed to be fitted with mechanical axis limitation, the workspace must be laid out in such a way that there is no danger to persons or material property, even in the absence of mechanical axis limitation.

在手臂本身設計無法安裝機構軸限器的狀況下，機器手臂的作業區域圍必須設計到不會造成人員危險及財物損害。

If this is not possible, the workspace must be limited by means of photoelectric barriers, photoelectric curtains or obstacles on the system side. There must be no shearing or crushing hazards at the loading and transfer areas.

如果無法執行，機器手臂作業區域必須使用光電阻隔器、光柵或是障礙物進行阻絕，尤其在上料及運送區域，絕對不可以有機器手臂剪切、壓擠的危險情況產生。



This option is not available for all robot models. Information on specific robot models can be obtained from KUKA Deutschland GmbH. 本選配不適用於所有形式的機器手臂，相關適用的特規手臂型號資料，可洽原廠取得



### 3.4.5. Options for moving the manipulator without drive energy 使用非電力驅動方式移動手臂軸選項



#### **Qualification of personnel with regard to behavior in emergency situations 緊急狀態下，人員處置作為的資格審定**

In emergencies or other exceptional situations, it may be necessary to move the manipulator without drive energy. 在緊急或例外狀況時，使用非電力驅動方式移動手臂，或許是必要的。

- Personnel must be trained in how to move the manipulator without drive energy. 人員必須經過訓練，才能使用非電力驅動方式移動手臂

#### **Description 描述**

The following options are available for moving the manipulator without drive energy after an accident or malfunction: 在事故或故障時，下列方式可以提供非電力驅動移動手臂的選擇

- Release device (optional) 釋放裝置 (選配)

The release device can be used for the main axis drive motors and, depending on the robot variant, also for the wrist axis drive motors.

釋放裝置可用於主軸驅動馬達，有些型號的手臂，也可以用於腕關節的馬達

- Brake release device (option) 煞車釋放裝置 (選配)

The brake release device is designed for robot variants whose motors are not freely accessible. 煞車釋放裝置用於一些無法方便進入馬達的機器手臂型式

- Moving the wrist axes directly by hand 直接使用人力移動機器手臂腕關節

There is no release device available for the wrist axes of variants in the low payload category. This is not necessary because the wrist axes can be moved directly by hand. 低負載的機器手臂並無釋放裝置可提供使用，因為使用人力即可輕易移動機器手臂腕關節。



Information about the options available for the various robot models and about how to use them can be found in the assembly and operating instructions for the robot or requested from KUKA Deutschland GmbH. 有關不同型號的機器手臂選項資訊，可以參考機器手臂組合及操作說明，或向原廠洽詢。



**NOTICE****Damage to property due to motion without drive energy 使用非電力驅動所造成的財物損失**

Moving the manipulator without drive energy can damage the motor brakes of the axes concerned. 使用非電力驅動方式移動手臂，可能造成被移動手軸馬達煞車的損壞

- Only move the manipulator without drive energy in emergencies, e.g. for rescuing persons. 只有在緊急狀況下，才能使用非電力驅動方式移動機器手臂，例如，在人員搶救時
- The motor must be replaced if the brake has been damaged. 如果煞車損壞，馬達必須做更換

**3.4.5. Labeling on the industrial robot 機器手臂貼標**

All plates, labels, symbols and marks constitute safety-relevant parts of the industrial robot. They must not be modified or removed. 所有銘牌、標籤、標誌及記號構成了機器手臂安全有關的配件

Labeling on the industrial robot consists of: 這些標誌有：

- Identification plates 識別銘牌
- Warning signs 警告標誌
- Safety symbols 安全標誌
- Designation labels 設計標誌
- Cable markings 電纜標誌
- Rating plates 額定銘牌



Further information is contained in the technical data of the operating instructions or assembly instructions of the components of the industrial robot. 有關更進一步資訊可以參考機器手臂操作及組合說明的技術資料。

### 3.4.5. External safeguards 外部安全維護

The access of persons to the danger zone of the industrial robot must be prevented by means of safeguards. It is the responsibility of the system integrator to ensure this. 必須有安全防護防止人員進入機器手臂危險區域

Physical safeguards must meet the following requirements: 實體安全防護必須符合下列需求：

- They meet the requirements of EN ISO 14120. 符合EN ISO 14120
- They prevent access of persons to the danger zone and cannot be easily circumvented. 能夠防止人員進入機器手臂危險區域，且不易被翻越、移除、破壞
- They are sufficiently fastened and can withstand all forces that are likely to occur in the course of operation, whether from inside or outside the enclosure. 具備足夠的固定支撐，能承受來自內部或外的力量，尤其是手臂操作路徑上可能產生的衝擊力。
- They do not, themselves, represent a hazard or potential hazard. 防護體自身不可以成為危害或存在危害風險
- Prescribed clearances, e.g. to danger zones, are adhered to. 清楚界定緊鄰處，所必須清空的區域，如危險區域。

Safety gates (maintenance gates) must meet the following requirements: 安全門（維修門）必須符合下列要求：

- They are reduced to an absolute minimum. 安全門尺寸必須降低到最小
- The interlocks (e.g. safety gate switches) are linked to the operator safety input of the robot controller via safety gate switching devices or safety PLC. 透過門鎖開關訊號或PLC，必須與控制器內的操作者安全輸入訊號連接，達到機械互鎖功能（Interlock），
- Switching devices, switches and the type of switching conform to the requirements of Performance Level d and category 3 according to EN ISO 13849-1. 門鎖切換裝置、開關及切換型式，必須符合EN ISO 13849-1 性能D、類別3的要求
- Depending on the risk situation: the safety gate is additionally safeguarded by means of a locking mechanism that only allows the gate to be opened if the manipulator is safely at a standstill.  
依據危害情形，安全門可以額外加設門鎖機構，只有在機器手臂安全靜止狀態下，才能夠開啟門鎖
- The button for acknowledging the safety gate is located outside the space limited by the safeguards.

確認安全門的按鈕需位於防護區外面



Further information is contained in the corresponding standards and regulations. These also include EN ISO 14120. G; 上述相關標準及規定，請參閱EN ISO 14120

## Other safety equipment 其他安全設備

Other safety equipment must be integrated into the system in accordance with the corresponding standards and regulations. 依據相關標準及規定，其他安全設備必須被整合到系統內

### 3.7 Overview of operating modes and safety functions 操作模式及安全功能概述

The following table indicates the operating modes in which the safety functions are active. 下列表格表示了在各種操作模式下，機器手臂開啟的安全防護功能：

Safety functions 安全功能	T1	T2	AUT	AUT EXT
Operator safety 操作者安全	-	-	Active 啟用	Active 啟用
EMERGENCY STOP device 急停開關	Active 啟用	Active 啟用	Active 啟用	Active 啟用
Enabling device 啟動裝置	Active 啟用	Active 啟用	-	-
Reduced velocity during program verification 程 式驗證中減速	Active 啟用	-	-	-
Jog mode 寸動	Active 啟用	Active 啟用	-	-
Software limit switches 作業空 間軟體限制開關	Active 啟用	Active 啟用	Active 啟用	Active 啟用

### 3.8 Safety measures 安全措施

#### 3.4.5. General safety measures 一般安全措施

The industrial robot may only be used in perfect technical condition in accordance with its intended use and only by safety-conscious persons. Operator errors can result in personal injury and damage to property.

工業機器手臂僅可依據其專業使用目的，在完整工業技術條件下，交由具備安全意識的人員操作。操作者的錯誤可能造成人員受傷或財務損失。

It is important to be prepared for possible movements of the industrial robot even after the robot controller has been switched off and locked out. Incorrect installation (e.g. overload) or mechanical defects (e.g. brake defect) can cause the manipulator or external axes to sag. If work is to be carried out on a switched-off industrial robot, the manipulator and external axes must first be moved into a position in which they are unable to move on their own, whether the payload is mounted or not. If this is not possible, the manipulator and external axes must be secured by appropriate means.

即使在控制器已經關閉並上鎖下，隨時保持對機器手臂可能的作動作準備，是非常重要的，錯誤的安裝（例如超過負載），或是機械缺陷（例如煞車缺陷），都可能造成機器手臂或外部軸下墜，如果必須在控制器已經關機的機器手臂上施工，不管手臂是否有承受負載，機器手臂及外部軸必位置，必須調整到手臂不會自行移動的位置，如果不可能做到，必須使用適當的方法，牢牢的固定機器手臂及外部軸。



#### **DANGER 危險**

##### **Risk of fatal injury due to non-operational safety functions or external safeguards** 欠缺作業安全功能及外部安全防護下，可能造成人員傷亡

In the absence of operational safety functions or safeguards, the industrial robot can cause death, severe injuries or damage to property.

在欠缺作業安全功能及安全防護下，機器手臂可能造成人員傷亡及財產損失

- If safety functions or safeguards are dismantled or deactivated, do not operate the industrial robot. 如果安全功能及安全防護拆除或未啟用，禁止操作機器手臂



#### **DANGER 危險**

##### **Danger to life and limb of persons under the robot arm** 在機器手臂下方人員，恐具有傷亡的危險

Sagging or falling parts can cause death or serious injuries. This applies at all times, e.g. also for assembly tasks or with the controller switched off. 機器手臂下墜或配件掉落，可造成人員傷亡事故，

- Never loiter under the robot arm. 絕不要在機器手臂下方暫停，甚至逗留

**CAUTION 注意****Risk of burns from hot motors 馬達表面溫度高，有灼傷的危險**

The motors reach temperatures during operation which can cause burns. 正常運作下的馬達溫度，可以到達灼傷的程度

- Avoid contact. 要避免觸摸
- Take appropriate safety precautions, e.g. wear protective gloves. 採取適當的安全措施，例如，戴上防護手套

**smartPAD 教導器**

The user must ensure that the industrial robot is only operated with the smartPAD by authorized persons. 使用單位必須確保機器手臂僅用教導器，由被授權的人員操作。

If more than one smartPAD is used in the overall system, it must be ensured that it is clearly recognizable which smartPAD is connected to which industrial robot. They must not be interchanged. 如果整套系統有超過一台教導器，必須確保能夠清楚辨識那一台教導器是在控制哪一台機器手臂，並且不可以交替使用。

**WARNING 警告****Danger to life and limb due to disconnected smartPAD 教導器中斷連結，恐導致生命財產損失**

If a smartPAD is disconnected, its EMERGENCY STOP device is not operational. There is a risk of connected and disconnected smartPADs being interchanged. Death, injuries or damage to property may result. 如果教導器中斷連接，其急停開關將無任何作用，將已連接和未連接的教導器對調互換，恐導致生命財產損失

- Remove the disconnected smartPAD from the system immediately.  
從系統中，移除未連接的教導器
- Store the disconnected smartPAD out of sight and reach of personnel working on the industrial robot.  
存放未連接的教導器於視線外及現場作業人員無法取得的地方

In certain cases, and at least every 12 months, the enabling switches on the smartPAD must be subjected to a function test.

(>>> *"Function test" Page 36*)

每12月至少做一次教導器上的啟動開關功能測試

**Modifications****變更**

After modifications to the industrial robot, checks must be carried out to ensure the required safety level. The valid national or regional work safety regulations must be observed for this check. The correct functioning of all safety functions must also be tested.

機器手臂在變更後，必須檢查確認達到安全標準，這檢查必須遵照國家或地方的法令規定執行，所有安全性功能必須被逐一測試，

New or modified programs must always be tested first in Manual Reduced Velocity mode (T1).

新撰寫或修改過的程式，永遠要使用T1減速模式做第一次的測試。

After modifications to the industrial robot, existing programs must always be tested first in Manual Reduced Velocity mode (T1). This applies to all components of the industrial robot and includes e.g. modifications of the external axes or to the software and configuration settings.

變更後的機器手臂，其現有程式永遠要使用T1減速模式做變更後的第一次的測試，這樣的準則適用於所有機器手臂元件變更、外部軸變更、或是軟體及組態設定變更。

**Faults****故障**

The following tasks must be carried out in the case of faults in the industrial robot: 萬一機器手臂有故障，以下的工作事項一定要被執行：

- Switch off the robot controller and secure it (e.g. with a padlock) to prevent unauthorized persons from switching it on again. 關閉控制器並上鎖，以避免未被授權人員去開啟控制器
- Indicate the fault by means of a label with a corresponding warning (tagout). 使用標示及相關警語做故障警告
- Keep a record of the faults. 紀錄故障相關事項
- Eliminate the fault and carry out a function test. 排除故障並進行功能測試

**3.4.5. IT security 資訊安全**

KUKA products must only be used in perfect technical condition in accordance with their intended use and only by safety-conscious persons.

In particular, safety-conscious use includes being operated in an IT environment which meets the current security-relevant standards and for which there is an overall concept for IT security.

KUKA 工業機器手臂僅可依據其專業使用目的，在完整工業技術條件下，交由具備安全意識性的人員操作。特別是，安全意識涵蓋現行操作下的資訊環境，必須符合的安全相關標準，以及整體資訊安全概念。



#### **Take measures to ensure IT security 採取行動措施，確保資訊安全**

IT security involves not only aspects of information and data processing as such, but also affects at least the following areas: 資訊安全不僅牽涉資訊及數據處理方面，同時也影響下列的領域：

- Technology, organization, personnel, infrastructure 技術、組織、人員、基礎架構

KUKA urgently recommends that users implement an information security management system for their products which designs, coordinates and monitors the tasks related to information security.

KUKA 懇切建議使用單位必須為其產品，建立一套資訊安全管理系統，設計、協調、監測有關資訊安全的事務。

Sources for information about IT security for companies include: 公司資安的資訊來源包含：

- Independent consulting firms 獨立的諮詢顧問公司
- National cyber security authorities 國家網路安全官方單位

National authorities often make their recommendations available on the Internet. In addition to their official language, some national authorities provide their information in English. 國家官方單位經常會把他們的安全建議放在網路上，除了使用他們官方語言外，有些也會使用英文提供這些資訊。

### 3.4.5. Transportation 運送

#### **Manipulator 機器手臂**

The prescribed transport position of the manipulator must be observed. Transportation must be carried out in accordance with the operating instructions or assembly instructions of the robot.

Avoid vibrations and impacts during transportation in order to prevent damage to the manipulator. 必須遵照機器手臂運送時的指定姿勢運送，運送必須依據機器手臂操作說明或組裝指示執行。

#### **Robot controller 控制器**

The prescribed transport position of the robot controller must be observed. Transportation must be carried out in accordance with the operating instructions or assembly instructions of the robot controller.

Avoid vibrations and impacts during transportation in order to prevent damage to the robot controller. 必須遵照機器手臂控制器運送時的指定姿勢運送，運送必須依據機器手臂操作說明或組裝指示執行，為避免損毀，運送期間須避免震動、衝擊。



### External axis (optional) 外部軸 (選配)

The prescribed transport position of the external axis (e.g. KUKA linear unit, turn-tilt table, positioner) must be observed. Transportation must be carried out in accordance with the operating instructions or assembly instructions of the external axis. 必須遵照機器手臂外部軸，如線性軸、旋轉傾斜平台、定位器，運送時的指定姿勢運送，運送必須依據機器手臂操作說明或組裝指示執行。

### 3.4.5. Start-up and recommissioning 開啟及交機

Before starting up systems and devices for the first time, a check must be carried out to ensure that the systems and devices are complete and operational, that they can be operated safely and that any damage is detected. 第一次開機前，必須確認系統和設備都是完整的，而且可以安全操控的，而且任何損壞已經被發現。

The valid national or regional work safety regulations must be observed for this check. The correct functioning of all safety functions must also be tested. 這檢查必須遵守所在國家或地區的現行作業安全規定，所有安全功能的正確作動都必須檢測。



#### Changing default passwords 更改出廠密碼

The KUKA System Software is supplied with default passwords for the user groups. If the passwords are not changed, this enables unauthorized persons to log on. 原廠手臂系統軟體已經提供出廠的密碼設定給使用族群，如果密碼未做變更，將可能造成未授權的人員也可登錄使用。

- Before start-up, change the passwords for the user groups. 啟動前，做使用族群密碼變更
- Only communicate the passwords to authorized personnel. 只告知被授權人員密碼



#### WARNING

#### Danger to life and limb due to incorrectly assigned cables 誤接非屬控制器的電纜可能造成傷亡意外

The robot controller is preconfigured for the specific industrial robot. The manipulator and other components can receive incorrect data if they are connected to a different robot controller. Death, severe injuries or damage to property may result. 控制器與特定型式的機器手臂是事先做過硬體組態設定的，如果接錯控制器，機器手臂和其他元件，可能會接收到不正確的資訊，可能造成傷亡意外或殘產損失





### Do not impair safety functions 不可損壞安全功能

Additional components (e.g. cables and hoses) not supplied by KUKA may be integrated into the industrial robot. If the safety functions are not taken into consideration, this may result in death, severe injuries or damage to property. 非KUKA所提供的外加元件（例如纜線、軟管），整合到機器手臂時，不可破壞既有的安全功能，否則會導致傷亡事故或財產損失

- Additional components must not impair or disable safety functions. 外加元件，不可破壞既有的安全功能

### NOTICE 小心

#### Damage to property due to condensation 水氣凝結恐導致財產損壞

If the internal cabinet temperature of the robot controller differs greatly from the ambient temperature, condensation can form. This may result in damage to property. 如果控制器機櫃內部與外界溫度差異太大，可能造成水氣凝結而導致控制器損壞

- Wait until the internal cabinet temperature has adapted to the ambient temperature in order to avoid condensation. 為避免水氣凝結，需待機調適機櫃內溫度與外界溫度接近。

## Function test

### 功能測試

The following tests must be carried out before start-up and recommissioning: 啟用及交機前，必須執行以下測試：

#### General test: 一般測試

It must be ensured that: 下列事項必須確認

- The industrial robot is correctly installed and fastened in accordance with the specifications in the documentation. 機器手臂已經依據文件規格，正確安裝固定。
- There is no damage to the robot that could be attributed to external forces. 沒有可以造成機器手臂損壞的外力存在
- There are no foreign bodies or defective or loose parts on the industrial robot. 無外掛物、有問題的或鬆脫的配件在機器手臂上
- All required safety equipment is correctly installed and operational. 所有的安全設備已經正確安裝且可供使用
- The power supply ratings of the industrial robot correspond to the local supply voltage and mains type. 供應機器手臂的電源規格，與機器手臂額定需求規格相符。



### WARNING 危險

#### **Danger to life and limb resulting from external forces 外力可能導致傷亡**

External forces, such as an impact or a collision, can cause non- visible damage. For example, it can lead to a gradual loss of drive power from the motor, resulting in unintended movements of the ma-nipulator.

Death, severe injuries or damage to property may result from non-visible damage. 外例如碰撞、衝擊的外力，可以造成目視檢測無法察覺到的內部損壞，導致手臂非預期的動作，可能造成傷亡事故或財產損失

Check the robot for damage that could have been caused by ex-ternal forces, e.g. dents or abrasion of paintwork. 檢查外力所造成的手臂損壞，例如噴漆時有防護衣，無法目視撞擊凹陷、磨損，必須進行實際檢查。

Check the motor and counterbalancing system particularly care-fully.

- In the case of damage, the affected components must be ex-changed. 詳實檢查馬達及制衡系統，有損傷的元件，必須更換。

- The ground conductor and the equipotential bonding cable are suffi-ciently rated and correctly connected. 接地導體及接地線均須符合額

定標準，並正確連接。

- The connecting cables are correctly connected and the connectors are locked. 連接電纜確實正確連接，且接頭完全緊扣

#### **Test of the safety functions: 測試安全功能**

A function test must be carried out for the following safety functions to en-sure that they are functioning correctly: 下列安全功能必須逐項執行，以確保其正常運作

- Local EMERGENCY STOP device 教導器上的急停開關
- External EMERGENCY STOP device (input and output) 外部急停開關
- Enabling device (in the test modes) 啟動開關 ( T1、T2 )
- Operator safety 操作者安全 ( 如安全門、防護阻絕設施 )
- All other safety-relevant inputs and outputs used 所有安全相關的輸出、輸入訊號
- Other external safety functions 所有外部安全功能

### 3.8.4.1 Checking machine data and safety configuration 檢查系統參數和安全組態設定



#### **WARNING 警告**

##### **Danger to life and limb due to incorrect data 錯誤的設定恐導致人員傷亡**

The industrial robot must not be moved if incorrect machine data or an incorrect controller configuration are loaded. Unforeseeable reactions may occur. Death, severe injuries or damage to property may result.

如有錯誤系統參數或組態設定，不可啟動機器手臂，無法預知的機器手臂反應動作，可造成傷亡事故。

- Only operate industrial robots with correct data. 機器手臂僅能在使用正確的系統參數及安全組態下操作

- Following the start-up procedure, the practical tests for the machine data must be carried out. The tool must be calibrated (either via an actual calibration or through numerical entry of the data). 啟動程序執行後，必須執行對系統參數的實際測試，工具必須做校正（不論是實際的校正或是數值資料的輸入）
- Following modifications to the machine data, the safety configuration must be checked. 修改系統參數後，必需檢查安全組態
- After activation of a WorkVisual project on the robot controller, the safety configuration must be checked. 在控制器開啟Workvisual專案後，必須檢查安全組態。
- If machine data are adopted when checking the safety configuration (regardless of the reason for the safety configuration check), the practical tests for the machine data must be carried out. 當檢查安全組態時，如果接受系統參數，必須執行系統參數實際測試
- System Software 8.3 or higher: If the checksum or the activation code of the safety configuration has changed, the safe axis monitoring functions must be checked. 系統版本在8.3或以上者，如果安全組態檢查碼或啟動碼變更，安全軸監測功能必須做檢查。

Up to and including System Software 8.5, the value in the safety configuration is "Checksum"; for 8.6 and above, it is "Activation code".

KSS 8.5(含)以下者，在安全組態的值為檢查碼，KSS 8.6以上，稱為啟動碼



Information about checking the safety configuration and the safe axis monitoring functions is contained in the Operating and Programming Instructions for System Integrators. 有關檢查安全組態及安全軸監測功能可參考操作、程式編輯手冊（for系統整合商）

If the practical tests are not successfully completed in the initial start-up, KUKA Deutschland GmbH must be contacted. 如果初始開機的實際測試無法成功完成，必須連絡原廠。

If the practical tests are not successfully completed during a different procedure, the machine data and the safety-relevant controller configuration must be checked and corrected. 如果在不同的實際測試程序中，無法成功完成，必須檢查並確認系統參數及安全相關的控制組態參數是否正確。

### General practical test 一般實際測試

If practical tests are required for the machine data, this test must always be carried out. 系統參數的實際測試如果是必要的，該測試一定要確實執行

#### For 6-axis robots: 對6軸機器手臂

The following methods are available for performing the practical test:

下列方法可提供作為執行實際測試：

- TCP calibration with the XYZ 4-point method 使用XYZ 4點式，做工具中心點(TCP)校正  
The practical test is passed if the TCP has been successfully calibrated. 如果TCP可以順利校正，則通過實際測試

Or: 或是

1. Align the TCP with a freely selected point. The point serves as a reference point. 選擇任一點作為TCP校正參考點。
  - The point must be located so that reorientation is possible. 不管機器手臂姿態如何改變，該參考點必須能夠被重新定位到。
  - The point must not be located on the Z axis of the FLANGE coordinate system. 該參考點不可位在法蘭座標系統的Z軸上面

2. Move the TCP manually at least 45° once in each of the A, B and C directions. 以至少差距A、B、C 方向45度方位，手動移動TCP

The movements do not have to be accumulative, i.e. after motion in one direction it is possible to return to the original position before moving in the next direction. 移動不必同時改變不同方位，也即是說，可以每次改變一個方位後，再回到參考點，再改變另外一個方位，再回到參考點，依序改變3個方位做測試。

The practical test is passed if the TCP does not deviate from the reference point by more than 2 cm in total. 如果TCP 不會偏離參考點超過2公分以上，則通過實際測試。

**For palletizing robots: 堆棧機器手臂**

Palletizing robots, in this case, are either robots that can be used only as palletizers from the start or robots operated in palletizing mode. The latter must also be in palletizing mode during the practical test. 在這裡堆棧機器手臂可以是堆棧專用機器手臂或是機器手臂使用於堆棧模式，後者在實際測試時，必須是在堆棧模式下測試

**First part: 首先**

1. Mark the starting position of the TCP. 在TCP起始點做記號

Also read and note the starting position from the **Actual position – Cartesian** display on the smartHMI. 讀取並記錄教導器上起始點位的實際位置

2. Jog the TCP in the X direction. The distance must be at least 20% of the robot's maximum reach. Determine the exact length via the **Actual position** display. 在X方向進行TCP寸動模式移動，移動距離必須為手臂最大伸長量的20%以上，透過教導器上的實際位置顯示，找出實際移動長度。
3. Measure the distance covered and compare it with the distance value displayed on the smartHMI. The deviation must be < 5%. 實際量測所移動距離，並和教導器所記錄的長度做比較，誤差必須小於5%。

4. Repeat steps 1 and 2 for the Y direction and Z direction. 重複上面的步驟1和2，但改為Y及Z方向。

The first part of the practical test is passed if the deviation is < 5% in every direction. 如果每個方向的誤差都小於5%，則通過第一部分的實際測試。

**Second part: 第二部分**

- Rotate the tool manually about A by 45°: once in the plus direction, once in the minus direction. At the same time, observe the TCP.

對A手動旋轉約45°，並正負角度交替，同時觀察TCP

The second part of the practical test is passed if the position of the TCP in space is not altered during the rotations. 如果TCP在空間中的位置，並未改變，則通過第二部分的實際測試。

**Practical test for axes that are not mathematically coupled 實際測試無關聯性的外部軸**

If practical tests are required for the machine data, this test must be carried out when axes are present that are not mathematically coupled. 如果需要對系統參數做實際測試，則無關聯性的外部軸，也必須測試。

1. Mark the starting position of the axis that is not mathematically coupled. 標示外部軸起始位置

Also read and note the start position from the **Actual position** display on the smartHMI. 取並記錄教導器上起始點位的實際位置

2. Move the axis manually by a freely selected path length. Determine the path length from the **Actual position** display. 選擇一定的路徑長度，手動移動外部軸，透過教導器上的位置顯示，找出實際移動量。
  - Move linear axes a specific distance. 移動線性軸一個特定的距離
  - Move rotational axes through a specific angle. 移動旋轉軸一個特定的角度
3. Measure the length of the path covered and compare it with the value displayed on the smartHMI.  
The practical test is passed if the values differ by no more than 5%.  
實際量測所移動量，並和教導器所記錄的長度做比較，誤差必須小於5%。
4. Repeat the test for each axis that is not mathematically coupled.  
對每一個外部軸，執行上述的測試。

### Practical test for robot on KUKA linear unit/ROBROOT kinematic system

對KUKA 線性軸/Robroot 運動系統做實際測試

**Applicable up to and including System Software 8.5:** 以下

適用KSS 8.5 ( 含 ) 以下版本

If practical tests are required for the machine data, this test must be performed if the robot and the **KUKA linear unit (KL)** are mathematically coupled. 如果需要對系統參數做實際測試，則有關聯性的KUKA線性軸，也必須測試。

- Move the KL manually in Cartesian mode. 以直角坐標系，移動 KUKA 線性軸

The practical test is passed if the TCP does not move at the same time. 如果TCP並未同時移動，則通過實際測試

**Applicable for System Software 8.6 or higher:** 以下適用

KSS 8.6 ( 含 ) 以上版本

If practical tests are required for the machine data, this test must be carried out if the robot is mounted on a mathematically coupled **ROBROOT kinematic system**, e.g. on a KL. 如果需要對系統參數做實際測試，且機器手臂安裝於關聯性的ROBROOT系統，例如KUKA線性軸，則需執行以下測試

- Move the axes of the ROBROOT kinematic system manually in Cartesian mode, individually and one after the other.

The practical test is passed if the TCP does not move at the same time. 以直角坐標系，逐一並先後移動ROBROOT kinematic system，如果TCP並未同時移動，則通過實際測試

## Practical test for couplable axes 對關聯軸做實際測試

If practical tests are required for the machine data, this test must be carried out when axes are present that can be physically coupled and uncoupled, e.g. a servo gun. 如果需要對系統參數做實際測試，當有可實體關聯或可無關聯的軸，如電焊機，須執行下列測試：

1. Physically uncouple the couplable axis. 解除實體關聯的關聯軸
2. Move all the remaining axes individually. 逐一移動所有各軸

The practical test is passed if it has been possible to move all the remaining axes. 如果所有各軸都能順利移動，則實際測試通過

## • Start-up mode 開始模式 ( HMI: start-up>>service>>start-up mode )

### Description

The industrial robot can be set to Start-up mode via the smartHMI user interface. In this mode, the manipulator can be moved in T1 without the external safeguards being put into operation. 機器手臂可以透過教導器設定為起始模式，在這個模式下，機器手臂可以在無外部安全防護下，以T1模式作動。

The safety interface used affects "Start-up" mode: 安全介面對Start-up mode的影響

### Discrete safety interface 分散式安全介面

- System Software 8.2 or earlier: KSS 8.2版或更早版本

Start-up mode is always possible if all input signals at the discrete safety interface have the state "logic zero". If this is not the case, the robot controller prevents or terminates Start-up mode. 只有在離散式安全介面輸入訊號均為 "zero" 狀態時，Start-up mode才能開啟，若不是，控制器會阻止或關掉Start-up mode。

If an additional discrete safety interface for safety options is used, the inputs there must also have the state "logic zero". 如果有使用額外的分散式安全介面，輸入訊號均為 "zero" 狀態時，Start-up mode才能開啟。

- System Software 8.3 or higher: KSS 8.3版或更新版本

Start-up mode is always possible. This also means that it is independent of the state of the inputs at the discrete safety interface. Start-up mode與分散式安全介面輸入無關。

If an additional discrete safety interface is used for safety options: The states of these inputs are also irrelevant. 如果有使用額外的分散式安全介面，輸入訊號狀態，也與Start-up mode開啟無關。



**Ethernet safety interface 網路安全介面**

The robot controller prevents or terminates Start-up mode if a connection to a higher-level safety system exists or is established. 如果有連接到高階安全系統，控制器會阻止或關掉Start-up mode。

**Effect**

When the Start-up mode is activated, all outputs are automatically set to the state “logic zero”. 當Start-up mode啟用，所有的輸出訊號會為“ZERO”

If the robot controller has a peripheral contactor (US2), and if the safety configuration specifies for this to switch in accordance with the motion enable, then the same also applies in Start-up mode. This means that if motion enable is present, the US2 voltage is switched on – even in Start-up mode. 當機器手臂有接外部開關(US2)時，如果安全組態會依據運動啟動對此開關設定，同樣的，在Start-up mode下也會執行相同設定，也就是說，如果出現運動啟動，US2 電壓開啟，即使在Start-up mode下也是會執行US2電壓開啟。



The maximum number of switching cycles of the peripheral contactors is 175 per day. 外部開關重複開啟、關閉的次數，最大為每天175次

卓智機器人內部技術文件 台灣版



## Hazards 危害

Possible hazards and risks involved in using Start-up mode: 使用Start-up mode的危害及風險

- A person walks into the manipulator's danger zone. 人員走進機器手臂危險區域
- In a hazardous situation, a disabled external EMERGENCY STOP device is actuated and the manipulator is not shut down. 在危險狀況時，按下已無作用的外部急停開關，機器手臂不會停機

Additional measures for avoiding risks in Start-up mode: 附加方法以避免開啟模式的風險

- Cover disabled EMERGENCY STOP devices or attach a warning sign indicating that the EMERGENCY STOP device is out of operation. 把外部已無作用的急停開關覆蓋或移除，以避免遭到誤用，或用警告標示該急停開關已無作用。
- If there is no safety fence, other measures must be taken to prevent persons from entering the manipulator's danger zone, e.g. use of warning tape. 如果並無安全圍籬，必須採取措施，阻絕人員進入危險區域，如使用警告標示牌

## Use 使用

Intended use of Start-up mode: Start-up mode的預期用途

- Start-up in T1 mode when the external safeguards have not yet been installed or put into operation. The danger zone must be delimited at least by means of warning tape. 外部安全防護尚未安裝或啟用，危險區域必須使用警語隔離，才能使用Start-up mode
- Fault localization (periphery fault). 在縮小範圍，局部尋找問題時
- Use of Start-up mode must be minimized as much as possible. 儘量避免使用Start-up mode



### WARNING 警告

**Risk of fatal injury due to non-operational external safeguards 無可運作的外部安全防護，具有致命的傷害風險**

Use of Start-up mode disables all external safeguards. Death, severe injuries or damage to property may result. 使用Start-up mode將停止外部防護功能，恐造成死亡、嚴重傷害及財產損失

- There must be no persons in the danger zone of the manipulator while it is in Start-up mode. 使用 start-up mode 時，務必確認無任何人員，在危險區域內

**Misuse 誤用**

Any use or application deviating from the intended use is deemed to be misuse and is not allowed. It will result in the loss of warranty and liability claims. KUKA is not liable for any damage resulting from such misuse. 任何偏離start-up mode的預期使用，均會被視為誤用且不被允許的，這將會造成機器手臂保固及原廠可靠度宣告失效，KUKA不負責誤用所造成的任何損壞

**3.8.9 Manual mode 手動模式****General  
概述**

Manual mode is the mode for setup work. Setup work is all the tasks that have to be carried out on the industrial robot to enable automatic operation. Setup work includes: 手動模式是為自動化建置工作所設計的模式，建置工作包和：

- Jog mode 寸動模式
- Teaching 教導
- Programming 程式編輯
- Program verification 程式驗證

The following must be taken into consideration in manual mode: 使用手動模式時，需注意下列事項：

- New or modified programs must always be tested first in Manual Reduced Velocity mode (T1). 新的或修正過後的程式，第一次使用前，定要使用T1手動模式測試
- The manipulator, tooling or external axes (optional) must never touch or project beyond the safety fence. 機器手臂、手臂上的工具、外部軸，不可碰觸會超出安全圍籬。
- Workpieces, tooling and other objects must not become jammed as a result of the industrial robot motion, nor must they lead to short-circuits or be liable to fall off. 工件、工具及其他物件，在機器手臂運動時，不可擠壓一起、造成線路短路或可能的掉落。
- All setup work must be carried out, where possible, from outside the safeguarded area. 如果場地許可，所有建置工作都需要安全防護區外執行。

## Setup work in T1 在T1下的建置工作

If it is necessary to carry out setup work from inside the safeguarded area, the following must be taken into consideration in the operating mode

**Manual Reduced Velocity (T1):** 如果必須在安全防護區內進行建置工作，在T1減速模式作業時，必須注意下列事項：

- If it can be avoided, there must be no other persons inside the safeguarded area. 如果可以避免，務必確認無人在安全防護區內
- If it is necessary for there to be several persons inside the safeguarded area, the following must be observed: 如果需要有多人在安全防護區內，須遵守下列要點：
  - Each person must have an enabling device. 每個人都需要有一個啟動裝置
  - All persons must have an unimpeded view of the industrial robot. 每個人都必須可以看到機器手臂的作動，而無任何視線遮蔽
  - Eye-contact between all persons must be possible at all times. 所有人目光必須隨時保持接觸
- The operator must be so positioned that he can see into the danger area and get out of harm's way. 操作者所佔位置，必須可以看到危險區域，且能脫離緊急危險
- Unexpected motions of the manipulator cannot be ruled out, e.g. in the event of a fault. For this reason, an appropriate clearance must be maintained between persons and the manipulator (including tool). 機器手臂不預期的運動很難排除，如故障時，因此，人員與機器手臂必須維持適當距離。

Guide value: 50 cm. 建議值：至少50公分

The minimum clearance may vary depending on local circumstances, the motion program and other factors. The minimum clearance that is to apply for the specific application must be decided by the user on the basis of a risk assessment. 最小的適當距離依據現場實際狀況、運動程式及其他因素而定，對於特定的應用，最小的適當距離由使用者基於安全評量，自行決定。

## Setup work in T2 在T2下的建置工作

If it is necessary to carry out setup work from inside the safeguarded area, the following must be taken into consideration in the operating mode

**Manual High Velocity (T2):** 如果必須在安全防護區內進行建置工作，在T2高速模式作業時，必須注意下列事項：

- This mode may only be used if the application requires a test at a velocity higher than that possible in T1 mode. 如果應用上確實需要比T1的速度高，才能選擇T2高速手動模式。
- Teaching and programming are not permissible in this operating mode. 教、程式撰寫，不可使用T2模式
- Before commencing the test, the operator must ensure that the enabling devices are operational. 在執行測試前，操作者必須確保啟動裝

置可以運作

- The operator must be positioned outside the danger zone. 操作者必須站立在危險區域外
- There must be no other persons inside the safeguarded area. It is the responsibility of the operator to ensure this. 操作者必須確認，沒有任何人在危險區域內

### 3.8.9 Simulation 模擬

Simulation programs do not correspond exactly to reality. Robot programs created in simulation programs must be tested in the system in **Manual Reduced Velocity mode (T1)**. It may be necessary to modify the program. 模擬程式並不真正等於真實狀態，由模擬產生的機器手臂程式，必須在 T1 減速模式下進行測試，進行程式修改可能會是必要的。

### 3.8.9 Automatic mode 自動模式

Automatic mode is only permissible in compliance with the following safety measures: 在符合下列安全條件下，才能使用自動模式

- All safety equipment and safeguards are present and operational. 所有的安全設備及安全防護都備便且可供使用
- There are no persons in the system. 系統內無任何人員
- The defined working procedures are adhered to. 遵行規劃好的工作流程

If the manipulator or an external axis (optional) comes to a standstill for no apparent reason, the danger zone must not be entered until an EMERGENCY STOP has been triggered. 如果手臂和外部軸無任何明顯原因停止作動，不得進入危險區域，除非已經按下急停開關。

### 3.8.9 Maintenance and repair 保養及維修

After maintenance and repair work, checks must be carried out to ensure the required safety level. The valid national or regional work safety regulations must be observed for this check. The correct functioning of all safety functions must also be tested. 保養修護後，必須檢查確保安全符合標準，且須按照現行國家或地方的安全法令作業規定執行檢查，所有的安全功能都需做測試。

The purpose of maintenance and repair work is to ensure that the system is kept operational or, in the event of a fault, to return the system to an operational state. Repair work includes troubleshooting in addition to the actual repair itself. 保養及維修工作是要確保系統維持運作，或是在故障時，回復原本運作狀態。維修工作除了本身的修理外，也包含故障排除。

The following safety measures must be carried out when working on the industrial robot: 下列的安全措施必須遵照執行：

- Carry out work outside the danger zone. If work inside the dangerzone is necessary, the user must define additional safety measures to ensure the safe protection of personnel. 在危險區域外執行作業，如果一定需要在危險區域內作業，使用單位必須採取額外措施確保人員安全。
- Switch off the industrial robot and secure it (e.g. with a padlock) to prevent it from being switched on again. If it is necessary to carry out work with the robot controller switched on, the user must define additional safety measures to ensure the safe protection of personnel. 關閉控制器並上鎖，以防止有人無心開啟，如果一定需要開機作業，使用單位必須採取額外措施確保人員安全。
- If it is necessary to carry out work with the robot controller switched on, this may only be done in operating mode T1. 如果一定需要開機作業，現用T1模式作業。
- Label the system with a sign indicating that work is in progress. This sign must remain in place, even during temporary interruptions to the work. 維修現場必須有“維修作業進行中”的標誌，即使是短暫的暫停作業，也必須保留該標誌。
- The EMERGENCY STOP devices must remain active. If safety functions or safeguards are deactivated during maintenance or repair work, they must be reactivated immediately after the work is completed. 急停開關必須維持有效運作，維修作業中，如果有需要關閉安全功能或安全防護，在作業完成後，必須立即回復。

**DANGER 危險****Danger to life and limb due to live parts 可動配件恐造成傷亡意外**

The robot system must be disconnected from the mains power supply prior to work on live parts. It is not sufficient to trigger an EMERGENCYSTOP or safety stop, because parts remain live. Death or severe injuries may result. 機器手臂維修可動元件前，必須解除和主電源的連結，按下急停開關或安全停止，都無法停止可動配件作動，恐造成傷亡意外

- Before commencing work on live parts, turn off the main switch and secure it against being switched on again. 執行可動元件的維修時，關閉電源並上鎖，避免被誤開
- Then check to ensure that the system is deenergized. 然後確認系統是無電力供應

Faulty components must be replaced using new components with the same article numbers or equivalent components approved by KUKA Deutschland GmbH for this purpose. 故障的元件必須使用相同料號且經過原廠認證的零件，去執行汰換。

Cleaning and preventive maintenance work is to be carried out in accordance with the operating instructions. 依據操作手冊，執行清潔及預防性保養。

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## Robot controller 機器手臂控制器

Even when the robot controller is switched off, parts connected to peripheral devices may still carry voltage. The external power sources must therefore be switched off if work is to be carried out on the robot controller. 即使關閉機器手臂控制器電源，與週邊設備有連接的部分，或許仍然具有電壓，因此控制器的維修作業，也必須關閉週邊設備的電源供應。

The ESD regulations must be adhered to when working on components in the robot controller. 執行機器手臂控制器內的元件維護時，必須遵守靜電釋放規定。

Voltages in excess of 50 V (up to 780 V) can be present in various components for several minutes after the robot controller has been switched off! To prevent life-threatening injuries, no work may be carried out on the industrial robot in this time. 在控制器關機後幾分鐘，在不同元件上，可能存在超過50V的電壓（甚至780V），為避免傷亡，這段期間禁止作業。

Water and dust must be prevented from entering the robot controller. 水和灰塵必須避免進入控制器內部。

## Counterbalancing system 制衡系統

Some robot variants are equipped with a hydropneumatic, spring or gas cylinder counterbalancing system. 不同型式的機器手臂使用不同的制衡系統，如液壓、彈簧、氣體制衡系統

The hydropneumatic and gas cylinder counterbalancing systems are pressure equipment and, as such, are subject to obligatory equipment monitoring and the provisions of the Pressure Equipment Directive. 液體和氣體制衡系統屬於高壓設備，因此必須遵照強制性設備檢測及壓力設備指導規範

The user must comply with the applicable national laws, regulations and standards pertaining to pressure equipment. 使用單位必須遵照現行國家法令、規定及標準維護壓力設施。

Inspection intervals in Germany in accordance with Industrial Safety Order, Sections 14 and 15. Inspection by the user before commissioning at the installation site. 在德國，其檢測間距依據工業安全法令，第14、15節規定辦理。交機前在安裝地點，由此用者執行檢查。

The following safety measures must be carried out when working on the counterbalancing system: 做制衡系統檢修時，下面事項必須遵照執行

- The manipulator assemblies supported by the counterbalancing systems must be secured. 由制衡系統所連結支撐的手臂軸，必須予以固定
- Work on the counterbalancing systems must only be carried out by qualified personnel. 必須由合格人員實施

## Hazardous substances 有害物質

The following safety measures must be carried out when handling hazardous substances: 當處理有害物質時，須遵照下列安全方式處理：

- Avoid prolonged and repeated intensive contact with the skin. 避免長時間、重覆密切接觸皮膚
- Avoid breathing in oil spray or vapors. 避免吸入油霧或氣體
- Clean skin and apply skin cream. 清潔皮膚並使用香皂清潔



### Use current safety data sheets 檢視毒物安全資料表

Knowledge of the safety data sheets of the substances and mixtures used is a prerequisite for the safe use of KUKA products. Death, injuries or damage to property may otherwise result. 檢查確認使用材料、混合物的安全資料表，是確保安全使用KUKA產品的先決條件。

- Request up-to-date safety data sheets from the manufacturers of hazardous substances regularly. 要向原廠要求保持毒物資料表的資訊更新

### 3.8.9 Decommissioning, storage and disposal 拆機、儲存、處理

The industrial robot must be decommissioned, stored and disposed of in accordance with the applicable national laws, regulations and standards.

工業機器手臂拆機、儲存、處理必須遵照國家法令規章及標準處理



### 3.8.10 Safety measures for single point of control 單點控制的安全措施

#### Overview

If certain components are used on the industrial robot, safety measures must be taken to ensure complete implementation of the principle of “single point of control” (SPOC). 如果機器手臂有使用特定的元件，必須採取必要的安全措施，確認SPOC(單點控制)完整執行

The relevant components are: 相關的元件有

- Submit interpreter
- PLC
- OPC server
- Remote control tools
- Tools for configuration of bus systems with online functionality
- KUKA.RobotSensorInterface (KUKA RSI)
- KUKA.DeviceConnector  
(but not KUKA.DeviceConnector pre-installed)

Since only the system integrator knows the safe states of actuators in the periphery of the robot controller, it is his task to set these actuators to a safe state, e.g. in the event of an EMERGENCY STOP. 因為只有系統整合商清楚控制器周邊的傳動器安全狀態，因此系統整合商有責任，把傳動器設定在安全狀態下，例如：急停開關被觸發時，致動器的安全設定。



#### Further safety measures for Single Point of Control 單點控制進階安全措施

Depending on the specific application, further safety measures may be required to ensure complete implementation of the principle of “single point of control”. Failure to take this precaution into consideration may result in death, injuries or damage to property. 依據特定的應用，必須採取進階的安全措施，確認SPOC(單點控制)完整執行，遺漏、未採取應有的預防性進階措施，恐導致生命財產損害。

- Check whether further safety measures are required; if so, implement them. 檢查是否需要進階的安全措施

#### T1, T2

In modes T1 and T2, the components referred to above may only access the industrial robot if the following signals have the following states:

上述制動器只有在下列手臂控制器訊號的所狀態下，才能控制機器手臂：

Signal 控制器訊號參數名稱	State required for SPOC 單點控制要求狀態
\$USER_SAF	TRUE
\$SPOC_MOTION_ENABLE	TRUE

## Submit interpreter, PLC

If motions, (e.g. drives or grippers) are controlled with the submit interpreter or the PLC via the I/O system, and if they are not safeguarded by other means, then this control will take effect even in T1 and T2 modes or while an EMERGENCY STOP is active. 如果使用submit interpreter提交直譯或PLC透過I/O控制運動（例如驅動開關或夾爪），如果沒有其他的安全維護措施，即使是在T1、T2模式下，或是急停開關已經觸發停止下，上述的控制方式還是可以有效進行。

If variables that affect the robot motion (e.g. override) are modified with the submit interpreter or the PLC, this takes effect even in T1 and T2 modes or while an EMERGENCY STOP is active. 如果控制機器手臂運動的參數（例如速度），如果使用submit interpreter或PLC，即使是在T1、T2模式下，或是急停開關已經觸發停止下，還是上述的控制方式還是可以有效進行。

### Safety measures: 安全措施

- In T1 and T2, the system variable \$OV\_PRO must not be written to by the submit interpreter or the PLC. 在T1及T2模式下，系統參數\$OV\_PRO不可被教導器或是PLC覆蓋或修改。
- Do not modify safety-relevant signals and variables (e.g. operating mode, EMERGENCY STOP, safety gate contact) via the submit interpreter or PLC. 不要透過教導器的submit interpreter或PLC更改安全有關的訊號或參數（如操作模式、急停開關、安全門觸發）

If modifications are nonetheless required, all safety-relevant signals and variables must be linked in such a way that they cannot be set to a dangerous state by the submit interpreter or PLC. This is the responsibility of the system integrator. 如果確實有變更需求，所有安全有關的訊號或參數，必須相互連結到不會造成危害，這是系統整合商的責任。

## OPC server, KUKA.DeviceConnector, remote control tools

These components can be used with write access to modify programs, outputs or other parameters of the robot controller, without this being noticed by any persons located inside the system.

OPC server、KUKA.DeviceConnector、遠端控制工具，可用來改變程式、輸出、或機器手臂控制器的其他參數，且不會通知現場的人員

Safety measure: 安全措施

If these components are used, outputs that could cause a hazard must be determined in a risk assessment. These outputs must be designed in such a way that they cannot be set without being enabled. This can be done using an external enabling device, for example.

如果使用這樣的系統，所造成的危害必須列入風險評估，這樣的控制必須設計一個能做確認的啟動裝置，例如使用外接的啟動裝置，來做執行確認動作。

## Tools for configuration of bus systems 匯流系統的組態設定工具

If these components have an online functionality, they can be used with write access to modify programs, outputs or other parameters of the robot controller, without this being noticed by any persons located inside the system. 匯流系統的組態設定工具，可用來改變程式、輸出、或機器手臂控制器的其他參數，且不會通知現場的人員

- WorkVisual from KUKA
- Tools from other manufacturers 其他製造商的工具

Safety measure: 安全措施

In the test modes, programs, outputs or other parameters of the robot controller must not be modified using these components. 在測試模式下，程式、輸出、或機器手臂控制器的控制參數，均不可被變更

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