

MATE



MATE Exoskeleton

Rel. 1.0

User's handbook

CR00758209-en_00/2018.12

Instructions Handbook



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SUMMARY

PREFACE3
Documentation storage	4
Limits on the handbook contents	4
Glossary.....	4
Symbols used in the handbook	4
 MODIFICATION HISTORY5
 1. GENERAL INTRODUCTION	 6
System description.....	6
Device presentation	7
Intended use	9
First use of MATE	9
Temperature and environmental operating conditions.....	10
Device storage	10
Unintended uses	10
 2. SYSTEM OVERVIEW	 11
System description.....	11
Physical Human-Robot Interface (pHRi)	12
Passive degrees of freedom (pDOFs)	13
Torque Generator Box	14
Description of the main components	14
Functioning of the locking mechanism	15
Levels of assistance	17
 3. PREPARATION AND WEARING OF THE DEVICE	 20
Initial configuration	20
Choice of the pHRi interface size.....	20
Interface adjustment.....	20
Installation of belt extenders.....	21
Adjustment of the rear support.....	22
Adjustment of the Velcro belt tension.....	23
Front buckle position and length adjustment	24
Adjustment of the rear elastic straps	25
Adjustment of the assistance level.....	26
Wearing procedure	27
Further adjustments	32

SUMMARY

Central buckle adjustment	32
Adjustment of the rear elastic straps	33
Device worn properly	35
Undressing procedure	36
4. NOISE EMISSIONS	40
5. RESIDUAL RISKS	41
6. MAINTENANCE AND CLEANING OF THE DEVICE	42
Cleaning of rigid parts	42
Cleaning of fabric parts	42
Washing instructions for soft components	42
Scheduled maintenance	43
Spare parts list	44
Procedure for disassembling the parts of the fabrics and padded parts	47
Interface resetting procedure	50
TGB replacement procedure (CR82434800 - CR82434900)	52
pDOF replacement procedure (CR82435000 - CR82435100)	56
7. WARRANTY	63
8. PARTS DISPOSAL	64

PREFACE

This chapter contains:

- [Documentation storage](#)
- [Limits on the handbook contents](#)
- [Glossary](#)
- [Symbols used in the handbook](#)
- [Modification History](#).

Documentation storage

All the documentation provided must be placed in the immediate vicinity of the area in which MATE is in use, kept at the disposal of all the people who work there and kept intact throughout its operational life.

Limits on the handbook contents

The images included in the instructions handbook have the purpose to represent the product and can differ from what is actually visible on the system.

Glossary

EXOSKELETON	Wearable device. It is intended here as a synonym for MATE.
DEVICE	It is intended here as a synonym for MATE.
USER	The person wearing MATE.

Symbols used in the handbook

Below are indicated the symbols that represent: **WARNING**, **CAUTION** and **NOTES** and their meaning.



This symbol indicates operating procedures, technical information and precautions that if are not observed and/or correctly performed may cause injuries to the staff.



This symbol indicates operating procedures, technical information and precautions that if are not observed and/or correctly performed may cause equipment damage.



This symbol indicates operating procedures, technical information and precautions that must be underlined.



The symbol draws the attention to materials disposal that is regulated by the WEEE Directive.

MODIFICATION HISTORY

The following table shows the history of the Handbook release, with related changes / improvements made.

Date	Edition of the Handbook	Contents
2018/12	00/2018.12	First release of the handbook

1. GENERAL INTRODUCTION

The Mate exoskeleton is a Comau S.p.a. product. Via Rivalta 30, 10095 Grugliasco (TO).

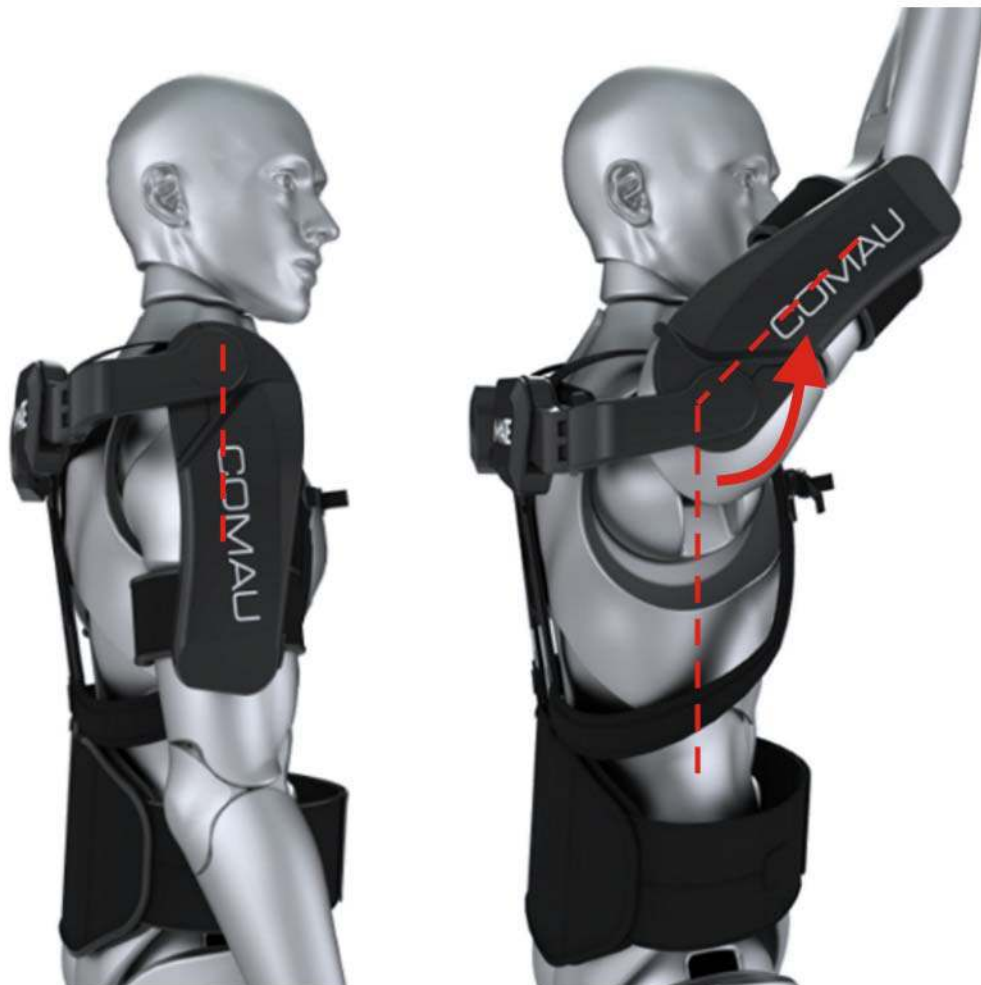
The instructions contained in this handbook should be sufficient to ensure the customer proper use of the device. Read the handbook carefully before using the device. If parts of this user handbook are not clear enough, contact COMAU S.p.a. for assistance.

1.1 System description

The device called MATE is a passive portable exoskeleton (without motors), designed to help the user upper limbs in flexion-extension movements.

It is made integral to the body in three different sites: back, waist and arm through a wearable garment.

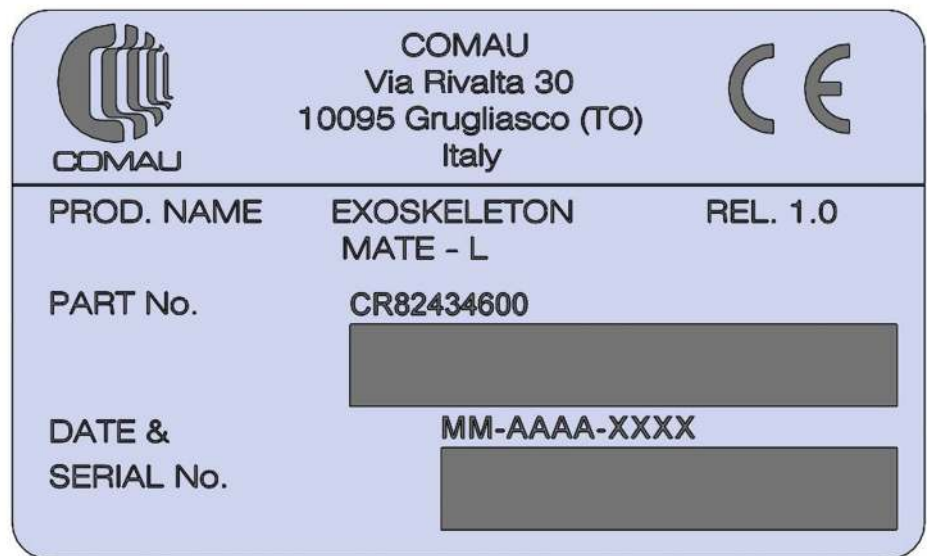
Fig. 1.1 - Example of shoulder flexion-extension movement



1.2 Device presentation

- **Name:** MATE.
- **Release:** 1.0.
- **Serial number:** verifiable on the product label placed on the inner surface of the Torque Generator Box.

Fig. 1.2 - Identification plate (example)



- **Weight:** verifiable on the product label placed on the inner surface of the Torque Generator Box.
 - **Size L:** 4.1 kg 9.04 lb
 - **Size M:** 4 kg 8.82 lb
- **Certification:**
 - DIRECTIVE 2006/42/EC
 - ISO EN 13482

GENERAL INTRODUCTION

– Declaration of Conformity

Comau S.p.A.

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CE DECLARATION of CONFORMITY				
DICHIARAZIONE CE DI CONFORMITA' - Direttiva 2006/42/CE - Allegato IIA	EC DECLARATION OF CONFORMITY - DIRECTIVE 2006/42/EC - Annex IIA	DÉCLARATION CE DE CONFORMITÉ - Directive 2006/42/CE - Annexe IIA	EG-KONFORMITÄTserklärung - Richtlinie 2006/42/EG - Anhang IIA	DECLARACIÓN CE DE CONFORMIDAD - DIRECTIVA 2006/42/CE - Anexo IIA
IL FABBRICANTE DICHIARA SOTTO LA SUA RESPONSABILITÀ CHE I PRODOTTI	THE MANUFACTURER DECLARES UNDER HIS OWN RESPONSIBILITY THAT THE PRODUCTS	LE FABRICANT DÉCLARE SOUS SA RESPONSABILITÉ QUE LES PRODUITS	DER HERSTELLER ERKLÄRT UNTER IHRER VERANTWORTUNG, DASS DIE PRODUKTE	EL FABRICANTE DECLARA BAJO SU RESPONSABILIDAD QUE LOS PRODUCTOS
commercial name and model/type	MATE			
function	Exoskeleton Passive - Size Large/Size Small			year of construction: 2018
code	CR82434600/CR82434700	code release:	serial number	
IT	EN	FR	DE	ES
SONO IN CONFORMITÀ CON I REQUISITI ESSENZIALI DI SICUREZZA DELLA DIRETTIVA 2006/42/CE.	ARE IN CONFORMITY WITH ESSENTIAL REQUIREMENTS OF THE DIRECTIVE 2006/42/EC.	SONT CONFORMES AUX EXIGENCES ESSENTIELLES DE SÉCURITÉ APPLICABLES DE LA DIRECTIVE 2006/42/CE.	ENTSPRECHEN MIT DEN GRUNDLEGENDEN SICHERHEITS VORSCHRIFTEN DER RICHTLINIE 2006/42/EG.	ESTÁN DE ACUERDO CON LOS REQUISITOS ESENCIALES DE SEGURIDAD APLICABLES A LA DIRECTIVA 2006/42/CE.
Sono realizzati in conformità con la seguente principale norma armonizzata: EN ISO 13482:2014 Robots and robotic devices - Safety requirements for personal care robots (<i>l'elenco delle direttive e delle norme di riferimento è contenuto all'interno del manuale istruzioni</i>).	Are manufactured in compliance with the following harmonized norms: EN ISO 13482:2014 Robots and robotic devices - Safety requirements for personal care robots (<i>The list of Declarations and the reference norms is included within the instruction manual</i>)	Ils sont fabriqués en conformité avec les normes harmonisées suivantes: EN ISO 13482:2014 Robots and robotic devices - Safety requirements for personal care robots (<i>La liste des directives et des normes de référence est contenue dans le manuel d'instructions</i>)	Sie werden in Übereinstimmung mit den folgenden harmonisierten Normen hergestellt: EN ISO 13482:2014 Robots and robotic devices - Safety requirements for personal care robots (<i>Die Liste der Richtlinien und Standards der Referenz wird in der Betriebsanleitung enthalten</i>)	Están realizados de conformidad con el siguiente estándares armonizados: EN ISO 13482:2014 Robots and robotic devices - Safety requirements for personal care robots (<i>El listado de las directivas y normas de referencia se encuentra en el manual de instrucciones</i>)
Persona autorizzata a costituire il Fascicolo Tecnico e stabilito nella Comunità Europea è: COMAU S.p.A - BU ROBOTICS AND AUTOMATION PRODUCTS - PRODUCT DEVELOPMENT nome: Maria Teresa Todarello	Person authorized to compile the relevant technical file and established within UE community is: COMAU S.p.A - BU ROBOTICS AND AUTOMATION PRODUCTS - PRODUCT DEVELOPMENT nome: Maria Teresa Todarello	Personne autorisée à constituer le dossier technique et établie dans l'Union européenne est: COMAU S.p.A - BU ROBOTICS AND AUTOMATION PRODUCTS - PRODUCT DEVELOPMENT nom: Maria Teresa Todarello	Person berechtigt, die technischen Unterlagen zusammenzustellen und in der Europäischen Union ansässig ist: COMAU S.p.A - BU ROBOTICS AND AUTOMATION PRODUCTS - PRODUCT DEVELOPMENT name: Maria Teresa Todarello	Persona facultada para elaborar el expediente técnico y establecida en la Unión Europea es: COMAU S.p.A - BU ROBOTICS AND AUTOMATION PRODUCTS - PRODUCT DEVELOPMENT nombre: Maria Teresa Todarello
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Luogo (Place)	Data (Date) (dd/mm/yyyy)	persona autorizzata a redigere la dichiarazione (person empowered to draw up the declaration)		
Grugliasco - Torino (Italy)		POSITION ROBOTICS AND AUTOMATION PRODUCTS BUSINESS UNIT CHIEF OPERATING OFFICER		
		NAME Pietro Ottavis		
		SIGNATURE 		
Sede legale: Via Rivalta, 30 - 10095 Grugliasco - Torino (Italy)				
Capitale Sociale: € 48;013;959,00 - R;E;I; Torino 474119 - Codice fiscale, Partita IV e Registro delle Imprese di Torino n; 00952120012 CEE IT 00952120012				

1.3 Intended use

The device creates an auxiliary variable torque on the shoulder joint to partially compensate for the gravitational torque created by the weight of the upper limbs.

The purpose of the device is to reduce fatigue and improve the quality of work in operations that require repetitive movements and with raised arms.

The reaction pairs are discharged on the human-robot interface (a system of padding and strings) and transferred to the lower back of the user.

Typical applications of MATE are:

- screwing with raised arms;
- sealing with raised arms;
- assembly operations performed with raised arms;
- underbody operations in the automotive sector.

In order to use the device correctly and in complete safety, dedicated training is required. Please refer to the documentation provided with the device.

MATE can only be used by people in a state of both good physical and psychological health.

Persons affected by the following diseases, or with a clinical history involving the following diseases, should consult the competent doctor before using the device:

- shoulder arthritis;
- shoulder dislocation;
- vertebral disorders;
- people who have undergone the following interventions:
 - shoulder arthroplasty;
 - shoulder arthroscopy;
 - any type of back surgery.

MATE is not to be considered a medical device.

MATE was designed as a device for a single user. The device can be shared among several workers after having cleaned and washed the fabric parts (see [par. 6.2.1 Washing instructions for soft components on page 43](#))

If you have any doubts about the permitted uses of MATE, you can contact Comau for additional information.

1.3.1 First use of MATE

It is suggested to start using MATE gradually. During the first day of use it is recommended to use it for one hour, two hours for the second day, 4 hours for the third. From the fourth day on, it will be possible to use the device for 8 hours.

It is good practice to undress MATE during work breaks, and limit their use to a maximum of 8 hours per day.

If the user senses inconvenience during the use of MATE must undress the device and seek assistance from a supervisor.

1.3.2 Temperature and environmental operating conditions

MATE can be used in environmental conditions within the following ranges:

- Temperature: from 0 to 40 °C (from 32 to 104°F)

It is recommended using MATE for 8 hours a day only when the temperature does not exceed 30 °C (86 °F).



Do not immerse the device in water and do not bring it into contact with liquids except as indicated in [Chap. Maintenance and cleaning of the device on page 43](#).

Keep exposed mechanical parts of MATE free from dust and generally from external bodies.

1.3.3 Device storage

MATE should be stored in a dry place, preferably hung on a rack.

Do not handle MATE by grasping it by plastic parts. Lift and manipulate the device by grasping it by the rear metal structure.

1.4 Unintended uses

All uses that do not fall under the definitions of intended use.

In particular:

- Do not unlock or move the locking mechanism of the Torque Generator Box when the device is not worn (see [par. 2.1.3 Torque Generator Box on page 16](#)).
- Do not use the device when driving a vehicle.
- Do not use the device to lift loads that are higher than normal or exceed the legal requirements.
- Do not lift the device by grasping it by the plastic parts. Grasp the device by the rear metal structure.
- The following categories of people should not use the device under any circumstances:
 - pregnant women;
 - minors.

2. SYSTEM OVERVIEW

2.1 System description

MATE (Fig. 2.1) is composed of:

- **Physical Human-Robot Interface (pHRi)**: all parts that are in direct contact with the user's body [1];
- **Passive degrees of freedom (pDOFs)**: parts that facilitate the free movement of the user, such as sliding and rotation joints [2];
- **Torque Generator Box**: a mechanism capable of storing and transforming the potential mechanical energy of a series of pretensioned springs in order to create a variable assistive torque for the arm. The assistive torques are maximum for bending angles of about 90° (Fig. 1.1).

Fig. 2.1 - MATE Exoskeleton - front view



2.1.1 Physical Human-Robot Interface (pHRi)

The Human-Robot interface (Fig. 2.2) is composed of non-allergenic and non-toxic materials. In particular, materials such as latex, PVC, phthalates, halogenated organic compounds, carcinogens and reproductive toxins have not been used as indicated in the "California Propositions 65", materials on the SVCH list (*Substances of very High Concern*) and materials of animal origin.

All fabric parts are removable and machine washable (see [par. 6.2.1 Washing instructions for soft components on page 43](#))

Fig. 2.2 - Physical Human Robot Interface (pHRi) - front view



1. Removable **rear padding**
2. Removable padded shoulder straps
3. Removable nylon arm supports with padding
4. Velcro belt
5. Removable panel
6. **Adjusting straps**
7. Adjustable front buckle
8. **Belt extenders** - to be installed if necessary, only for size L (see [par. 3.1.2.1 Installation of belt extenders on page 22](#))

The MATE interface is available in two main sizes:

- Small
- Large

The device also incorporates some adjustment elements in order to adapt to the different body sizes of the users and facilitate ease of use.

The instructions for a correct wearing are indicated at [par. 3.2 Wearing procedure on page 28](#).

The same instructions for use must be applied to both sizes.

Please contact Comau to understand which size is most suitable for your needs. As an indicative reference, it is possible to consult the following table:

Tab. 2.1 - Indicative references for choosing the appropriate size

	Size for braces	pHRi size
Men	34 - 38 (US) / 44 - 48 (EU)	S
	40 - 50 (US) / 50 - 60 (EU)	L
Women	0 - 12(US) / 36 - 48 (EU)	S
	14 - 16 (US) / 50 - 52 (EU)	L

2.1.2 Passive degrees of freedom (pDOFs)

Fig. 2.3 - Passive degrees of freedom (pDOFs)



1. Horizontal axis hinge
2. Back elastics
3. Vertical axis hinge
4. Horizontal axis rear sliding elements
5. Arm supports sliding cuffs

Passive degrees of freedom ([Fig. 2.3](#)) allow the correct wearing of MATE and its adaptation to different body sizes. They also allow the user to move freely once the device is worn.

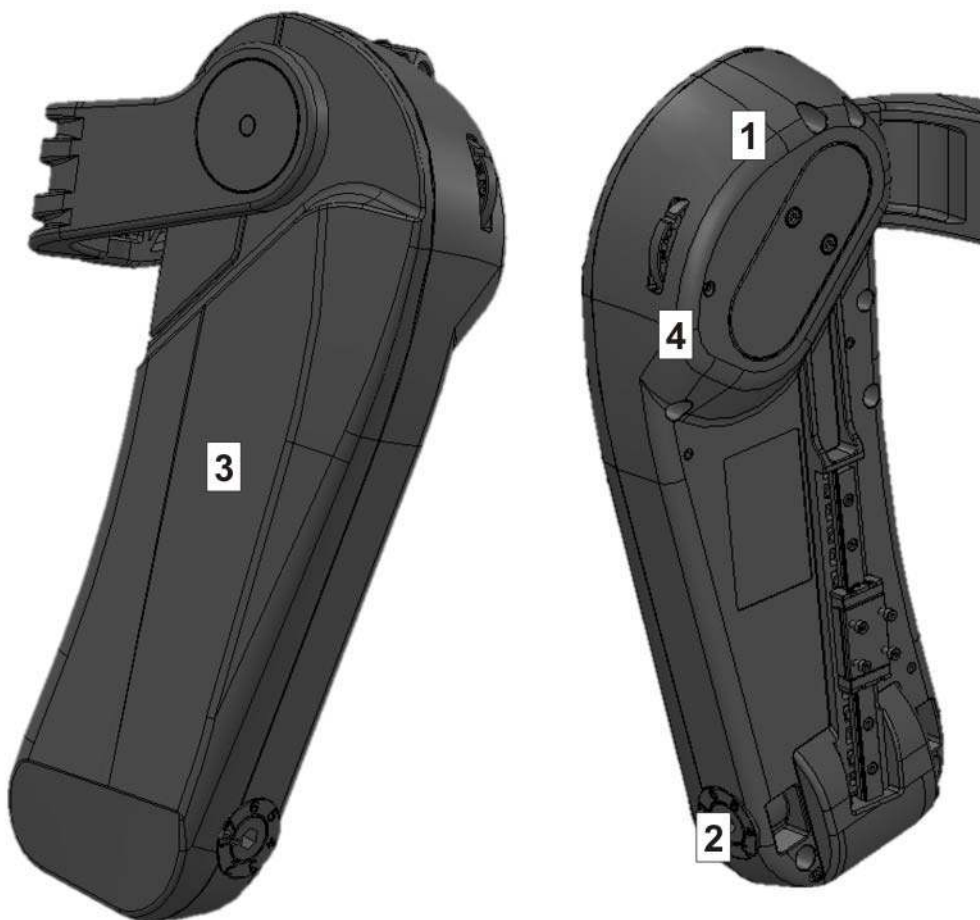
2.1.3 Torque Generator Box

This paragraph contains:

- [Description of the main components](#)
- [Functioning of the locking mechanism](#)
- [Levels of assistance](#)

2.1.3.1 Description of the main components

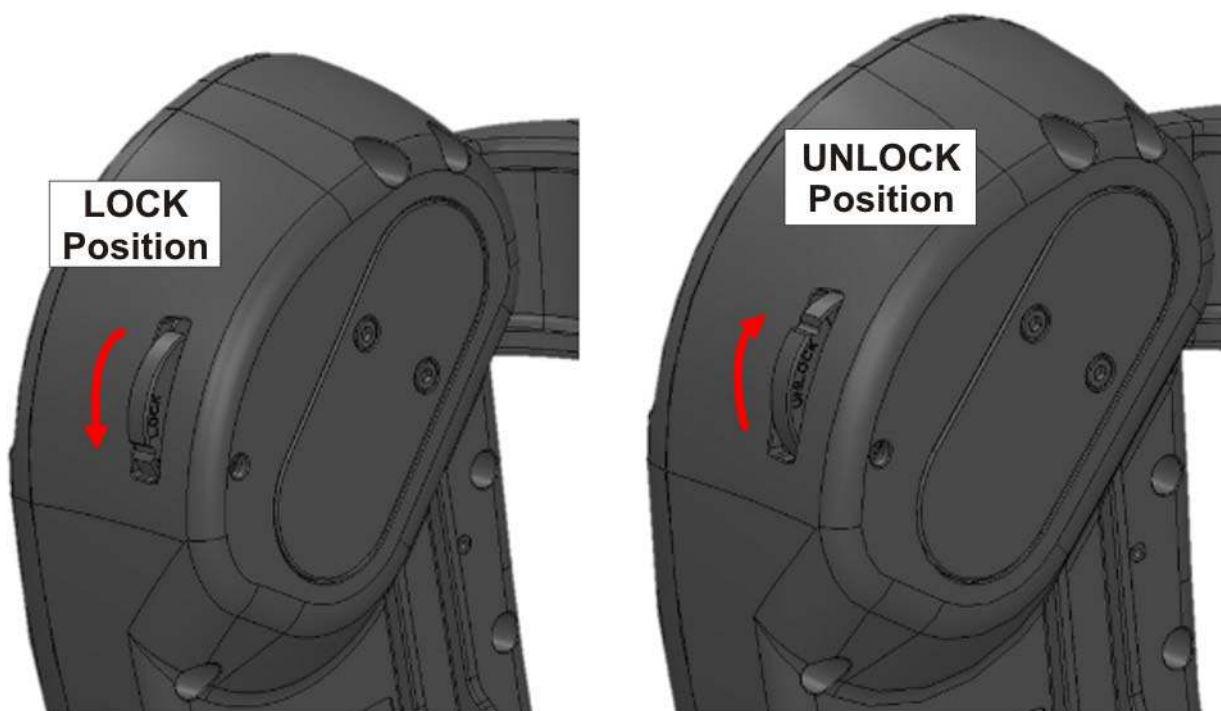
Fig. 2.4 - Torque Generator Box: overview



1. Structure of the mechanism housing
2. Hexagonal seat for adjusting the assistance level
3. External cover
4. Locking mechanism

2.1.3.2 Functioning of the locking mechanism

Fig. 2.5 - Torque Generator Box (TGB): locking mechanism. **LOCK** position: locked mechanism, rotation not allowed. **UNLOCK** position: unlocked mechanism, free rotation.



The locking mechanism positioned on the Torque Generator Box is a safety mechanism that prevents the Torque Generator Box from activating when the exoskeleton is not worn. The LOCK position is to be set every time the device is removed, while the UNLOCK position is to be selected only during the wearing procedure as indicated in the [par. 3.2 Wearing procedure on page 28](#).



If the locking mechanism is unlocked improperly the Torque Generator Box can be activated if unintentionally set in rotation. This activation can generate impacts of parts of the TGB with external objects or people.



The locking mechanism can be activated (switching from LOCK position to UNLOCK position and vice versa) only when the Torque Generator Box is in the rear rest position ([Fig. 2.6](#)).

Fig. 2.6 - Torque Generator Box in rear rest position. This is the only position where the locking mechanism can be activated or deactivated



2.1.3.3 Levels of assistance

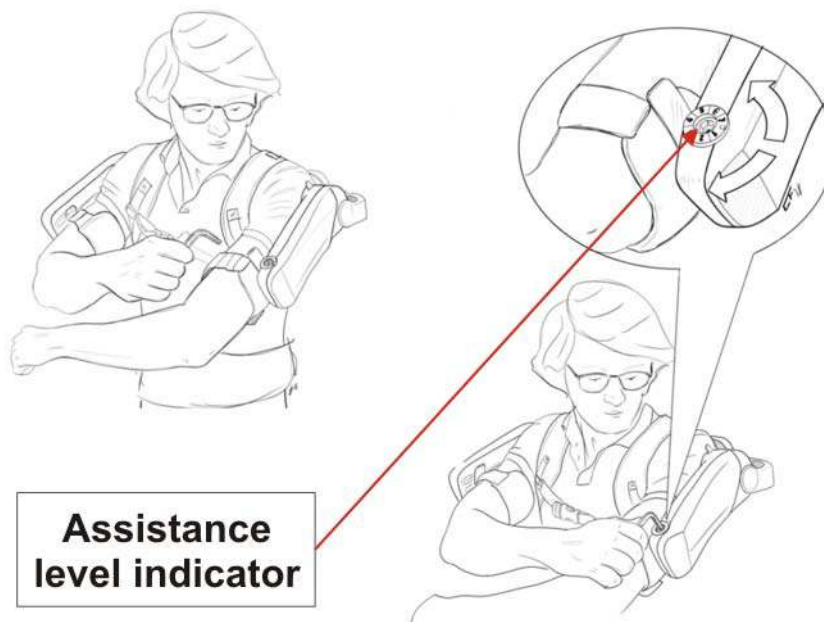
MATE can be used by setting various levels of assistance. The value of the assistance level is selected by the user indicatively based on the [Tab. 2.2](#). This table was created taking into account ergonomic assessments and calculations based on the height and body mass of the potential group of users.



The procedure to be followed in order to change the level of assistance is described in [par. 3.1.2.6 Adjustment of the assistance level on page 27](#). The use of an incorrect assistance level can generate discomfort but no harm to the user.

The Torque Generator Box can offer seven different and increasing levels of assistance from 1 to 7.

Fig. 2.7 - Close view of the adjustment seat on the Torque Generator Box and the assistance level indicator



Tab. 2.2 - Range of assistance levels in relation to height and weight of the user

		WEIGHT (kg)												
		45	50	55	60	65	70	75	80	85	90	95	100	
HEIGHT (cm)	150	1	1	1	2									
	155	1	1	2	2	2								
	160	1	2	2	2	3	3							
	165	1	2	2	2	3	4	4						
	170		2	3	3	3	4	5	5					
	175				3	3	4	5	5	5				
	180				3	4	4	5	5	6	6	7		
	185					4	5	5	5	6	7	7	7	
	190					4	5	5	5	6	7	7	7	
	195						5	5	5	6	7	7	7	
	200							5	6	6	7	7	7	
	205								6	6	7	7	7	
	210									6	7	7	7	
	215									7	7	7	7	
220									7	7	7	7		

3. PREPARATION AND WEARING OF THE DEVICE

This section of the user's handbook explains how to configure and wear MATE.

- [Initial configuration](#)
- [Wearing procedure](#)
- [Further adjustments](#)
- [Device worn properly](#)
- [Undressing procedure](#)



All the adjustments described below are intended to increase the comfort of use of the device. Not optimal adjustments do not compromise the efficiency of the device and its possibility of use; however, it is recommended to follow in detail the procedure described below

3.1 Initial configuration

This paragraph contains:

- [Choice of the pHRi interface size](#)
- [Interface adjustment](#)

3.1.1 Choice of the pHRi interface size

MATE is available in two pHRi sizes. In the [par. 2.1.1 Physical Human-Robot Interface \(pHRi\) on page 14](#) are given reference indications to choose which size suits your physical shape.

3.1.2 Interface adjustment

Some dimensional adjustments are available on the interface:

- [Installation of belt extenders](#)
- [Adjustment of the rear support](#)
- [Adjustment of the Velcro belt tension](#)
- [Front buckle position and length adjustment](#)
- [Adjustment of the rear elastic straps](#)
- [Adjustment of the assistance level](#)

3.1.2.1 Installation of belt extenders

MATE size L is supplied with two belt extenders for Velcro belt to be installed if necessary.

Depending on the waist circumference, it may be necessary to install a belt extender or two.

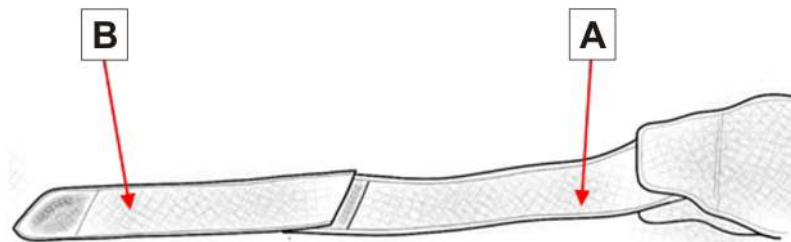
Follow the reference table:

Tab. 3.1 - References for installation of belt extenders

Waist circumference	Number of belt extenders required
Less than 110 cm (3.61 ft)	0
Between 110 and 135 cm (between 3.61 ft and 4.43 ft)	1
Between 135 and 160 cm (between 4.43 ft and 5.25 ft)	2

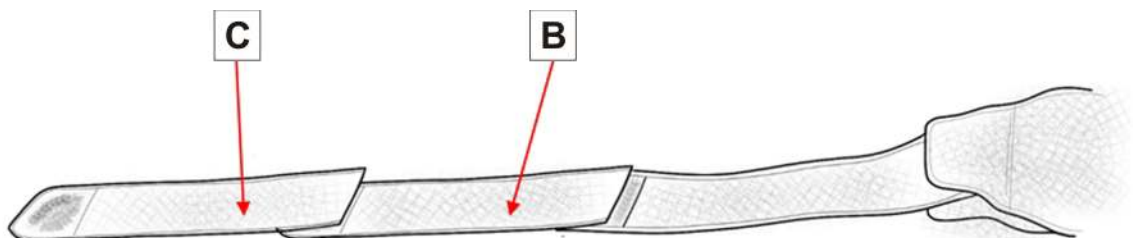
To install the first belt extender, overlap the Velcro end "A" of the belt at the end of the belt extender "B":

Fig. 3.1 - Schematic representation of the installation of the first belt extender on the Velcro belt



To install the second belt extender, overlap the Velcro end of the first belt extender "B" on the end of the second one "C":

Fig. 3.2 - Schematic representation of the installation of the second belt extender on the Velcro belt



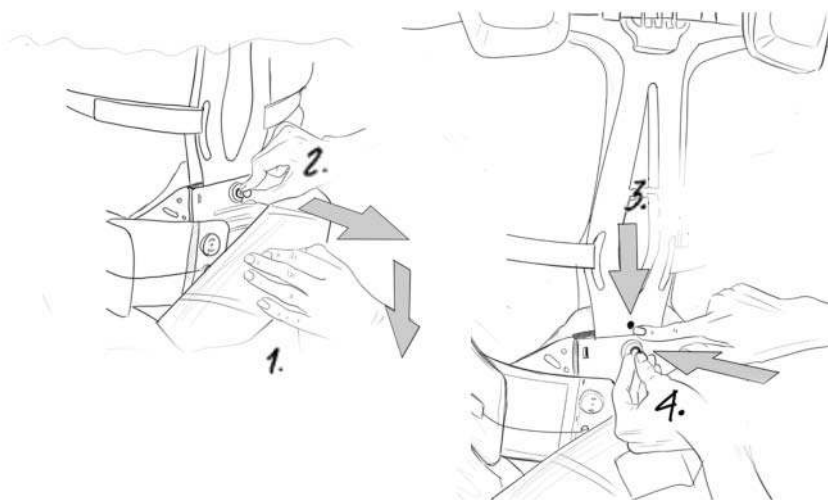
3.1.2.2 Adjustment of the rear support



Adjust the rear support to a not worn device

1. Open the protective panel on the back of the device.
2. Pull the spring button back.
3. Slide the metal support inside the plastic panel until you reach the needed length.
4. Release the spring button in position and close the protective panel to bring it back to its original configuration.

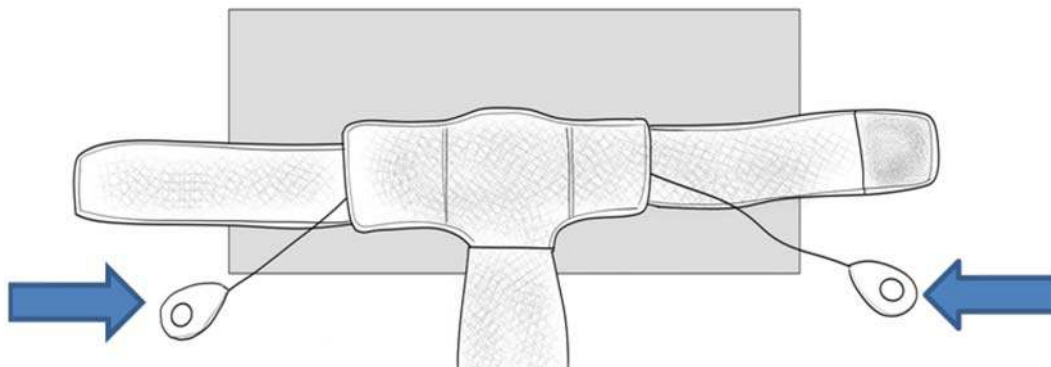
Fig. 3.3 - Schematic representation of the rear support adjustment



3.1.2.3 Adjustment of the Velcro belt tension

The adjustment of the Velcro belt tension is carried out by pulling the cords with Velcro ends visible in [Fig. 3.4](#). By pulling them and loosening them, it will be possible to adjust the tightness of the belt to different users and body sizes.

Fig. 3.4 - Operating principle of the Velcro belt adjustment



3.1.2.4 Front buckle position and length adjustment

The position of the front buckle can be adjusted according to the various body shapes by sliding it on the padded shoulder straps. Even its length can be adjusted making it more or less tight to the user's chest.

Fig. 3.5 - Operating principle of the front buckle adjustment



3.1.2.5 Adjustment of the rear elastic straps

The length of the rear elastic straps can be modified by pulling them or loosening them according to the needs, as shown in [Fig. 3.6](#).

Fig. 3.6 - Rear elastic straps adjustment modes



3.1.2.6 Adjustment of the assistance level



The assistance level value is a parameter that can be changed according to the user who is wearing the device. The adjustment of the assistance level must be carried out with the device worn and after having unlocked the locking mechanism.

Required instruments:

- Allen wrench of 6 mm
1. Place the Allen wrench in the hexagonal seat on the Torque Generator Box.
 2. Turn the key to bring the assistance level indicator (Fig. 2.7) in correspondence with the needed assistance level.

Fig. 3.7 - Assistance level operating principle



A non-optimal setting of the assistance level can generate inconvenience but no harm to the user.

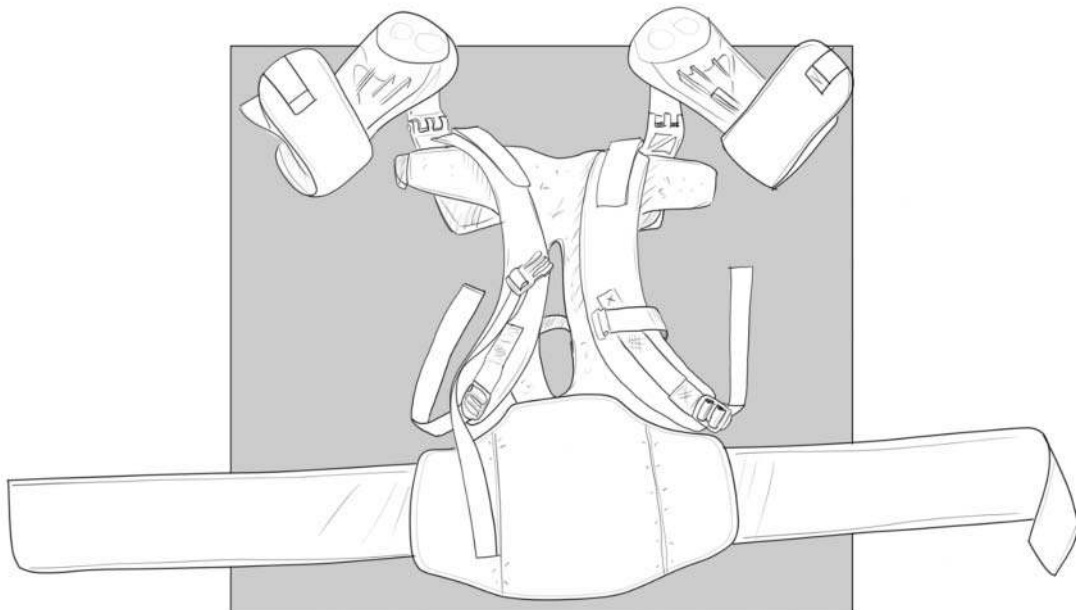
3.2 Wearing procedure

- MATE is meant to be worn and undressed by a person independently.
- During the first wearing it is necessary to be helped by a trained person who can speed up the understanding of the process, and help to find the best combination of the available adjustments.
- Try to wear and undress the device independently for 3 times in the presence of a trained person in order to become familiar with the procedure.

Preliminary instructions

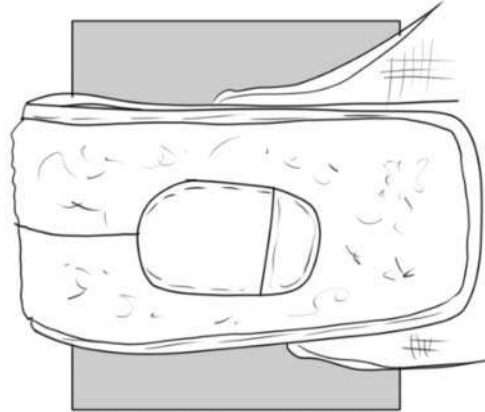
- Do not position the device in direct contact with the skin, and make sure that clothing is appropriate: do not wear too loose-fitting or too thick clothes. We recommend the use of a well-close-fitting cotton t-shirt or shirt.
- Make sure the Velcro belt is open, as well as the adjusting straps (component 6 in [Fig. 2.2](#)).
- Pull the Velcro belt from both ends to get its maximum length.

Fig. 3.8 - Opening and extension of the Velcro belt ends



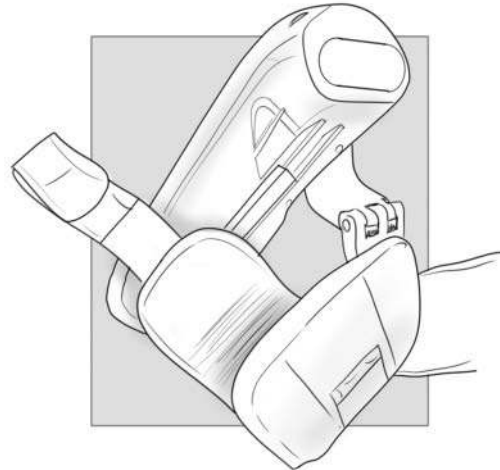
- Adhere the Velcro ends of the adjusting straps to the Velcro belt.

Fig. 3.9 - Velcro end positioned on the Velcro belt



- Make sure that the locking mechanism is in the LOCK position.
- Open the straps of the arm supports, and attach the Velcro on the strap itself as shown in [Fig. 3.10](#) to avoid entanglement.
- Verify that the press-studs of the **arm supports** are closed.

Fig. 3.10 - Opening of the arm support strap and momentary fixing of the strap on itself



Wearing procedure

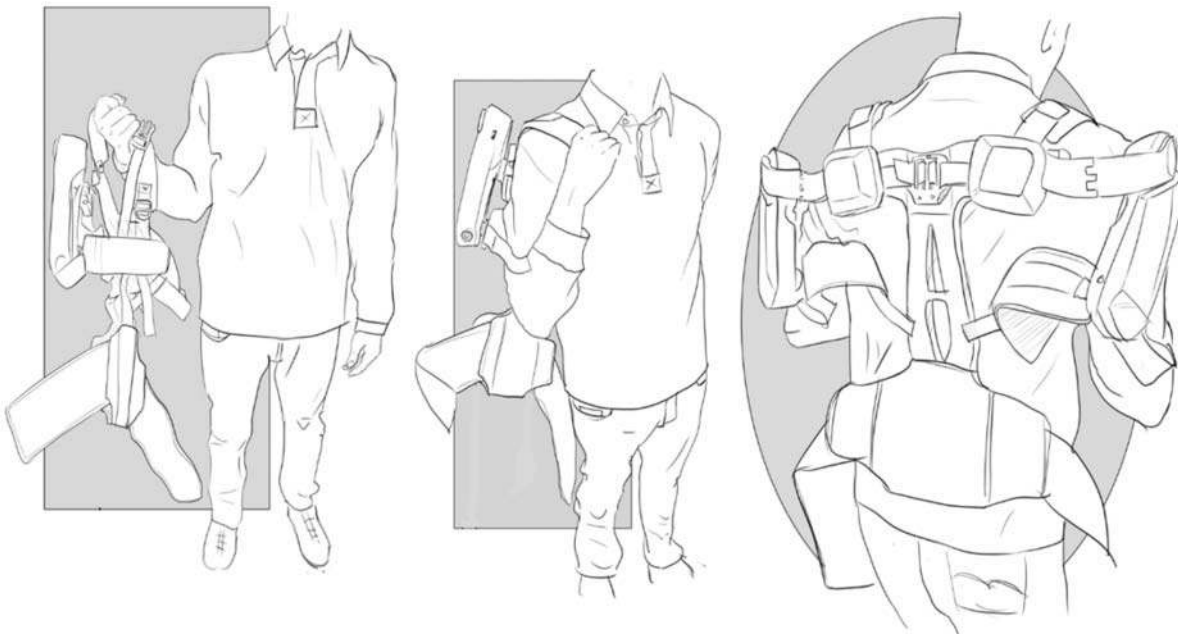


Before wearing MATE, check the effective closing of the press-studs on the arm supports (Fig. 6.4).

If the press-studs of the **arm supports** are not correctly closed, it is possible that during use the TGB loses contact with the arm of the user causing a sudden rotation of the TGB itself. Such rotation can generate impacts of TGB parts with external objects or people.

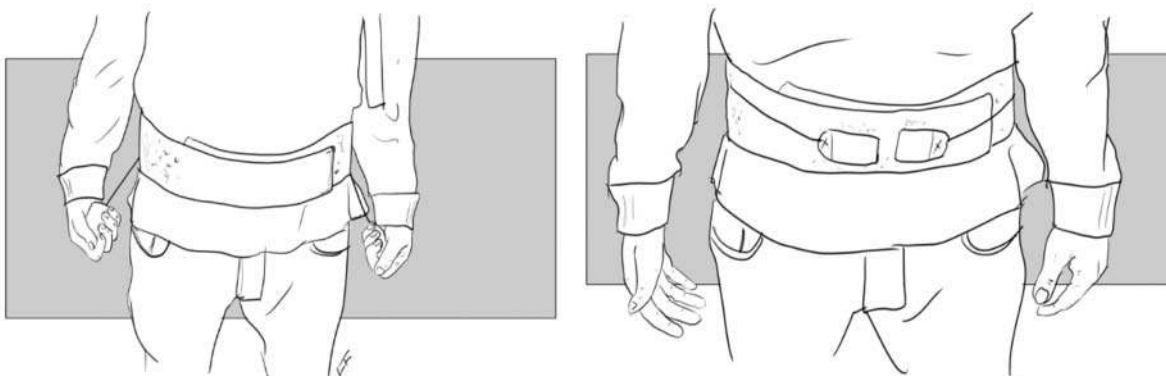
1. Lift MATE by seizing it by a shoulder strap and wearing it like a backpack.

Fig. 3.11 - First phase of wearing of MATE



2. Fasten the Velcro belt.
3. Adjust the tension of the Velcro belt by pulling the adjustment mechanism. Attach the Velcro ends to the belt to block it from slipping.

Fig. 3.12 - Closure of the Velcro belt and adjustment of its tension



4. Repeat the following steps for each arm:
 - a. Unlock the locking mechanism of the Torque Generator Box.

Fig. 3.13 - Unlocking the locking mechanism of the Torque Generator Box.



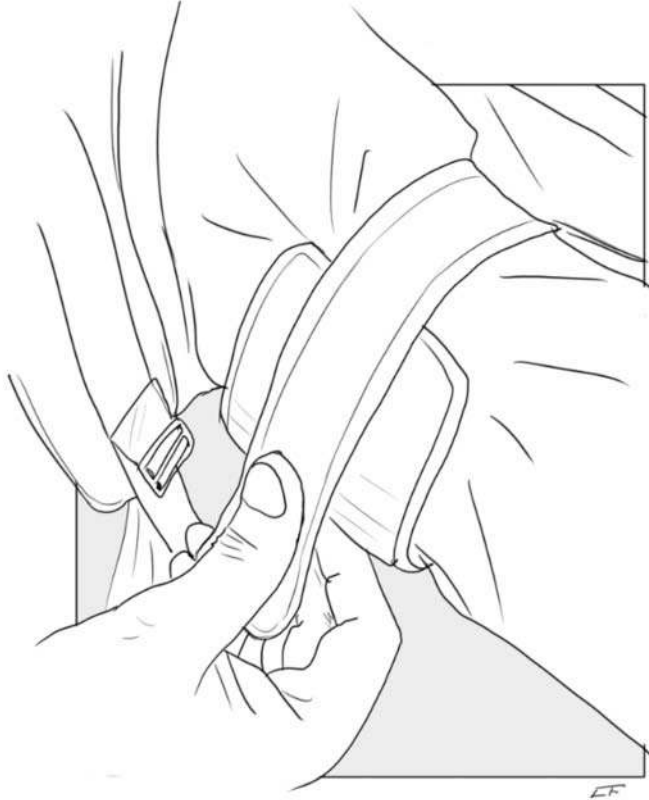
- b. Bring an arm into contact with its support
 - c. Rotate the torque generator box so that it supports the arm

Fig. 3.14 - Torque Generator Box activation procedure



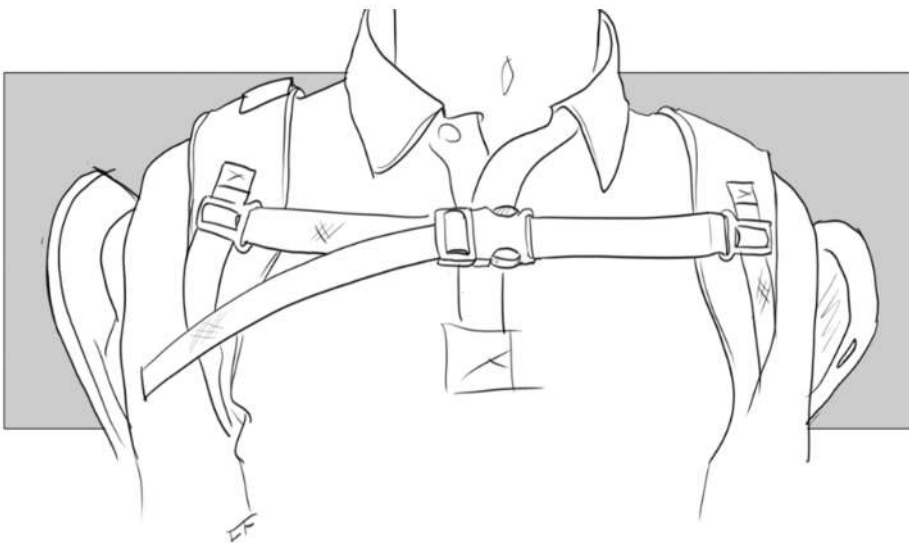
- d. Close the arm support strap.

Fig. 3.15 - Closing the arm support strap



- 5. Close and tighten the front buckle.

Fig. 3.16 - Closing buckle adjustment



3.3 Further adjustments

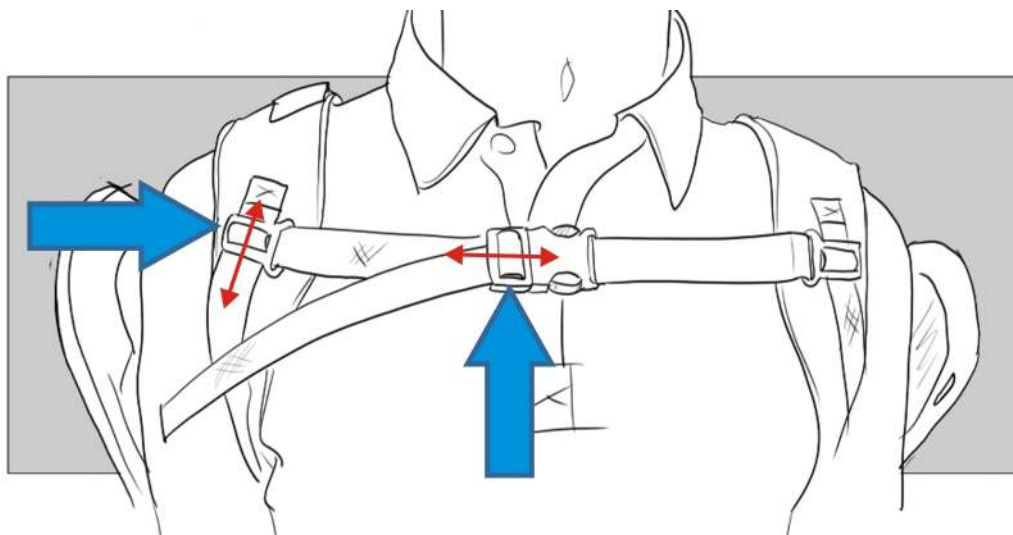
Some additional adjustments may be useful for improving the alignment between the device and the user body:

- [Central buckle adjustment](#)
- [Adjustment of the rear elastic straps](#)

3.3.1 Central buckle adjustment

An additional adjustment of the height and length of the front buckle may be required, as described in [par. 3.1.2.4 Front buckle position and length adjustment on page 25](#). The fact of moving close/away the shoulder straps avoids the possibility of relative slipping between the shoulder straps and the user arms

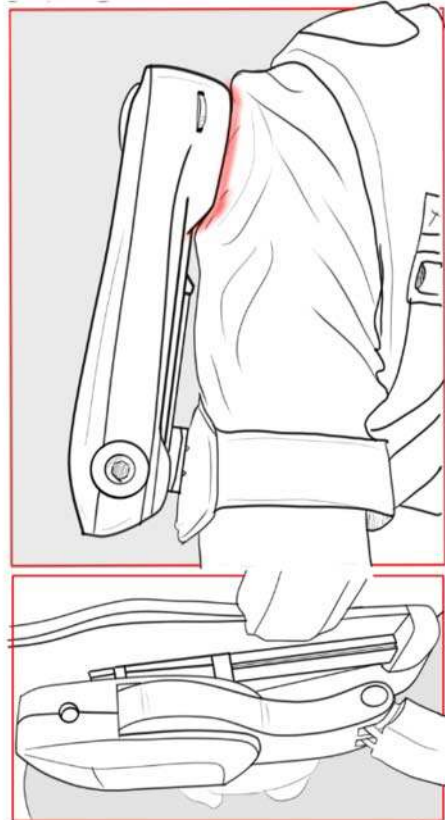
Fig. 3.17 - Adjustment the front buckle



3.3.2 Adjustment of the rear elastic straps

An additional adjustment of the length of the rear elastic straps may be necessary in order to improve the adherence of the device to the user arms.

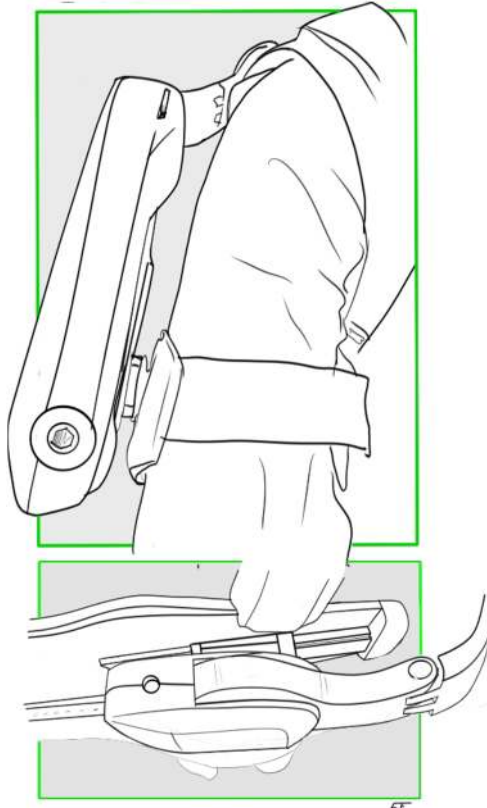
Incorrect positioning that requires adjustment of the rear elastic straps



Incorrect positioning of the Torque Generator Box which is in direct contact with the user shoulder and may cause relative slipping.

The rear elastic straps are, in this case, too tight and the sliding element on the pDOF works unbalanced on one side.

Correct positioning

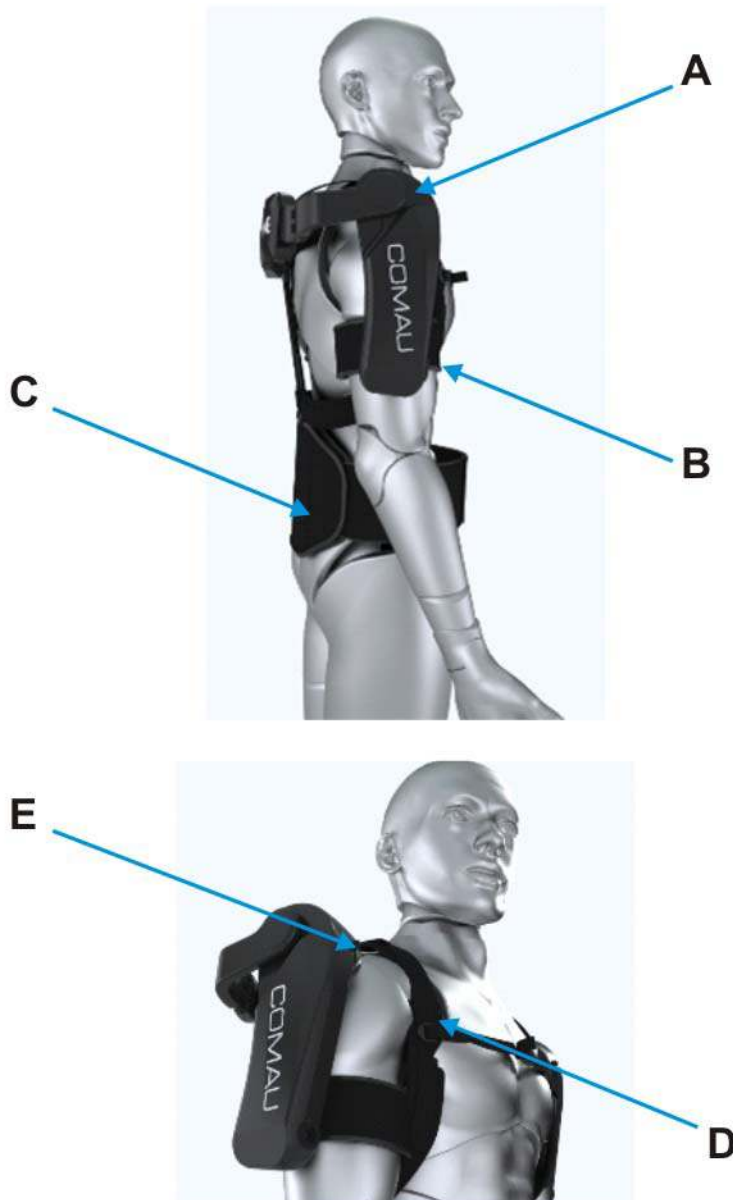


Correct position of the Torque Generator Box: between the shoulder and the device there is a light of about 1 cm

In this case, the sliding element works in a central position when the user has the arm in the rest position

3.4 Device worn properly

Fig. 3.18 - Representation of the correct wearing of MATE



A: Check that the rotation axis of the TGB coincides with the rotation axis of the shoulder. This match is done by changing the length of the back support.

B: Check that the shoulder straps are close-fitting to the body and do not get tangled.

C: Check that the Velcro belt is at the lower level of the back area. A comfortable seat is a good criterion to understand if the device is well worn.

D: Adjust the height of the closure of the shoulder straps according to the body shape.

E: Check that there is a light of approximately 1 cm between the Torque Generator Box and the shoulder. If it is distant from the shoulder or blocks its movement, operate on the rear elastic straps by loosening or pulling them accordingly.

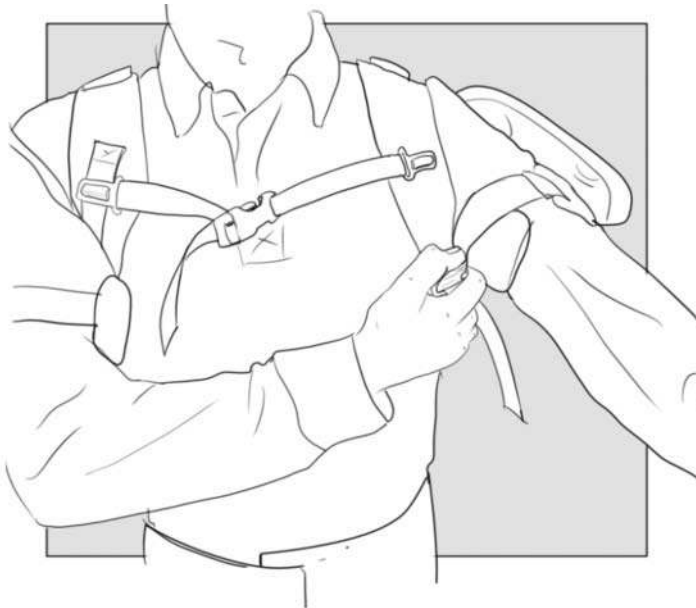
3.5 Undressing procedure



The following operations must be repeated for both arms separately

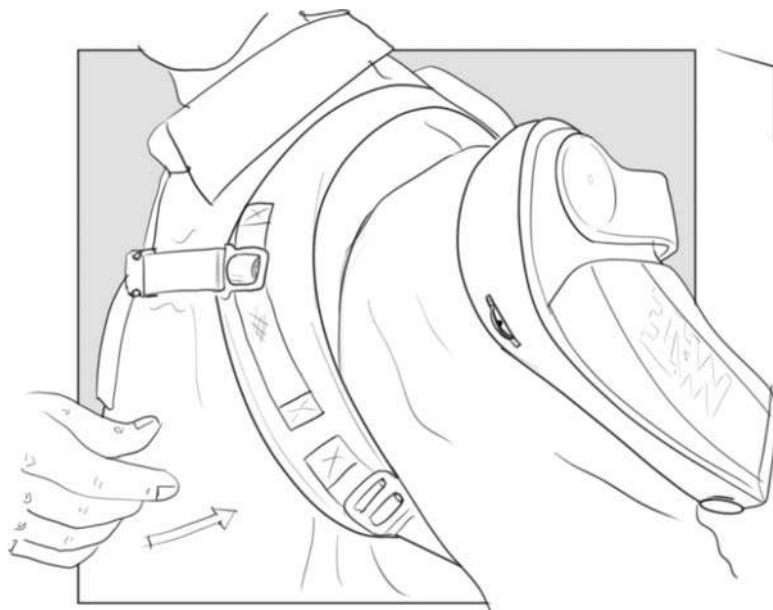
1. Open the support strap of one of the two arms and attach it on itself as shown in [Fig. 3.10](#).

Fig. 3.19 - Opening the arm support strap



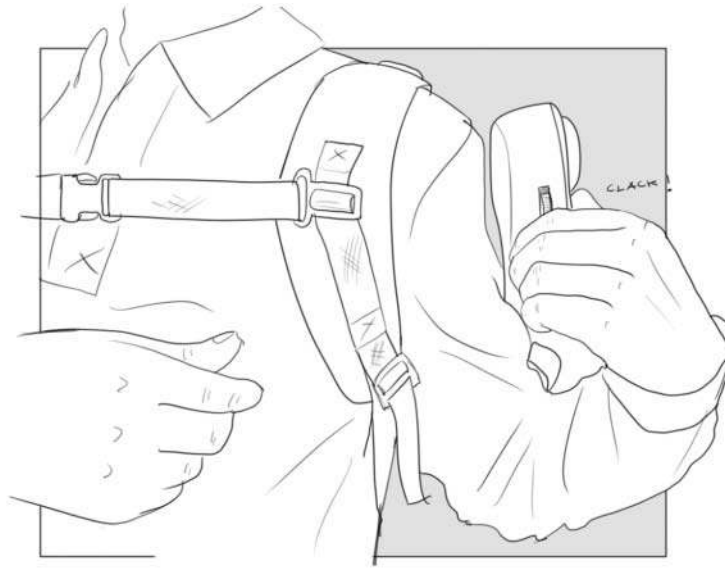
2. Move the corresponding arm backwards.

Fig. 3.20 - Arm in back position



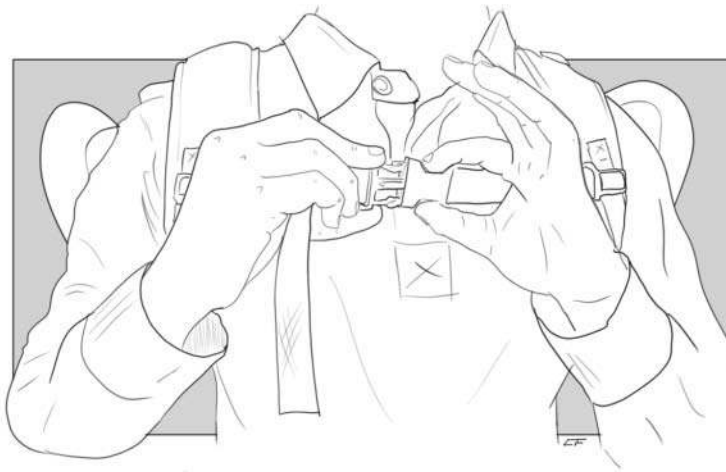
3. Lock the locking mechanism of the corresponding Torque Generator Box.

Fig. 3.21 - Locking the TGB locking mechanism



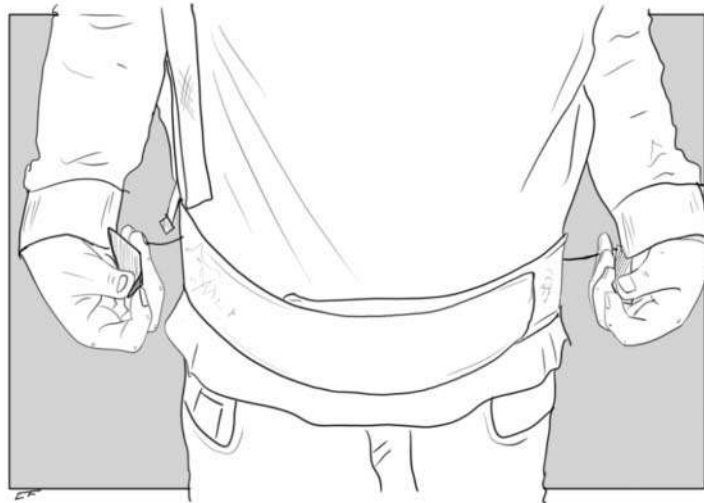
4. Open the front buckle.

Fig. 3.22 - Opening the front buckle



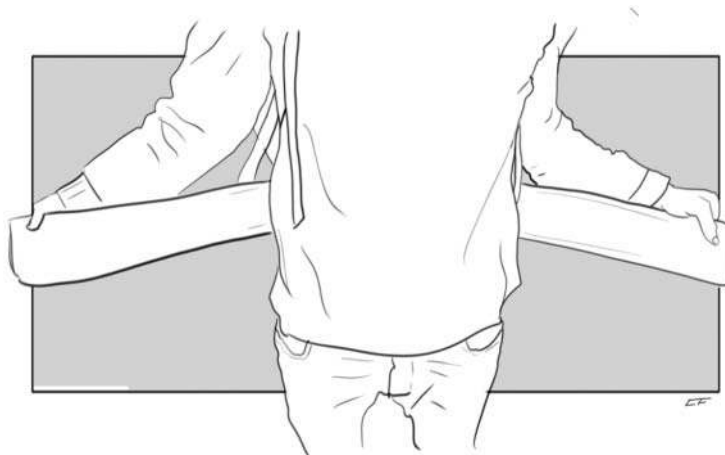
5. Detach the Velcro ends of the adjustment straps, and attach them laterally to the Velcro belt.

Fig. 3.23 - Opening the adjustment straps of the Velcro belt



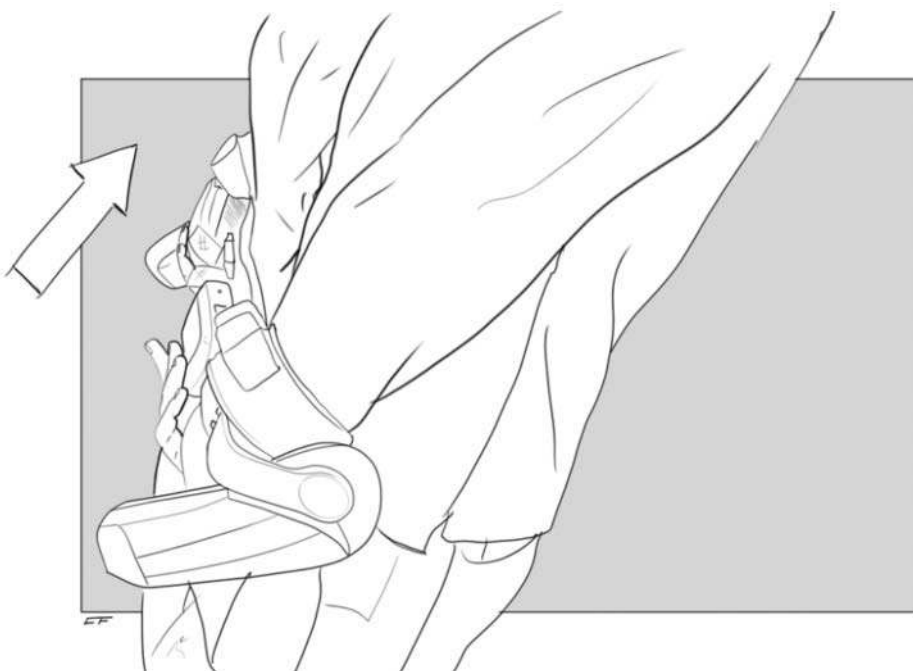
6. Open the Velcro belt.

Fig. 3.24 - Opening the Velcro belt.



7. Remove MATE pulling it out by the padded shoulder straps.

Fig. 3.25 - Last phase of the MATE undressing



4. NOISE EMISSIONS

The sound pressure level does not exceed 70 dB(A).

5. RESIDUAL RISKS



Danger. Pinch point. Keep hands and fingers clear.

Bringing fingers closer to the chain of passive degrees of freedom (pDOFs) or the Torque Generator Box (TGB) while the device is in use may result in pinching of the fingers.

This warning also applies to people who may be around the user of MATE when the device is in use.

6. MAINTENANCE AND CLEANING OF THE DEVICE

6.1 Cleaning of rigid parts

Clean the rigid parts and exposed mechanical components of the MATE device using a dry or lightly soaked with water cloth and neutral soap. Do not use aggressive cleaning agents, gases, alcohol or diluents.

Do not immerse the device in water and make sure that no liquid enters it.

6.2 Cleaning of fabric parts

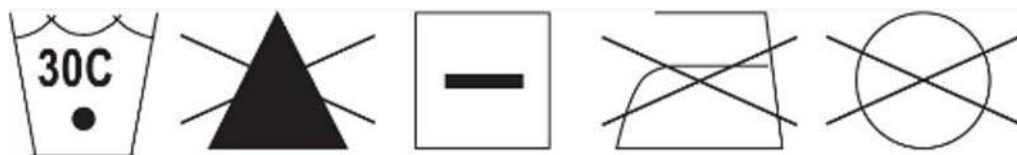
All fabrics and padded parts can be disassembled and washed. This can be done approximately once a month after a daily use of the device.

6.2.1 Washing instructions for soft components

Use the instructions described in [par. 6.3.2 Procedure for disassembling the parts of the fabrics and padded parts on page 48](#) to disassemble the washable parts from the device.

Use the following directions to wash the fabric parts of the wearable interface:

- Machine wash cold.
- Do not bleach.
- Dry flat.
- Do not iron.
- Do not dry clean.
- Use delicate soaps, do not use fabric softeners.



Wash the various components individually using a laundry bag, making sure the Velcro connections are closed.

Once washed and dried, use the procedure in [par. 6.3.3 Interface resetting procedure on page 51](#) to reset the wearable parts on the device.

6.3 Scheduled maintenance

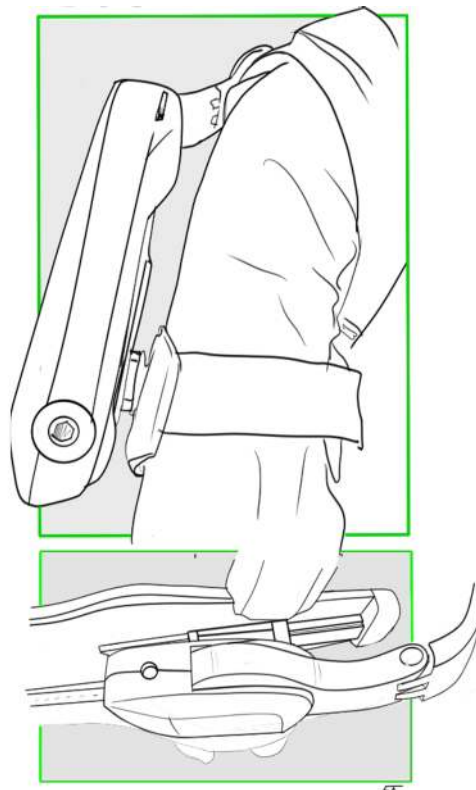


Before starting to use the device, check the integrity of the wearable interface and the cleaning of the exposed mechanical parts that make up the pDOFs and the Torque Generator Box.

In particular, in order to avoid malfunctions, check that the sliding elements on the Torque Generator Box and on the pDOFs are free of dust and debris.

For the most suitable cleaning procedure, refer to [par. 6.1 Cleaning of rigid parts on page 43](#).

Fig. 6.1 - Detail on the sliding elements of the TGB and the pDOFs



Fabric parts (pHRI)

After one year of daily use of the device it may be necessary to replace some of the fabric parts of the pHRI.

Mechanical parts (TGB and pDOF)



The frequency of scheduled maintenance interventions depends on the working conditions of the device.

However, it is advisable to always carry out a scheduled maintenance operation when the 12 months of use are reached.

Please refer to COMAU for technical assistance and scheduled maintenance (www.comau.com/mate).

6.3.1 Spare parts list

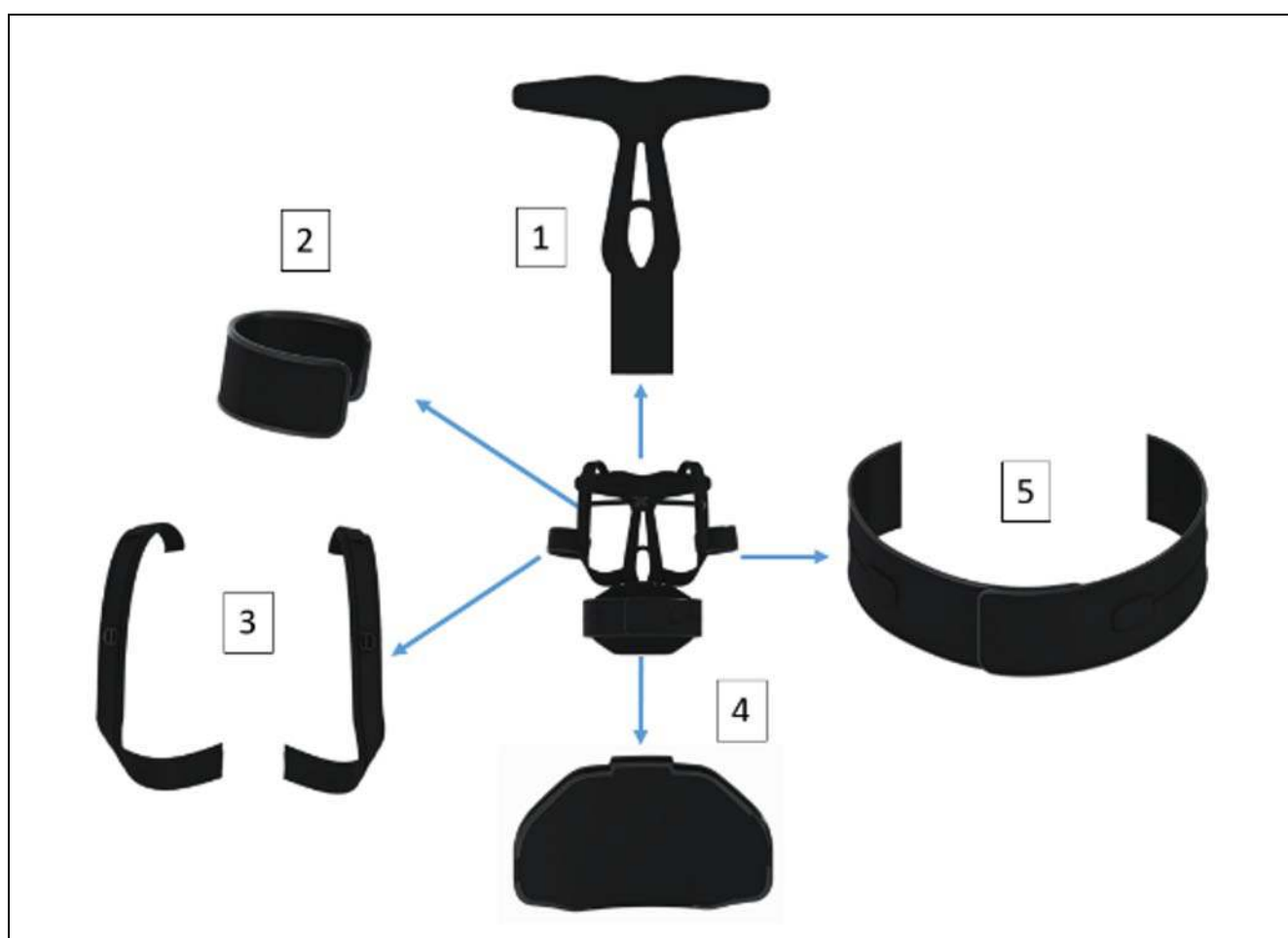


For the maintenance of MATE use only original spare parts.
Do not use spare parts for different purposes than those indicated.

In the following tables are indicated:

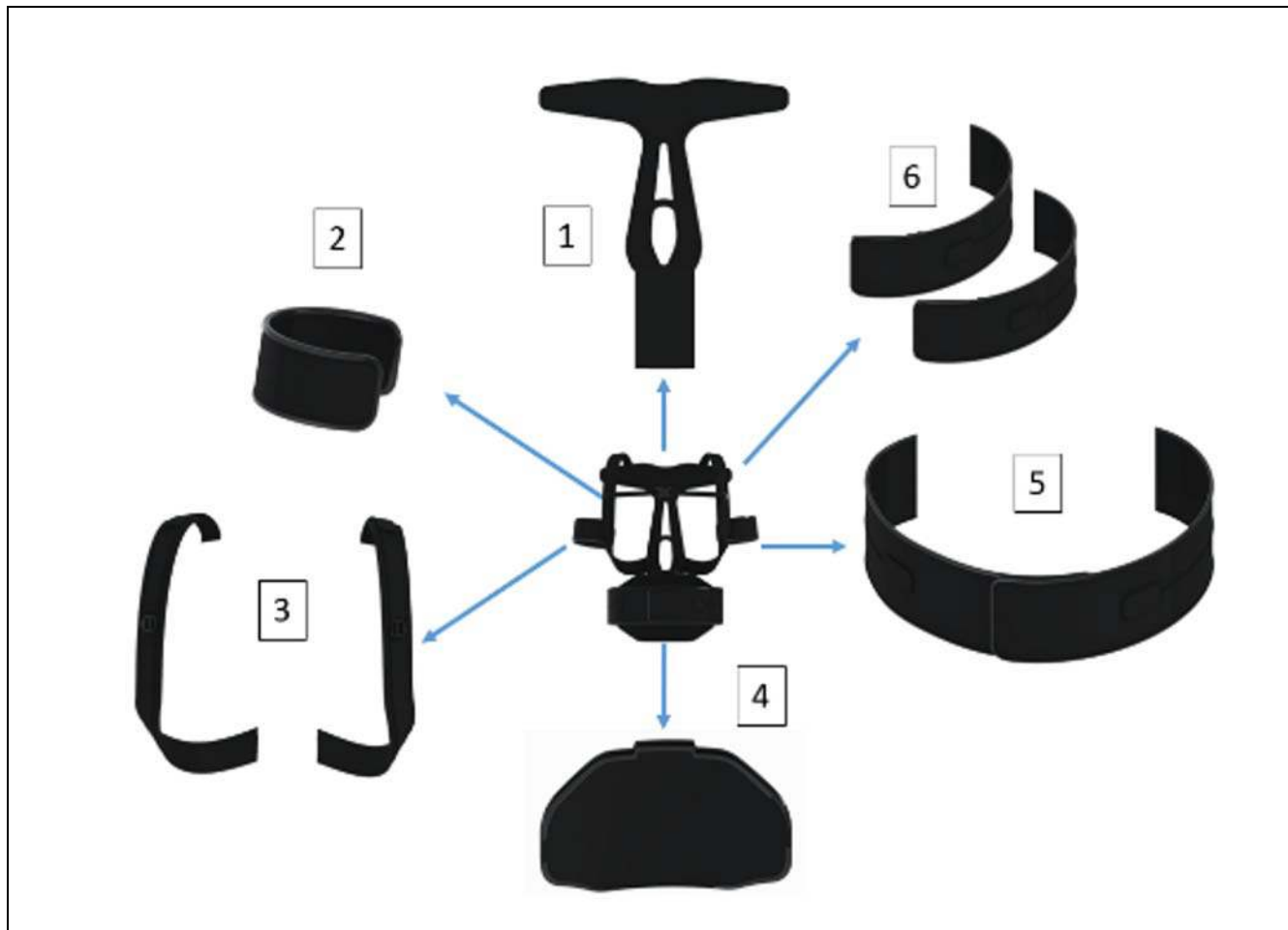
- [Small pHRI spare parts](#)
- [Large pHRI spare parts](#)
- [TGB and pDOFs spare parts](#)

Tab. 6.1 - Small pHRI spare parts



Position	Comau Part No.	Description	Quantity
1	CR82438501	Removable back padding (Small)	1
2	CR82438502	Nylon arms supports	2
3	CR82438503	Removable padded shoulder straps (set)	1
4	CR82438504	Removable panel	1
5	CR82438505	Velcro belt	1

Tab. 6.2 - Large pHRI spare parts



Position	Comau Part No.	Description	Quantity
1	CR82438601	Removable back padding (Large)	1
2	CR82438502	Nylon arms supports	2
3	CR82438503	Removable padded shoulder straps (set)	1
4	CR82438504	Removable panel	1
5	CR82438505	Velcro belt	1
6	CR82438602	Velcro belt extenders (set)	1

Tab. 6.3 - TGB and pDOFs spare parts

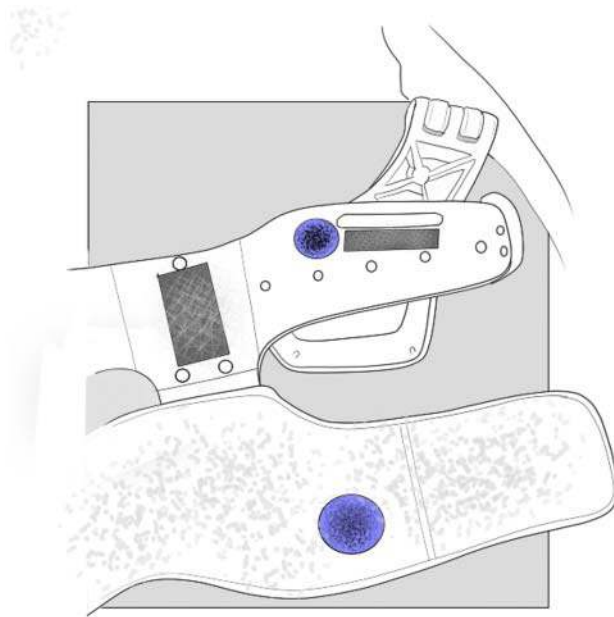


Position	Comau Part No.	Description	Quantity
1	CR82434800	TORQUE GENERATOR BOX DX	1
2	CR82434900	TORQUE GENERATOR BOX SX	1
3	CR82435000	PASSIVE DOF DX	1
4	CR82435100	PASSIVE DOF SX	1

6.3.2 Procedure for disassembling the parts of the fabrics and padded parts

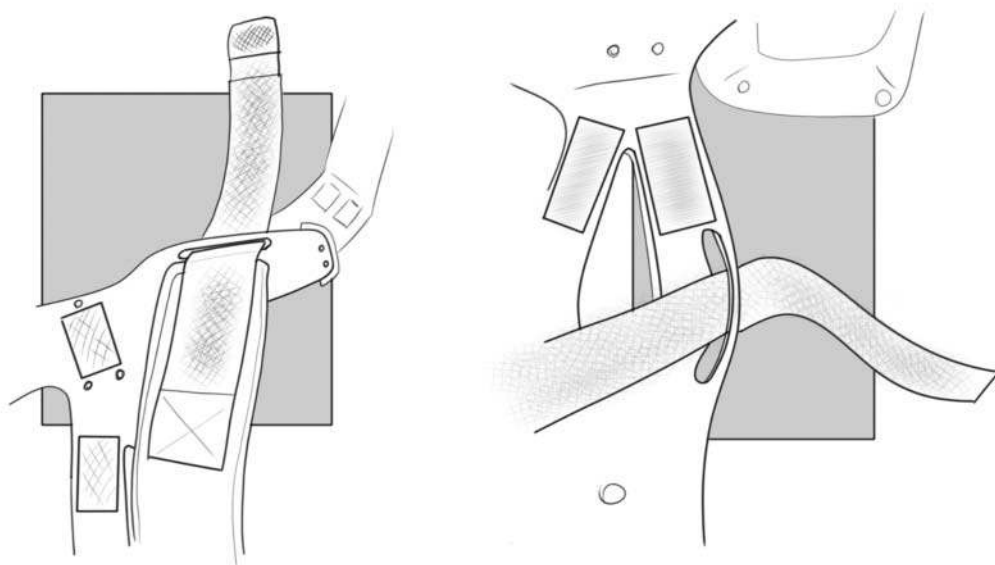
1. **Rear padding:** Remove the back padding by gently operating on the Velcro connection.

Fig. 6.2 - Removing the back padding



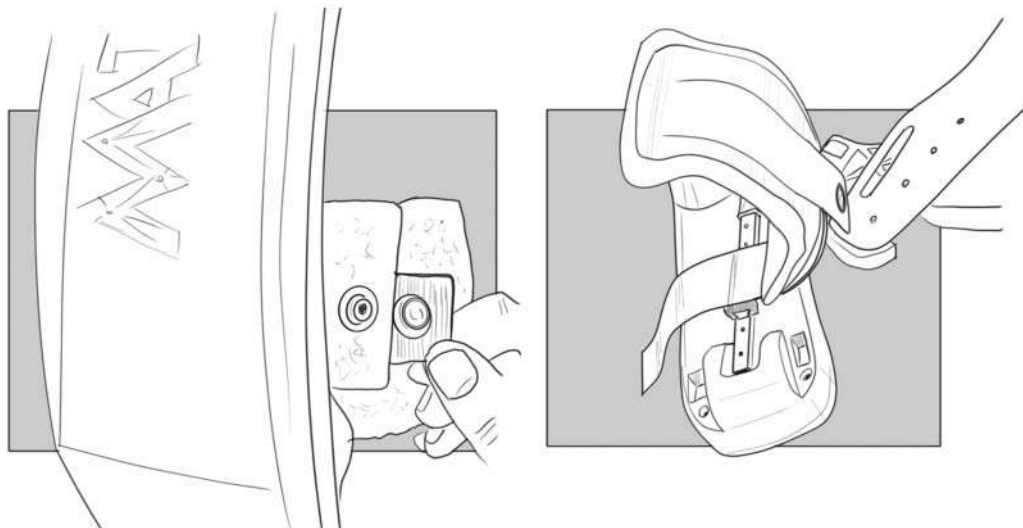
2. **Padded shoulder straps:** Remove the padded shoulder straps by opening the Velcro connections at the ends.

Fig. 6.3 - Removing the padded shoulder straps



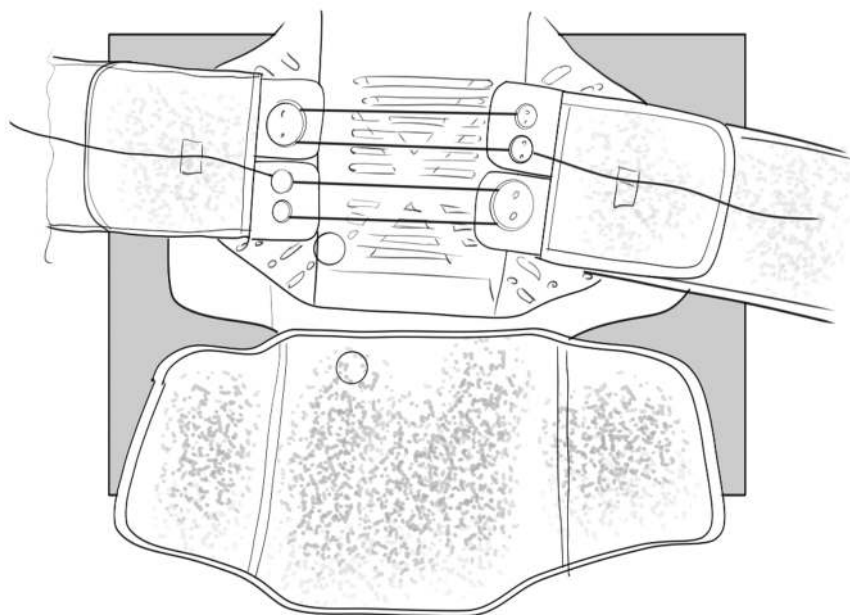
3. **Arm supports:** Remove the supports of the arms by opening the side press-stud and sliding them on the aluminium support.

Fig. 6.4 - Removing the arm support



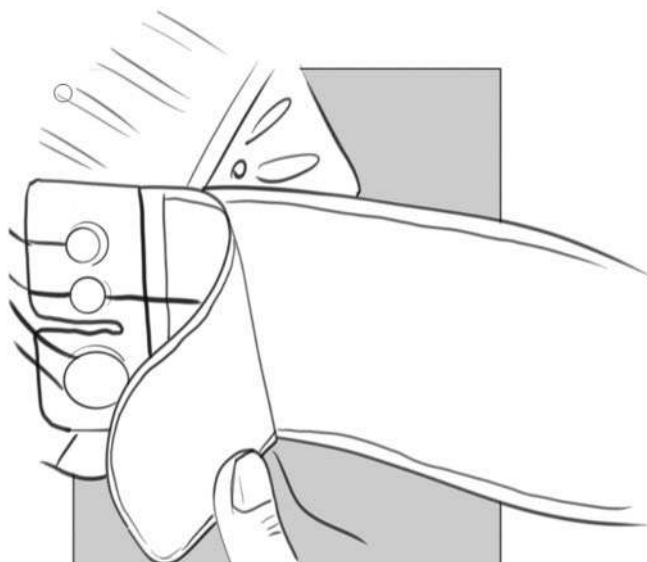
4. Remove the rear **panel** by opening the Velcro connections

Fig. 6.5 - Removing the rear panel



5. Remove the Velcro **belt** by opening the end connection.

Fig. 6.6 - Removing the Velcro belt.

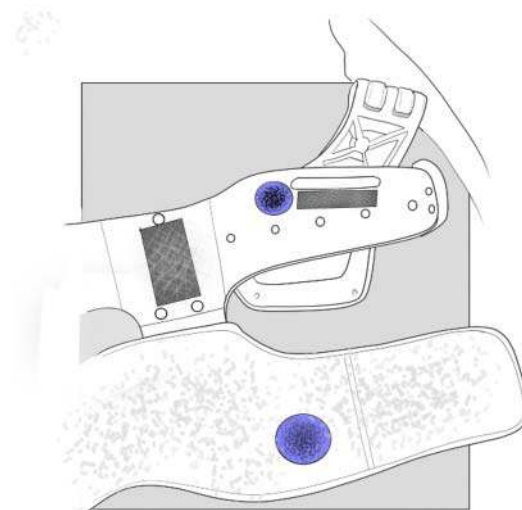


6.3.3 Interface resetting procedure

If you need to reset the interface components, use the instructions below:

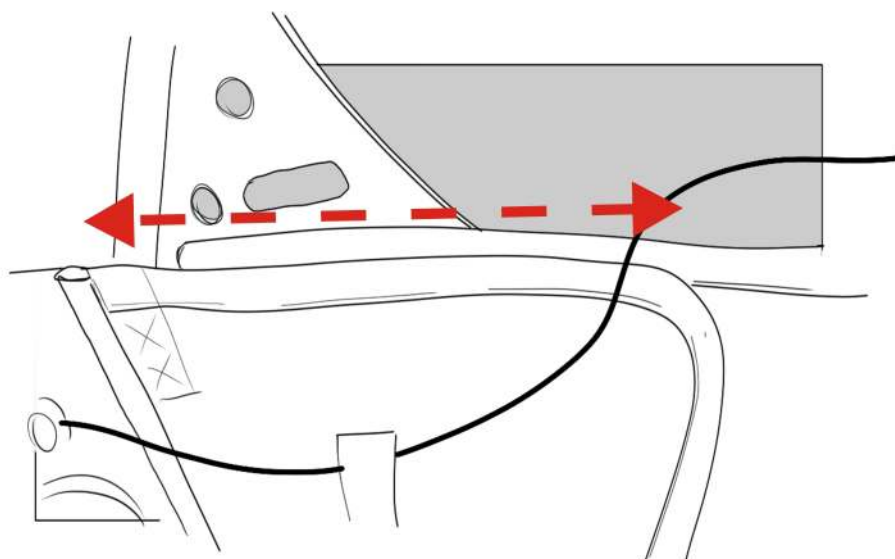
1. Connect the removable **rear padding** to the metal structure by connecting the Velcro connections, making sure that the blue reference points coincide in order to be sure of the correct orientation of the component:

Fig. 6.7 - Connection of the rear padding



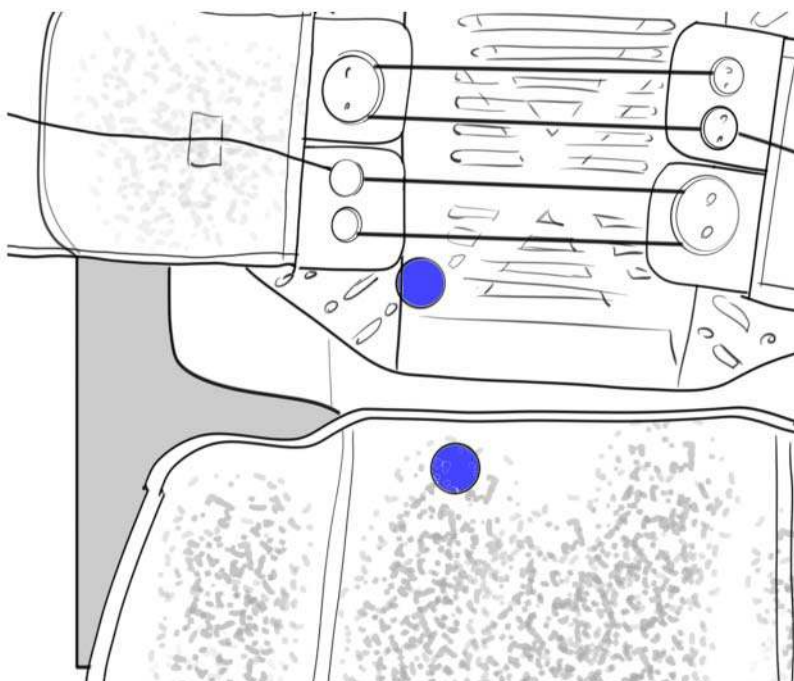
2. Bring the padded **shoulder straps** back to their positions by using Velcro connectors at the ends.
3. Reposition the **arms supports** by inserting them into the aluminium support. Lock the component by closing the press-stud.
4. Reposition the Velcro **belt** by closing the end connection. Make sure that the entire Velcro section is well fixed.

Fig. 6.8 - Opening the Velcro belt.



5. Reposition the rear **panel**, operating on the Velcro connections, making sure that the blue references overlap so as to be sure of the correct orientation of the padding.

Fig. 6.9 - Repositioning the rear panel



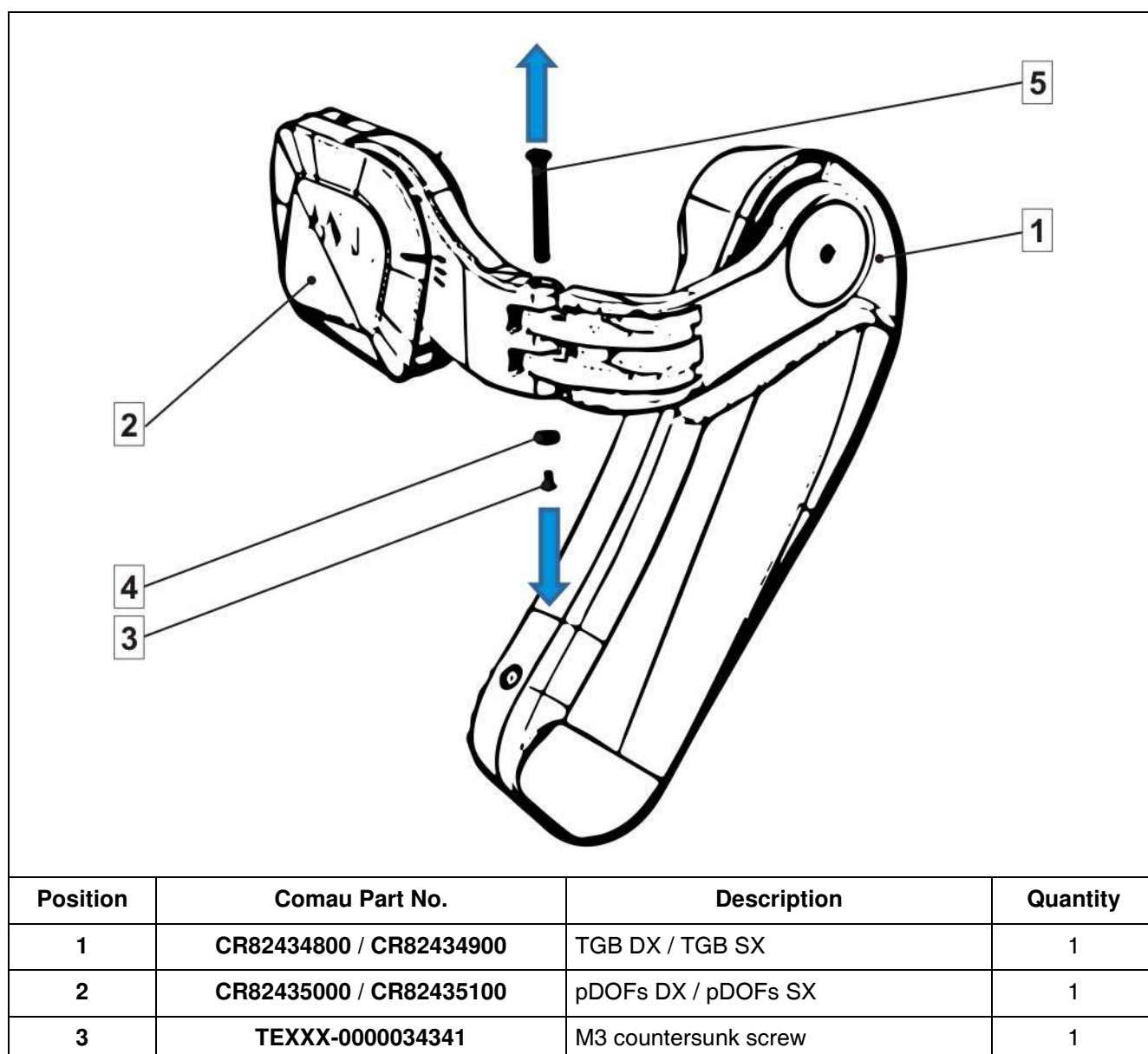
6.3.4 TGB replacement procedure (CR82434800 - CR82434900)

Required instruments:

- 2 mm Allen wrench
- Torque wrench with 2 mm hex bit (for tightening torque 0.5 Nm).
- LOCTITE 222 threadlocker

1. Verify that the TGB is in the lock position (see [par. 2.1.3.2 Functioning of the locking mechanism on page 17](#)).
2. Unscrew the part “3” (Countersunk screw) with a 2 mm Allen wrench.
3. Remove the part “4” (Special washer) and “5” (Passive DOF second pin).

Fig. 6.10 - Removal of the connection pin from the TGB and pDOFs forks holes

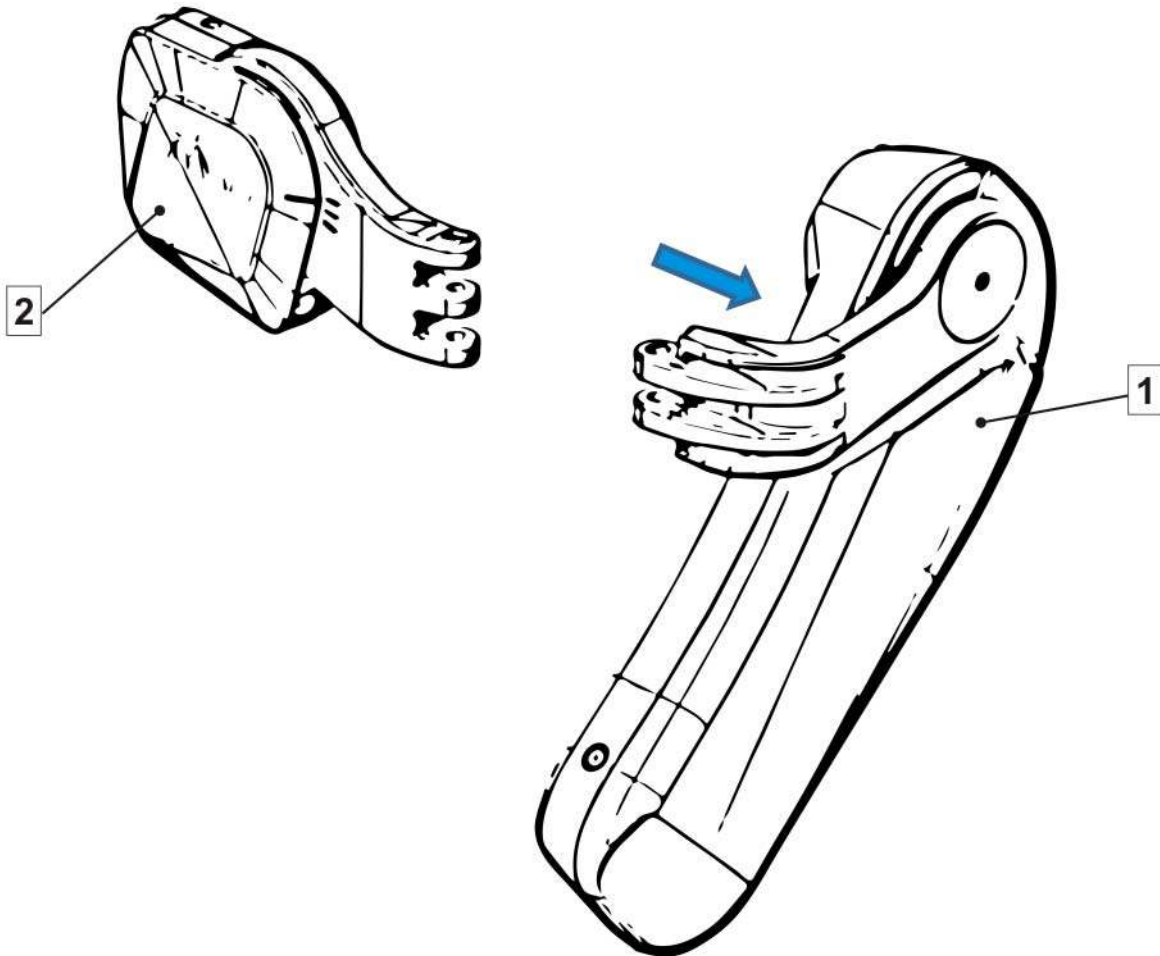


MAINTENANCE AND CLEANING OF THE DEVICE

Position	Comau Part No.	Description	Quantity
4	CR82435008	Special washer	1
5	CR82435007	Passive DOF second pin	1

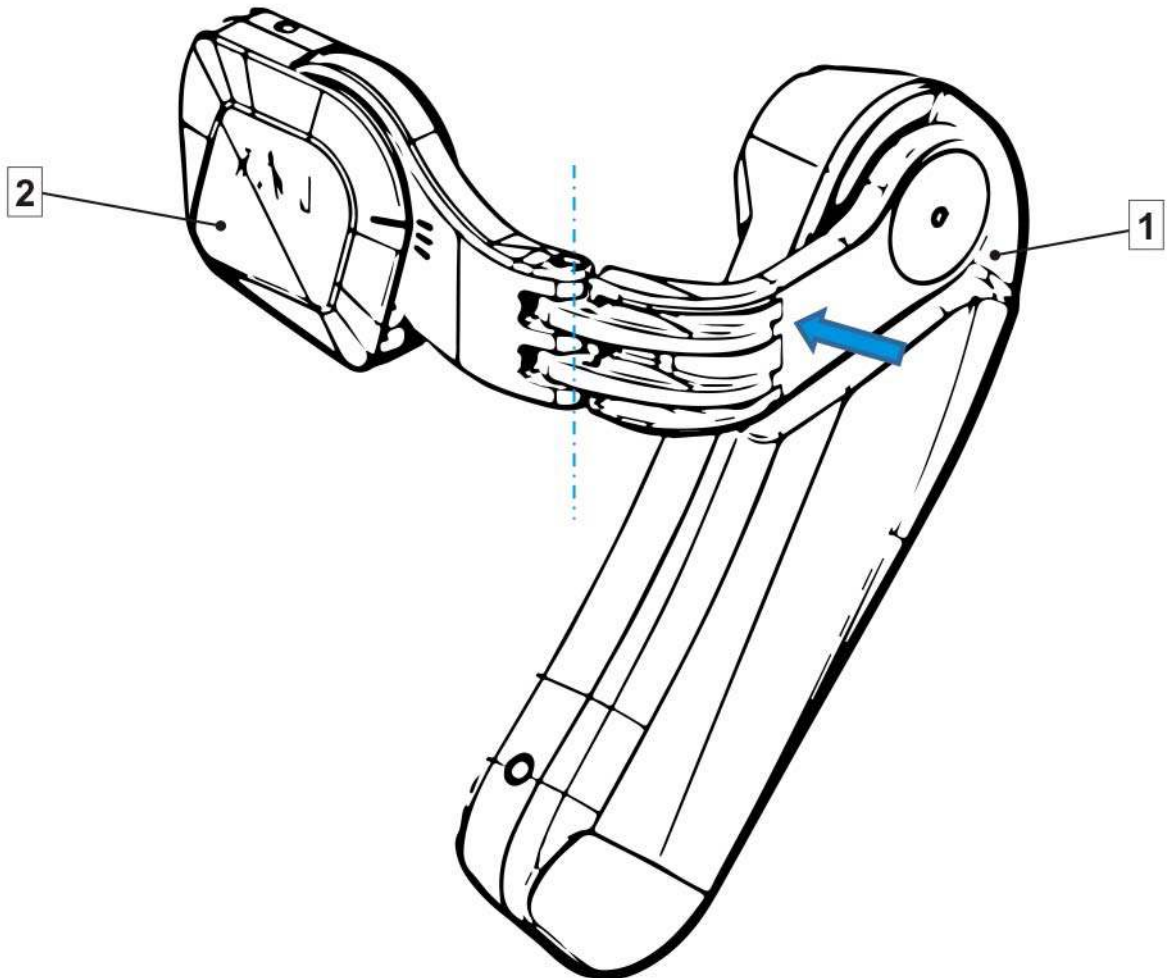
4. Uncouple the item "1" (TGB) from the item "2" (pDOF).

Fig. 6.11 - Separation of TGB and pDOF



5. Replace the TGB with the spare part and position the new item "1" (TGB) so that the holes of the forks of the TGB and of the item "2" (pDOF) are aligned.

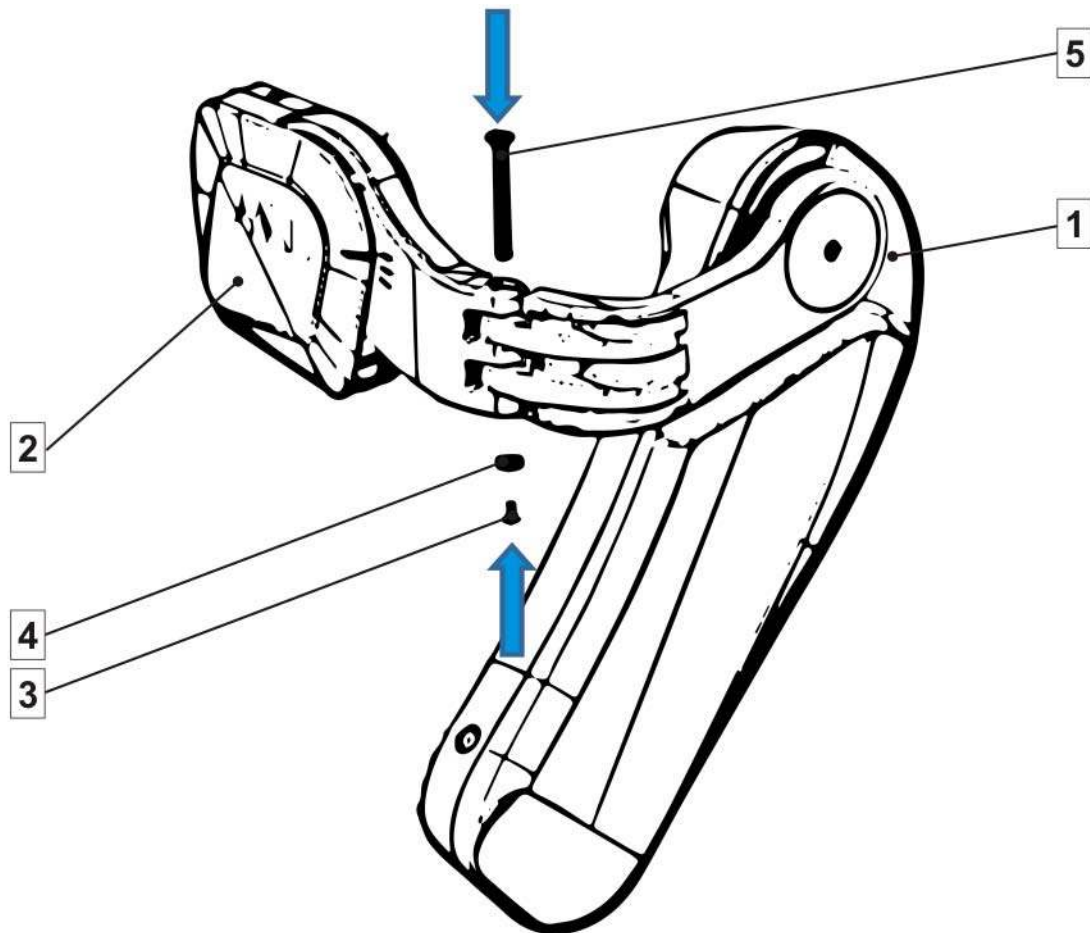
Fig. 6.12 - Insertion of the new TGB



MAINTENANCE AND CLEANING OF THE DEVICE

6. Insert the part "5" (Passive DOF second pin) in all the holes of the forks of the part "1" (TGB) and "2" (pDOF) and check that the head of the pin reaches the mechanical stop.
7. Position the item "4" (Special washer) and tighten the part "3" (Countersunk screw) using the 2 mm torque wrench to the tightening torque of 0.5 Nm after applying LOCTITE 222 threadlocker.

Fig. 6.13 - Insertion of the connection pin into TGB and pDOF forks holes

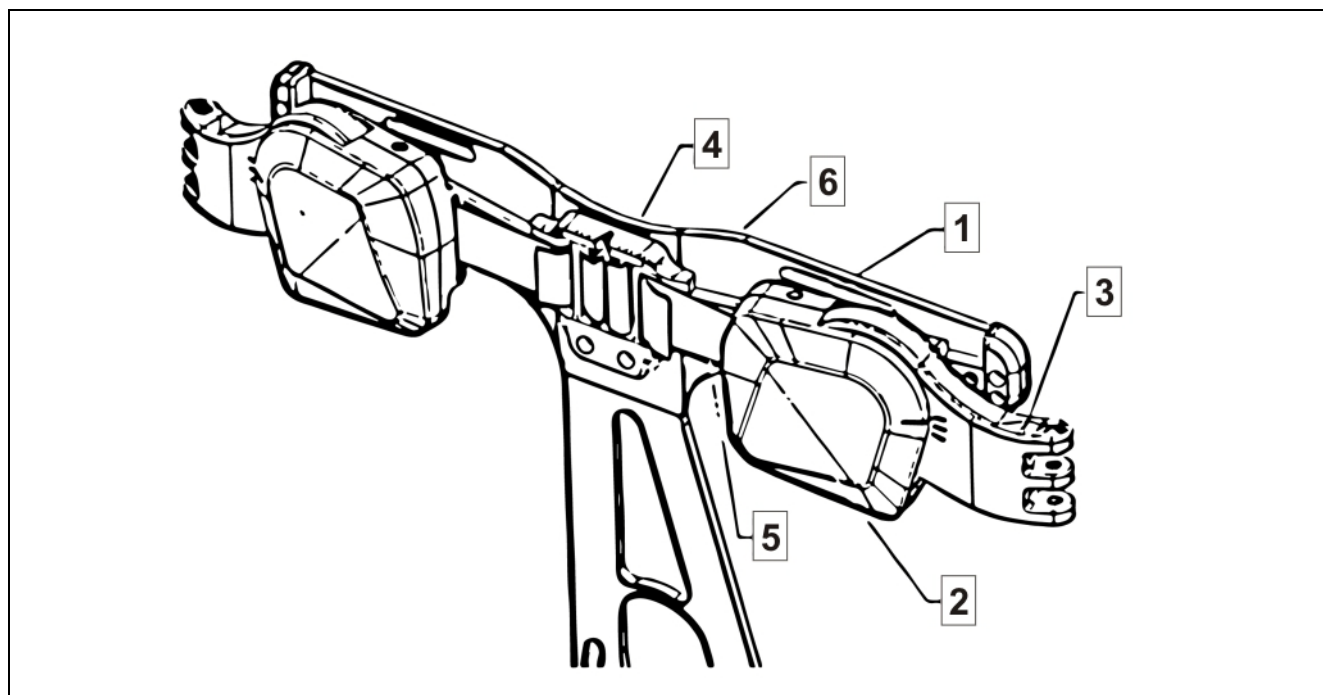


6.3.5 pDOF replacement procedure (CR82435000 - CR82435100)

Required instruments:

- 2.5 mm Allen wrench
- Torque wrench with 2.5 mm hex bit (for tightening torque 0.7 Nm).
- Welding gun.

Fig. 6.14 - pDOFs assembled on the pHRI

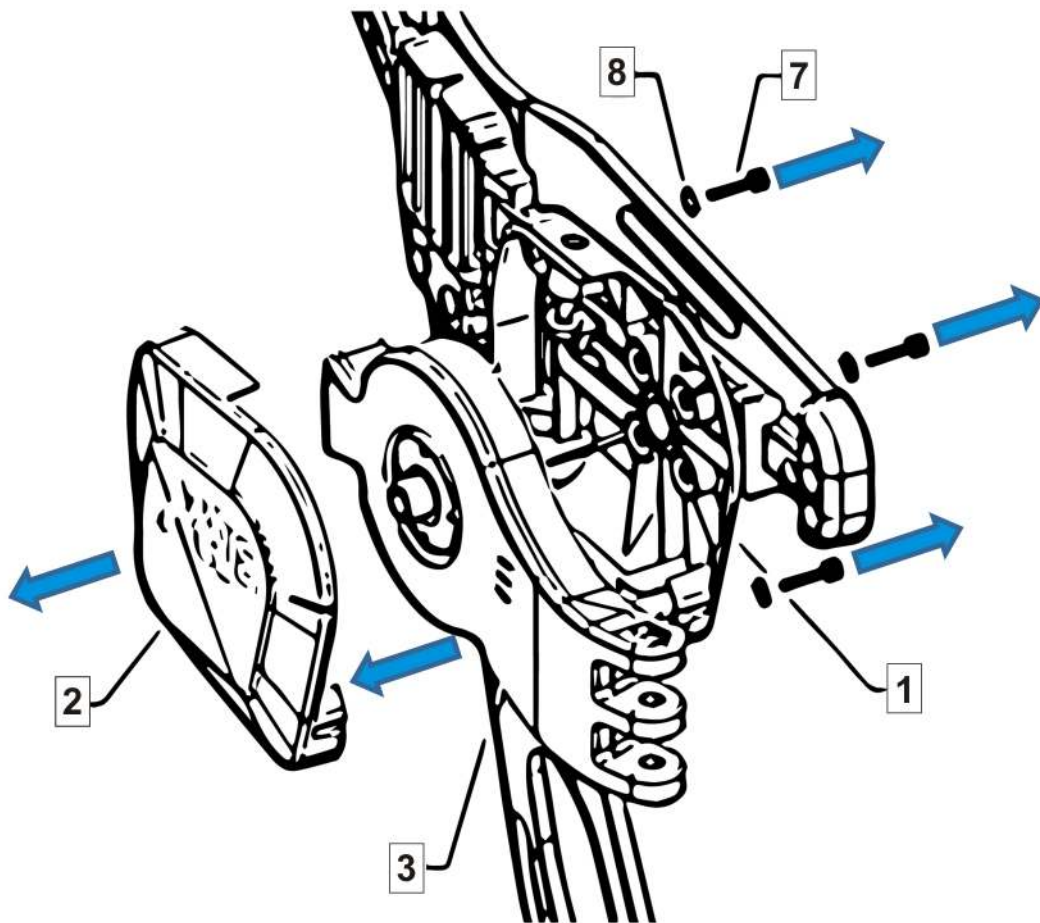


Position	Comau Part No.	Description	Quantity
1	CR82435001 / CR82435101	TGB DX / TGB SX	1
2	CR82435002 / CR82435102	pDOFs DX / pDOFs SX	1
3	CR82435003 / CR82435103	ARM RIGHT / ARM LEFT	1
4	CR82435302	Elastic strap interface	1
5	CR82435202	Elastic belt	1
6	CR82435200 / CR82435300	pHRI L / pHRI S	1
7	00301924	Socket hex head screw M3x12	3
8	00303577	Washer	11
9	00301908	Socket hex head screw M3x8	4

MAINTENANCE AND CLEANING OF THE DEVICE

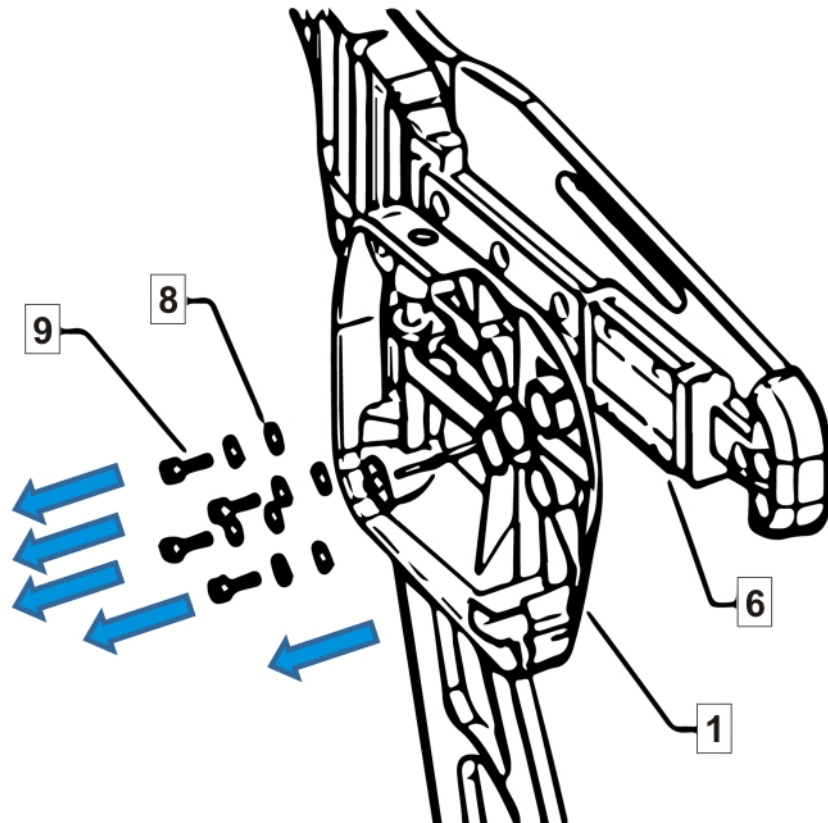
1. Remove the metal terminal of the elastic straps and relax the elastic item, the part "5" (Elastic belt), until removing it from the part "4" (Elastic strap interface).
2. Using an Allen wrench of 2.5 size, disassemble the No.3 screws M3 (part "7") and the No.3 washers (part "8") that hold the parts "1" (SHELL) and part "2" (COVER) together.
3. Remove the part "2" (COVER) and remove the part "3" (ARM) from the bushing of the particular "1".

Fig. 6.15 - Removal of the pDOF COVER and ARM parts



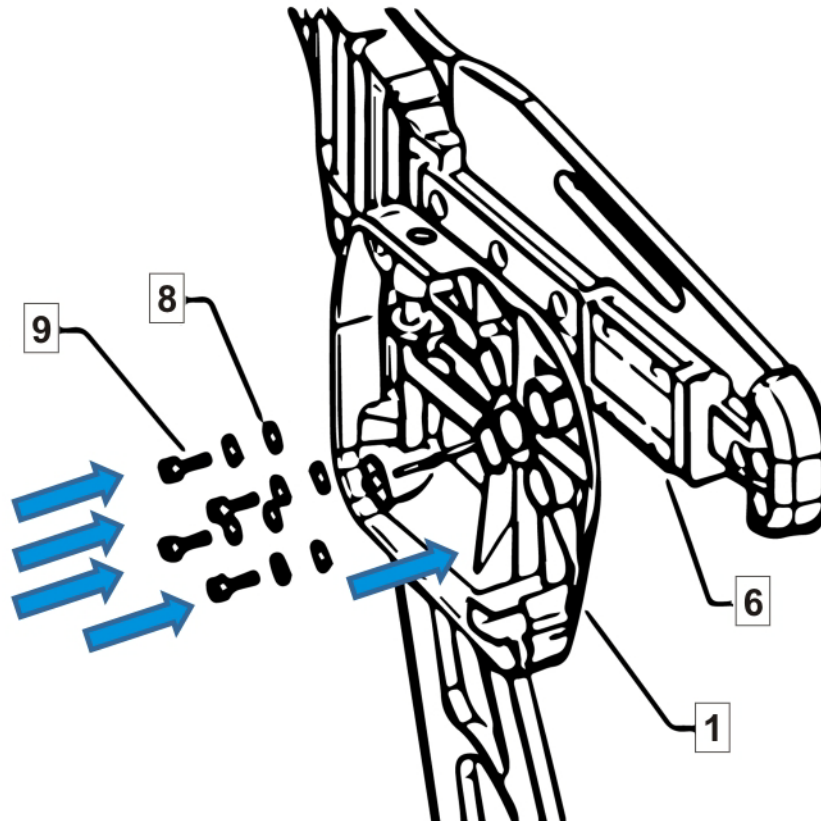
4. Unscrew the No.4 screws M3 (part "9") using a 2.5 mm Allen wrench and remove the No.8 washers (part "8").
5. Remove the part "1" (SHELL) from the part "6" (pHRI).

Fig. 6.16 - Removal of the SHELL part from the pHRI



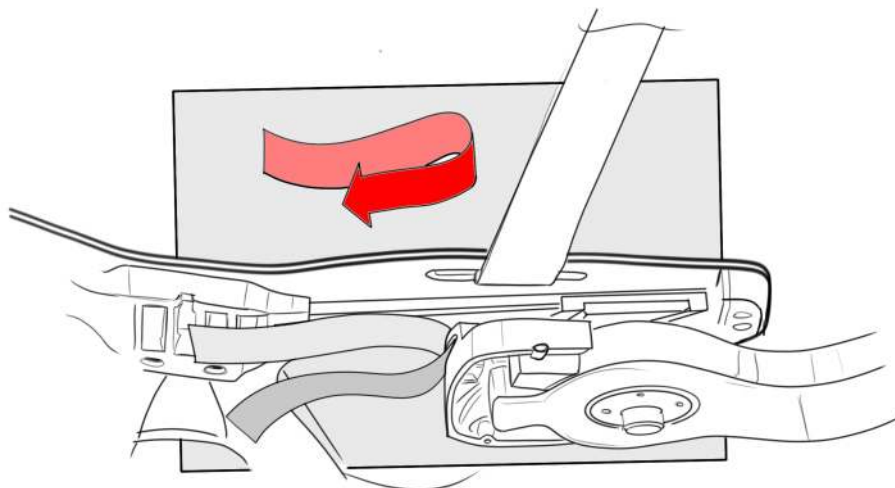
6. Position the new part "1" (SHELL) on the carriage of the linear guide of the part "6" (pHRi).
7. Using the torque wrench, tighten the No.4 screws M3 (part "9") after having inserted under each screw head the No.2 washers (part "8"). Tighten up to 0.7 Nm.

Fig. 6.17 - Positioning of the new SHELL part on the pHRi



8. Pass the elastic item, part "5" (Elastic belt), into the appropriate slots; let it enter the rear slot and let it come out from the lateral slot of the part "1" (SHELL). Pay attention that during the following assembly phases the elastic belt does not slip.

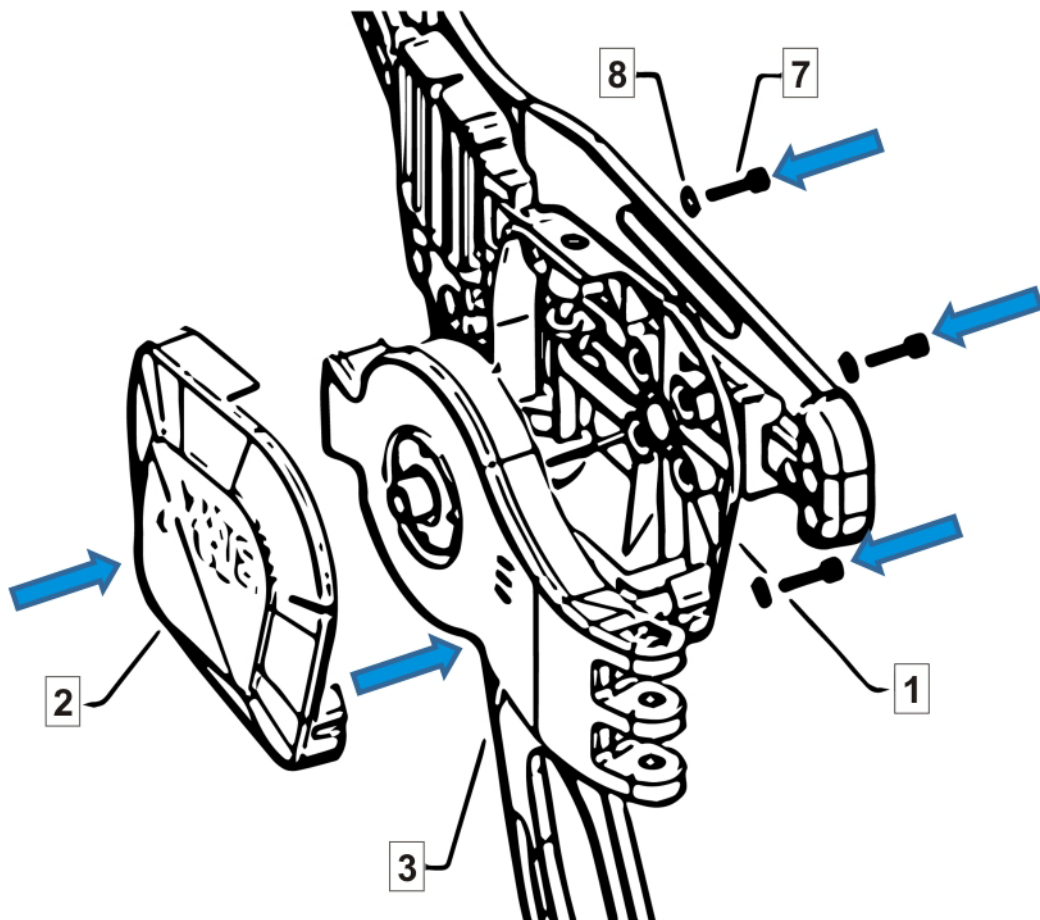
Fig. 6.18 - Passage of the elastic belt within the SHELL part



MAINTENANCE AND CLEANING OF THE DEVICE

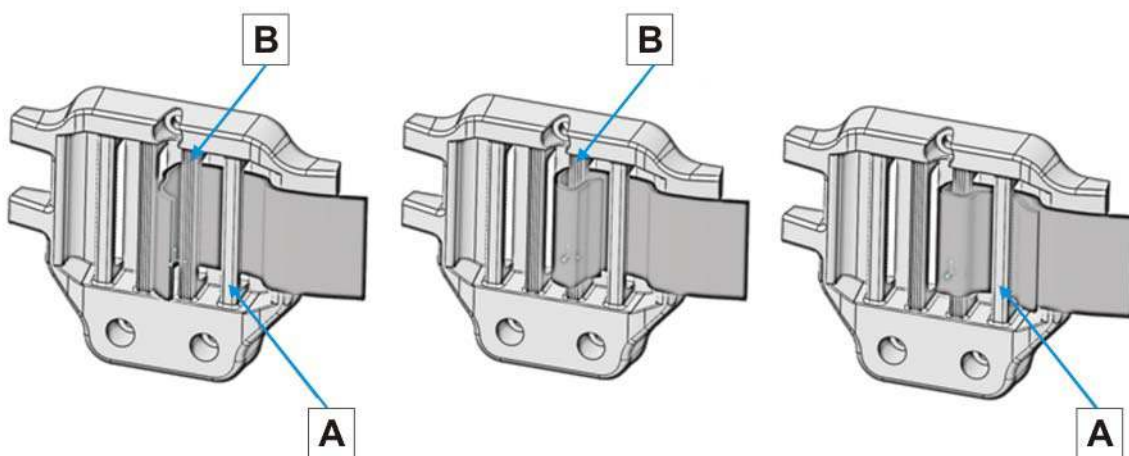
9. Assemble the new part "3" (ARM) and the new part "2" (COVER) on the part "1" (SHELL) making sure that the shaft of the part "2" is inserted in the bushings of the parts "1" and "2".
10. Using the torque wrench, tighten the No.3 screws M3 (part "7") after having inserted under each screw head the No.1 washers (part "8"). Tighten up to 0.7 Nm.

Fig. 6.19 - Assembly of the COVER and ARM parts on the SHELL part



11. Pass both parts of the elastic belt (part "5") under the two rods "A" and "B" until reaching the middle of the part "4".
12. Extract the elastic belt, part "5" from the middle groove of the part "4", let it go backwards passing both parts of the elastic belt over the rod B.
13. By loosening the elastic belt, pass the two ends of the elastic belt under the rod A.
14. Match the two ends of the elastic belt and fix them with a new metal terminal.

Fig. 6.20 - Procedure for inserting the elastic belt inside the Elastic strap interface part



15. Adjust the elastic strap as described in [par. 3.1.2.5 Adjustment of the rear elastic straps on page 26](#).

7. WARRANTY

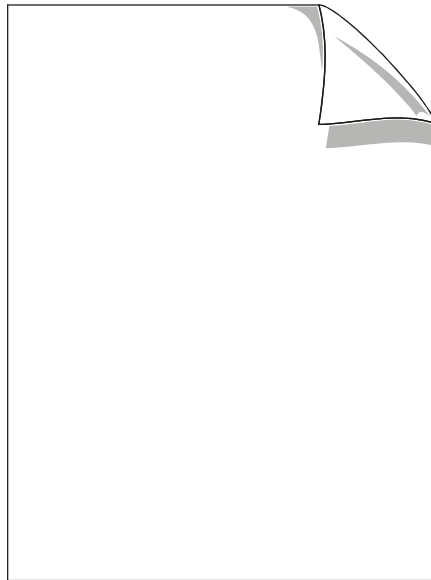
COMAU S.p.A. guarantees the quality of construction and materials of the MATE exoskeleton for a period of 12 months from the date of delivery. This standard warranty does not cover defects attributable to user errors, incorrect use, negligence or willful misconduct or from any other activity excluded from the allowed uses of the device or otherwise contrary to the instructions contained in the Instructions Handbook.

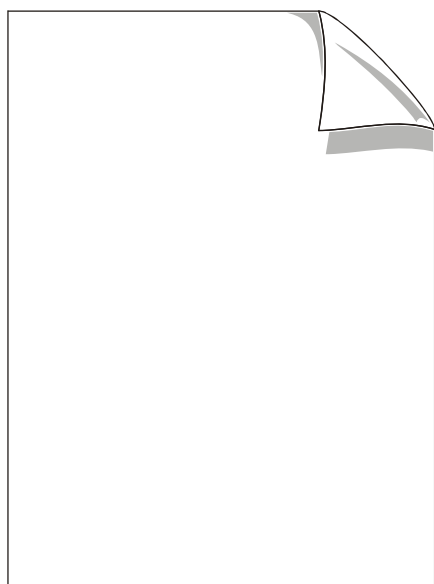
8. PARTS DISPOSAL



If partial or total disposal of the MATE is necessary, a separate collection of the parts to be disposed of (e.g. iron with iron and plastic with plastic) must be carried out. The disposal operations must be carried out in compliance with the law in force in the country where the MATE is used.

PARTS DISPOSAL







robotics.comau.com

Original instructions

Made in Comau