ARTROMOT® - K4

Service Manual

Starting from serial number 10000

Table of contents

1. History

Revision	Date	Name	Change
1	31.01.2008	S. Herr	Service Manual created

2. Purpose

This service manual is to perform some repairs on ARTROMOT®-K4 products. Repair and maintenance work may only be carried out by authorised persons, as otherwise all warranty services and liabilities shall be void. Only original parts may be used for servicing in accordance with the attached spare part list.

3. General

3.1 Electronics, connection cables

Electronic devices as hand-held programming unit, motor electronics, power supply electronics and spiral cable are **not interchangeable** with ARTROMOT®-K4 serial number < 10000.

NEW PROCEDURE to perform a reference run/ calibration. See chapter Special function Service menu.

No plugs may be connected or disconnected while the unit is switched on. Always switch the ARTROMOT®-K4 off before connecting or disconnecting a plug.

The locks for spiral cable for the hand-held programming unit have to be closed at all times.

When you assembling with electronic parts make sure to use ESD (Electro Static Discharge) equipment.

If you have to exchange any of the printed circuit boards including the knee electronics or motor control **you have to perform a calibration**.

Possible errors: Following error codes in number will be shown on the display:

ERROR XX

(XX = Number of the error)

1 Potentiometer error:
Wrong angle information provided from potentiometer

-> Check the femur settings
-> Replace knee electronics (Pos. 9.11)
-> Replace motor control (Pos. 1.35)

2 Failure at the potentiometer:
Connection to the potentiometer is interrupted

-> Replace the spiral cable of the potentiometer(Pos 9.12)
-> Replace knee electronics (Pos. 9.11)
-> Replace motor control (Pos. 1.35)

3 Motor driver error:
The motor driver IC reported an error
-> Replace motor control (Pos. 1.35)

4 Motor error:
The motor did not turn properly.

-> Replace motor control (Pos. 1.35)
-> Replace the motor (Pos. 3.1)

5 Motor over current:
The current for the motor exceeded the maximum limit
-> Check the mechanics
-> Replace motor control (Pos. 1.35)
-> Replace motor (Pos. 3.1)

6 Motor control error:
Internal error in the motor control.
-> Replace motor control (Pos. 1.35)

7 Eprom access error:
Memory error in the access of the EPROM.
-> Replace hand held programming unit (Pos. 1.31)

8 CPM ROM error:
Memory error in the motor control
-> Replace motor control (Pos. 1.35)

9 Communication:
Communication to the motor control is not possible
-> Check spiral cable and connector
-> Replace hand held programming unit (Pos. 1.31)
-> Replace motor control (Pos. 1.35)

10 Unkown error in the motor control:
Unknown error in the motor control
-> Replace motor control (Pos. 1.35)

11 Motor enable timeout
Motor could not be enabled in time.
-> Replace motor control (Pos. 1.35)

12 Invalid parameter motor error:
Motor has received a invalid parameter
-> Replace motor control (Pos. 1.35)
-> Replace hand held programming unit (Pos. 1.31)

13 Stop release error:
The motor could not be released
-> Replace motor control (Pos. 1.35)
-> Replace hand held programming unit (Pos. 1.31)

14 Unexpected motor Stop:
-> Check cables and connectors
-> Replace motor control (Pos. 1.35)

15 Motor disabled:
Motor control disabled the motor.
-> Replace motor control (Pos. 1.35)

16 Wrong command in the motor :
-> Replace motor control (Pos. 1.35)
-> Replace hand held programming unit (Pos. 1.31)

17 5V supply error:
5V supply of motor control not sufficient
-> Replace motor control (Pos. 1.35)

18 Initialise error real time clock:
-> Replace hand held programming unit (Pos. 1.31)

19 Communication error real time clock:
-> Replace hand held programming unit (Pos. 1.31)

20 Error real time clock:
-> Replace hand held programming unit (Pos. 1.31)

21 Range exceeded:
The measured angle is out of the range of motion.
-> Replace motor control (Pos. 1.35)

22 ROM error in the hand held programming unit:
Memory error in the hand held programming unit
-> Replace hand held programming unit (Pos. 1.31)

23 Invalid parameter:
Internal error in the hand held programming unit
-> Replace hand held programming unit (Pos. 1.31)

24 24V supply error motor control:
Error in the 24V supply in the motor control
-> Replace motor control (Pos. 1.35)
-> Replace the power supply electronics (Pos. 1.41)

25 Bus error:
Bus system error
-> Replace spiral cable of the hand held programming unit
-> Replace hand held programming unit (Pos. 1.31)
-> Replace motor control (Pos. 1.35)

26 24V supply hand held programming unit:
24V supply of the hand held programming unit is defective
-> Replace hand held programming unit (Pos. 1.31)

27 5V supply hand held programming unit:
5V supply of the hand held programming unit is defective.
-> Replace hand held programming unit (Pos. 1.31)

28 3.3V supply hand held programming unit:
3.3V supply of the hand held programming unit is defective
-> Replace hand held programming unit (Pos. 1.31)

29 Calibration:
The calibration data in the motor control are wrong.
-> Perform a calibration

30 Calibration error:
-> Repeat the calibration
-> Replace knee electronics (Pos. 9.11)
-> Replace motor control (Pos. 1.35)

31 Calibration timeout:
-> Replace motor control (Pos. 1.35)

32 Motor enable error:
The motor could not be enabled
-> Replace motor control (Pos. 1.35)

33 Motor disable error:
The motor could not be disabled
-> Replace motor control (Pos. 1.35)

34 Motor stop error:
Motor stop command timeout error:
-> Replace motor control (Pos. 1.35)

35 Configuration error:
Invalid configuration of the hand held programming unit
-> Replace hand held programming unit (Pos. 1.31)

45 Wrong product combination:
Mixup between non compatible device and hand held programming unit
-> Use the correct hand held programming unit (Pos. 1.31)

46 Handset error internal communication:
Invalid interchip communication inside the hand held programming unit
-> Replace hand held programming unit (Pos. 1.31)

47 Internal communication error motor control:
Internal communication error motor control..
-> Replace motor control (Pos. 1.35)

48 User stoped the special function

49 Unknown error in the motor control:

-> Replace motor control (Pos. 1.35)

3.2 Mechanics

The threaded spindle and spindle nut is **not interchangeable with ARTROMOT®-K4 serial number < 3000**.

Do not loosen the knurled handles completely for any adjustment. For operation or transport, make sure that the knurled handles are tight.

The frame is unstable:
Possible cause: Bolt / screws missing or loose. Tighten the screws / bolts.

3.3 Others

Do not clean the casing or the support with grease or oil.

Do not utilize any solvent for cleaning the ARTROMOT®-K4.

4. Packing and unpacking

The following settings must be made to transport the ARTROMOT®-K4:

Set the packing setting in the menu or move the device in a position of EXTENSION = 10 degrees.

Switch off the device.

Remove power cord and disconnect the hand-held programming unit.

Remove the the femur extension assembly.

For transportation, use the original packaging.

Put the hand-held programming unit and the femur extension assembly into a extra box.

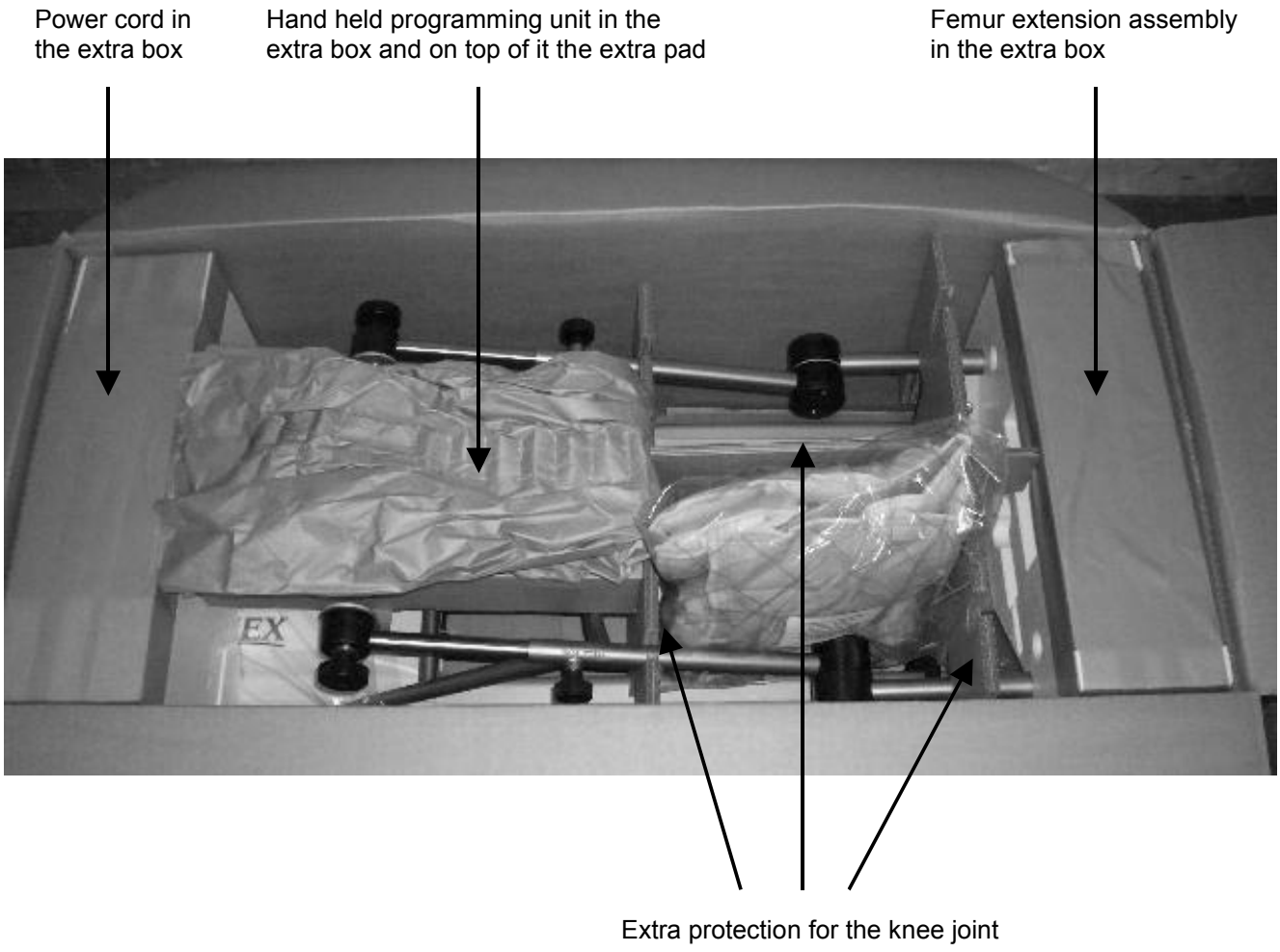
Set the angle joint horizontal.

Put three extra protection for the knee joint on the device as shown on the figure below.

Move the two styrofoam parts on the device.

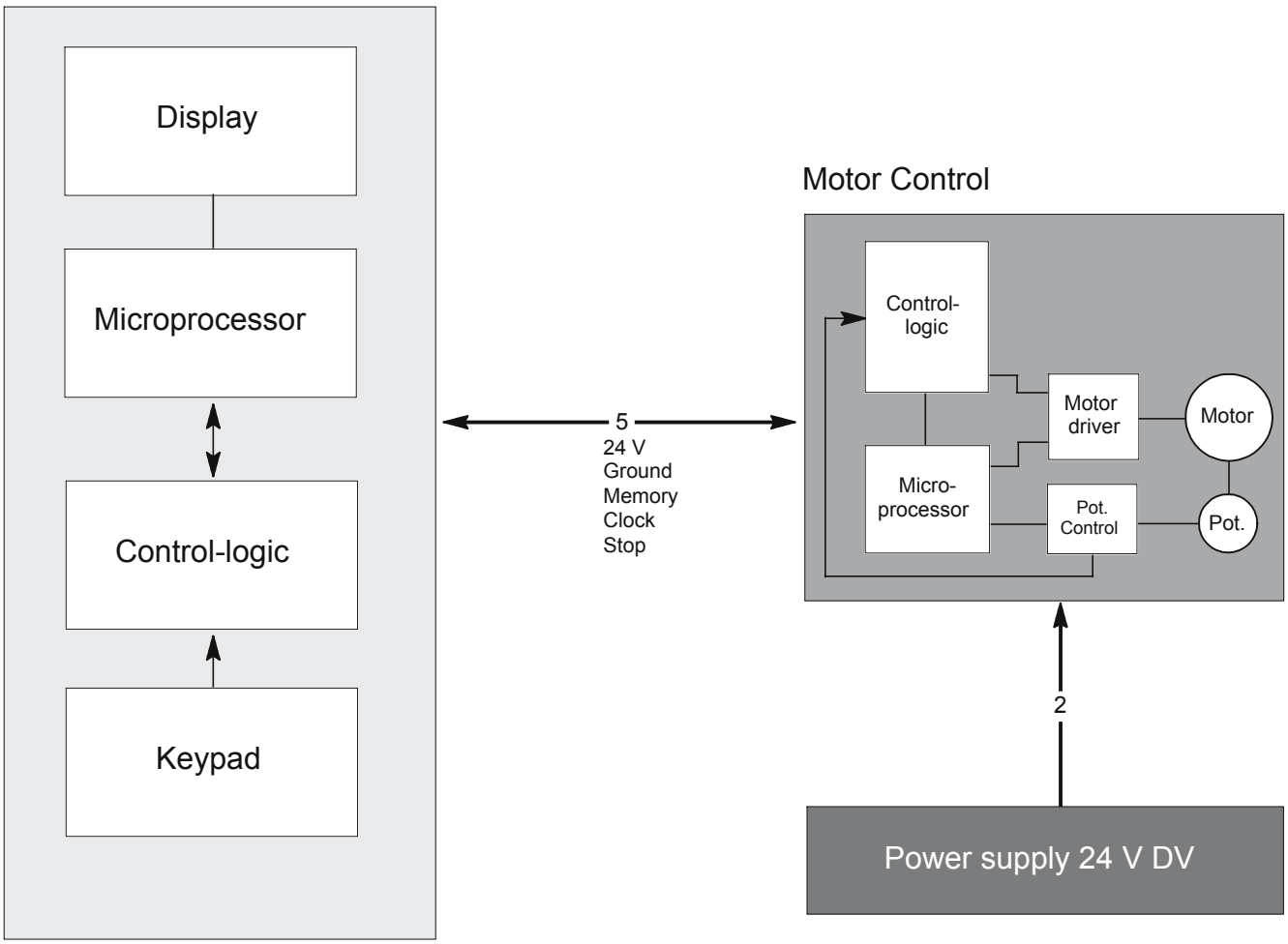
Put the device with the styrofoam parts in the carton.

First put the power cord in the extra box, the femur extension assembly in the extra box, the hand held programming unit in the extra box and the extra pad in the packing as shown in figure below.



5. Block diagramm of the electronic parts

Hand-held programming unit



6. Bill of material for service parts

Position	Description	Ordernumber
	Electronics	
1.30	Power cord EU version	0.0034.118
	Power cord USA version	0.0034.011
1.31	Hand held programming unit K4 with spiral cable SN > 10000	0.0031.400
1.32	Spiral cable for hand held programming unit	2.0037.035
1.33	Rubber mat	2.0031.235
1.34	Base plate complete	2.0031.005
1.35	Motor control K4 SN > 10000	2.0031.921
1.36	Distance piece	0.0031.017
1.39	Cable retainer	0.0031.003
1.40	Wire set	2.0031.036
1.41	Power supply electronics	0.0034.244
1.42	Wire set K3 K4	2.0032.139
1.43	Wire set hand held programming unit	2.0037.004
1.44	Nomex insolation paper	2.0031.239
1.45	Pan head screw	DIN912M3x6
1.46	Wire set power connector	2.0038.017
1.47	Cable retainer	0.0013.118
1.48	Self –adhesive tie mounts	0.0013.001
1.49	Grounding connector	2.0034.358
1.50	Hex-nut	DIN934M4vz
1.51	Serrated washer	DIN6798AD4,3vz
1.53	Fuses holder	0.0034.246
1.54	Fuse 1 AT	0.0000.005
1.55	Grounding connector	0.0034.126
1.56	Grounding symbol	0.0038.058
1.57	Puffer	2.0031.238
1.58	Washer	DIN125D4,3vz
1.59	Hexagon head screw	DIN933M4x40vz
1.60	Head screw	LIKOM4x8A2
1.61	Washer	DIN125D4,3vz
1.62	Power switch (ON/OFF) with connection	0.0034.245
1.63	Holding clip	0.0031.004
1.64	Protection for hand held programming unit	0.0037.103

Position	Description	Ordernumber
	Exterior underframe	
2.40	Right profile	2.0031.244
2.41	Left profile	2.0031.243
2.42	Rubber mat femur	2.0031.234
2.43	Lip	2.0031.193
2.44	Interior slit 750 mm	2.0031.155
2.45	Interior slit 125 mm	2.0031.242
2.47	Shaft bearing	2.0031.112
2.48	DU collar	0.0031.110
2.49	Interior slit 480 mm	2.0031.197
2.50	Interior slit 190 mm	2.0032.156
2.51	Exterior slit 870 mm	2.0031.168
2.52	Connecting plate	2.0031.233
2.55	Thread plate M6	962.901
2.56	Pan head screw	DIN912M6x8A2
2.57	Pan head screw	2.0031.166
2.58	Blind rivet	DIN7337D4ALST1
2.59	Sping wire	0.0031.300
2.64	Inplementation spout	0.0031.145
2.65	Left cover	2.0031.110
2.66	Right cover	2.0031.111
2.67	Threaded plate	962.903
2.68	Split pin	DIN1481D3x12
	Drive technology	
3.1	Motor including transmission	0.0031.100
3.2	Left slide	2.0031.109
3.3	Right slide	2.0031.108
3.4	Threaded spindle	2.0031.212
3.5	Rubber ring	2.0031.176
3.7	Rubber plate	2.0028.170
3.8	Motor plate	2.0031.156
3.9	Spline shaft drive	2.0031.181
3.10	Toothed belt	0.0031.130
3.11	Toothed lock washer drive	2.0031.180
3.13	Bearing plate left	2.0031.165
3.14	Rubber plate	2.0031.102
3.15	Sheet metal	2.0031.115
3.17	Ball bearing	910.008
3.18	Rubber ring	2.0031.105
3.19	Rubber disk	2.0031.104

Position	Description	Ordernumber
3.20	Joint plate	2.0031.113
3.22	Covering plate	0.0028.105
3.23	Ring	0.0028.106
3.24	Split rivet	0.0031.136
3.26	Retaining ring	DIN471A8x0,8
3.27	Rubber buffer	0.0031.109
3.28	Spacer sleeve	0.0031.104
3.29	Pin	2.0031.188
3.30	Countersunk screw	DIN7991M5x20vz
3.31	Screw thread pin	DIN916M4x4sw
3.32	Screw thread pin	DIN914M4x4sw
3.33	Countersunk screw	DIN7991M4x10vz
3.34	Hexagonal nut	DIN934M5vz
3.35	Pan head crew	DIN912M5x6vz
3.36	Countersunk screw	DIN7991M5x25A2
3.37	Countersunk screw	DIN7991M5x55vz
3.38	Countersunk screw	DIN7991M5x16vz
3.39	Bearing plate right	2.0031.103
3.50	Countersunk screw	DIN7991M4x16vz
3.51	Pan head screw	DIN912M4x12vz
3.53	Spindle nut	2.0032.141
3.54	Sticker ARTROMOT K4 right	2.0031.241
3.55	Sticker ARTROMOT K4 left	2.0031.240
3.60	Housing K4 complete with stickers SN > 10000	0.0031.232
	Femur extension	
	Femur extension assembly (7.1 –7.8)	2.0031.051
7.1	Leaf Spring	2.0031.143
7.2	Stud bolt	2.0031.142
7.3	Square tube	2.0031.025
7.4	Push-button	2.0031.141
7.5	Dwell bolt	GN617-5-A-NI
7.6	Countersunk screw	DIN7991M4x8A2
7.7	Hexagonal nut	DIN985M4vz
7.8	Nut	0.0031.106
	Ankle joint	
8.5	Washer	0.0031.111
8.10	Fastening band	0.0031.144
8.11	Rigid pipe	2.0031.117
8.12	Knurled handle	2.0031.031
8.13	Washer	DIN440D6,6vz
8.14	Hinge box	2.0031.119

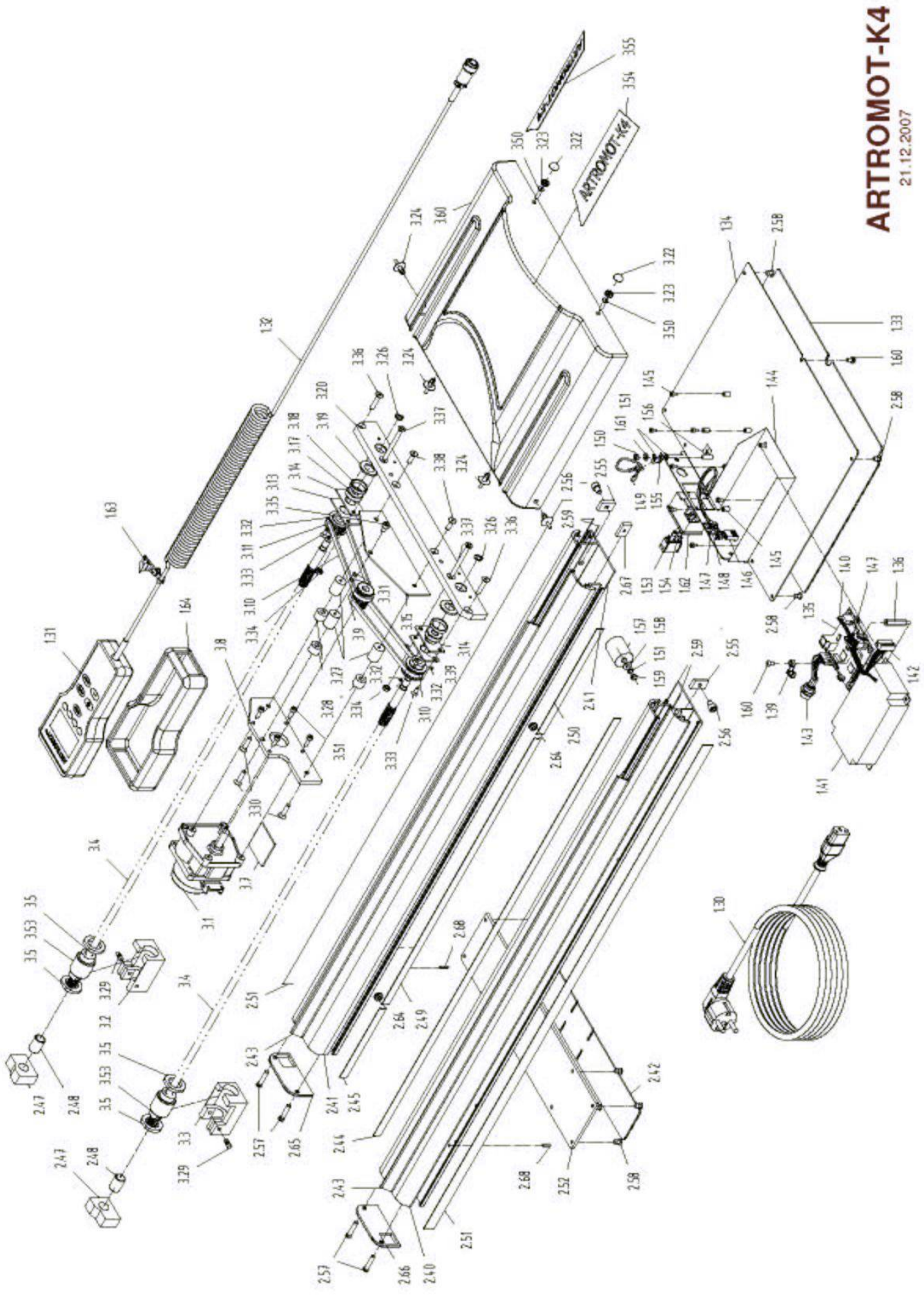
Position	Description	Ordernumber
8.15	Washer	2.0031.118
8.18	Nut	0.0031.108
8.19	Nut	0.0031.105
8.20	Supporting disk	2.0031.213
8.21	Akle joint bow	2.0037.163
8.22	Base plate	2.0037.168
8.23	Countersunk screw	DIN79991M5x12A2
8.24	Ankle joint nut	2.0037.165
8.25	Distance disk	0.0037.027
8.26	Wing screw	GN531-32-M6-10sw
8.28	Pin	DIN6325D4x12
8.29	Holder hand held programming unit	2.0037.166
8.30	Rivet top part	0.0028.300
8.31	Rivet buttom part	0.0028.301
	Knee case	
9.1	Cover knee case	2.0031.245
9.2	Retaining ring	DIN471A10x1
9.3	Bearing shell	2.0031.146
9.4	Knee case	2.0031.231
9.5	Disk	2.0031.248
9.6	Shim	DIN988D10x16x0,1
9.7	Catch	2.0031.150
9.8	Shaft	2.0031.147
9.9	Knee case potentiometer	2.0031.247
9.10	Cover knee case potentiometer	2.0031.246
9.11	Knee electronics	2.0031.033
9.12	Spiral cable for knee electronics	0.0031.122
9.13	Thread grooving screw	0.0031.013
9.14	Cylinder pin	DIN6325D5x40
9.15	Threaded pin	DIN913M6x6A2
9.16	Shim	DIN988D10x16x0,1
9.17	Plastic bolt	DIN964M3x12PA
	Femur bow	
10.1	Frame (shank)	2.0031.027
10.2	Knurled handle	GN534-32-M6-10
10.3	Frame (thigh)	2.0031.028
10.4	Tube end plug	2.0031.023
10.5	Retaining ring	DIN472I20x1
10.6	CB-Disc spring	0.0028.109
10.7	Compression spring	2.0031.179

Position	Description	Ordernumber
10.8	Bolt	2.0031.127
10.9	Knurled handle	2.0031.135
10.10	Joint bolt	2.0031.237
10.11	Femur tube	2.0031.236
10.12	Split pin	DIN1481D3x16
10.13	Disc	0.0037.027
10.14	Tube	2.0031.139
10.15	Washer	DIN9021D6,4vz
10.16	Flat head screw	0.0031.025
10.17	Flat head screw	DIN921M3x5A2
10.18	Screw thread in	DIN914M5x6A2
10.19	Edge-protection profile	2.0031.202
10.20	Sticker (lock insert)	0.0031.153
10.21	Sticker (insert)	0.0031.152
10.23	Sticker (PRECAUTION)	0.0031.146
10.24	Round nut	0.0031.026

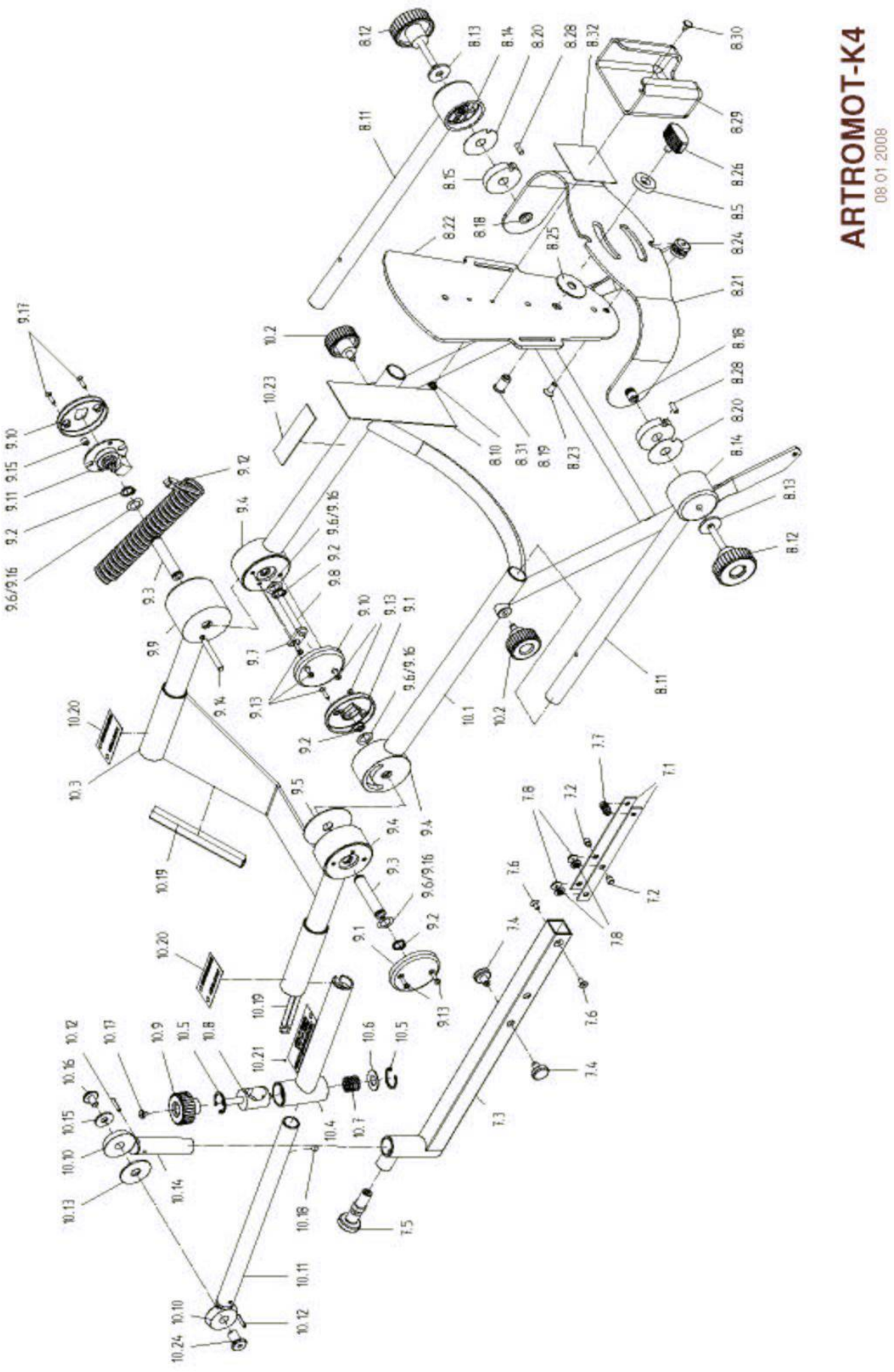
Patient kits

No illustration	Patient kit fleece	2.0032.155
No illustration	Patient kit cool-quilt	2.0032.155B

7. Explosion drawing part 1



8. Explosion drawing part 2



9. Special function Service Menu

Function of service Menu

Calibration

Display contrast

Error log

Device runtime

Entering the service menu:

Press the menu key until Service Menu shows up (menu 3).

Press for 5 seconds,

is flashing on the display.

The display will change and show:
Entering code.

For the code press: 1 3 2 4

Now you see the symbols of the service menu

9.1 Calibration

ATTENTION!

Before you do a calibration switch the device OFF and ON.

Adjust a maximum femur length, a minimum lower leg length, hip axis in smallest position and the middle position of the foot rotation.

Press the symbol calibration

Display:

Press + or - to move the ARTROMOT®-K4 to 0 degrees.

Press START, the calibration starts automatically. The device will reach both maximum points and move between –10 bis 125 degrees with different speed.

Wait until the ARTROMOT®-K4 stops.
If the calibration was succesful the device stops at 0 degrees and show following symbols on the display:

Display:

Press STOP twice to leave the service menu.
Finally, a safety and function test has to be performed (see chapter 11).

9.2 Display contrast

Press the symbol display contrast

Display: XX %

Press + or - to set up the requested display contrast.
You can set the display contrast from 0 – 100%.

Press STOP twice to save the settings and leave the service menu.

9.3 Error log Err

Press the symbol error log Err

You will find following information on the display:

Upper line: Number of the current showed error message and the total number of the saved error messages.
Right number is the error code of the error message (see chapter 3.1)

Lower line: Error message
Left side: The symbol of the causer.

 = Hand held programming unit  = Motor

Press + or - to see the entries of the error log.

Press STOP twice to leave the service menu.

General note to the error log:

Entries are always in english.

The entries are ordered by causer and not in temporal order.

9.4 Device runtime

Press the symbol device runtime . 

The display shows the device runtime

Display:  **XX** (XX = Runtime in hours).

Press STOP twice to leave the service menu.

10. How to perform repairs

10.1 How to remove the housing cover (Pos. 3.60).

Move the ARTROMOT®-K4 in a position of approximately 110 degrees.
Turn the power OFF at the ARTROMOT®-K4 and remove the power cord.
Hit the 4 pins of the split rivet (Pos. 3.24) inwards.
Remove the 2 covering plates (Pos. 3.22)
Loosen the 2 countersunk screws (Pos. 3.50) and remove the casing.
Remove the 4 pins of the split rivet, which are inside the casing.
If you have exchanged any of the printed circuit boards including the knee electronics and the hand held programming unit or any parts of the drive technology, **you have to perform a calibration**. See chapter 9.1.
Finally, a safety and function test has to be performed.

10.2 How to exchange the motor control (Pos. 1.35).

ATTENTION!
When you assembling with electronic parts make sure to use ESD (Electro Static Discharge) equipment.

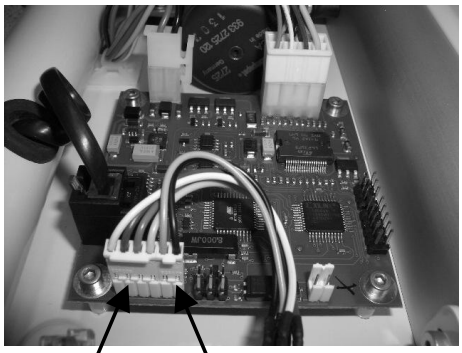
Remove the housing cover, see chapter 10.1.

Pull out the connectors of the motor control.

Loosen the four screws.

Exchange the defective motor control and fix it with the screws.

Put back in the connectors in the same position.



3-pin connector 2-pin connector

Rebuild the housing cover.

A calibration has to be performed.

Finally, a safety and function test has to be performed.

10.3 How to exchange the power supply electronics (Pos. 1.41).

ATTENTION!
When you assembling with electronic parts make sure to use ESD (Electro Static Discharge) equipment.

Remove the housing cover, see chapter 10.1.

Pull out the connectors of the power supply electronics.

Loosen the four screws.

Exchange the defective electronics and fix it with the screws.

Put back in the connectors in the same position.

Rebuild the housing cover.

A calibration has to be performed.

Finally, a safety and function test has to be performed.

10.4 Repairs of the drive unit.

ATTENTION!
Only authorized and certified staff may perform repairs and maintenance at the drive unit otherwise the manufacturer´s warranty and liability will be invalidated.

11. Checklist of safety and function test ARTROMOT®- K4

Safety test		Measured value	Date/ Signature
Protective earth conductor resistance	0,1 Ohm	Ohm	
Ground leakkage current EN 60601 / IEC 601/ VDE 0751	500 µA	µA	
Or			
Ground leakkage current as in UL 2601	300 µA	µA	

Function test	OK	Error
1. Switch on the ARTROMOT® K4. Press the two outer buttons simultaneously. Display: Software version VX.X XX.XX.XX (X = optional) Keep on pressing. Display: ARTROMOT K4 "Product version"		
2. The maximum range of motion for Extension/ Flexion is -10 to 125 degrees. Check the angle in position 0 degrees. Tolerance +/- 5 degrees. Check the angle in position 60 degrees. Tolerance +/- 5 degrees. Check the angle in position 100 degrees. Tolerance +/- 5 degrees.		
3. Check the emergency-off function. Start the ARTROMOT® K4 in any mode. Press any key, the ARTROMOT® K4 will stop immediately. Check this for all keys.		
4. Set up the special function "new patient" →0← press to activate it. Press **START**. The ARTROMOT® -K4 will move automatically to 30 degrees and stop there.		
5. Check the set values of "new patient" →0← Extension -> Display: 25° Flexion -> Display: 35° Speed -> Display: 100 % Reverse -> Display: 25 Therapy Duration -> Display: 00:00		
6. Start the ARTROMOT® -K4 in the motion range between –10 to 120 degrees. Set the speed to 100%. Both extreme points should be reached within 70 – 100 seconds.		
7. All special funtion are deactivated. Select a therapy time of 3 minutes. At the end of the 3 minutes the ARTROMOT®-K4 will stop automatically in the set up value of extension + 10 degrees.		

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IDEAS IN MOTION