Q10 2020
10.5 YEAR OLD CHILD
012-0000

012-9900 Q10 2020

USER MANUAL [Rev. 1]

HUMANETICS
23300 HAGGERTY ROAD
FARMINGTON HILLS, MICHIGAN 48335 USA

Our Vision

Global leadership in occupant safety test & measurement
for the development of safer vehicles, ultimately saving lives.

Our Mission

To achieve our vision and increase enterprise value,
our customer focused organization will:

» Attract and develop exceptional people
» Reduce performance variability of our products, systems, and services
» Continuously improve and innovate our products and services
» Invent the next generation of test & measurement products by facilitating the cooperation of industry, regulators, government, and academic institutions
» Exceed our customer’s expectations of reliability, support, dependability and innovation
» Achieve supply chain and manufacturing excellence

Company & Support

Humanetics is the world's leading supplier in the design and manufacture of sophisticated crash test dummies, associated technical support and laboratory services, development and supply of finite element software dummy models for computerized crash test simulations and specialties in static and dynamic strain measurements.

Humanetics is the only full service provider worldwide offering on and off-site customer laboratory management service, training and consultancy. In addition, Humanetics' local offices and agents are capable of providing full technical support on both the physical and virtual product lines. Humanetics also has an Engineer to Order capability, catering to specific customer needs. Humanetics also designs and manufactures all applicable load cells in the crash safety area, ranging from single axis low-weight seat belt to multi-axis heavy duty crash wall load cells.

Calibration Laboratories

Crash Wall Load Cells

Dummy Load Cells

Engineer to Order Products

Localized Technical Support

Users Training

Spare Parts Management

Safety Symbols & Description

The safety instructions in this manual are structured and defined as follows:

DANGER
TYPE AND SOURCE OF DANGER
Refers to an immediately dangerous situation, which may lead to death or serious injury.

WARNING
TYPE AND SOURCE OF DANGER
Refers to an immediately dangerous situation, which may lead to death or serious injury.

CAUTION
TYPE AND SOURCE OF DANGER
Refers to an immediately dangerous situation, which may lead to minor injuries or material damage if not prevented.

NOTICE
Indicates useful tips, recommendations and information for an improved or more efficient and trouble-free operation.

General Safety Instructions

Non compliance with these general safety instructions can endanger the safety of humans (including death or serious injury), the environment and the equipment. This can lead to loss of any claims to compensation for damages.

DANGER
FATAL INJURY BY ELECTRIC SHOCK
There is a risk of electric shock when connecting the device to the power supply. Finding and removing faults on electrical components, cables, and connections may lead to accidents, including electrocution. All work on electrical connections must only be carried out by a qualified electrician in accordance with technical electrical regulations.

DANGER
SUBSTANCE RISKS
The operator must ensure that personnel are protected from material/substance hazards caused by the test set-up and procedure.

DANGER
RISK OF INJURY
There is a risk of injury due to the toppling and slipping of the device. Install the device on a industrial concrete floor with a minimum thickness of 15 cm. Position the device in the location specified and secure with suitable fastening bolts.

DANGER
RISK OF FATAL INJURY
The operator must ensure that the test device is completely visible from the operator's desk.

DANGER
RISK OF INJURIES CAUSED BY NOISE, FIRE, AND FLYING DEBRIS
The operator must ensure that personnel are protected against risks caused by the test set-up/procedure, for example, noise and fire risks or risks of injury as a result of flying debris.

Safety Symbols & Description

Additional safety symbols and descriptions:

WARNING
EXPLOSION
Refers to the risks and dangers of explosion.

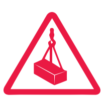
WARNING
HAND INJURIES
Refers to the risks and dangers of hand injuries.

WARNING
HOT SURFACES
Refers to the risks and dangers of injury from hot surfaces.

WARNING
HIGH VOLTAGE
Refers to the risks and dangers of electric shock, possibly with fatal consequences.

WARNING
CORROSIVE
Refers to the risks and dangers of corrosion.

WARNING
ENTRAPMENT
Refers to the risks and dangers of entrapment.



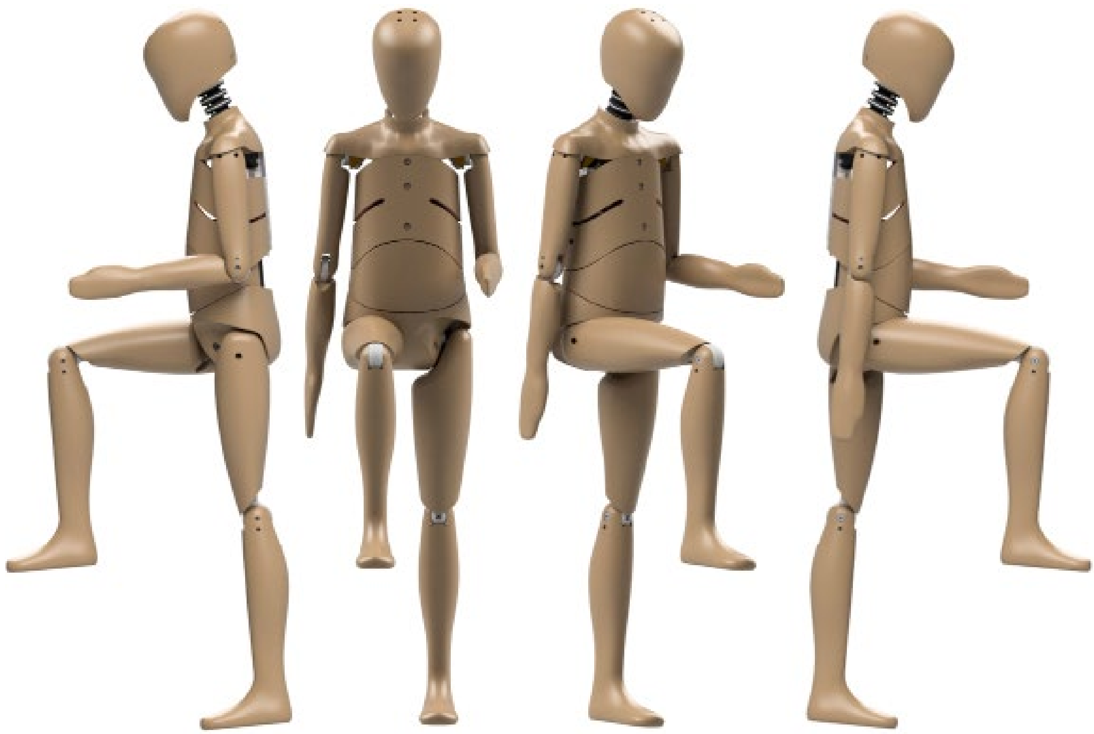
WARNING
OVERHEAD CRANE
Refers to the risks and dangers of lifted loads that can fall down or injure people.

WARNING
WEAR EYE PROTECTION
Refers to a potentially dangerous situation, which may lead to death or serious injury if not prevented.

WARNING
WEAR HAND PROTECTION
Refers to a potentially dangerous situation, which may lead to death or serious injury if not prevented.

WARNING
READ INSTRUCTION MANUAL
Refers to a potentially dangerous situation, which may lead to death or serious injury if not prevented.

WARNING
WEAR FOOT PROTECTION
Refers to a potentially dangerous situation, which may lead to death or serious injury if not prevented.



LEFT VIEW FRONT VIEW ISO VIEW RIGHT VIEW

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SECTION 1

Introduction

1.1 Q10 2020 Introduction

In the late 1970's and early 1980's, TNO and others developed the P-dummies, a series of child dummies that cover almost the complete child population up to 10 years. The P-series dummies up to 2013 are still test tools for the European regulation ECE-R44 and are also adopted by many other standards.

In 1993 the international Child Dummy Working Group started the development of a new series of child dummies as a successor to the P-series. This new series was called the Q-series.

The Q series dummies are available in the following age groups: Newborn, 1 year, 1 ½ year, 3 year, 6 year and 10 year old child. The Q3s is a side impact only adaptation of the Q3 dummy designed to complement the Part 572 Subpart P Hybrid III 3 year old child dummy. A Q6s dummy is also available.

Humanetics controls the configuration of the Q-dummies in close contact with dummy user groups and regulatory bodies like EuroNCAP and UNECE-GRSP. Since spring 2004 the design of the Q-dummies was frozen and no changes, that affect the dummy performance or interchangeability of parts, were implemented.

In 2009-2011 the last member of the Q-dummy family was developed and evaluated in a European FP7 Project called EPOCh. In 2011-2012 third parties evaluated the Q10 prototype dummy (SBL-A). These evaluations resulted in recommendation for design updates that were implemented in SBL-B.

In the European Enhanced Vehicle-Safety Committee Q10 dummy report – Advanced Child Dummies and Injury Criteria for frontal dummies 2015 it is recommended "Based on the extensive evaluation and validation results described in this report, EEVC recommends that the Q10 dummy is used in child restraint homologation tests (UN R129)." For the other recommendations and further details please refer to the full report. [vii]

In 2015 Euro NCAP requested a design update to address issues that came to light in full scale car testing. The main issue to address was to improve shoulder belt stability. Humanetics designed solutions and build a prototype that was evaluated in 2017. After the internal and third party evaluation of the 2017 prototype, a limited set of design updates were selected by Euro NCAP. In September 2018 the hardware update proposed was adopted for the Euro NCAP 2020 protocol called the Q10 2020 configuration. To comply with Euro NCAP approval process, the Humanetics 2020 kit was subjected to a large suit of (comparative) tests that were conducted with the help of Euro NCAP labs ADAC, BASt and TASS and various vehicle manufacturers and Tier-1 suppliers. Comparative data was submitted to Euro NCAP at component level on geometry, mass and dynamic response and further at full dummy level in certification, sled and full scale vehicle type testing. Generally the reported differences with the competitor hardware were minor and within tolerance; dynamic and kinematic performance were found very similar and within expected dummy variation. For injury prediction both kits gave very similar results. For details of the evaluation results refer to conference presentations [i] and [ii].

In April 2020 the Humanetics Q10 2020 hardware was accredited by Euro NCAP. This manual describes the Q10 2020 dummy (drawing 012-0000).

The so called standard Q10 production version dummy is still in use in UN-ECE Regulation 129. The standard dummy is described in the 010-9900 User Manual Q10. In that manual the history of Q10 hardware updates are listed.

In chapter 14.21 of this manual it is described how to modify the standard Q10 into the Q10 2020 by replacing 23 parts in the Q10 2020 Update kit (010-4450)

1.1.1 DEVELOPMENT HISTORY

Q10 design started in 2009 and was developed with co-funding from the EU commission within the Seventh Framework program under the project name EPOCh (Enable Protection for Older Children). The Q10 has the anthropometry of a 10.5 year old 50th percentile child as defined in CANDAT (Child ANthropometry DATabase). After EPOCH improvements were made taking comments from users into consideration, this raised the standard build level to SBL-B. In 2013 a lateral shoulder kit was developed which raised the service build level (SBL) to C. In 2018 the Q10 2020 (012-0000) configuration for Euro NCAP 2020 protocol testing was defined alongside the standard Q10 dummy used for CRS testing according to UNECE Regulation 129.

1.1.2 APPLICATION

The Q10 dummy is suitable for frontal as well as side impact CRS evaluations, to be used for both homologation, consumer rating and research purposes. Possible applications include:

- **Child Restraint Systems (CRS) testing. This includes the European UNECE R129 and the US FMVSS 213 regulations. The Q-dummies have been designed to succeed the P-dummies in CRS evaluation regulations.**
- **EuroNCAP tests. The dummy has been designed to withstand impacts up to 64 km/h partial overlap and 56 km/h full width frontal tests under the EuroNCAP protocol on the rear seat in modern cars.**

1.1.3 STANDARD DUMMY DELIVERY

The standard Q-dummy is delivered with the following items (if not ordered otherwise):

- **Clothing (a yellow suit);**
- **Hip shields (red colored)**
- **Structural replacements in the location of the load cells;**
- **Mounting blocks for use with uni-axial accelerometers and angular velocity sensors to customer requirements.**
- **Two 2D-IRTRACCs mounted in the chest**
- **H-shaped bracket for mounting the 2D-IRTRACCs in side impact configuration**
- **Provisions for IES tilt sensors in head, thorax and pelvis**
- **Dummy tool, hip adjuster**
- **Manual**

1.2 Getting Familiar with the User Manual

This manual is designed to serve as a reference book for technical people working with the Q10 2020 Crash Test Dummy. Each assembly of the Q10 2020 dummy has been described in great detail to assist the technical personnel in the proper set-up and adjustment of the dummy for testing. The user manual has been divided into sections as outlined below:

- **Introduction**
- **Dummy Preparation and Use**
- **Top Level Dummy Assembly**
- **Head Assembly**
- **Neck Assembly**

- Thorax Assembly
- Arm Assembly
- Lumbar Assembly
- Pelvis Assembly
- Leg Assembly
- Dummy Suit and Hip Shield
- Instrumentation
- Pretest Checks
- Certification Equipment
- Certification Procedures
- Mass Measurement
- External Measurement
- Dummy Setup and Positioning Procedure
- IR-TRACC Processing
- Q10 Side Impact Shoulder Kit
- Q10 2020 Kit

1.2.1 SECTION ORGANIZATION

Each segment section of this manual has been divided into the following subsections to provide a complete overview of each assembly.

- Description of Features
- Assembly of the Segment
- Assembly of Component

The assembly section of the manual assumes that the components have been disassembled to replace, inspect or service instrumentation.

1.2.2 CONVENTIONS USED THROUGHOUT THIS MANUAL

Right-hand and Left-Hand

The references to the right-hand and left-hand side of a component or assembly are made with the assumption that the component is installed within the dummy. Reference is made as if the laboratory personnel is oriented in the same position as the test dummy.

Front and Back

The reference to front and back refer to the anterior and posterior sides of the part or assembly based on the dummy reference system.

Top and Bottom

The reference to top and bottom refer to the superior and inferior sides of the part of assembly based on the dummy reference system.

Dummy Coordinate System

All references made to the coordinate system of X, Y, and Z will be based on the SAE Information Report J1733 – Sign Convention for Vehicle Crash Testing. This SAE sign convention is provided below:

+X is toward the anterior (front) of the dummy

+Y is laterally toward the right

+Z is toward the inferior (bottom) of the dummy

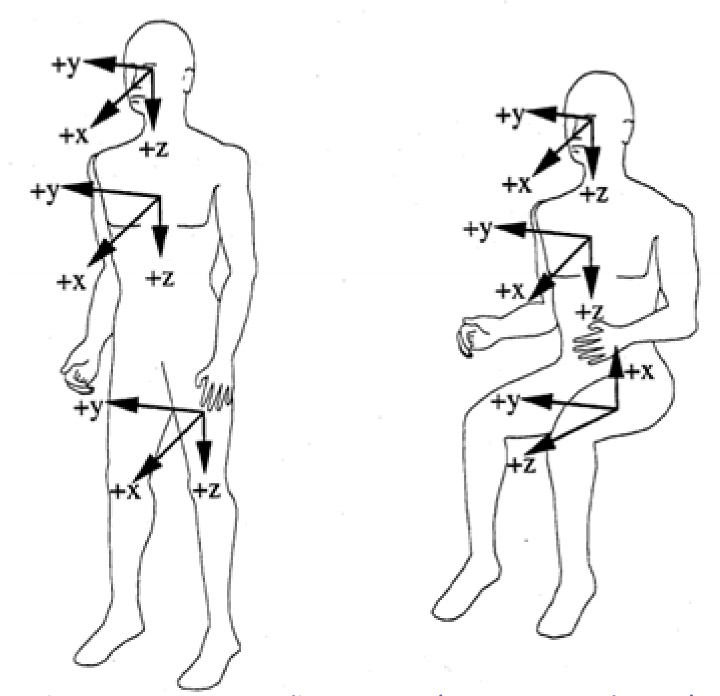


Figure 1.1 Dummy Coordinate System (SAE J1733 Issued DEC94)

SECTION 2

Dummy Preparation and Use

2.1 General

2.1.1 HARDWARE AND FASTENERS

All hardware and fasteners used on the Q10 2020 crash test dummy are standard metric sizes. The following abbreviations are used throughout this manual.

Table 2-1 Hardware and Fastener Abbreviations

Abbreviation	Description
FHCS	Flat Head Socket Cap Screw
BHCS	Button Head Socket Cap Screw
SHCS	Socket Head Cap Screw
SSS	Socket Set Screw
NP	Nylon Pellet (Used in conjunction with one of the above.)

2.1.2 RECOMMENDED TOOLS

The following tool list includes the recommended standard tools which should be available at the test labs using the Q10 2020 dummy. This list will allow the laboratory personnel to make any necessary adjustments and to perform the standard disassembly and assembly procedures. These tools are listed in the table below.

Table 2-2 List of Recommended Tools

Tool Description	Size of Range
Set of "T" Handle Hex Wrenches (Ball End)	2, 2.5, 3, 4, 5, 6, 8, and 10 mm
Set of "l" Handle Hex Wrenches (Ball End)	1.5, 2, 2.5, 3, 4, 5, 6, 8, and 10 mm
Set of Straight Hex Wrenches (Screwdriver Style)	0.7, 0.9, 1.3, 1.5, 2, 2.5, and 3 mm
Socket Set 3/8 Drive	6 mm to 19 mm
Torque Wrench 3/8 Drive	10-98 Nm
Hex Bit Socket Set	4, 5, 6, 7, 8, and 10 mm
Needle Nose Pliers	-
Diagonal Wire Cutters	-
Flat Head Screwdriver	3/16" Slotted, 4" Shaft Length

2.1.3 TORQUE VALUES

The following table indicates the recommended torque values for the various bolt sized used in the Q10 2020 dummy assemblies. For fastener sizes smaller than those listed, engineering judgment should be used to arrive at a "reasonably snug" torque which will prevent the fastener from vibrating loose during impact.

Table 2-3 Recommended Fastener Torque Specifications (SHCS)

Metric Fastener	Recommended Torque Range (Nm)
M2	0.5 Nm
M2.5	0.8 Nm
M3	1.5 Nm
M4	3.5 Nm
M5	7.0 Nm
M6	13.0 Nm
M8	30.0 Nm
M10	55.0 Nm
M12	100.0 Nm
M14	160.0 Nm
M16	250.0 Nm

Table 2-4 Recommended Fastener Torque Specifications (BHCS & FHCS)

Metric Fastener	Recommended Torque Range (Nm)
M2	0.3 Nm
M2.5	0.5 Nm
M3	1.0 Nm
M4	2.5 Nm
M5	5.0 Nm
M6	10.0 Nm
M8	22.0 Nm
M10	40.0 Nm
M12	75.0 Nm
M14	120.0 Nm
M16	190.0 Nm

Top Level Dummy Assembly

3.1 Description of Features

The features of the Q10 2020 dummies are listed below.

- **The Q-dummies have improved biofidelity over the P-series. Biomechanical information from children and scaled adult biomechanical response curves has been used to define the dummy response [i] and [ii]. The anthropometry of the dummy is based on CANDAT data [iii].**
- **The dummies can be equipped with accelerometers, angular velocity sensors, load cells, displacement sensors and pressure sensors. This allows evaluation of the injury risk under various circumstances.**
- **Special attention has been paid to the handling characteristics of the dummy, ensuring the dummy can be assembled and disassembled quickly with the use of metric hex keys.**
- **The influence of transducers upon the kinematics of the dummy is minimized, and protection of transducers and cables is integrated into the dummy design.**
- **The abdomen is foam filled covered with a PVC skin. Biomechanical data from children has been used to determine the required stiffness. Pressure sensors can be placed in the abdomen to measure belt loading.**

3.2 Assembly of Top Level

3.2.1 TOP LEVEL PARTS LIST

The following figures refers to the top level Q10 2020 assembly, 012-0000.

Figure 3.1 Top Level Assembly

Top Level Dummy Assembly

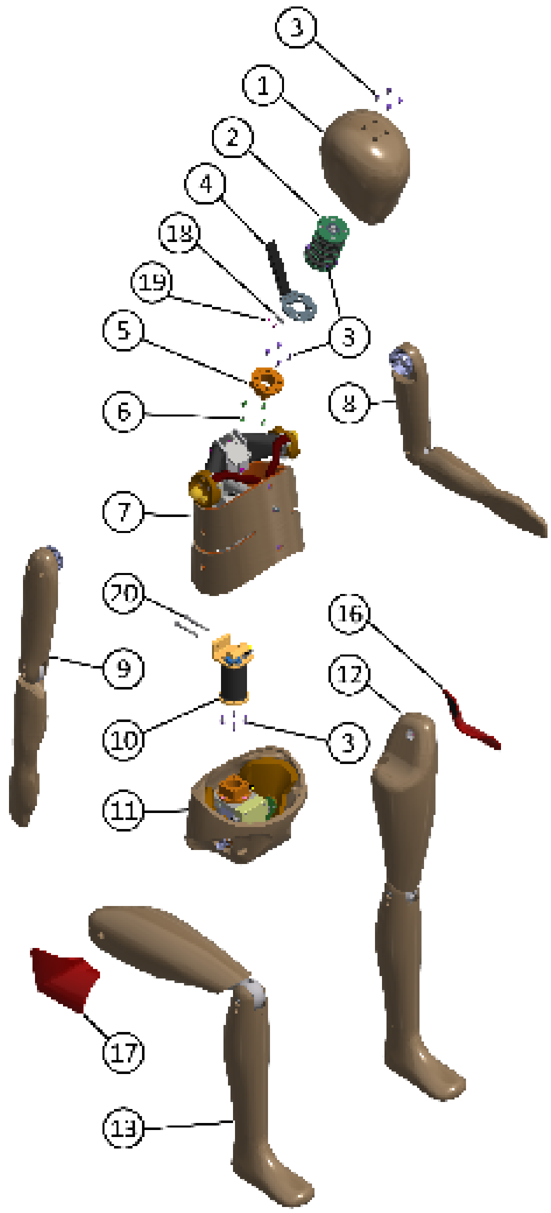


Figure 3.2 Top Level Assembly Exploded View

SECTION 3

Top Level Dummy Assembly

The table below lists the parts in the Top level Dummy Assembly, 012-0000.

Table 3-1 Top Level Assembly Parts List

Item	Qty.	Part Number	Description
1	1	010-1000	HEAD ASSEMBLY
2	1	010-2000	NECK ASSEMBLY
3	16	5001173	M5 X 0.8 X 10 LG. SHCS ZINC
4	1	010-2010	NECK INTERFACE ASSEMBLY Q10
5	1	010-2007	LOAD CELL STRUCTURAL REPLACEMENT
6	4	5001176	M5 X 0.8 X 12 LG. FHCS ZINC
7	1	012-4000	Q10 THORAX ASSEMBLY 2020
8	1	010-9300	ARM ASSEMBLY, LEFT
9	1	010-9300	ARM ASSEMBLY, RIGHT
10	1	010-6000	LUMBAR SPINE ASSEMBLY, TESTED & CERTIFIED
11	1	012-7000	PELVIS ASSEMBLY, 2020
12	1	012-9100	LEG ASSEMBLY 2020, LEFT Q10
13	1	012-99200	LEG ASSEMBLY 2020, RIGHT Q10
14	1	010-4300	ABDOMEN
15	1	010-8000	SUIT, Q10 (NOT SHOWN)
16	1	010-9220	HIP SHIELD, LEFT 65D
17	1	010-9221	HIP SHIELD, RIGHT 65D
18	1	010-4505	T1 ACCEL MOUNT
19	2	5000116	M3 X 0.5 X 8 LG. FHCS
20	2	5001317	M6 X 1 X 55 LG. SHCS ZINC
21	1	012-KIT	Q10 PARTS/TOOL KIT (NOT SHOWN)
22	1	010-3513	SHOULDER LINER 2020

3.3 Disassembly of Body Segments

This section describes how to disassemble body segments from the dummy and assemble them back. For further work on each body segment, refer to the relevant body segment section of this manual. Please keep in mind, it may not always be necessary to remove a particular body segment as described below, for instance, the head assembly can be worked on when it is mounted on the dummy. The reader should decide which is the best way to handle any particular job. As a first precaution, make sure to sit the dummy on a stable surface. A stable sitting dummy may become unstable during disassembly by removing consecutive parts. It is recommended to keep the dummy stable by securing the top of the spine of the dummy, preferably to an overhead crane or tackle using the lifting strap at the top of the spine.

3.3.1 SUIT DISASSEMBLY

To remove the suit, unzip the zipper around the abdomen then open the suit at the back using the hook and loop fasteners (Velcro).

3.3.2 HEAD/NECK DISASSEMBLY

Remove four M5 X 0.8 X 12 LG. BHCS and the skull cap (010-1005).

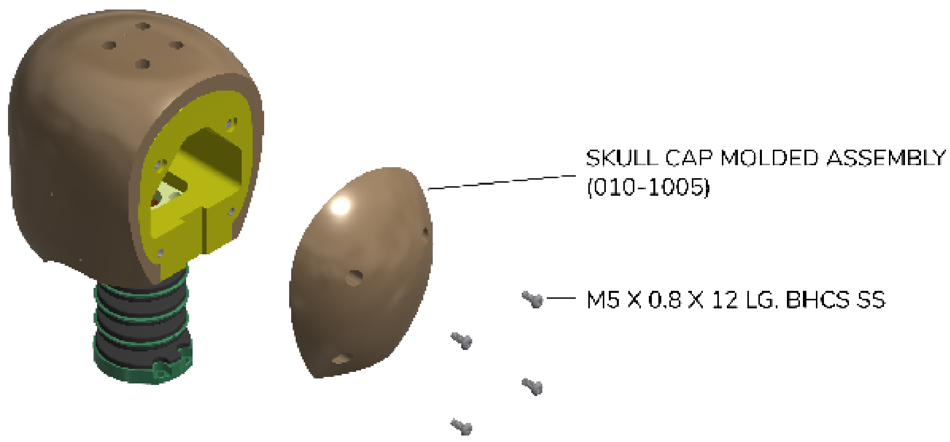


Figure 3.3 Remove the Skull Cap

Next, remove the two M4 X 0.7 X 20 LG. SHCS from the mounting bracket (010-1004). Pull the mounting bracket off its location of a single 3mm dowel and remove from the head.

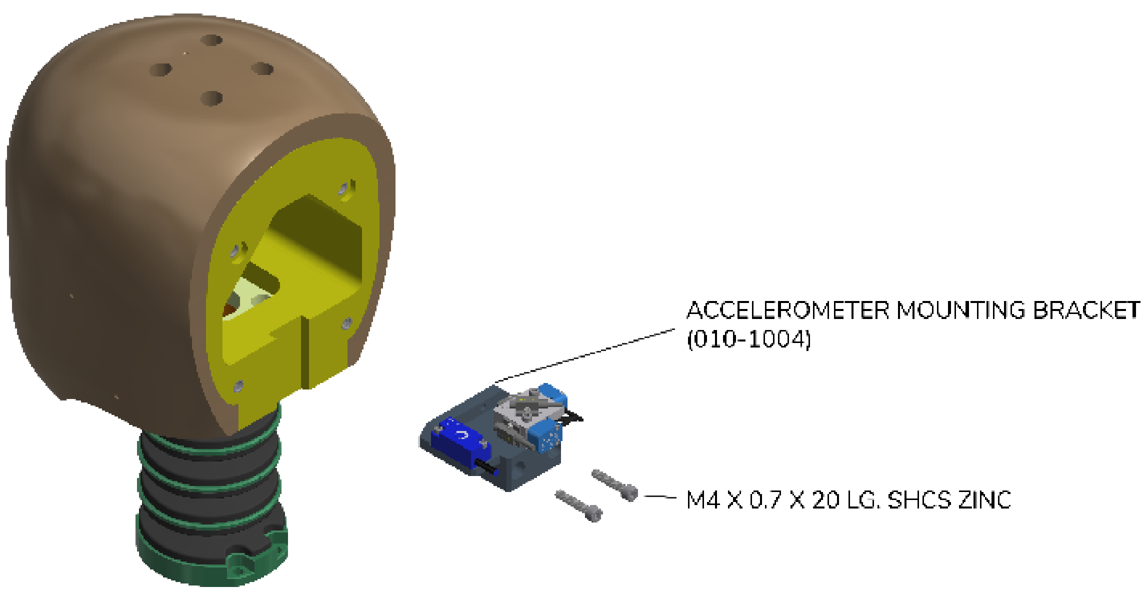


Figure 3.4 Remove the Accelerometer Mounting Bracket

The four M5 X 0.8 X 10 LG. SHCS which attach the upper neck load cell or its replacement to the neck can be accessed through the four holes in the top of the skull. Remove the four M5 screws and detach the head with upper neck load cell from the neck.

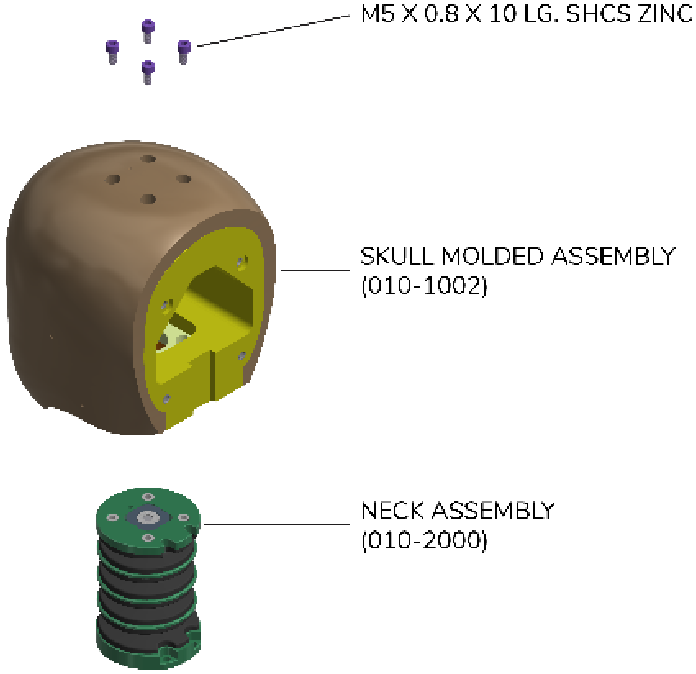


Figure 3.5 Disassemble the Neck Assemble from the Head Assembly

3.3.3 NECK/TORSO DISASSEMBLY

Remove the four M5 x 10 SHCS that attach the neck assembly to the neck torso interface plate assembly 010-2010 with plate 010-2015 and dummy lifting strap. To inspect the neck cable assembly, remove the retaining nut and neck cable from the neck.

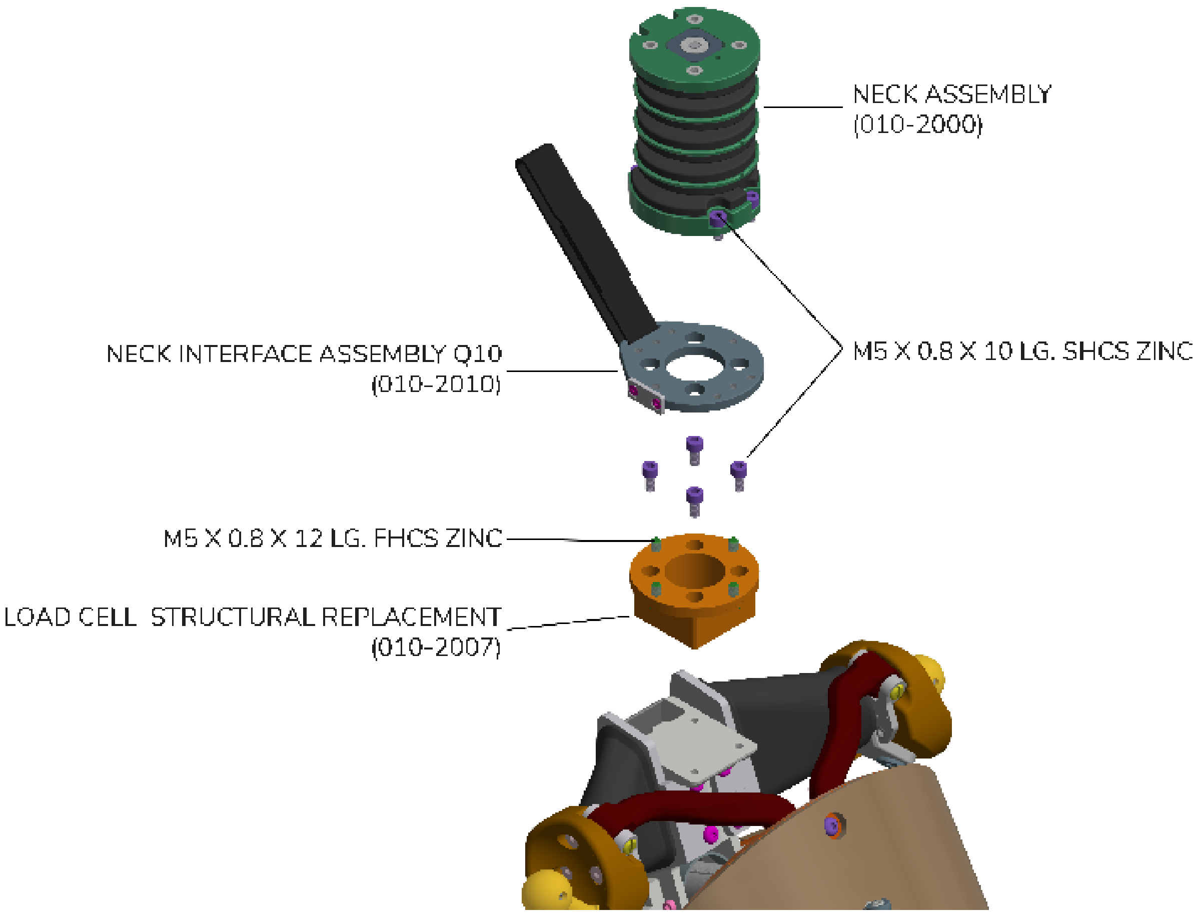


Figure 3.6 Remove the Neck Assembly from the Torso Assembly

3.3.4 TORSO DISASSEMBLY

To remove the upper and lower torso, you must first separate the abdomen (010-4300) at the lumbar spine. Remove the two M6 X 1 X 55 LG. SHCS ZINC from the rear of the spine and lumbar. This method of disassembly is preferred so that it does not stress the abdomen by pulling it out of an assembled torso.

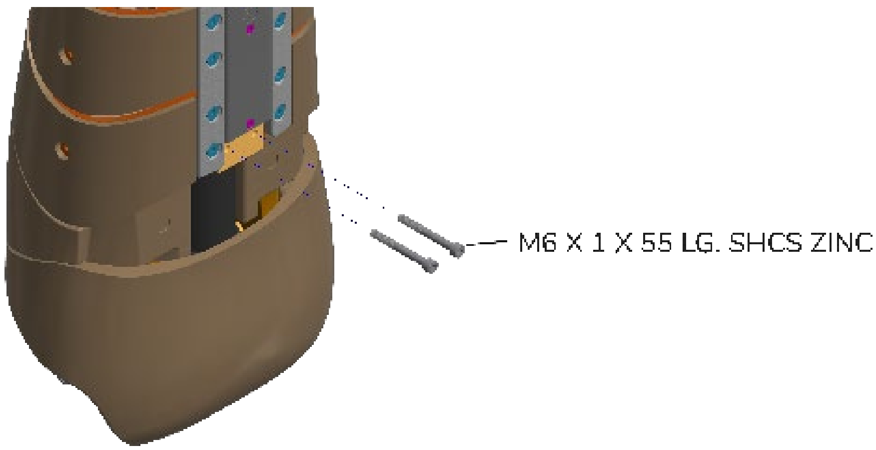


Figure 3.7 Remove the M6 X 1 X 55 LG. SHCS ZINC

3.3.5 ARM DISASSEMBLY

The arms are detached from the shoulder by removing three M5 X 0.8 X 12 LG. SHCS and washers that attach the arms 010-9300 LH, 010-9400 RH to the shoulder ball retainer ring 010-9308. The shoulder bearing cup (020-9705) is permanently assembled to the upper arm bone and does not need to be disassembled in normal use and maintenance of the dummy.

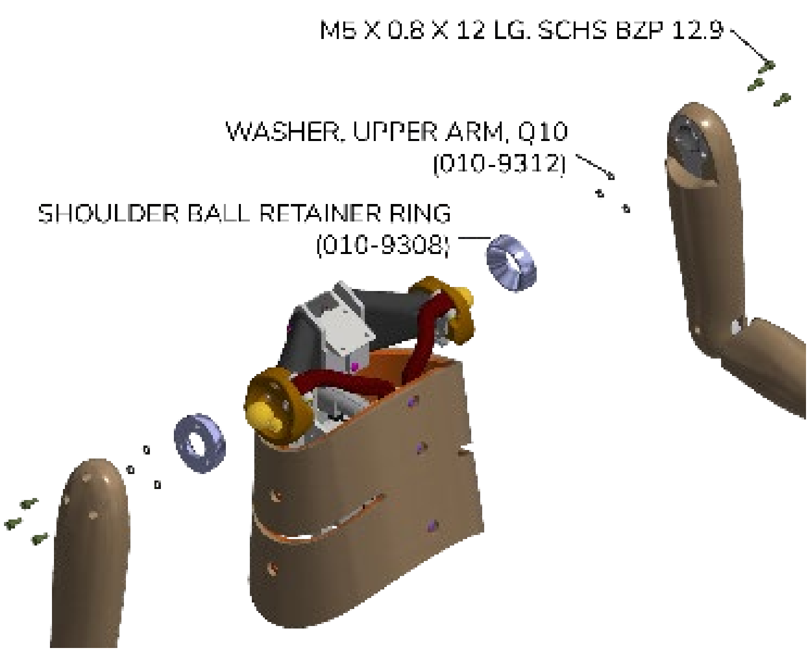


Figure 3.8 Remove Arms from the Shoulder

3.3.6 LUMBAR DISASSEMBLY

To remove the lumbar (010-6000) from the pelvis (012-7000), first, unscrew four M5 X 0.8 X 16 LG. SHCS from the load cell or its structural replacement (010-2007).

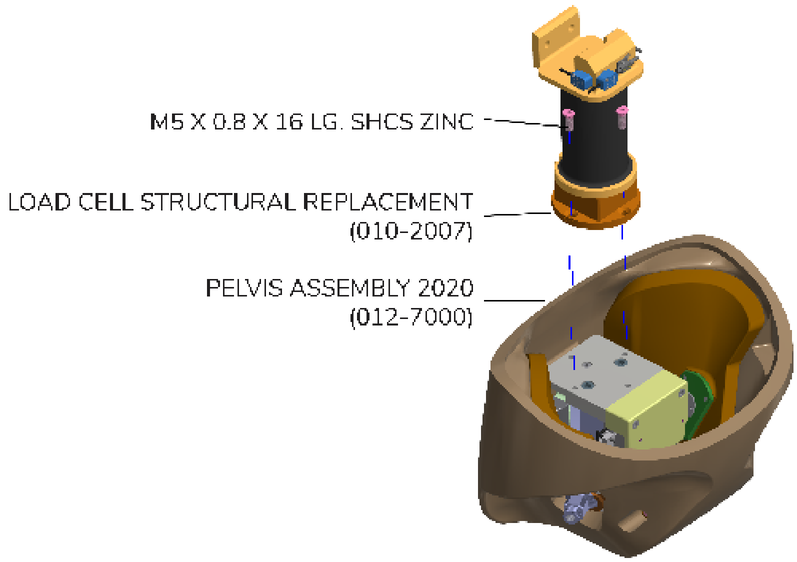


Figure 3.9 Remove M5 X 0.8 X 16 LG. SHCS ZINC to Free the Load Cell Structural Replacement

Remove the M5 X 0.8 X 10 LG. SHCS to remove the Load Cell Structural Replacement (010-2007) from the Lumbar Spine Assembly (010-6000).

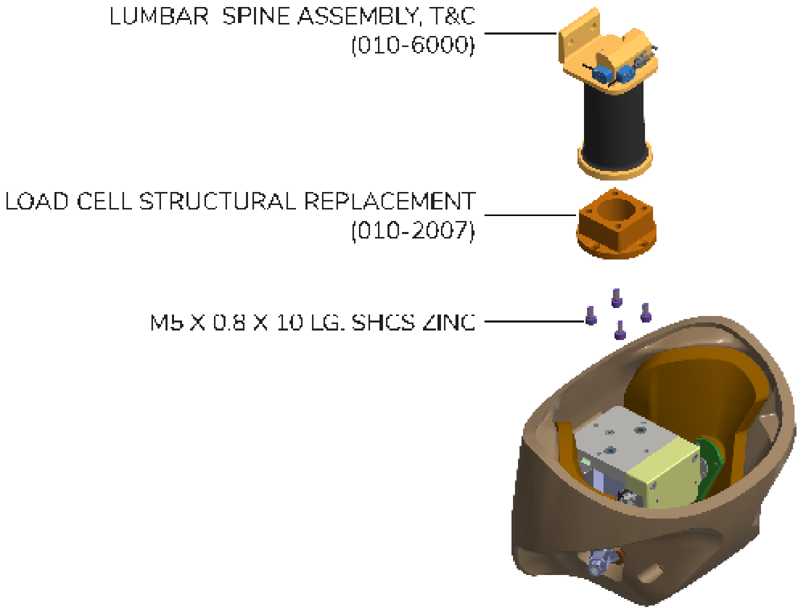


Figure 3.10 Remove the M5 X 0.8 X 10 LG. SHCS to Remove the Lumbar Assembly

3.3.7 PELVIS DISASSEMBLY

To remove the pelvis flesh (010-7002), point the hip shafts downwards or remove femur ball assemblies and hip ball retainer plates and lift the iliac wing-Sacrum structure away, out of the flesh part.

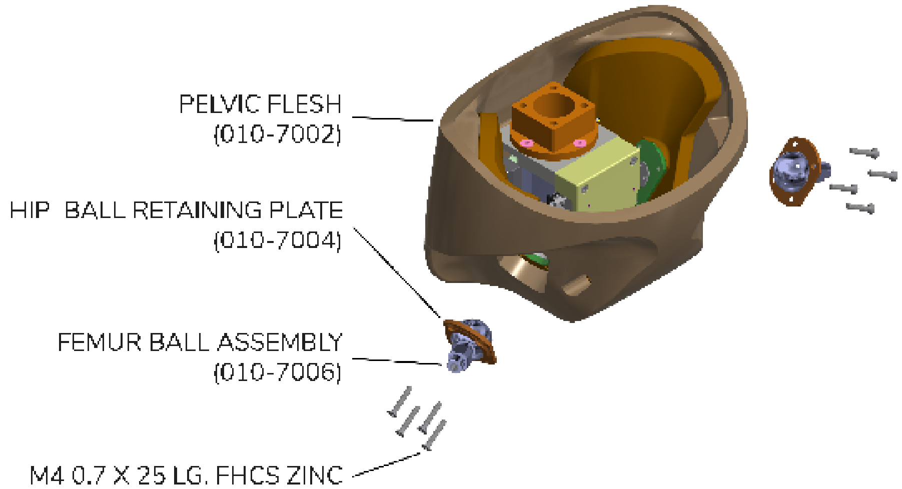


Figure 3.11 Remove the Pelvis Flesh

3.3.8 LEG DISASSEMBLY

Remove the two M8 x 16 BHCS that attach the legs (012-9100) (L) and (012-9200) (R) to the pelvis (012-7000).

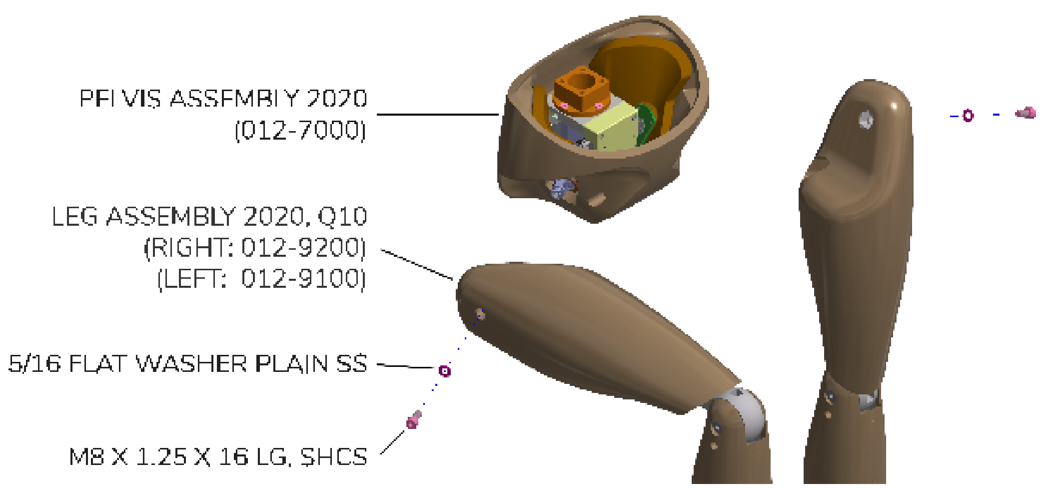


Figure 3.12 Remove the Legs from the Pelvis

4.1 Description of Features

The head is largely made from polyurethane synthetics. The head cavity is large enough to allow use of several instruments, including linear accelerometers, angular velocity sensors, data acquisition, and a tilt sensor.

4.2 Assembly of Head

4.2.1 HEAD ASSEMBLY PARTS LIST

The figure below is an exploded view of the Head Assembly and the table gives a general description of each item.

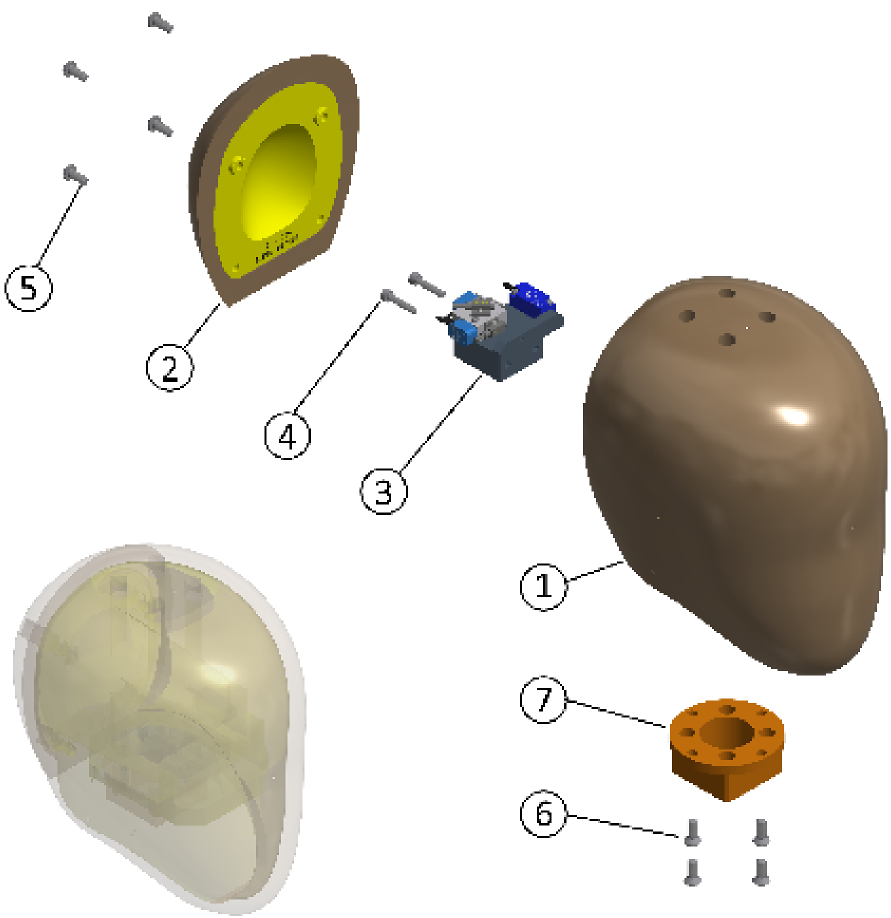


Figure 4.1 Head Assembly Exploded View

Table 4-1 Head Assembly Parts List

Item	Qty.	Part Number	Description
1	1	010-1002	SKULL MOLDED ASSEMBLY
2	1	010-1005	SKULL CAP MOLDED ASSEMBLY
3	1	010-1004	ACCELEROMETER MOUNTING BRACKET
4	2	5001189	M4 X 0.7 X 20 LG. SHCS ZINC
5	4	5000565	M5 X 0.8 X 12 LG. BHCS SS
6	4	5001177	M5 X 0.8 X 14 LG. FHCS ZINC
7	1	010-2007	LOAD CELL STRUCTURAL REPLACEMENT

4.2.2 ASSEMBLY OF HEAD COMPONENTS

The following procedure is a step-by-step description of the assembly procedure for the head components. All bolts should be tightened to the torque specifications provided in **Section 2.1.3 Torque Values**.

1. **Attach load cell or structural replacement with four M5 X 0.8 X 14 LG. FHCS.**

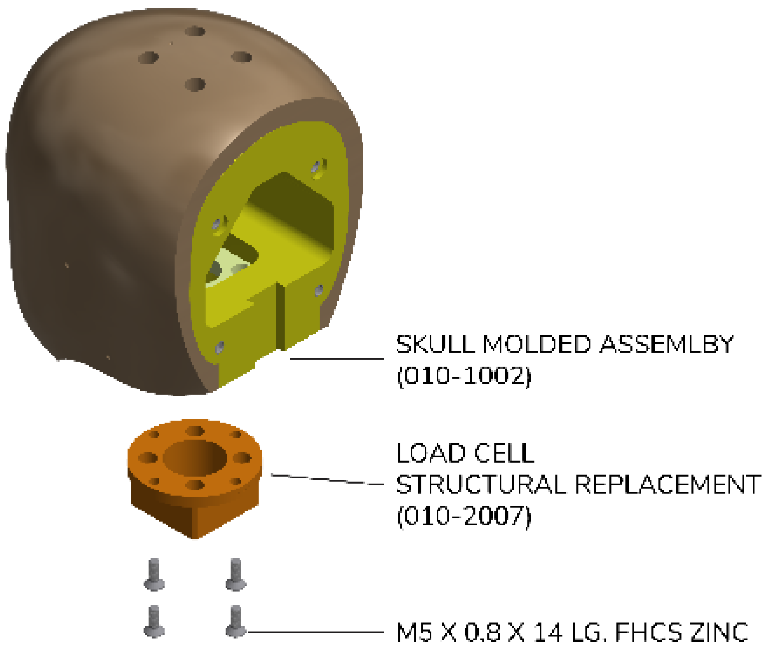


Figure 4.2 Attach the Load Cell to the Skull Molded Assembly

2. **Attach the head to neck with four M5 X 0.8 X 10 LG. SHCS.**

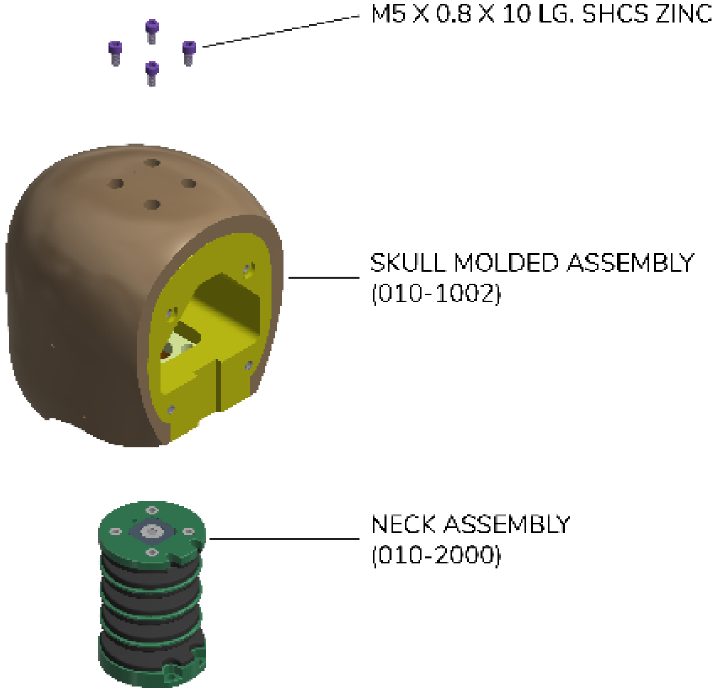


Figure 4.3 Attach the Head to the Neck

3. **Attach mounting bracket (010-1004) with two M4 X 0.7 X 20 LG. SHCS.**

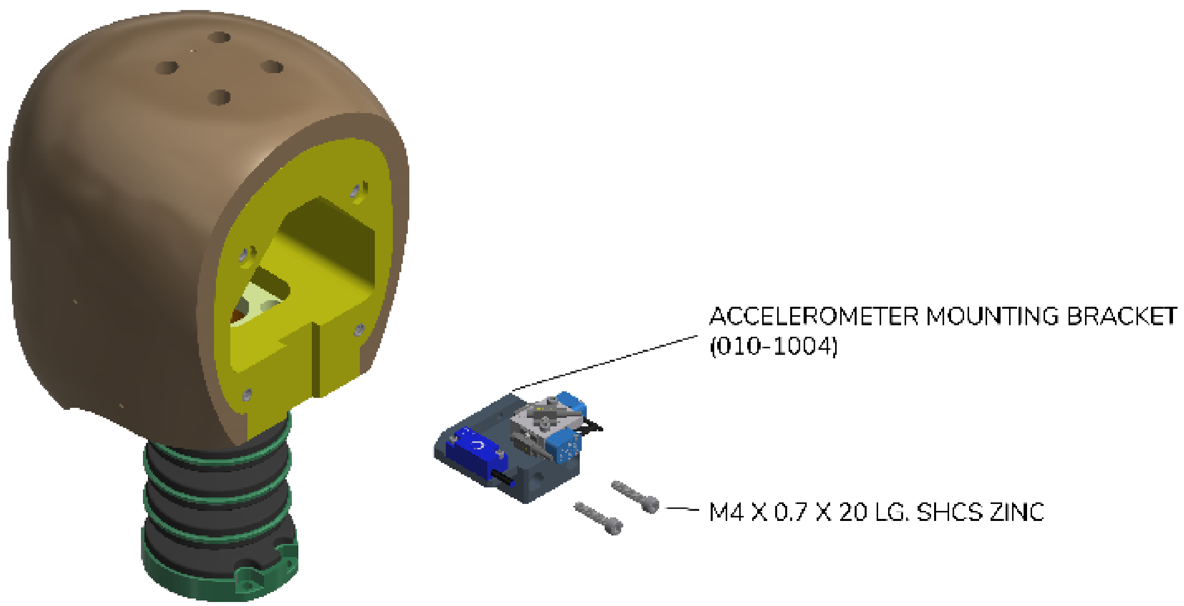


Figure 4.4 Attach the Mounting Bracket to the Head

4. **Attach the skull cap with four M5 X 0.8 X 12 LG. BHCS.**

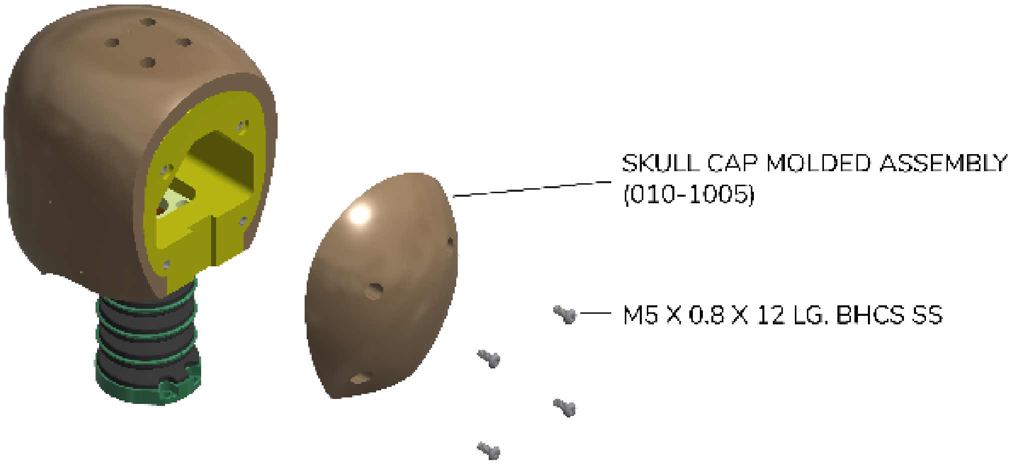


Figure 4.5 Attach the Skull Cap

Neck Assembly

5.1 Description of Neck Assembly and Features

The neck is flexible and allows shear and bending in all directions. The segmented design prevents buckling and allows realistic rotational behavior. The neck is fitted with a flexible stainless-steel wire at its core to prevent failure under high load. A six-channel load cell can be mounted at the neck-head and neck-thorax interface.

5.2 Assembly of the Neck

5.2.1 NECK ASSEMBLY PARTS LIST

The following figure is an exploded view of the neck assembly, 010-2000.

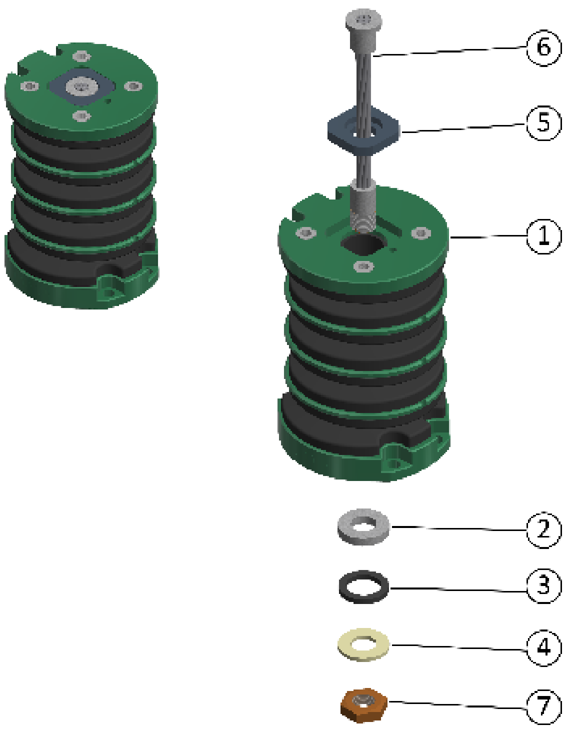


Figure 5.1 Neck Exploded View

Table 5-1 Neck Assembly Parts List

Item	Qty.	Part Number	Description
1	1	010-2005	MOLDED NECK
2	1	010-2008	SPACER, CABLE
3	1	9003247	WASHER, WAVE SPRING .53 ID X .76 OD X .09 HGT
4	1	010-2009	NYLON WASHER, Q10 NECK
5	1	010-2004	BUSHING, NECK CABLE
6	1	010-2200	NECK CABLE ASSEMBLY
7	1	010-2006	RETAINING NUT, Q10 NECK

5.2.2 ASSEMBLY OF NECK COMPONENTS

The following procedure is a step-by-step description for the assembly procedure of the neck components. All bolts should be tightened to the torque specifications provided in **Section 2.1.3 Torque Values**.

Slide the bushing (010-2004) and the neck cable (010-2200) through the top of the neck. Add the spacer (010-2008), spring washer (9003247) and nylon washer (010-2009) to the bottom of the neck, and then hand tighten the retaining nut (010-2006) to the cable assembly plus half a turn with the wrench.

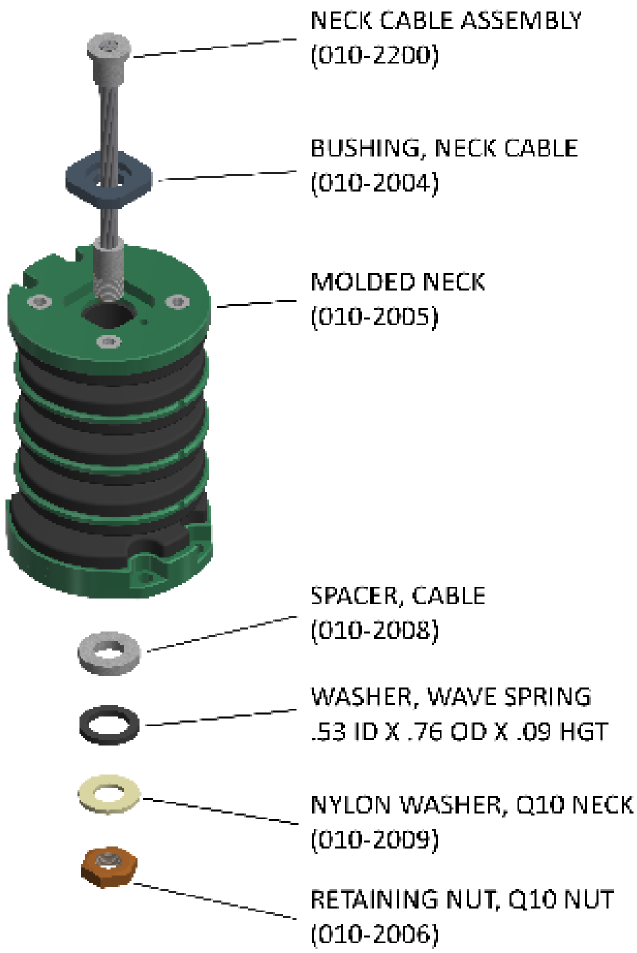


Figure 5.2 Assemble the Neck Cable, Bushing, Washers, and Nut to the Molded Neck

SECTION 6

Thorax Assembly

6.1 Description of Thorax Assembly and Features

The ribcage of the child is represented by a single part. The deformation can be measured with two IR-TRACC 2D sensors located in the upper and lower regions of the ribcage. The shoulders are connected with a flexible joint to the thorax, allowing deformation. There is a shoulder liner that covers the shoulder rubbers and clavicles as well as the gaps between the shoulders and the upper arms. The neck base at T1 for Q10 2020 has been shifted 20 mm forward and rotated 5.3 degrees nose up relative to the standard Q10. The thorax mass has increased 1.4 kg relative to the standard Q10. Accelerometers can be mounted in the thoracic spine and on the ribcage to measure linear accelerations. Moreover, the thoracic spine facilitates the use of angular velocity sensors and a tilt sensor. A side impact shoulder kit can also be fitted.

6.2 Assembly of the Thorax

6.2.1 THORAX ASSEMBLY PARTS LIST

The figure below shows an exploded view of the thorax assembly, 012-4000.

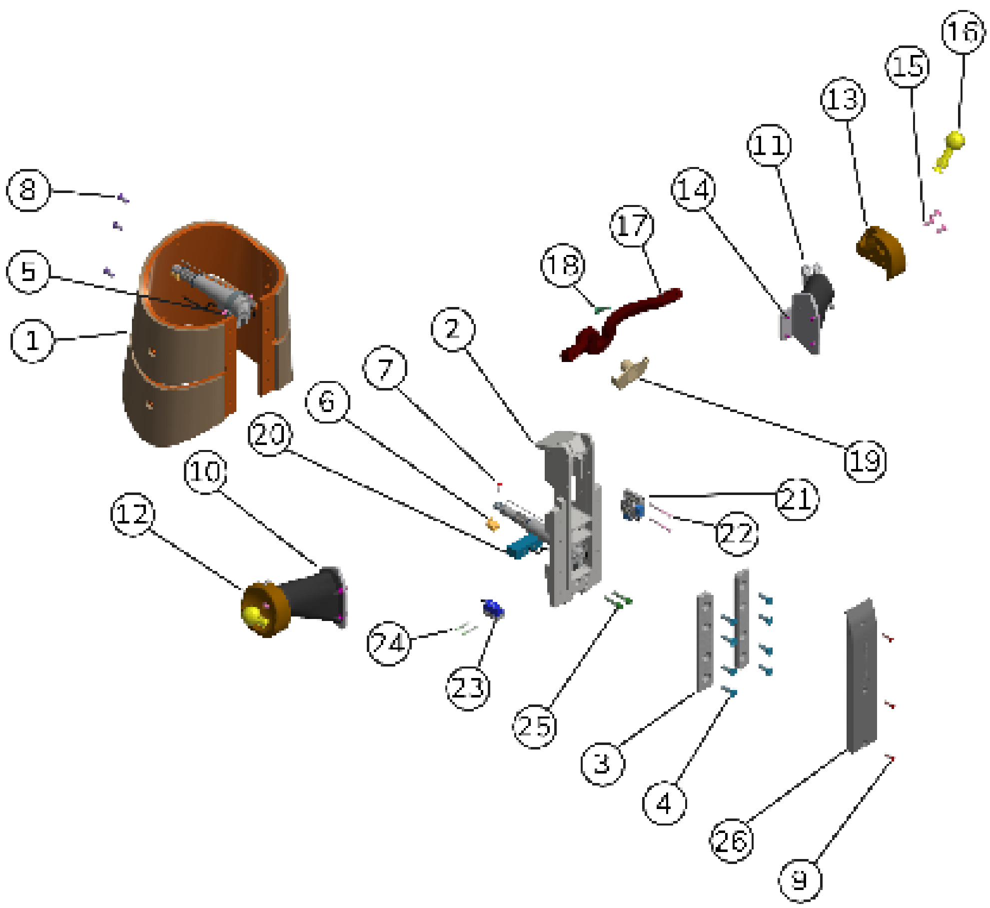


Figure 6.1 Thorax Exploded View

Table 6-1 Thorax Assembly Parts Lists

Item	Qty.	Part Number	Description
1	1	010-4100	RIBCAGE, Q10
2	1	010-4451	SPINEBOX, Q10
3	2	010-4104	SPINE RAIL
4	8	5001179	M6 X 1 X 20 LG. FHCS ZINC
5	4	010-4108	PIVOT SCREW
6	2	010-4105	IR-TRACC ADAPTOR
7	2	5001188	M3 X 0.5 X 10 LG. SHCS ZINC
8	3	5000846	M5 X 0.8 X 12 LG. BHCS ZINC
9	3	5001175	M4 X 0.7 X 16 LG. FHCS ZINC
10	1	010-3501	MOLDED SPINE INTERFACE ASSEMBLY, LEFT
11	1	010-3502	MOLDED SPINE INTERFACE ASSEMBLY, RIGHT
12	1	010-3311	SHOULDER JOINT HOUSING 2020, LEFT
13	1	010-3312	SHOULDER JOINT HOUSING 2020, RIGHT
14	8	5001181	M5 X 0.8 X 10 LG. BHCS ZINC
15	6	5001177	M5 X 0.8 X 14 LG. FHCS ZINC
16	2	010-3004	SHOULDER BALL ASSEMBLY
17	1	010-3300	CLAVICLE, Q10
18	2	010-3420	CLAVICLE PIN
19	1	010-4200	CLAVICLE RETAINER
20	1	010-4005	BALLAST, Q10 FRONTAL
21	1	010-4109	MOUNT, UPPER THORAX, Q10
22	2	5001208	M3 X 0.5 X 35 LG. SHCS ZINC
23	1	010-4110	THORAX TILT SENSOR BRACKET
24	2	5001186	M3 X 0.5 X 20 LG. SHCS ZINC
25	2	5000721	M3 X 0.5 X 20 LG. SHCS ZINC
26	1	010-4452	BACK PLATE 2020

6.2.2 ASSEMBLY OF THORAX COMPONENTS

The following procedure is a step-by-step description for the assembly procedure of the neck components. All bolts should be tightened to the torque specifications provided in **Section 2.1.3 Torque Values**

Before assembly of the thorax, make sure that the IR-TRACCs are in their desired position for frontal or lateral (left or right) impact. The assembly of the Torso, IR-TRACCs and Abdomen is the reversal of the disassembly process.

IR-TRACC Position for Lateral Impact

Attach the Side Impact IR-TRACC Mount (010-4006) with three M5 X 0.8 X 25 LG. SHCS.

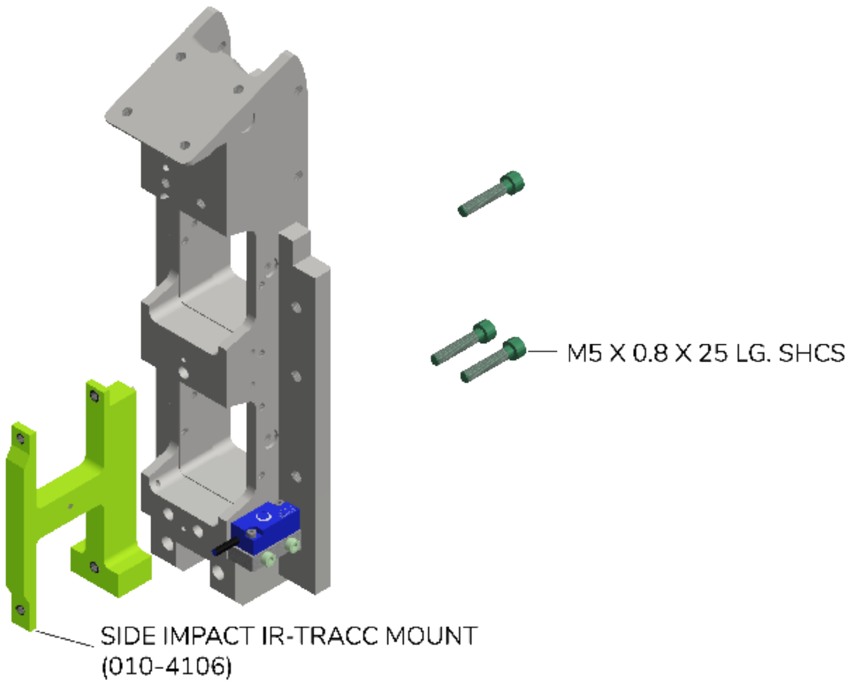


Figure 6.2 Attach the Side Impact IR-TRACC Mount

Attach the IR-TRACCs with two Pivot Screw (010-4108) each, to the Side Impact Mount.

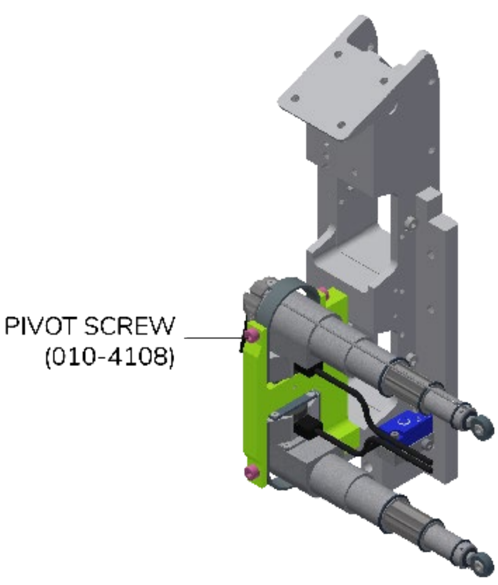


Figure 6.3 Attach the IR-TRACCs to the Side Impact Mount

IR-TRACC Position for Frontal Impact

For frontal impact remove the side impact IR-TRACC mount (010-4106) and attach the Ballast (010-4005) using the same two M5 X 0.8 X 25 LG. SHCS. The upper screw is not required for frontal IR-TRACCs. Insert the IR-TRACCs in the appropriate cavities of the thoracic spine box with the potentiometers downwards as shown below with two Pivot Screw (010-4108) each.

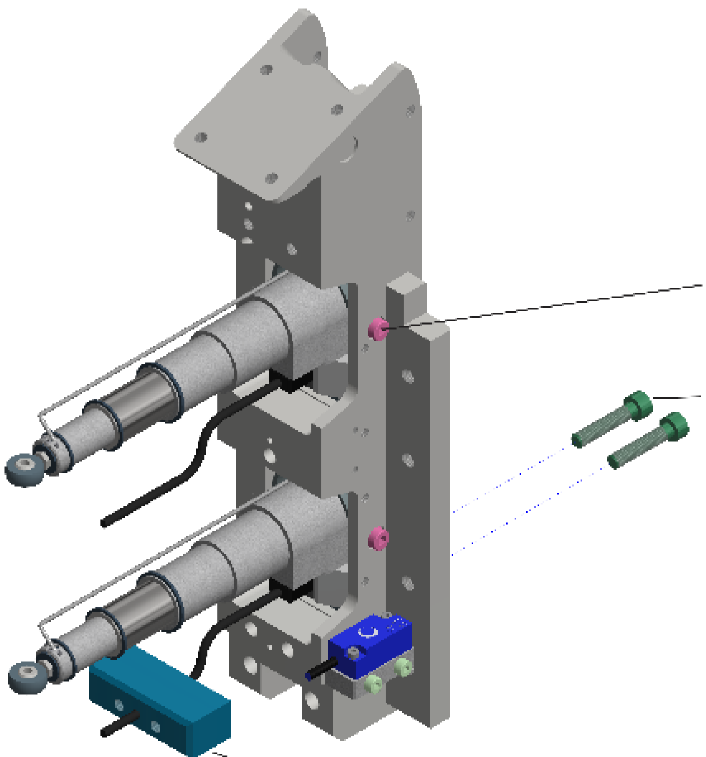


Figure 6.4 Frontal IR-TRACC Configuration

For general maintenance it is not necessary to disassemble the parts in the shoulder area. Make sure that the shoulder joint retainer rings are behind the shoulder ball assemblies before mounting. It is recommended to inspect the M8 FHCS screws that attach the shoulder ball assemblies (010-3004) to the shoulder interface parts. These screws have a paint dot on their thread to make them self-locking. Make sure that these M8 FHCS screws are tightened.

Arm Assembly

7.1 Description of Lower Arm and Hand Assembly and Features

The friction in the elbow joints and the shoulders can be adjusted to a one g setting. The side impact shoulder kit has a more compliant upper arm with no lower arm to improve repeatability.

7.2 Assembly of the Arm

7.2.1 ARM ASSEMBLY PARTS LIST

The figure below shows the left and right arm assemblies, 010-9300/010-9400.

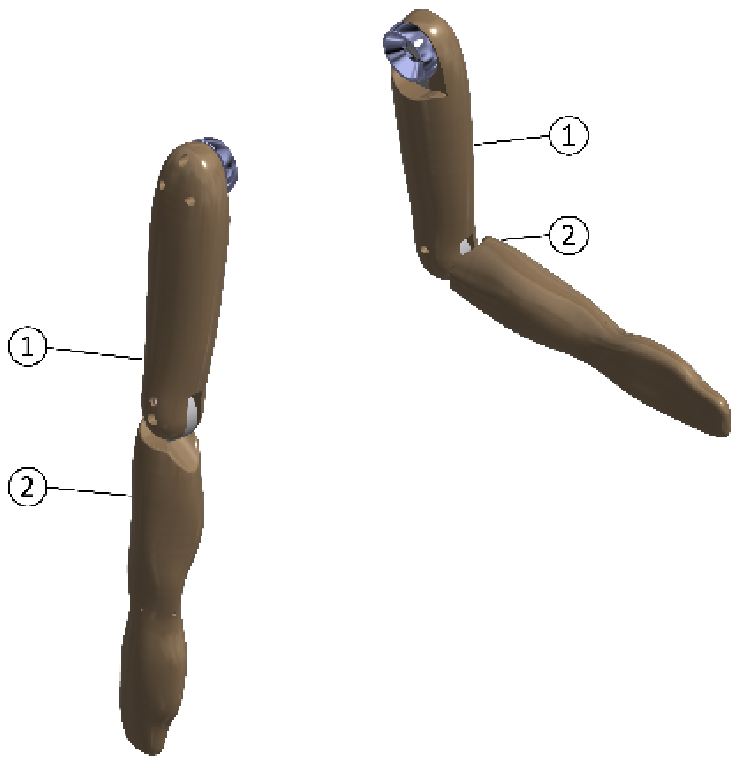


Figure 7.1 Arm Assembly View

Table 7-1 Arm Assembly Parts List

Item	Qty.	Part Number	Description
1	1	010-9301	UPPER ARM ASSEMBLY, LEFT
1	1	010-9401	UPPER ARM ASSEMBLY, RIGHT
2	1	010-9302	LOWER ARM ASSEMBLY, LEFT
2	1	010-9402	LOWER ARM ASSEMBLY, RIGHT

Upper Arm Assembly

The figure below shows the exploded view of the Upper Arm Assembly, 010-9301.

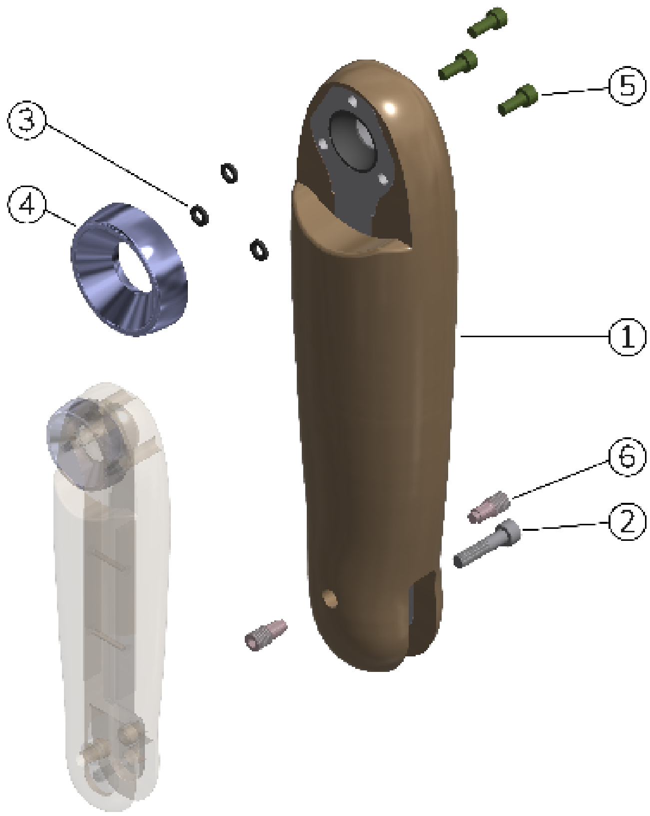


Figure 7.2 Upper Arm Exploded View

Table 7-2 Upper Arm Assembly Parts List

Item	Qty.	Part Number	Description
1	1	010-9307	MOLDED UPPER ARM ASSEMBLY, LEFT
1	1	010-9407	MOLDED UPPER ARM, ASSEMBLY, RIGHT (NOT SHOWN)
2	1	010-9313	SCREW, SHCS M6 X 1, ZINC PLATED MODIFIED
3	3	010-9312	WASHER, UPPER ARM, Q10
4	1	010-9308	SHOULDER BALL RETAINER RING
5	3	5001174	SCREW, SHCS M5 X 0.8 X 12, BZP 12.9
6	2	010-9316	SCREW, SSNT M8 X 16 MODIFIED

Lower Arm Assembly

The figure below shows the exploded view of the Lower Arm Assembly, 010-9302.

Figure 7.3 Lower Arm Exploded View

Table 7-3 Lower Arm Assembly Parts List

Item	Qty.	Part Number	Description
1	1	010-9305	MOLDED LOWER ARM ASSEMBLY, LEFT
1	1	010-9405	MOLDED LOWER ARM ASSEMBLY, RIGHT (NOT SHOWN)
2	2	010-9315	END STOP, ELBOW
3	2	010-9310	WASHER, LOWER ARM

7.2.2 ASSEMBLY OF THE ARM COMPONENTS

The following procedure is a step-by-step description of the assembly procedure for the Arm components.

Before fitting the lower arm ensure the rubber end stops are in place. Fit the two plastic washers into their recesses in the elbow and slide the lower arm into the yoke of the upper arm, align and fit the elbow pivot screw. A nylon tipped set screw fits into the inner and outer M8 threaded holes. Set the elbow friction by tightening or loosening the friction set screws at both sides of the elbow. The maximum intended friction is 1 g with the lower arm horizontal and the upper arm vertical.

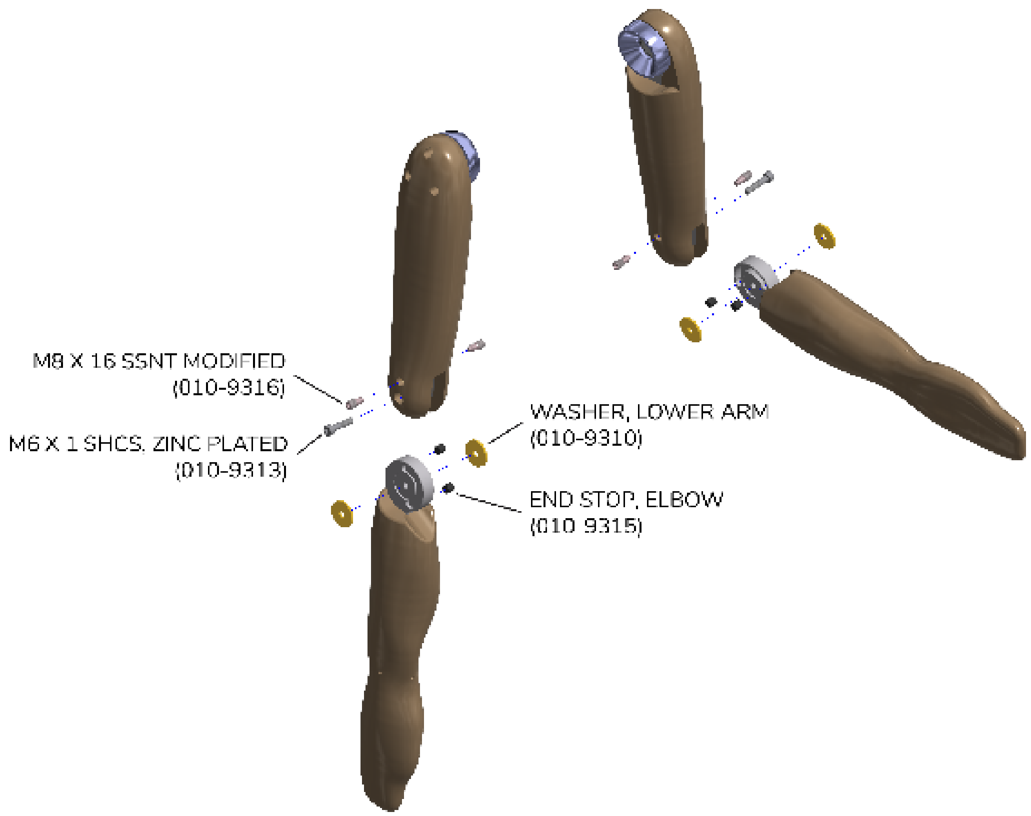


Figure 7.4 Assemble Lower Arm to Upper Arm

The upper arm is attached to the shoulder using three M5 x 12 SHCS. A rubber washer fits on each screw between the upper arm and the shoulder retainer ring. The user can set the friction in the shoulder by adjusting these three screws evenly. The maximum intended friction is 1 g with the upper arm horizontal without the lower arm fitted.

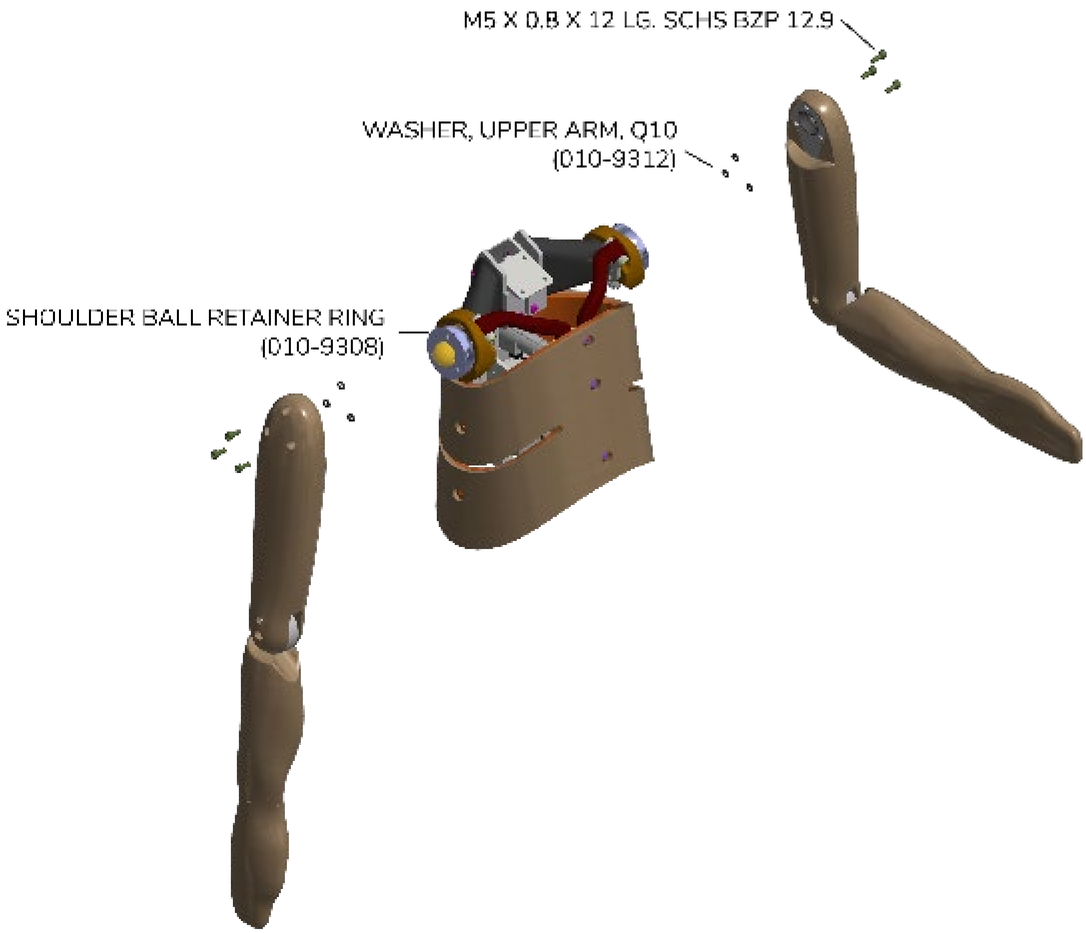


Figure 7.5 Attach the Upper Arms to the Shoulder

SECTION 8

Lumbar Assembly

8.1 Description of Lumbar Assembly

The lumbar spine is a flexible rubber column, which allows shear and bending in all directions. A six-channel load cell can be mounted between the lumbar spine and the pelvis.

8.2 Assembly of the Lumbar

8.2.1 LUMBAR ASSEMBLY PARTS LIST

The figure below shows the lumbar assembly, 010-6000.

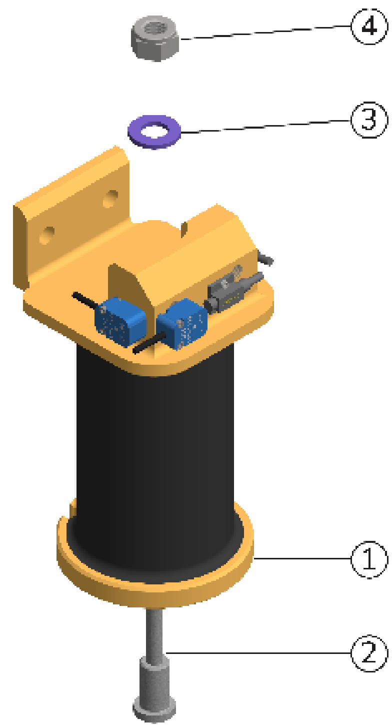


Figure 8.1 Lumbar Exploded View (Optional Instrumentation shown)

Table 8-1 Lumbar Assembly Parts List

Item	Qty.	Part Number	Description
1	1	010-6001	LUMBAR SPINE, MOLDED
2	1	010-6100	LUMBAR SPINE CABLE ASSEMBLY
3	1	5000552	WASHER, FLAT M8 (8.4 ID X 16.0 OD X 1.6 THK)
4	1	5000486	M8 X 1.25 HEX LOCK NUT ZINC

8.2.2 ASSEMBLY OF THE LUMBAR ASSEMBLY COMPONENTS

The following procedure is a step-by-step description of the assembly procedure for the lumbar components.

Push the cable back into the lumbar as shown below. Fit the washer and nut, tighten until there is no clearance on the washer. Then tighten half a turn. There is a slot in the end of the cable for a screwdriver to prevent the cable rotating on tightening.

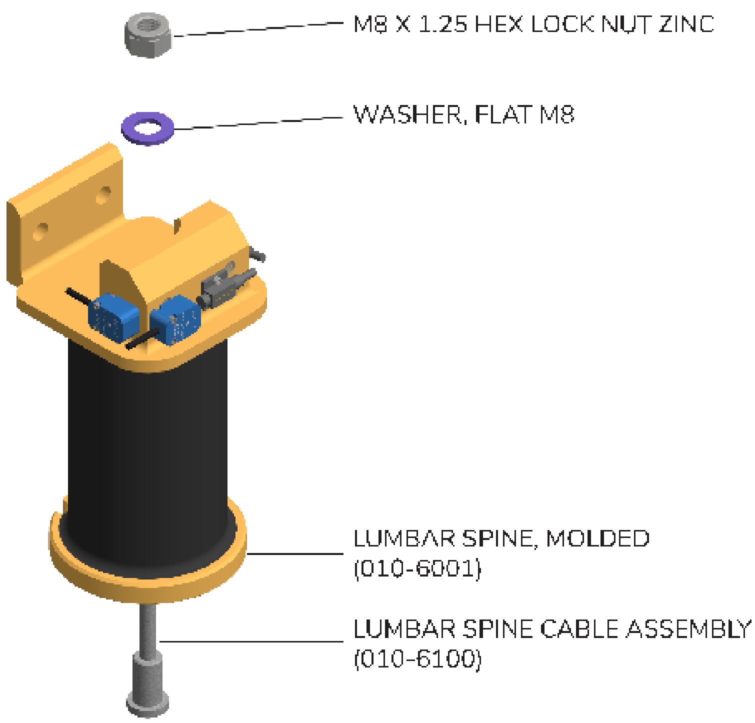


Figure 8.2 Assemble the Cable, Washer, and Lock Nut to the Lumbar Spine, Molded

SECTION 9
Pelvis Assembly

9.1 Description of Pelvis Assembly

The Q10 dummy pelvis has a different design from other Q-dummies. Its design is similar to the WorldSID dummy with an option to fit a single channel pubic symphysis load cell, two sacro-iliac load cells and ASIS load cells. The pelvis therefore has a more compliable design for side impact with plastic bones and a flexible rubber pubis. The anthropometric shape of the bones has been designed to ensure realistic belt interaction [v] and [vi]. Additional space has also been allocated to package on-board DAS systems. Accelerometers, angular velocity sensors, and a tilt sensor can be mounted in this space. Friction can be applied to the hip joint for positioning. The pelvis mass has decreased 1.4 kg relative to the standard Q10.

9.2 Assembly of the Pelvis

9.2.1 PELVIS ASSEMBLY PARTS LIST

The figure below shows the pelvis assembly, 012-7000.

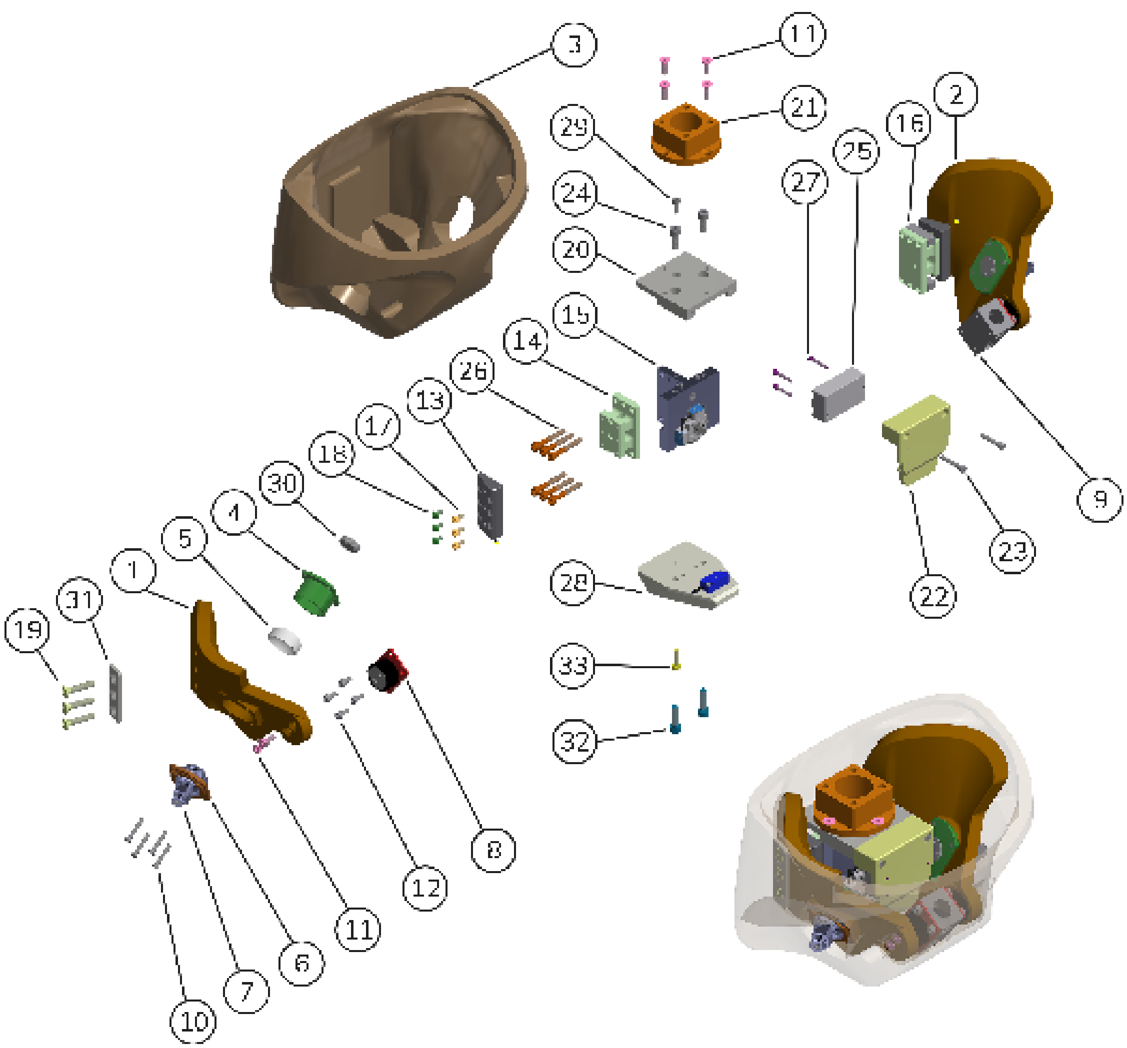


Figure 9.1 Pelvis Exploded View

SECTION 9

Pelvis Assembly

Table 9-1 Pelvis Assembly Parts List

Item	Qty.	Part Number	Description
1	1	010-7302	ILIAC WING, RIGHT
2	1	010-7301	ILIAC WING, LEFT
3	1	010-7002	PELVIC FLESH
4	2	010-7003	HIP CUP
5	2	010-7005	HIP BEARING
6	0	010-7004	HIP BALL RETAINING PLATE
7	2	010-7006	FEMUR BALL ASSEMBLY
8	2	010-7012	PUBIC BUFFER, MOLDED
9	1	W50-71059	STRUCTURAL REPLACEMENT PUBIC LOAD CELL
10	8	5001197	M4 X 0.7 X 25 LG. FHCS ZINC
11	8	5001198	M5 X 0.8 X 16 LG. FHCS ZINC
12	8	5001198	M4 X 0.7 X 10 LG. SHCS ZINC
13	2	010-7022	INTERFACE SACRO ILIAC LC
14	2	010-7023	Q10 SACROILIAC LOAD CELL STRUCTURAL REPLACEMENT
15	1	010-7250	SACRUM, CENTRAL SUPPORT ASSEMBLY
16	2	010-7024	NUT PLATE
17	6	5000024	M4 X 0.7 X 8 LG. SHCS ZINC
18	6	5001201	M4 X 0.7 X 8 LG. BHCS ZINC
19	6	5001200	M6 X 1 X 30 LG. FHCS ZINC
20	1	010-7211	SACRUM TOP PLATE 2020
21	1	010-2007	LOAD CELL STRUCTURAL REPLACEMENT
22	1	010-7203	SACRUM, FRONT PLATE
23	2	5001190	M4 X 0.7 X 25 LG. SHCS ZINC
24	2	5001193	M6 X 1 X 16 LG. SHCS ZINC
25	1	010-7021	DAS, BALLAST PELVIS
26	6	5001192	M5 X 0.8 X 35 LG. SHCS ZINC
27	3	5001186	M3 X 0.5 X 20 LG. SHCS ZINC
28	1	010-7213	SACRUM BOTTOM PLATE 2020
29	1	5001182	M4 X 0.7 X 12 LG. SHCS ZINC
30	2	010-7020	HIP ADJUSTER
31	2	010-7214	RETAINING PLATE 2020, PELVIS BONE
32	2	5000282	M6 X 1 X 22 LG. SHCS
33	1	5001147	M4 X 0.7 X 18 LG. SHCS

9.2.2 ASSEMBLY OF THE PELVIS ASSEMBLY COMPONENTS

The following procedure is a step-by-step description of the assembly procedure for the pelvis components.

1. **Assemble the Sacrum Top Plate (010-7211) to the Sacrum, Central Support Assembly (010-7250) with two M6 X 1 X 16 LG. SHCS and one M4 X 0.7 X 12 LG. SHCS. Then attach the Sacrum Bottom Plate (010-7213) to the Sacrum, Central Support Assembly (010-7250) with two M6 X 1 X 22 LG. SHCS and one M4 X 0.7 X 18 LG. SHCS.**

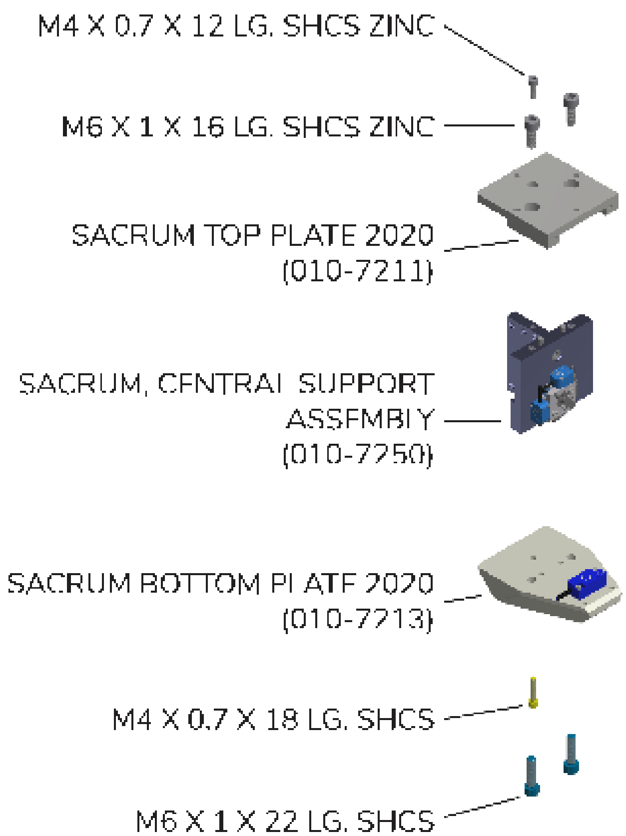


Figure 9.2 Assemble the Sacrum Top Plate, Central Support Assembly, and Bottom Plate Together

2. Assemble the Nut Plate (010-7024) and two Sacro Iliac Load Cell Structural Replacement (010-7023) to the Sacrum, Central Support Assembly (010-7250) with six M5 X 0.8 X 35 LG. SHCS as shown below.

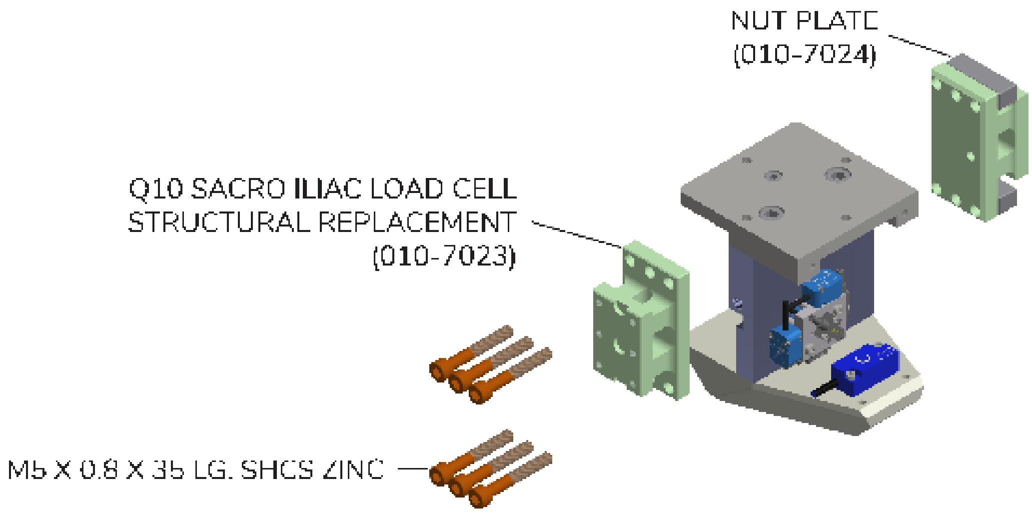


Figure 9.3 Attach the Sacro Iliac Load Cell Structural Replacement

3. Attach the Interface Sacro Iliac Load Cell (010-7022) to the Sacro Iliac Load Cell Structural Replacement (010-7023) with three M4 X 0.7 X 8 LG. SHCS and three M4 X 0.7 X 8 LG. BHCS on each side.

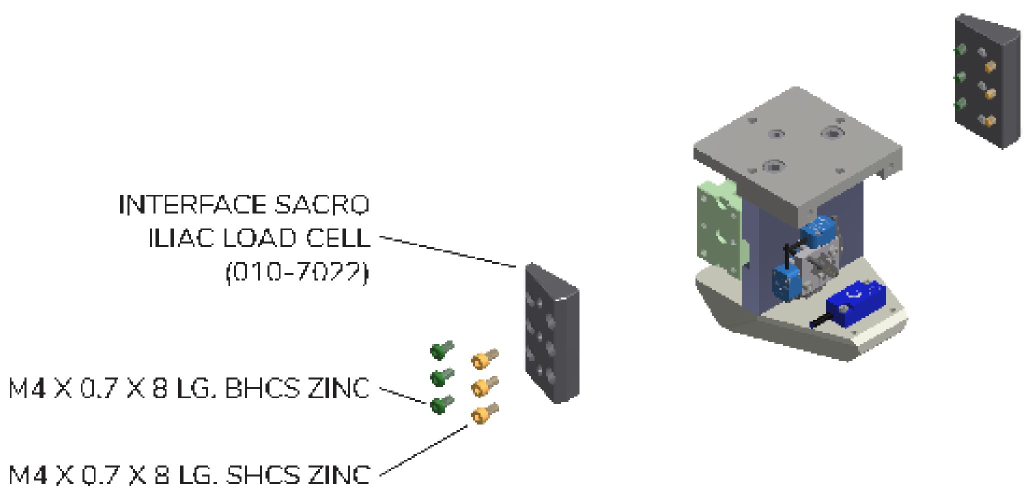


Figure 9.4 Attach the Interface Sacro Iliac Load Cell

4. Attach the DAS, Ballast Pelvis (010-7021 to the Sacrum, Front Plate (010-7203) with three M3 X 0.5 X 20 LG. SHCS. Then position the dowel pins on the Sacrum, Front Plate (010-7203) to the dowel pin holes on the sacrum bottom plate. Secure the Sacrum, Front Plate (010-7203) to the sacrum top plate with two M4 X 0.7 X 25 LG. SHCS.

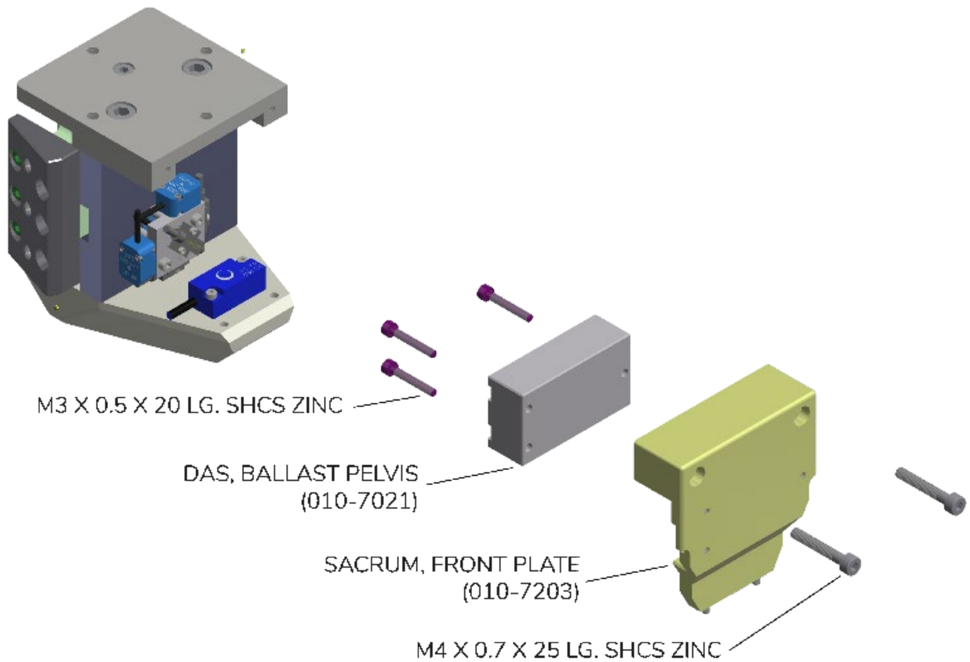


Figure 9.5 Attach the DAS Ballast, Pelvis to the Sacrum Front Plate

5. Attach the Pubic Buffer (010-7012) to the Pubic Load cell (W50-71059) with four M4 X 0.7 X 10 LG. SHCS on each side. Then attach the Iliac Wing (left: 010-7301; right: 010-7302) with two M5 X 0.8 X 16 LG. FHCS each side.

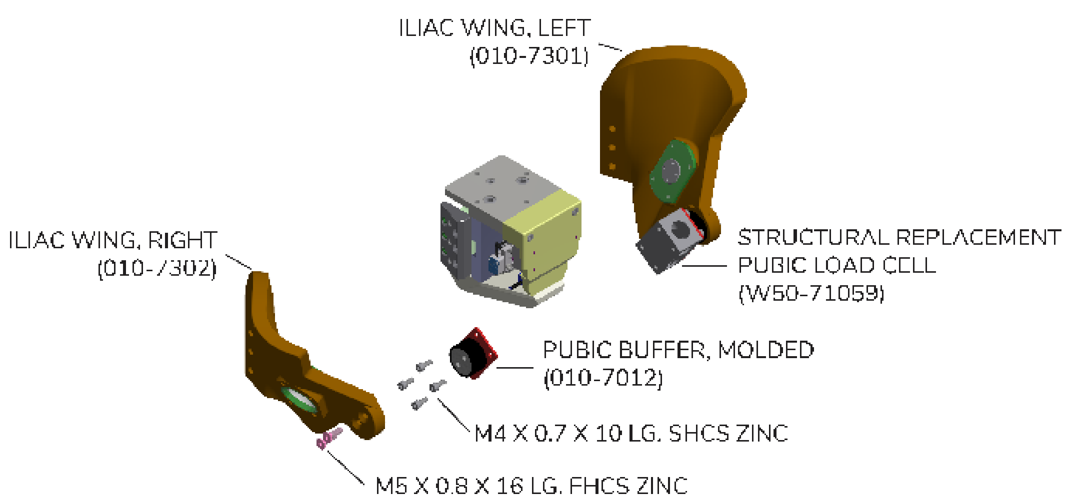


Figure 9.6 Attach the Iliac Wings, the Pubic Buffer and the Pubic Structural Replacement Load Cell

6. Attach the Load Cell Structural Replacement with four M5 X 0.8 X 16 LG. FHCS. Secure the Iliac Wings with the Retaining plate (010-7214) and three M3 X 1 X 30 LG. FHCS on each side.

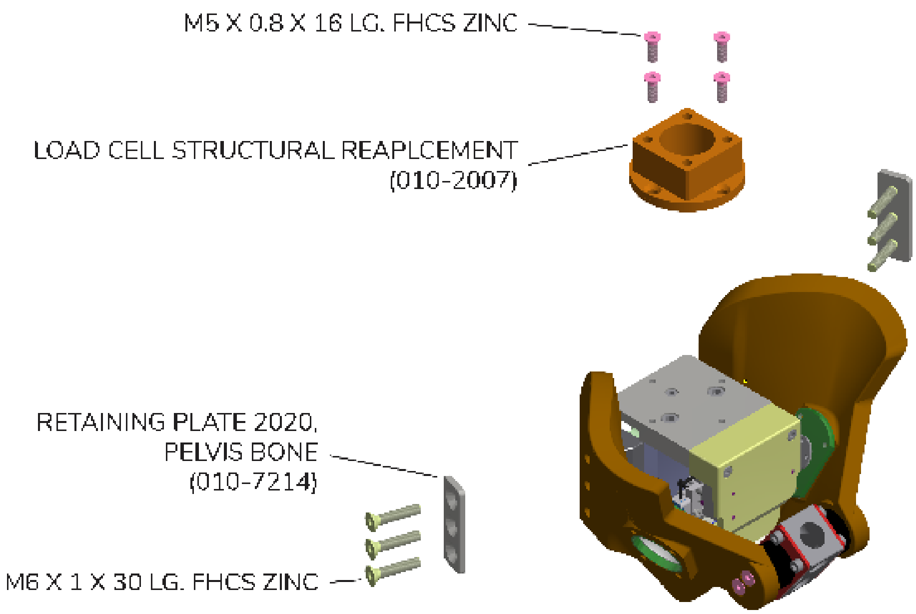


Figure 9.7 Attach the Retaining Plate and the Load Cell

7. Assembly the Pelvic Flesh (010-7002). Attach the Femur Ball Assembly (010-7006) and Hip Ball Retaining Plate (010-7004) with four M4 X 0.7 X 25 LG. FHCS on each side.

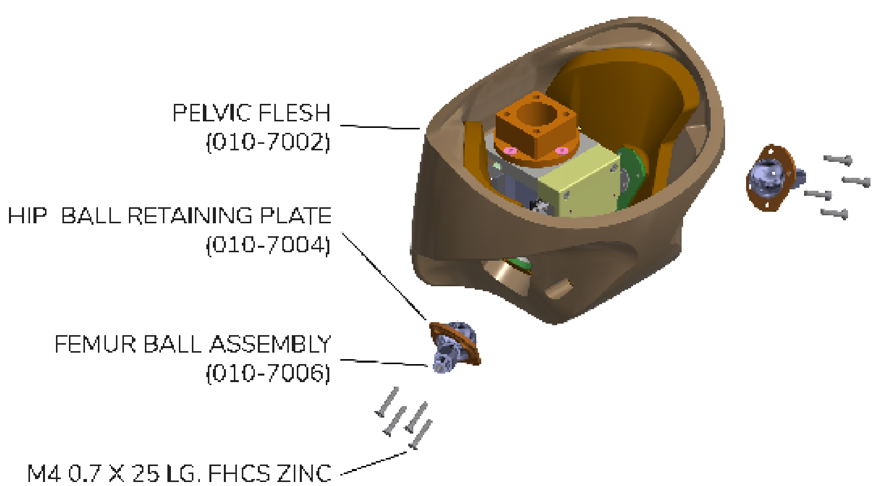


Figure 9.8 Assemble the Pelvic Flesh, Femur Ball Assembly, and Hip Ball Retaining Plate

If the hip balls have play or feel lose, the hip joints will need re-adjusting. The hip adjusters 010-7020 are located at the back of the hip cups inside the pelvis cavity. See figure below. These are locked with low strength thread lock on assembly to prevent them loosening, so should be stiff to undo. There is a special two prong tool in the tool kit which locates into holes in the adjuster. Remove the adjuster, clean the threads male and female and reassemble the adjuster. Turn clockwise to remove play: the joint should rotate and some friction should be felt in the hip ball when correctly adjusted. (The joint is not designed to apply a 1 g setting). Apply low strength thread lock before final adjustment approximately 2 turns before final position.

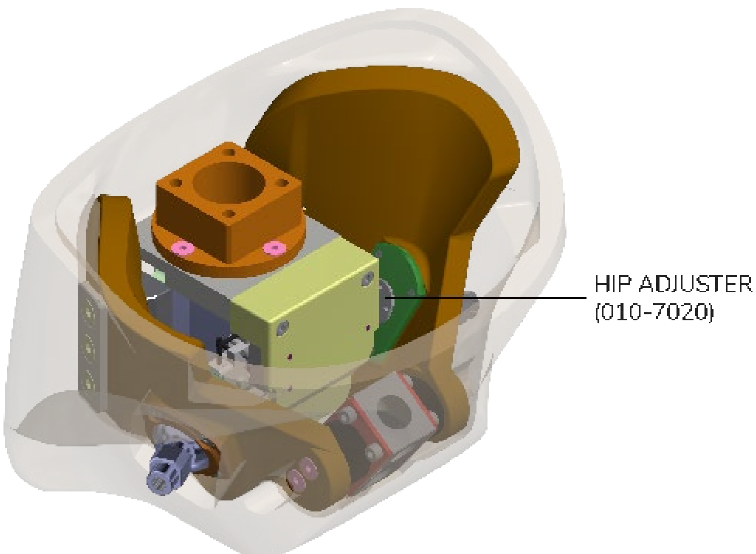


Figure 9.9 Hip Adjuster Location

SECTION 10
Leg Assembly

10.1 Description of Leg Assembly

Six axis femur load cells can be fitted. The friction in the knee joints can be adjusted to a one g setting. The lower legs use the same part both sides. The thigh flesh is made from solid urethane compared to standard Q10 and the feet are made 30 mm shorter relative to the standard Q10.

10.2 Assembly of the Leg

10.2.1 LEG ASSEMBLY PARTS LIST

The figure below shows the leg assembly, left 012-9100 and right, 012-9200.

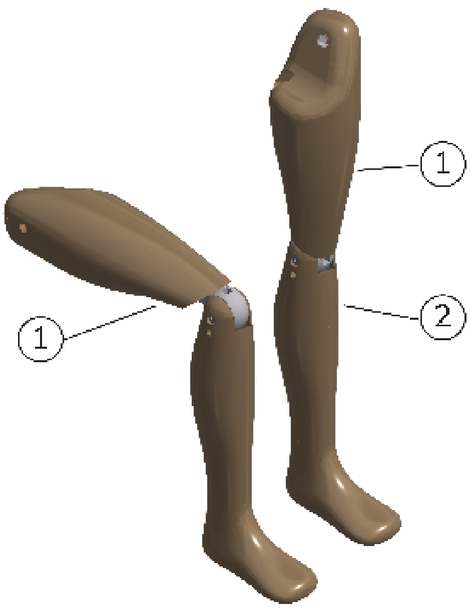


Figure 10.1 Leg Assembly View

Table 10-1 Leg Assembly Parts List

Item	Qty.	Part Number	Description
1	1	012-9101	UPPER LEG ASSEMBLY 2020, LEFT
1	1	012-9201	UPPER LEG ASSEMBLY 2020, RIGHT
2	1	010-9222	LOWER LEG FLESH 2020

Upper Leg Assembly

The figure below shows the exploded view of the Upper Leg Assembly, Left, 012-9101.

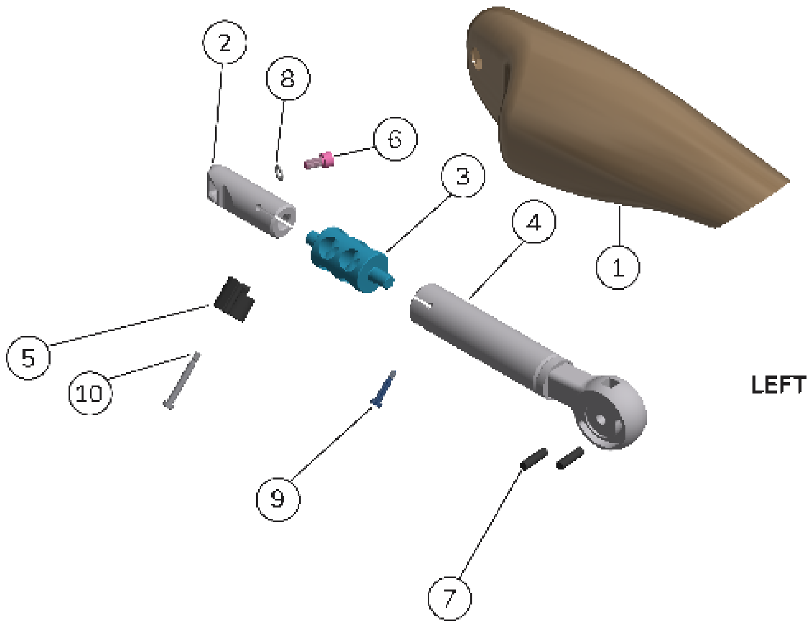


Figure 10.2 Left Upper Leg Exploded View

Table 10-2 Left Upper Leg Parts List

Item	Qty.	Part Number	Description
1	1	010-9230	UPPER LEG FLESH, LEFT
2	1	010-9106	FEMUR BONE, LEFT
3	1	010-9311	FEMUR LOAD CELL STRUCTURAL REPLACEMENT
4	1	010-9108	UPPER LEG WELDMENT, LEFT
5	1	010-9109	FLESH RESTRAINT INSERT
6	1	5001042	M8 X 1.25 X 16 LG. SHCS
7	2	010-9110	KNEE BUFFER
8	1	9000022	5/16 FLAT WASHER PLAIN SS
9	1	5000626	M6 X 20 LG. SHSS
10	1	5001206	M6 X 40 LG. SHSS

The figure below shows the exploded view of the Upper Leg Assembly, Right, 012-9201.

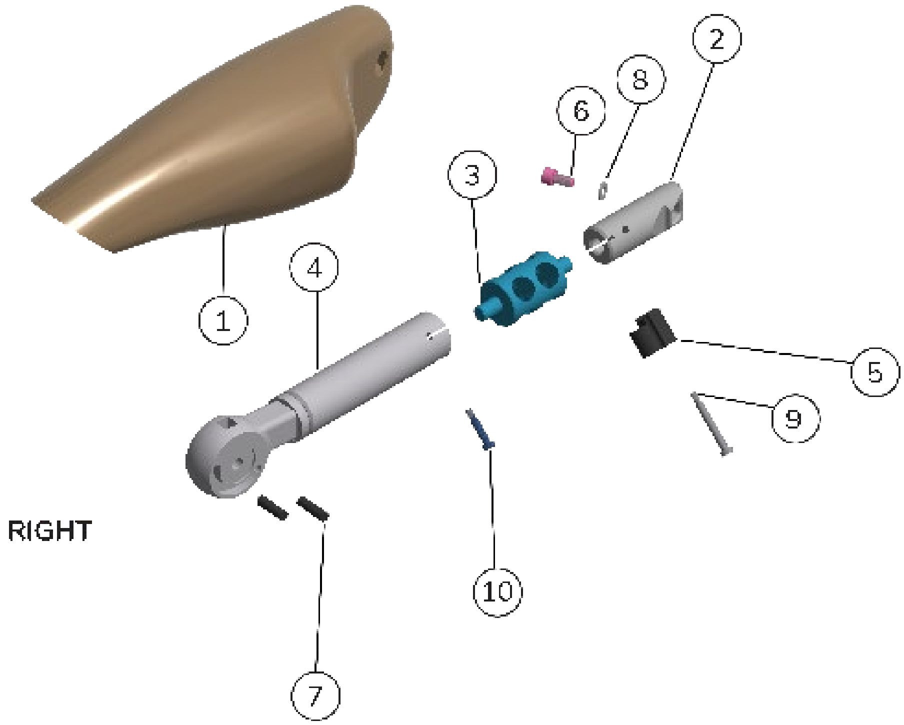


Figure 10.3 Right Upper Leg Exploded View

Table 10-3 Right Upper Leg Parts List

Item	Qty.	Part Number	Description
1	1	010-9231	UPPER LEG FLESH, RIGHT
2	1	010-9206	FEMUR BONE, RIGHT
3	1	010-9311	FEMUR LOAD CELL STRUCTURAL REPLACEMENT
4	1	010-9208	UPPER LEG WELDMENT, RIGHT
5	1	010-9109	FLESH RESTRAINT INSERT
6	1	5001042	M8 X 1.25 X 16 LG. SHCS
7	2	010-9110	KNEE BUFFER
8	1	9000022	5/16 FLAT WASHER PLAIN SS
9	1	5001206	M6 X 40 LG. SHSS
10	1	5000626	M6 X 20 LG. SHSS

Lower Leg Assembly

The figure below shows the exploded view of the Lower Leg Assembly LH and RH, 010-9222.

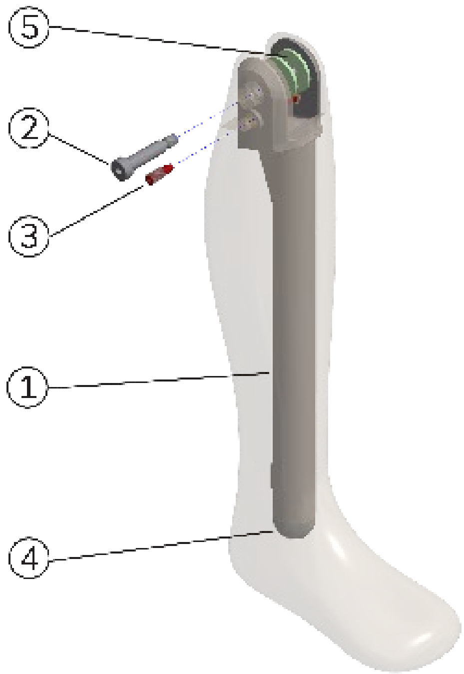


Figure 10.4 Lower Leg exploded view

Table 10-4 Lower Leg Parts List

Item	Qty.	Part Number	Description
1	1	010-9209	LOWER LEG BONE WELDMENT ASSEMBLY
2	1	010-9217	SCREW, M10 X 35 LG. SHSS, MODIFIED
3	2	010-9215	SCREW, SSNT M8 X 20 MODIFIED
4	1	010-9223	END CAP, LOWER LEG BONE NCAP
5	2	010-9216	WASHER, KNEE SPACER

10.2.2 ASSEMBLY OF THE LEG COMPONENTS

The following procedure is a step-by-step description of the assembly procedure for the leg components.

Before fitting the lower leg, ensure the knee buffers are in place. Fit the two plastic washers (010-9216) into their recesses in the knee and slide the lower leg yoke over the knee of the upper leg, align and fit the knee pivot SHSS M10 X 35 (010-9217). The two Nylon tipped friction-stop SSNT M8 X 20 (010-9215) fit into the M8 threaded hole on both sides of the lower leg, these are screwed in as far as it will go. Set the knee friction by tightening or loosening evenly the friction set screws at both sides of the knee. The maximum intended friction is 1 g with the lower leg fully extended.

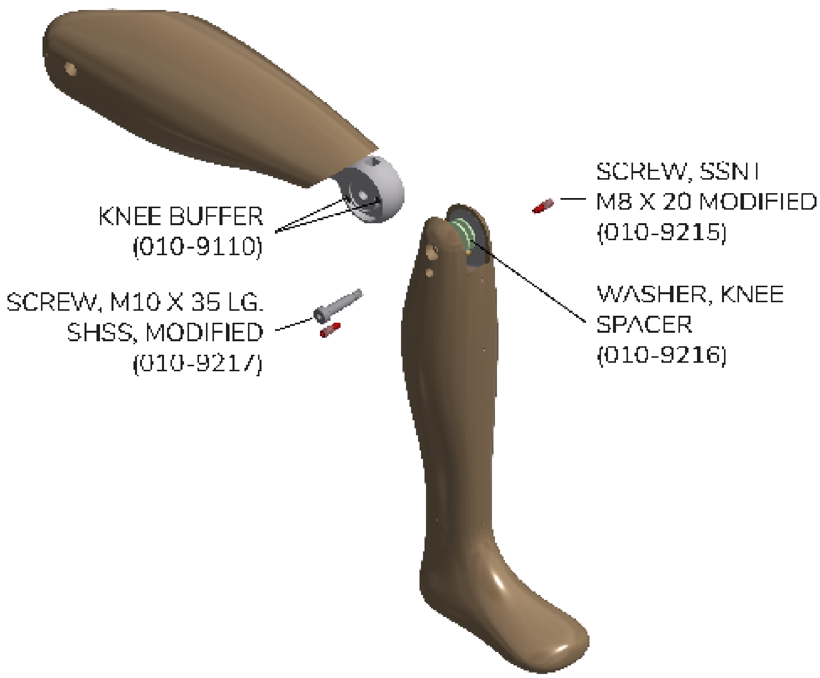


Figure 10.5 Attach the Lower Leg to the Upper Leg

10.2.3 ASSEMBLY OF THE UPPER LEG TO THE PELVIS

Attach the legs to the pelvis with one 5/16 washer and one M8 X 1.25 16 LG. SHCS each side.

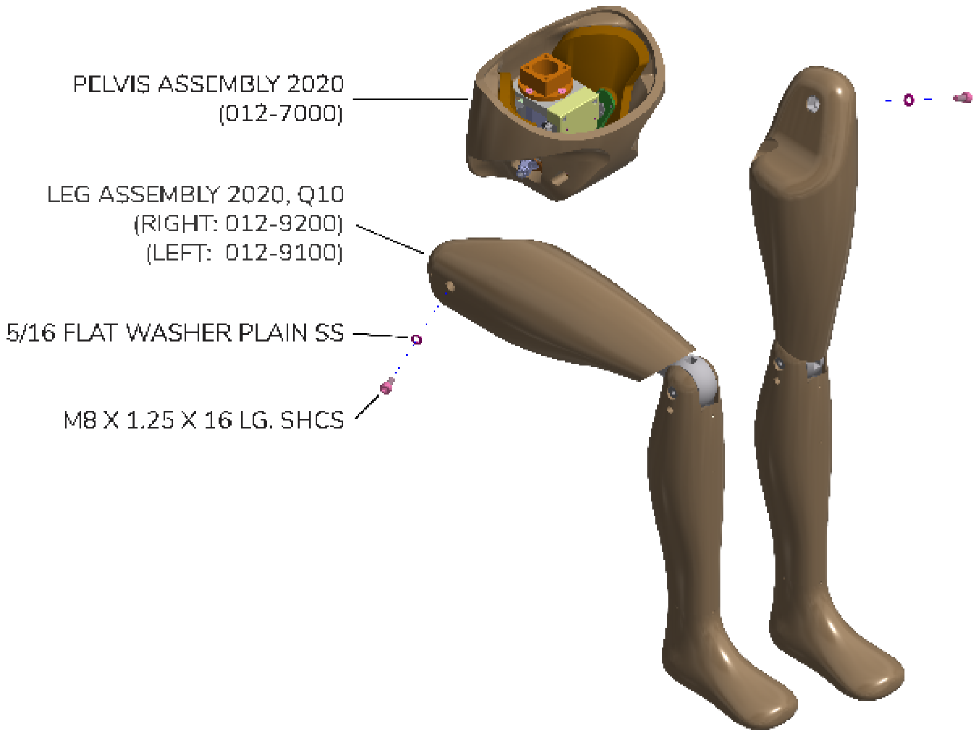


Figure 10.6 Attach Legs to Pelvis

SECTION 11

Dummy Suit and Hip Shield

11.1 Description of the Suit and Hip Shield Features

The dummy is dressed in a tight-fitting neoprene suit (010-8000) split with an upper and lower part connected with a zipper at abdomen level. This suit is an integral part of the dummy and should be worn by the dummy during all tests. A suit with a 50 x 50mm grid on the chest is optional, part 010-8000 GS for high speed video analysis.

The hip shields are red colored plastic covers (left hand and right hand) fitted outside the suit over the hip area once the dummy has been positioned. These are for the frontal configuration only to prevent the lap belt going into the gap between the pelvis and upper leg flesh preventing potential submarining.

11.2 Assembly of the Suit

11.2.1 SUIT PARTS LIST

The following table shows the parts associated with the Q10 Suit drawing, 010-8000.

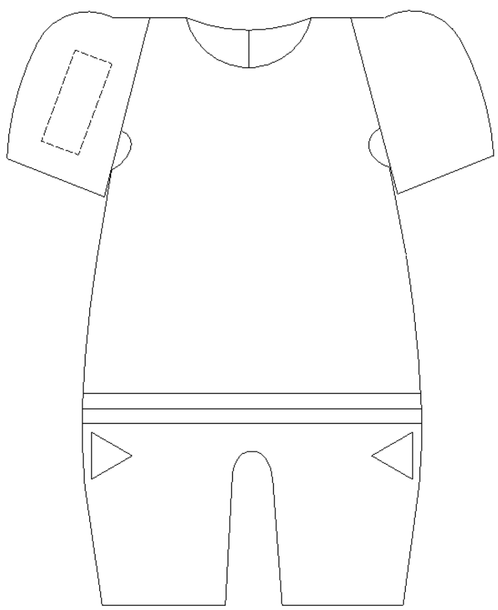


Figure 11.1 Suit

11.2.2 ASSEMBLY OF SUIT

The following procedure is a step-by-step description of the assemble procedure for the jacket assembly.

1. **To put the suit on, put the lower suit part on over the legs and pull the shorts section well into the crotch and over the buttocks. Rolling the dummy on each of its sides subsequently helps when fitting the lower suit.**
2. **Then put the arms through the sleeves of the upper suit and pull it upward towards the arm pits. Turn the sleeves around the upper arms and pull them towards the elbow, so that the shoulder part of the sleeves fit properly over the upper arm. Zip up the zipper around the abdomen then close the suit at the back using the hook and loop fasteners (Velcro). Pull the shorts towards the knees so that the suit pants are flush over the dummy.**
3. **The dummy does not wear shoes.**

11.3 Assembly of the Hip Shields

The hip shields, right hand and left hand are meant to prevent the belt trapping between pelvis and thigh in frontal tests only, these should be installed in the contour with pelvis and thigh, when the dummy is in its desired test position with the shorts pulled forward. See pictures below. The hip shields are attached with Velcro as shown in **Figure 11.2**. When fitted there should be a gap between the hips shields of 154 mm minimum to allow the belt to freely load the pelvis bones without interference from the shields. See **Figure 11.3** below.

The shields must be replaced after a maximum of 20 tests or when the dummy is being re-certified. Humanetics recommends they are replaced every 5 tests.

Figure 11.2 Fitting of the Hip Shields

Figure 11.3 Fitted Hip Shields with Recommended Min. Distance between Shields

12.1 General

The dummy accepts both accelerometers and load cells as standard instrumentation. Angular velocity sensors (DTS ARS) can be fitted to the head thorax and pelvis. The dummy can be equipped with uni-axial accelerometers for all locations.

The load cells or their structural replacements are a part of the dummy structure; the structural replacements have to be used in absence of the actual transducer. A 6 channel load cell (FTSS model IF-217-HC, High Capacity) can be placed in the upper neck, lower neck and lumbar spine location. The pelvis can be fitted with a WorldSID pubic load cell W50-71051S3 and two 6 channel sacro-iliac load cells. The upper legs can also be fitted with 6 channel femur load cells. A 3-channel shoulder load cell can also be fitted with the side impact shoulder kit. Two channel ASIS load cells have recently been added as optional.

12.2 Transducers

The Q10 2020 dummy can be fitted to measure the following parameters:

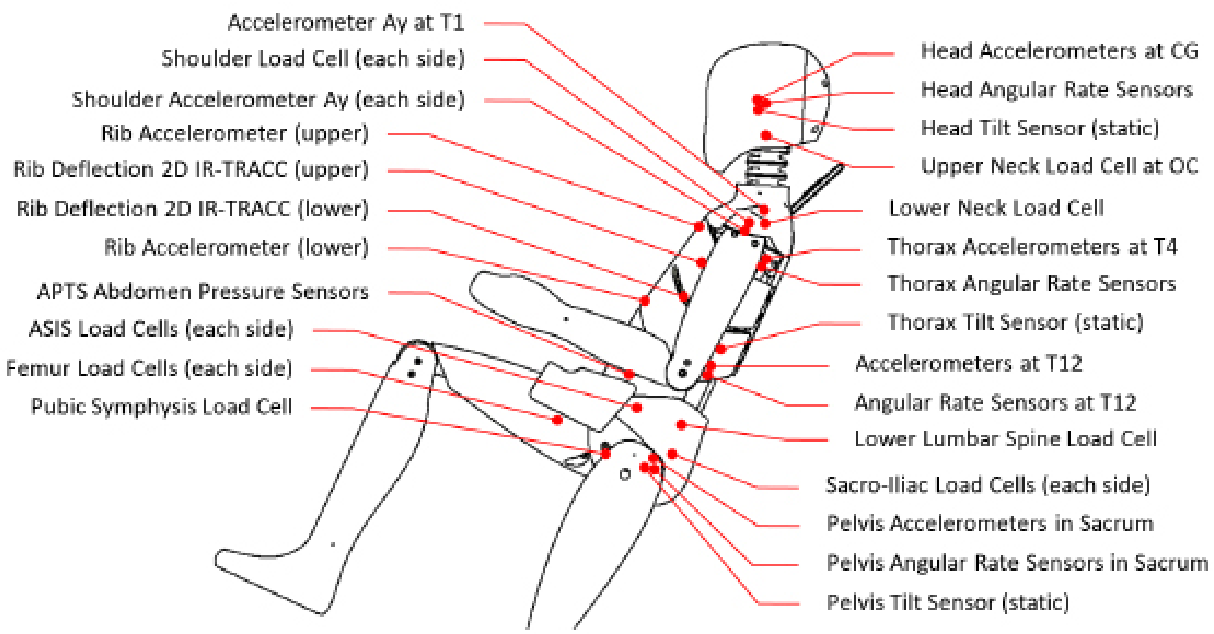


Figure 12.1 Q10 2020 Instrumentation Overview

Table 12-1 Q10 2020 Instrumentation

Location	Instrumentation Description
Head	
Standard	3 uni-axial accelerometers in head (Ax, Ay, Az)
Optional	DTS ARS 3 uni-axial angular velocity sensors (ωx, ωy, ωz)
	IES tilt sensor (for static measurement during dummy positioning)
Neck	
Standard	Upper neck 6 channel load cell, 3 forces, 3 moments (Fx, Fy, Fz, Mx, My, Mz). Model IF-217-HC (the high capacity version is required)
	Lower neck 6 channel load cell, 3 forces, 3 moments (Fx, Fy, Fz, Mx, My, Mz). Model IF-217-HC (the high capacity version is required)
Thorax	
Standard	3 uni-axial accelerometers at T4 location in upper spine (Ax, Ay, Az)
	2 IR-TRACC 2D sensors to measure chest deformation, frontal or lateral (Dx or Dy and ϕxy) model IF-372.
Optional	Additional accelerometers may be installed on the thorax and the rib cage (see notes below) (Ax, Ay).
	DTS ARS 3 uni-axial angular rate sensors (ωx, ωy, ωz)
	T1 acceleration (Ay) for testing optional but used for certification
	Shoulder acceleration (Ay)
	Shoulder forces (Fx, Fy and Fz) side shoulder kit only models IH-10970JI4 right and IH-10980JI4 left
	IES tilt sensor (for static measurement during dummy positioning)
Lumbar Spine	
Standard	6 channel load cell at base of lumbar spine/ pelvis interface (Fx, Fy, Fz, Mx, My, Mz). Model IF-281J-HC
Optional	Ax, Ay accel and ωx, ωy angular rate sensor at top of lumbar spine
Abdomen	
Optional	Abdomen Pressure Twin Sensor (APTS) for R129 regulation
Pelvis	
Standard	3 uni-axial accelerometers and angular rate sensors in sacrum structure (Ax, Ay, Az) and (ωx, ωy, ωz)
Optional	DTS ARS 3 uni-axial angular rate sensors (ωx, ωy, ωz)
	Lateral pubic load cell (Fy,) model W50-71051S3.
	6 channel sacro iliac load cells left and right (Fx, Fy, Fz, Mx, My, Mz).
	ASIS load cell (Fx, My)
Legs	
Standard	6 channel femur load cell LH IH-12590J and RH IH-12610J (Fx, Fy, Fz, Mx, My, Mz).

Notes:

1. **Two IR-TRACCs can be mounted to measure lateral deflection on the left or right side.**
2. **Information on the installation of the instrumentation can be found in the assembly/disassembly section of this manual.**
3. **The Upper Neck Load Cell does not require any correction for measurement of the moment around the OC joint. The (theoretical) OC joint coincides with the neutral axis of the moment measurement of the load cell.**

12.3 Accelerometers Mounts

Humanetics supports these brands/models of accelerometers:

- **Endevco 7264A, 7264B & 7264C type**
- **Kyowa ASM Series**
- **MS 64C**
- **EGAS-FS-50**

The following accelerometers and mounts can be used for the Q10 dummy:

Table 12-2 Uni-Axial Accelerometers

Accelerometer Type	Location Head	 Thorax	 Pelvis
ENDEVCO 7264-2000 7264C-2000 7264D MS 64C KYOWA ASM-200BA MSC 126M/CM	1 034-1201 allows for ARS or 020-1017 without ARS	034-1201 allows for ARS or 020-1017 without ARS	034-1201 allows for ARS or 020-1017 without ARS
7264A 7264B EGAS-FS-50	036-1101 allows for ARS or I.AD without	036-1101 allows for ARS or I.AD without	036-1101 allows for ARS or I.AD without

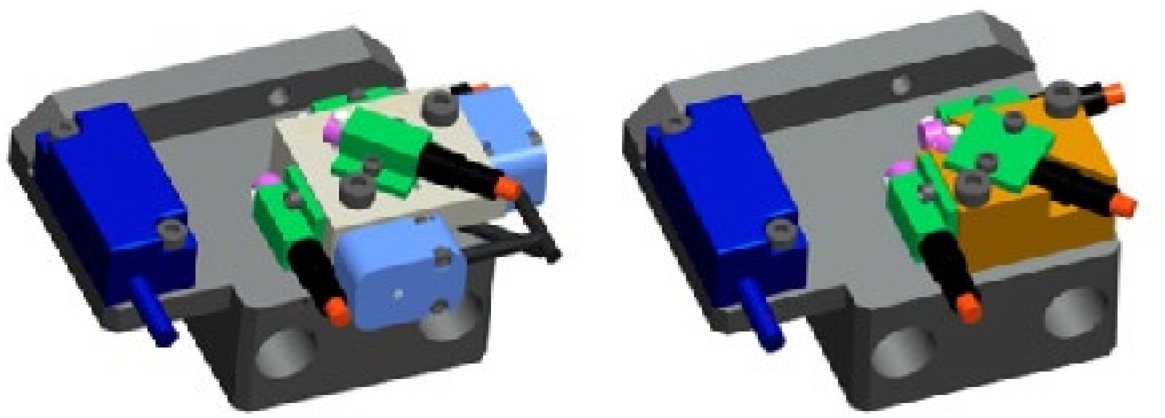


Figure 12.2 Head Accel Mounts for Type 7264C (034-1201 with ARS & 020-1017 w/o)

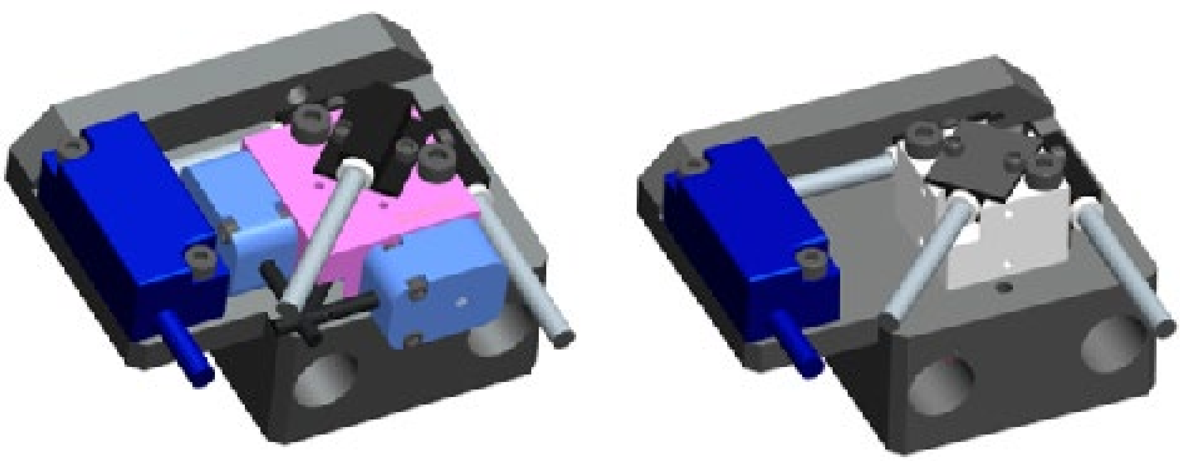


Figure 12.3 Head Accel Mounts for Type 7264B (036-1101 with ARS & I.AD w/o) for T1 Accelerometer

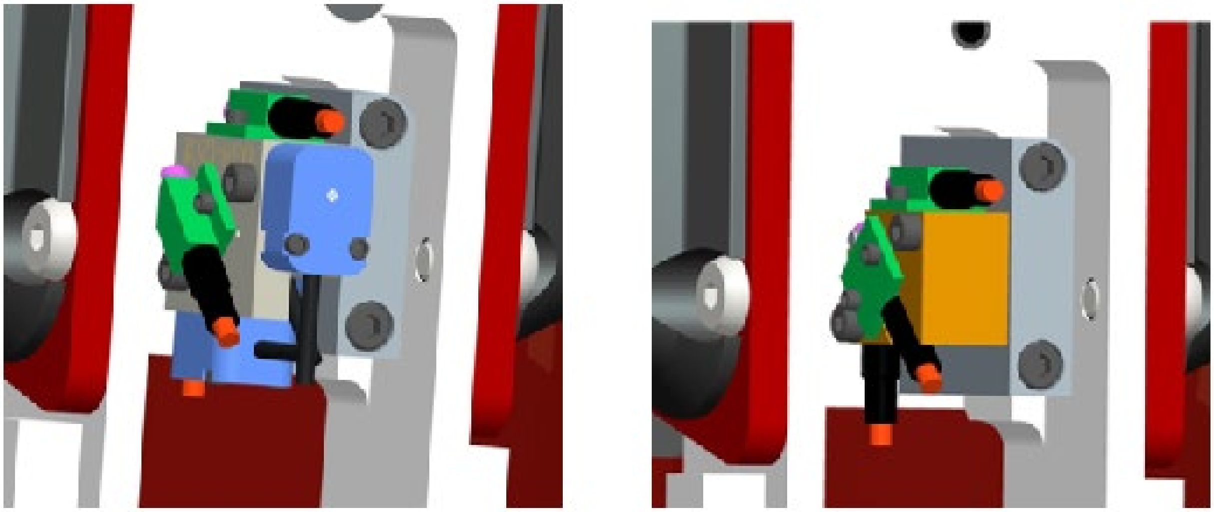


Figure 12.4 Thorax Accel mounts at T4 for Type 7264C (034-1201 with ARS & 020-1017 w/o)

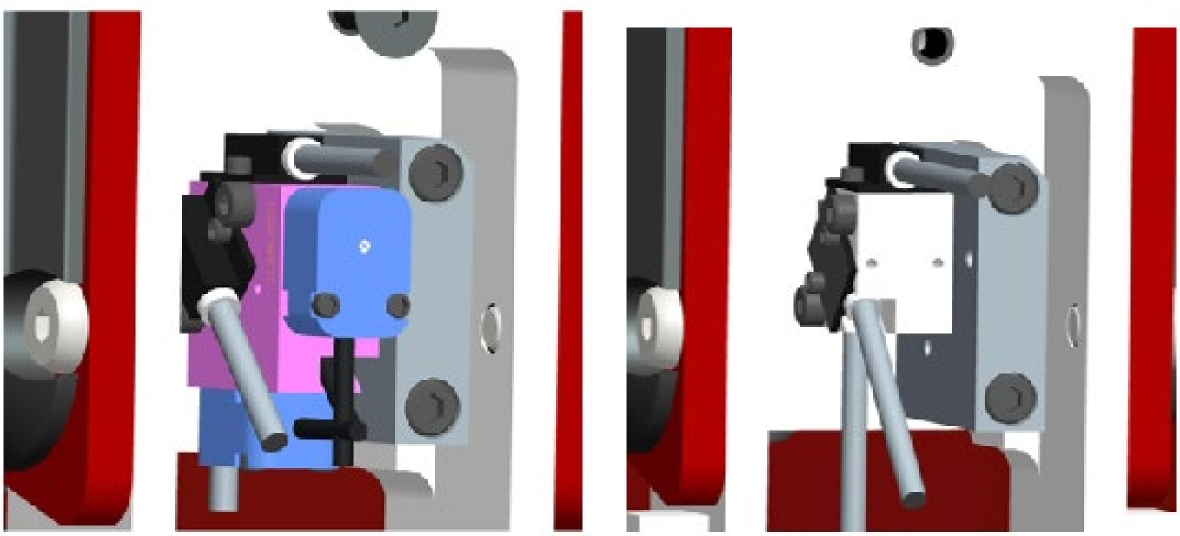


Figure 12.5 Thorax Accel Mounts at T4 for Type 7264B (036-1101 with ARS & I.AD w/o)

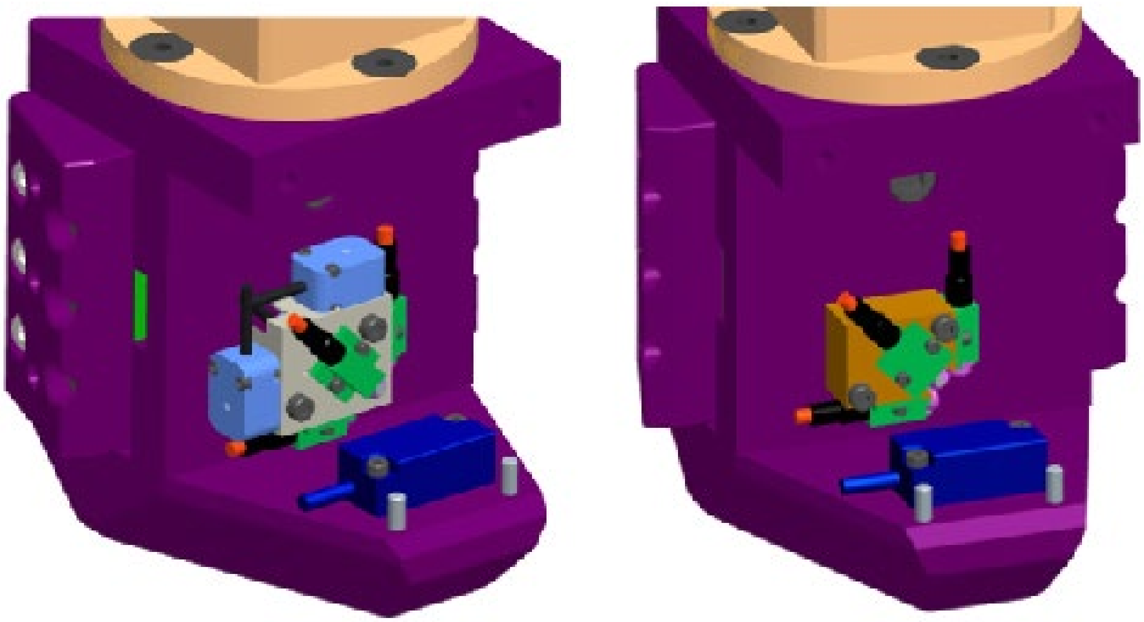


Figure 12.6 Pelvis Accel Mounts for Type 7264C (034-1201 with ARS & 020-1017 w/o)

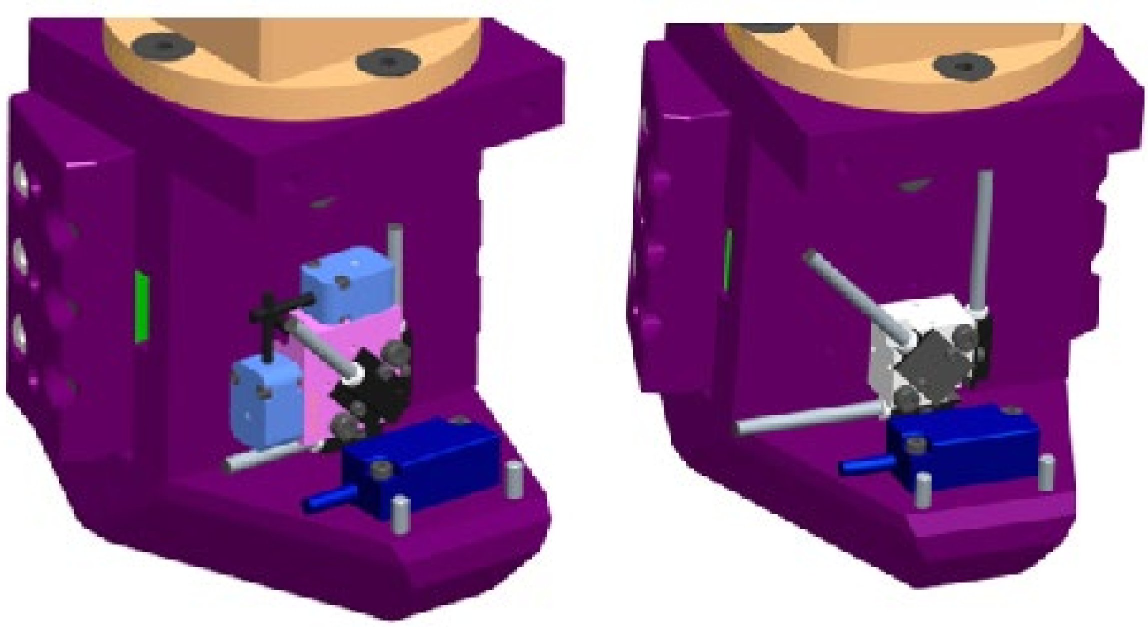


Figure 12.7 Pelvis Accel Mounts for Type 7264B (036-1101 with ARS and I.AD w/o)

12.4 Cable Routing

The general guideline is that all cables should be routed towards the thoracic spine of the dummy. Cables should run from the top, to the base of the thoracic spine. At the lumbar spine/thorax interface, the cables go either towards the left or the right side. The abdomen has been formed to allow the routing of the cables in such a way that they lie recessed between the rib cage and the pelvis skin. A cable cover is mounted on the back of the thoracic spine. This cover will protect the cables and provides a fixed contour on the back of the dummy.

Consideration must be given to the cables inside the pelvis. The cables of the accelerometers and the angular rate sensors should not protrude to the front or bottom of the sacrum as in lateral impacts the wires could be damaged due to bottoming out of the iliac wing. If fitted the cable of the pubic symphysis load cell should be routed to the non-impact side of the sacrum top plate, to the back of the dummy. The picture below shows recommended wire routing for LH and RH impacts.

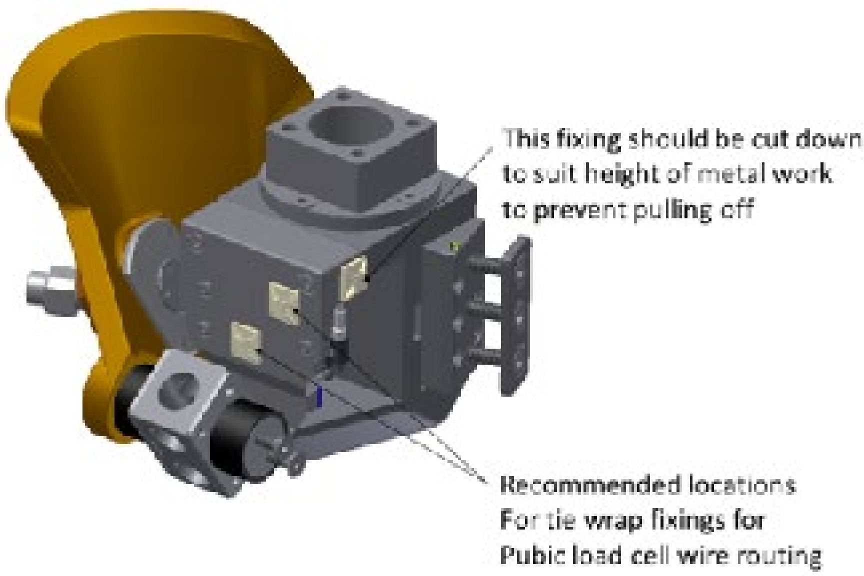


Figure 12.8 Recommended Wire Routing to Pubic Load Cell

12.5 Abdomen Pressure Twin Sensor (APTS)

12.5.1 PURPOSE

To measure belt pressure on abdomen, particularly for submarining. Injury criteria has been established under regulation R129.

12.5.2 DESCRIPTION

The sensors are polyurethane bladders closed with an aluminum cap and filled with fluid. The pressure generated in the bladder is measured via a sensor in the cap. The APTS system is a requirement in regulation R129. The sensor design was developed by IFSTARR and is sold by Transpolis SAS. The bladders come in three sizes 30, 40 and 50 mm diameter. The larger 50 mm diameter is used on Q10.

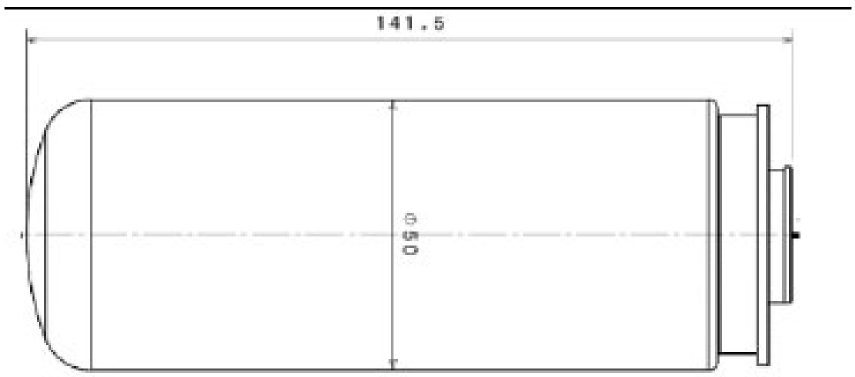


Figure 12.9 50 mm Bladder Details

The APTS are mounted inside a special abdomen assembly part number 010-4309. This part has two blind holes for the sensors parallel to the lumbar spine. The APTS are inserted aluminum cap down and the sensor cables come out through small holes at the base on the blind holes. The bladders are put into Lycra sleeves to reduce friction with the abdomen and held in place with Velcro at the bottom of the hole. The abdomen assembly is delivered with foam plugs to facilitate standard certification of the abdomen as in **Section 15.16 bdomen Certification.** The Lycra sleeves are not used with the foam plugs.

The APTS have a higher density than the removed standard foam so there is an increase to the abdomen of around 184 grams that is added to the R129 mass distribution.

Figure 12.10 Q10 Abdomen APTS Sleeves Assembled w/o Sensors & Foam Plugs for Certification

For information on biofidelity, sensitivity, performance, repeatability, reproducibility and injury criteria development refer to EEVC document number 661.

The assembly and component part numbers are listed below.

Table 12-3 APTS Component Part Numbers

Qty.	Part Number	Description
1	010-4309	ABDOMEN ASSEMBLY, APTS, TESTED & CERTIFIED
1	010-4311	ABDOMEN APTS, Q10
2	010-4306	SENSOR SLEEVE, FABRIC WITH STRING TIE
2	010-4307	SENSOR REPLACEMENT, FOAM

Pretest Checks

Before performing a test, a visual inspection of the dummy should be performed. Special attention should be paid to the following items.

Neck

- ✓ **The rubber-molded parts of the neck should not be damaged, that is: it should not show any tear and wear. By bending the neck slightly small cracks can be detected.**
- ✓ **The neck cable should be checked on visible damage only periodically.**

Neck Shield

- ✓ **Check for signs of damage, this part is still usable with some damage as long as it maintains integrity.**
- ✓ **After testing, check that the neck shield is in the correct position before testing.**

Shoulders

- ✓ **Periodically examine the shoulder to spine interface for splits in the rubber or de-laminating from the end plates.**

Clavicle

- ✓ **Inspect the clavicle periodically for cracks in the material.**

Rib Cage

- ✓ **Check the rib cage for tears and cracks in the material. Deform the rib by hand, as this will show cracks, if present. Cracks can be hidden by PVC skin that covers the outside of the rib cage. To find significant damage, pay special attention to the rear of the rib at the spine interface and around any holes and edges.**

Lumbar Spine

- ✓ **Inspect the rubber molding for tears and cracks. Replace if the spine is damaged.**
- ✓ **The cable must be inserted and the nut at the top screwed on. There is no pretension required. The nut should be tightened up until play is eliminated.**

Abdomen

- ✓ **The abdomen should be checked periodically (10 tests) for tearing of the PVC skin. Note that the wear of the abdomen is reduced by observing the proper installation procedure. First remove the upper torso. The abdomen can then be removed by lifting it out of the pelvis.**
- ✓ **After testing check that the abdomen is in the correct location before testing.**

Pretest Checks

Pelvis

- ✓ Check the legs rotate freely in the hip socket there should be a light friction feel.

Arms

- ✓ Check the friction setting of the shoulder and elbow regularly.

Legs

- ✓ Check the leg attachment bolts are tight. Check the friction setting of the knees regularly.

Cable Routing

- ✓ Always provide sufficient slack in the cables to allow the dummy to deform without putting any strain on the cables. This is especially important for the instrumentation located in the head (accelerometers, load cell). Please note that the slack can cause the cables to snag behind some other object in the test set-up, which can result in damage of the head instrumentation.

Suit

- ✓ Check the suit for major cuts and tears that would affect performance.
- ✓ When the dummy is installed in the crash environment, pull the sleeves towards the elbow and the pants towards the knees so that they fit smoothly over the dummy.
- ✓ Install the hip shields when the dummy is in its desired test position, these are meant to help prevent the belt trapping between pelvis and thigh in frontal tests.

Dummy Certification

- ✓ Besides the inspections to be performed before each test as described above, the dummy should be regularly certified to check its performance.
- ✓ It is advised to certify the dummy regularly as described in Section 14, Certification Procedures.

Time Interval between Tests

- ✓ When conducting tests with the dummy or with dummy components a time interval of at least 30 minutes should be observed between consecutive tests. This also applies when, for example, a lateral test is followed by a frontal test using the same dummy component.

Pretest Checks

13.1 Recommended Spare Parts

During operation dummy parts can fail. When the dummy is exposed to extreme pulses a failure can suddenly occur. Normally, however, an early warning for a part that may fail is noticed during the certification procedures. It is recommended that the dummy is inspected as described above before each test and certify the dummy regularly as described in Section 15, Certification Procedures. To safeguard continuous operation with the Q10 dummy it is recommended to take and maintain the following spare parts in stock:

Table 13-1 Recommended Spare Parts List

Part Number	Qty.	Description
010-4100	1	RIBCAGE ASSEMBLY TEST AND CERTIFIED
010-8000	1	SUIT
010-2000	1	NECK
010-6000	1	LUMBAR SPINE
3670-10	2	BALL JOINT IR-TRACC*
010-8001	1	HIP SHIELD LEFT
010-8002	1	HIP SHIELD RIGHT

* If the ball joint is replaced the IR-TRACC should be subjected to the absolute length verification as described in Section 19, IR-TRACC Processing.

SECTION 14

Certification Equipment

14.1 Requirements

The frequency of the Q10 certification and the number of tests that can be performed between certifications strongly depends on the type and severity of the tests in which the dummy is used, as well as the test frequency. Which certification tests have to be carried out depends on the dummy application (UNECE-Regulation, Full Scale NCAP, Airbag), and is different for frontal and side impact tests. When used in side impact applications, the dummy must be certified depending on the side of impact. Although it can be assumed that the dummy performance is symmetrical it is recommended to certify for lateral impact the side that will be impacted. For NCAP it is recommended to certify the dummy every 20 tests, frontal and side combined.

The dummy and dummy parts should be kept in the test environment at least 4 hours prior to the use in a test. The testing laboratory environment should be controlled to have:

• A temperature of 20 ± 2 degrees Celsius.

• A relative humidity of 40 ± 30%.

When conducting certification tests a time interval of at least 30 minutes should be observed between two consecutive tests. This also applies when, for example, a lateral test is followed by a frontal test using the same dummy or dummy component.

When certifying the dummy, a particular order of operation should be observed:

1. **Perform the component tests: head, neck, lumbar spine and abdomen,**
2. **Perform the full body tests on the dummy with the certified components: thorax for frontal and shoulder, thorax and pelvis for lateral impact.**

To perform the certification tests, certain test setups are required: a head drop table, a wire-suspended pendulum for the full body impacts, an abdomen compression device, a part 572 neck pendulum and a Q series headform for neck and lumbar spine certifications. In chapter 13.2 the use of the test setups and some dedicated Q10 test equipment is described.

14.2 Equipment

14.2.1 HEAD DROP

For the free-fall head drop test, a support and release mechanism is necessary as well as steel plate with a thickness of at least 50 mm this will act as an impact surface. This plate should be similar to the plate described in CFR 49, Part 572 Hybrid III head drop test, and should have equivalent roughness and size. In the drop test the head should be equipped with an additional head certification mass (TE-010-1007) which represents half a load cell (replacement).

14.2.2 NECK AND LUMBAR SPINE

A pendulum which meets the requirements of CFR 49 part 572.33(c) is needed to perform the certifications of the neck and lumbar spine, see below. The spine or neck are mounted upside down on the pendulum arm using an interface plate which replaces the standard part 572 pendulum mounting plate. To load the part, a headform is used, which is shown in the figures below.

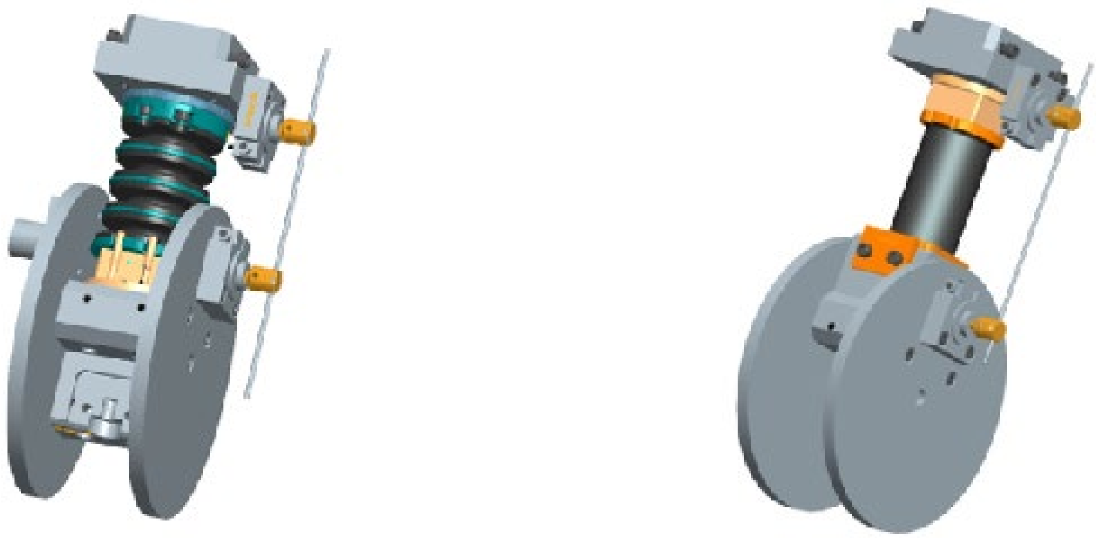


Figure 14.1 Neck (left) and Lumbar Spine (right) Headform Test Set-Up for Frontal Test

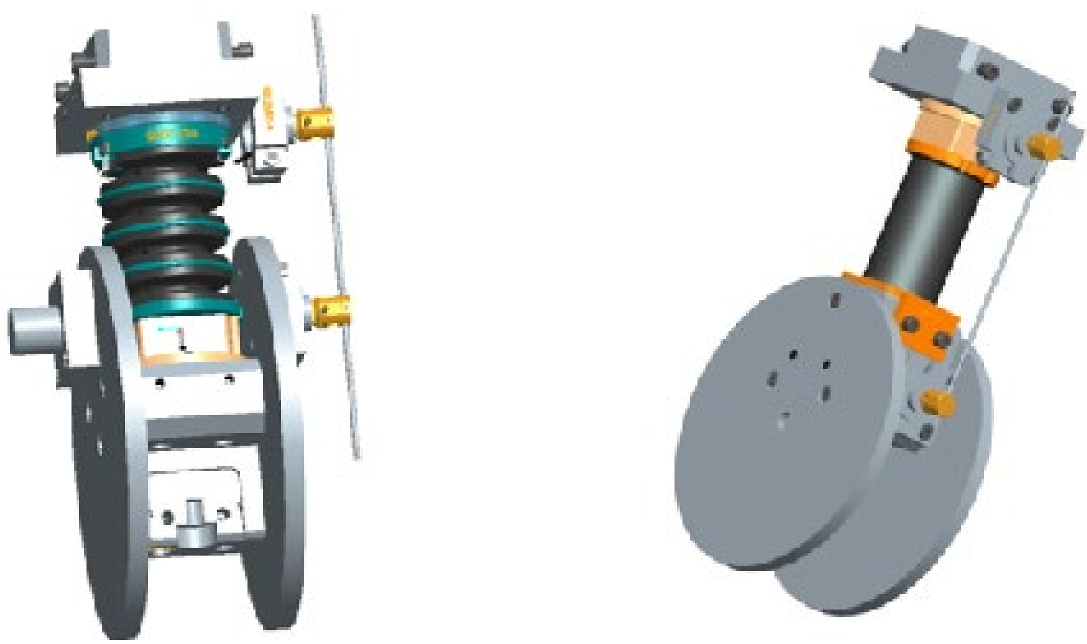


Figure 14.2 Neck (left) and Lumbar Spine (right) Headform Test Set-Up for Lateral Test

The total mass of the neck headform should be 2.736 ± 0.05 kg, including the high capacity load cell. The total mass of the lumbar headform should be 2.48 ± 0.05 kg. The interface to the part 572 pendulum should weigh 0.95 ± 0.02 kg.

The neck or lumbar spine is attached upside down to this pendulum. The neck is attached to the pendulum base with a neck adaptor plate TE 010-2015. Between the pendulum base and the lumbar spine a load cell (IF-217-HC) or load cell structural replacement (010-2007) is mounted. A headform is used to load the neck or lumbar spine. This headform consists of two flat disks connected by an interface, which allows certification of both the neck and the lumbar spine. Moreover the headform carries a potentiometer at one side and ballast mass at the opposite side.

The headform has different configurations: one for testing the neck and one for testing the lumbar spine. **Figure 14.6,** sheet 1 shows the headform setup in neck testing configuration. The central block (TE-2650-14) is dedicated for Q10, because of the Q10 lumbar spine upper attachment asymmetry.

For testing the neck, the large end of the central block is facing towards the pendulum arm.

When testing the neck, a load cell (IF-217-HC) is mounted between the neck and the central block.

To test the lumbar spine, the discs need to be removed and mounted on a dedicated Q10 central block TE-2650-14. The large end of the central block must be facing away from the pendulum. Note: That the central block is mounted 180 degrees relative to the neck mounting. The upper lumbar bracket mounts directly to the small end of the central block. Make sure that the lumbar spine column centerline is in the same plane as the centerline of the headform disks. In the lumbar spine test no load cell or load cell structural replacement is required between the lumbar spine and the headform. (See **Figure 14.1** right and **Figure 14.2** right).

Two rotational potentiometers are used to measure the angle of the headform relative to the pendulum arm. One potentiometer is attached to the pendulum interface, the other to the headform (See **Figure 14.1** and **Figure 14.2**). A thin rod connects the potentiometers. The rod should be fixed to the headform potentiometer (using an M3 set screw), but be able to slide freely through the hub on the axis of the pendulum interface potentiometer. The rod must be protruding from both potentiometer axes equal length. A balance mass is attached to the opposite side of the headform to assure symmetrical loading of the neck and lumbar spine. The potentiometer and balance mass are mounted on the sides of the headform with their common centerline perpendicular to the movement of the pendulum. This can be seen in **Figure 14.3** and **Figure 14.4**.

The neck and lumbar spine test fixture can be used for both frontal and lateral testing of the neck and lumbar spine. For testing in frontal direction the headform discs are parallel to the axis of the pendulum. For lateral lumbar test the headform discs are perpendicular to the axis of the pendulum for lateral neck the discs are parallel, see **Figure 14.4.** Both configurations use three screws for fixing the discs to the central block. The angle transducer and the balance weight of the headform must be repositioned when changing from frontal to lateral testing and vice versa.

14.2.3 FULL BODY PENDULUM

The full body pendulum, part number TH-010-9920 “Q10 Probe Assembly” (see figure below), consists of a hollow metal tube closed at both ends, two axles with suspension pulleys and a speed vane. An accelerometer which measures the longitudinal acceleration must be mounted on the rear end. An Endevco model 2262CA-200 or equivalent is recommended.

The total mass, including instrumentation, suspension pulley wheels and speed vane (the release wire not included) as well as the impactor face dimensions are specified in the table below.

Table 14-1 Probe Specs

Description	Q10 Probe
Probe weight including speed vane, accelerometers and rigidly attached hardware	8.76 ± 0.1 kg
Probe impact face diameter	112 mm
Impact face round off radius	5 mm

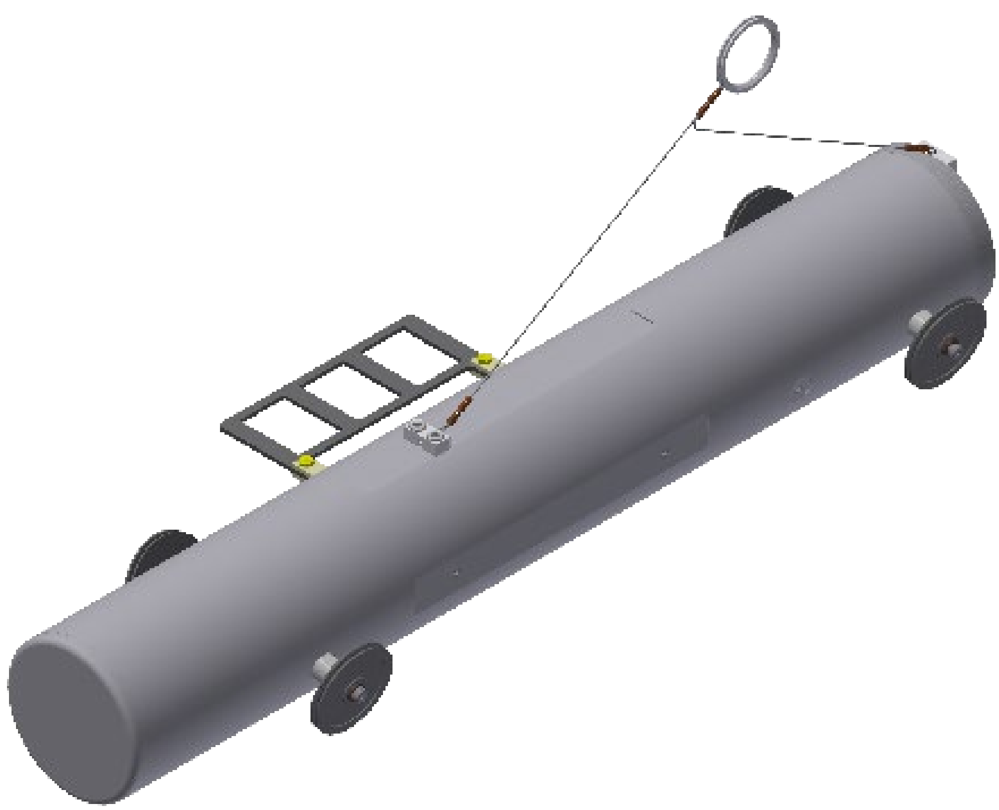


Figure 14.3 Q10 Full Body Impactor

The impactor is suspended as a guided pendulum by six 7 x 7 stainless steel wires (2 mm diameter). The figure below shows a front view of the impactor and four of the suspension wires in the required cross configuration. At the rear pulleys four suspension wires are used: two wires forming a trapezoid and two crossing wires. At the front pulleys only the two outer wires forming a trapezoid and no cross wires are used.

A flat, horizontal surface should be available to sit the dummy on. The impact velocity of the impactor must be measured and recorded.

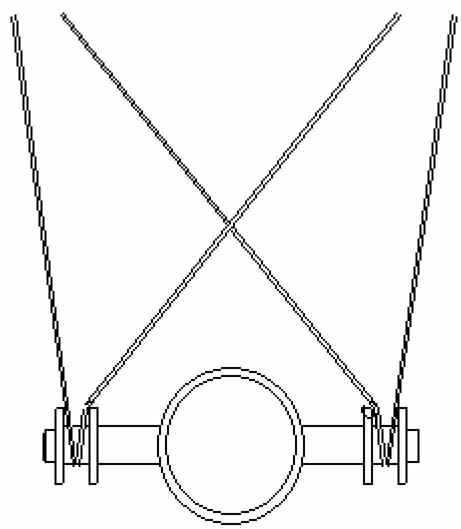


Figure 14.4 Full Body Pendulum Impactor Suspension Wire Diagram

14.2.4 ABDOMEN TEST RIG

The abdomen test compresses the abdominal insert between a Q10 abdomen certification support block (Part number TE-010-9910) and a flat plate. The support block shape matches the shape of the rear side of the abdomen. The support is placed on a horizontal surface, and the abdomen is placed on the block with the front outer surface facing up. A guided flat plate should be placed parallel to the horizontal base plate on top of the abdomen. The dimensions of this plate are 300 by 250 mm, and the mass is 2.05 ± 0.025 kg. A picture of the set-up is shown in **Figure 15.10** and **Figure 15.11**.

14.3 Equipment List

The table below shows the equipment required for certification.

Table 14-2 Equipment Parts List

Part Number	Description	Test
TE-010-1007	HEAD CERTIFICATION MASS	HEAD DROP
TE-2651	HEAD POSITIONING BASKET	HEAD DROP
TE-2650	HEADFORM Q DUMMIES	NECK AND LUMBAR SPINE
TE-010-2015	INTERMEDIATE PLATE	NECK
TE-2650-14	CENTRAL BLOCK	LUMBAR
TE-010-9910	ABDOMEN CERTIFICATION	ABDOMEN
TH-010-9920	BODY PROBE Q10	THORAX

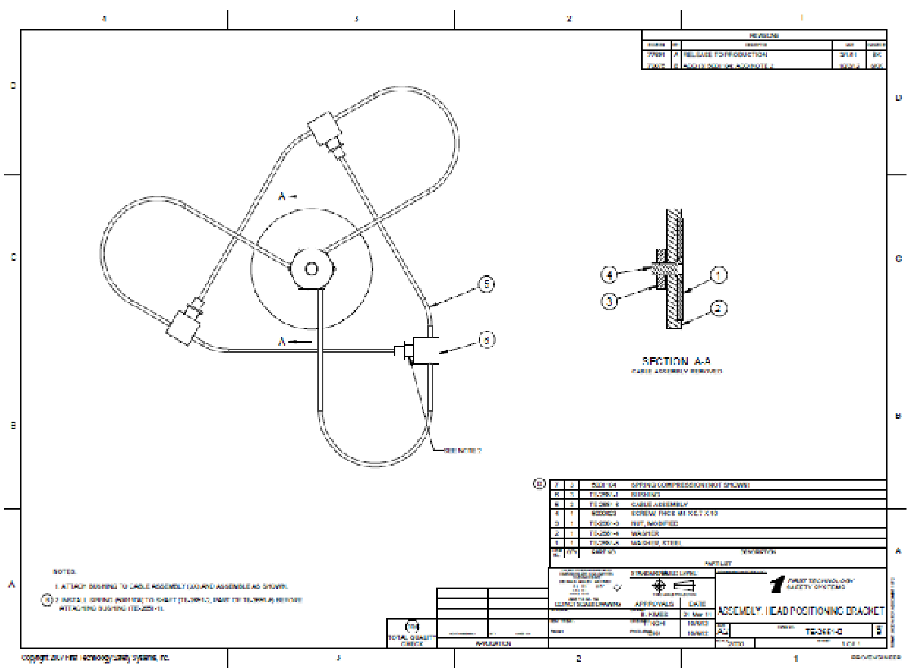
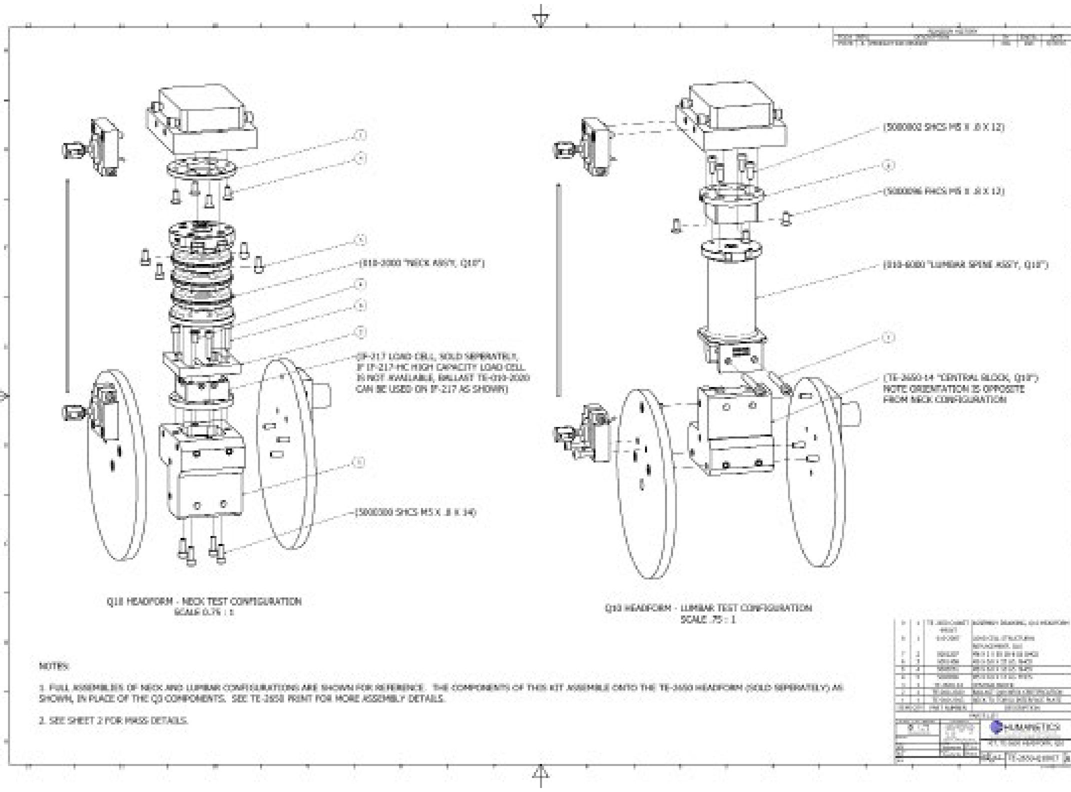


Figure 14.5 TE-2651 Head Drop Fixture



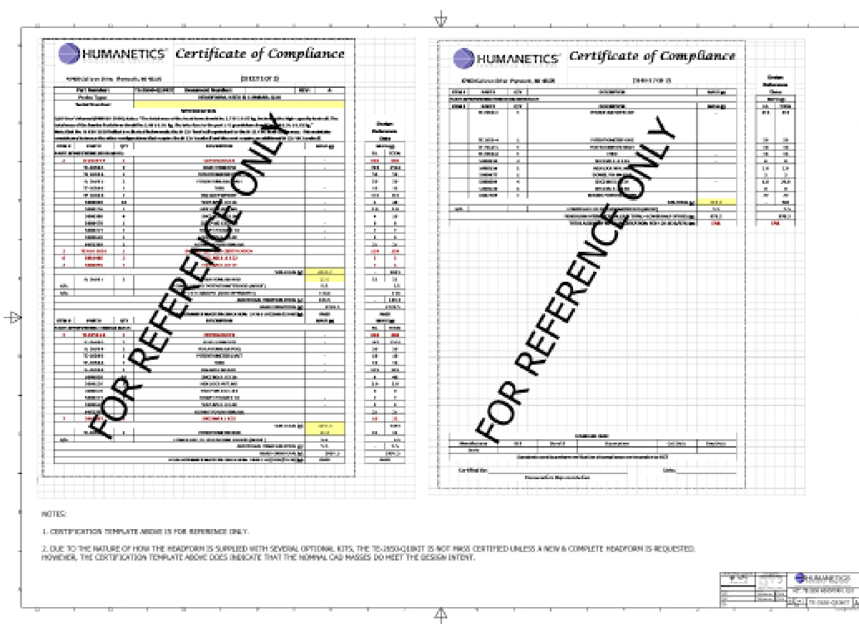


Figure 14.6 TE-2650-Q10KIT Neck and Lumbar Headform

Figure 14.7 From Left, Neck Adaptor Plate, Head Drop Ballast, and Lumbar Central Block

SECTION 15
Certification Procedures

15.1 Head Certification

15.1.1 GENERAL

No tears or cracks in the skin and skull are allowed.

The head is suspended above a rigid, thick, metal plate. The properties of this plate are described in **Section 14.2.1 Head Drop** under the heading “Head Drop” of this manual. The Head test is performed with a head drop table as described in CFR 49, Part 572.152

Mount the half load cell replacement (head drop ballast TE-010-1007) to the lower face of the head base.

The data acquisition system and all instrumentation must comply with the requirements of SAE J211, version March 1995. All data channels should be filtered using a hardware filter prior to A/D conversion according to SAE J211, version March 1995.

15.1.2 INSTRUMENTATION

Mount three uni-axial accelerometers to one of the accelerometer mounts in **Table 12-2** and fit into the head as shown **Figure 12.2 & Figure 12.3** (the angular rate sensors shown in the pictures are not required).

15.2 Frontal Impact Head Certification

15.2.1 TEST PROCEDURE

1. **The head is suspended above a Part 572 plate. Users are advised to use a thin wire basket (TE-2651) to position the head. The net has a piece of steel attached to it, which allows the use of a magnet to keep the head in place. The net allows easy adjustment of the head in any orientation.**
2. **The z-axis of the head should make an angle of 28 ± 2 degrees with the horizontal plane, and the medial-lateral axis should be horizontal, ± 1 degree. When released, the head should impact the surface with its forehead. The z-axis of the head is parallel to the skull cap plane, see figure below.**
3. **The lowest point of the head should be 130 ± 1mm above the impact surface.**
4. **Release the head.**
5. **The minimum time interval to observe on same location is 30 minutes.**

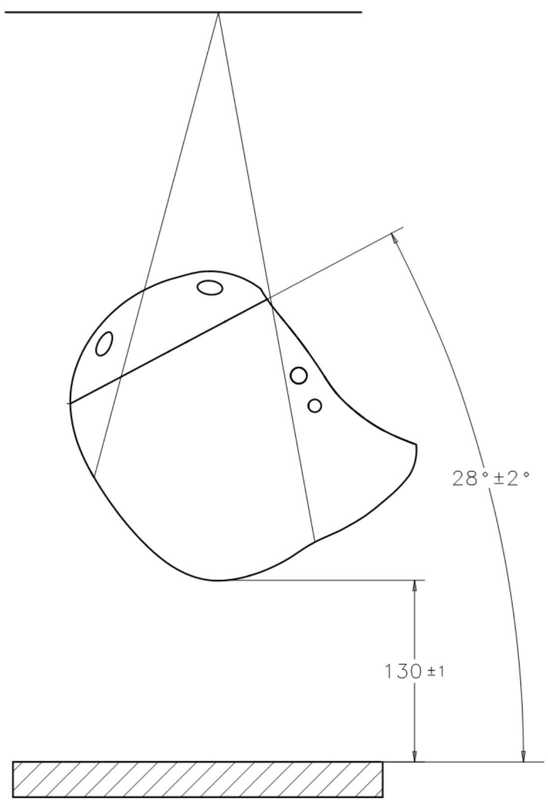


Figure 15.1 Frontal Impact Test Procedure

15.2.2 DATA PROCESSING

1. All three accelerations should be filtered at CFC1000.
2. Determine the resultant head acceleration.

15.2.3 REQUIREMENT

1. The maximum resultant head acceleration response should be between 124.2 – 151.8 g's.
2. The acceleration in Y-direction should be between -10 and 10 g.

15.3 Lateral Impact Head Certification

15.3.1 TEST PROCEDURE

1. The head is suspended above a Part 572 metal plate. Users are advised to use a thin wire basket (TE-2651) to position the head. The net has a piece of steel attached to it, which allows the use of a magnet to keep the head in place. The net allows easy adjustment of the head in any orientation.
2. Position the head in such a way that the mid-sagittal plane has an angle of 35 ± 2 degrees with the horizontal axis, and the anterior-posterior axis is horizontal, ± 1 degree. This corresponds to an angle between the horizontal plane and the head base plane of 55 ± 2 degrees, see figure below. When released, the head should impact the surface with the side of its head. Both side's left hand and right hand can be tested in accordance with what is desired.
3. The lowest point of the head should be 130 ± 1 mm above the impact surface.
4. Release the head.
5. The minimum time interval to observe on same location is 30 minutes.

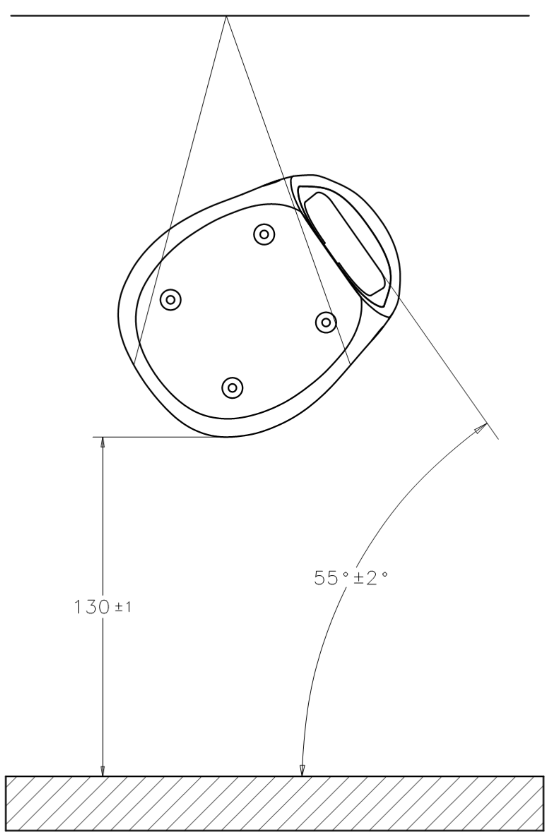


Figure 15.2 Lateral Impact Test Procedure

15.3.2 DATA PROCESSING

1. **All three accelerations should be filtered at CFC1000.**
2. **Determine the resultant head acceleration.**

15.3.3 REQUIREMENT

1. **The maximum resultant head acceleration response should be between 128.7 – 157.3 g's.**
2. **The acceleration in X-direction should be between -20 and 20 g.**

15.4 Neck Certification

15.4.1 GENERAL

The neck test is a component test, which is performed using a pendulum as defined in CFR49 part 572. The complete neck consists of the following parts:

Table 15-1 Neck Test Components

Part Number	Qty.	Description
010-2005	1	NECK MOLDING
010-2200	1	NECK CABLE ASSEMBLY
5000374	4	SCREW, FHCS M5 X 12
5000291	4	SCREW, SHCS M5 X 10
IF-217 HC	1	LOAD CELL

The neck is attached upside down to the pendulum base (TE-2650-1). A headform is used to load the neck. This headform consists of two flat disks connected by central block (TE-2650-14), which allows certification of both the neck and the lumbar spine. The headform orientation is measured using two rotational potentiometers. One is installed on the base of the neck-pendulum interface. The second one is attached to the headform. The sum of the two angles measured on the potentiometers is the angle of the head relative to the pendulum. Moment is measured using an upper neck load cell IF-217 HC mounted between the headform and the neck.

The data acquisition system and all instrumentation must comply with the requirements of SAE J211, version March 1995. All data channels should be filtered using a hardware filter prior to A/D conversion according to SAE J211, version March 1995.

The pendulum acceleration should be measured with an accelerometer, which is located on the pendulum arm, 1657.4 mm from the pendulum pivot in accordance with the CFR 49 Part 572.

15.5 Flexion Neck Test

15.5.1 SET-UP

1. **Assemble the complete neck, as described in Section 5, Neck Assembly.**
2. **Attach the IF-217-HC 6 Axis Load Cell to the top of the neck with four M5 x 10 SHCS with wires aligned with cut outs in neck plate. Attach the load cell and neck to the headform with four M5 x 12 FHCS with load cell wires to non-impact side.**
3. **Attach the intermediate plate TE-010-2015 to the pendulum base with four M5 countersunk screws see drawing TE-2650** Figure 14.6 **above. Attach the neck to the pendulum interface plate (four, M5 SHCS).**
4. **Align the neck and the interface, making sure that longitudinal axis of the neck is in the direction of motion of the pendulum arm.**
5. **Attach the headform-neck system to the Part 572 pendulum. The front of the neck should point in the direction of motion of the pendulum. See figure below.**
6. **Install the potentiometers to the mounting interface and on the headform. Mount the balance weight for the potentiometer on the other side of the headform. This ensures that the inertial properties of the head are symmetrical in the impact direction.**
7. **Insert the rod connecting the axes of the potentiometers and tighten the screw on the bottom-most axis (headform potentiometer) to secure the rod. The other end of the rod should be able to slide freely through the upper most transducer axis (pendulum base potentiometer). The rod must be protruding from both sides of the transducers axes equal length.**
8. **The minimum time interval to observe between tests on the neck is 30 minutes.**

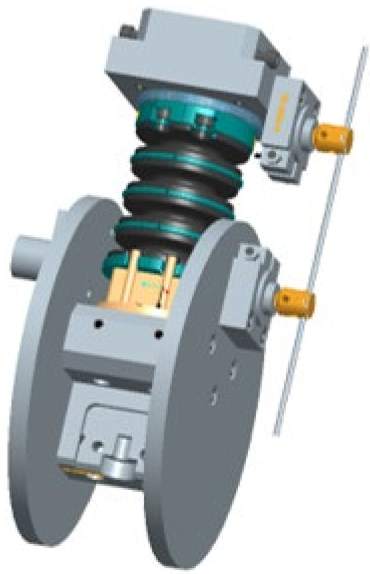


Figure 15.3 Neck Certification Setup for Frontal Flexion Test, View from Rear in Drop Position

15.5.2 PERFORMING THE TEST

1. **To stop the pendulum, attach honeycomb material to the pendulum anvil. Use 152.4 mm (6") thick aluminum Hexcel density 28.8 Kg/m3 (1.8 lb/ft3) with a number of cells appropriate to meet the pulse requirement in** Table 15-2 Pendulum Velocity**.**
2. **Auto-balancing and shunt calibration of the transducer signals should be performed with the pendulum arm in the vertical position.**
3. **Lift the pendulum up to its pre-test height and check that the headform is in the correct initial position (symmetric with respect to neck top yoke). Do not leave the head-neck system in this position for more than 1 minute, as the neck will start to deform due to the mass-gravity loading of the headform.**
4. **Release the pendulum.**

15.5.3 DATA PROCESSING

1. **Filter the pendulum acceleration at CFC180.**
2. **Filter the potentiometer readings at CFC600.**
3. **Filter the load cell readings at CFC600**
4. **Determine time zero of the impact by finding the 1 g deceleration level in the pendulum signal (after software filtering).**
5. **Software zero all transducer readings by averaging the part of the signal before time zero and subtracting this from the transducer reading.**
6. **Integrate the pendulum acceleration to check the deceleration velocity of the pendulum. The velocity of the arm must be calculated at a point 1657.4 mm from the pendulum pivot point.**
7. **Sum the potentiometer signals to derive the total head angle of the headform relative to pendulum arm.**

15.5.4 REQUIREMENTS

1. **The impact velocity should be at 4.8 ±0.1 m/s.**
2. **The pendulum velocity decrease should be as indicated in the table below.**

Table 15-2 Pendulum Velocity

Time (ms)	Lower Limit (m/s)	Upper Limit (m/s)
10	1.0	2.0
20	2.3	3.4
30	3.6	4.8

To meet the requirements of the frontal neck certification test:

- **The maximum head angle should be 50.4 – 61.6 degrees.**
- **The peak moment within the head angle corridor shall be 28.8 – 35.2 Nm.**

15.6 Extension Neck Test

15.6.1 SET-UP

1. **Assemble the complete neck, as described in** Section 5, Neck Assembly**.**
2. **Attach the IF-217-HC 6 Axis Load Cell to the top of the neck with four M5 x 12 SHCS with wires aligned with cut outs in neck plate. Attach the load cell and neck to the headform with four M5 x 12 FHCS with load cell wires to non-impact side.**
3. **Attach the intermediate plate TE-010-2015 to the pendulum base with four M5 countersunk screws. Attach the neck to the pendulum interface plate (four, M5).**
4. **Align the neck and the interface, making sure that longitudinal axis of the neck is in the direction against the motion of the pendulum arm.**
5. **Attach the headform-neck system to the Part 572 pendulum. The front of the neck should point in the direction against the motion of the pendulum. See figure below.**
6. **Install the potentiometers to the mounting interface and to the headform. Mount the balance weight for the potentiometer on the other side of the headform. This ensures that the inertial properties of the head are symmetrical in the impact direction.**
7. **Insert the rod connecting the axes of the potentiometers and tighten the screw on the bottom-most axis (headform potentiometer) to secure the rod. The other end of the rod should be able to slide freely through the upper most transducer axis (pendulum base potentiometer). The rod must be protruding from both sides of the transducers axes equal length.**
8. **The minimum time interval to observe between tests on the neck is 30 minutes.**

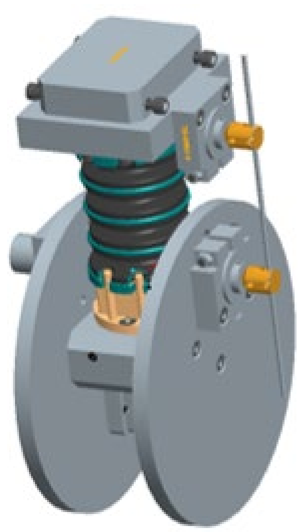


Figure 15.4 Neck Certification Setup for Frontal Extension Test, Front in Drop Position View

15.6.2 PERFORMING THE TEST

1. **To stop the pendulum, attach honeycomb material to the pendulum anvil. Use 152.4 mm (6") thick aluminum Hexcel density 28.8 Kg/m3 (1.8 lb/ft3) with a number cells appropriate to meet the pulse requirement in** Table 15-3 Pendulum Velocity**.**
2. **Auto-balancing and shunt calibration of the transducer signals should be performed with the pendulum arm in the vertical position.**
3. **Lift the pendulum up to its pre-test height and check that the headform is in the correct initial position (symmetric with respect to neck top yoke). Do not leave the head-neck system in this position for more than 1 minute, as the neck will start to deform due to the mass-gravity loading of the headform.**
4. **Release the pendulum.**

15.6.3 DATA PROCESSING

1. **Filter the pendulum acceleration at CFC180.**
2. **Filter the potentiometer readings at CFC600.**
3. **Filter the load cell readings at CFC600**
4. **Determine time zero of the impact by finding the 1 g deceleration level in the pendulum signal (after software filtering).**
5. **Software zero all transducer readings by averaging the part of the signal before time zero and subtracting this from the transducer reading.**
6. **Integrate the pendulum acceleration to check the deceleration velocity of the pendulum. The velocity of the arm must be calculated at a point 1657.4 mm from the pendulum pivot point.**
7. **Sum the potentiometer signals to derive the total head angle of the headform relative to pendulum arm.**

15.6.4 REQUIREMENTS

1. **The impact velocity should be at 3.7 ±0.1 m/s.**
2. **The pendulum velocity decrease should be as indicated in the table below.**

Table 15-3 Pendulum Velocity

Time (ms)	Lower Limit (m/s)	Upper Limit (m/s)
10	0.7	1.7
20	1.7	2.8
30	2.8	4.0

To meet the requirements of the frontal neck certification test:

- **The maximum head angle should be 56.7 – 69.3 degrees.**
- **The peak moment shall be [-12.96] – [-15.84] Nm.**

15.7 Lateral Neck Test

15.7.1 SET-UP

1. **Assemble the complete neck as described in** Section 5, Neck Assembly**.**
2. **Attach the IF-217-HC 6 Axis Load Cell to the top of the neck with four M5 x 12 SHCS with wires aligned with cut outs in neck plate. Attach the load cell and neck to the headform with four M5 x 12 FHCS, with lateral axis RH and LH aligned with the direction of motion of the headform.**
3. **Attach the intermediate plate TE-010-2015 to the pendulum base with four M5 countersunk screws. Attach the neck to the pendulum interface plate (four, M5 SHCS).**
4. **Align the neck and the interface, making sure that lateral axis of the neck is in the direction of motion of the pendulum arm. Also, make sure that the bending direction of the neck in the certification is the same as the initial bending direction experienced in the test the dummy is being certified for (LHS or RHS).**
5. **Attach the headform-neck system to the part 572 pendulum. The impact side of the neck should point in the direction of motion of the pendulum. See figure below.**
6. **Install the potentiometers to the mounting interface and on the headform. Mount the balance weight for the potentiometer on the other side of the headform. This ensures that the inertial properties of the head are symmetrical in the impact direction. The figure below indicates the proper position and orientation of the potentiometers.**
7. **Insert the rod connecting the axes of the potentiometers and tighten the screw on the bottom-most axis (headform potentiometer) to secure the rod to that potentiometer. The other end of the rod should be able to slide freely through the upper most transducer axis (pendulum base potentiometer). The rod must be protruding from both sides of the transducer axes equal length.**
8. **The minimum time interval to observe between tests on the neck is 30 minutes.**

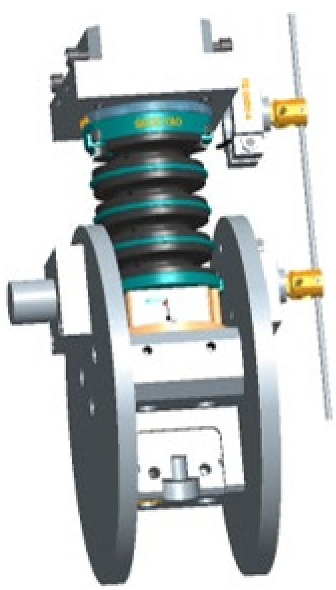


Figure 15.5 Neck Certification Setup for Lateral Test, View from Rear in Drop Position

15.7.2 PERFORMING THE TEST

1. **To stop the pendulum, attach honeycomb material to the pendulum anvil. Use 152.4 mm (6”) thick aluminum Hexcel density 28.8 Kg/m3 (1.8 lb/ft3) with a number cells appropriate to meet the pulse requirement in** Table 15-4 Pendulum Velocity**.**
2. **Auto-balancing and shunt calibration of the transducer signals should be performed with the pendulum arm in the vertical position.**
3. **Lift the pendulum up to its pre-test height. Do not leave the head-neck system in this position for more than 1 minute, as the neck will start to deform due to the mass-gravity loading of the headform.**
4. **Release the pendulum.**

15.7.3 DATA PROCESSING

1. **Filter the pendulum acceleration at CFC180.**
2. **Filter the potentiometer readings at CFC600.**
3. **Filter the load cell readings at CFC600**
4. **Determine time zero of the impact by finding the 1 g deceleration level in the pendulum signal (after software filtering).**
5. **Software zero all transducer readings by averaging the part of the signal before time zero and subtracting this from the transducer reading.**
6. **Integrate the pendulum acceleration to check the deceleration velocity of the pendulum. The velocity of the arm must be calculated at a point 1657.4 mm from the pendulum pivot point.**
7. **Sum the potentiometer signals to derive the total head angle of the headform relative to pendulum arm.**

15.7.4 REQUIREMENTS

1. **The impact velocity should be 3.7 ±0.1 m/s.**
2. **The pendulum velocity decrease should be as indicated in the table below.**

Table 15-4 Pendulum Velocity

Time (ms)	Lower Limit (m/s)	Upper Limit (m/s)
10	0.7	1.7
20	1.7	2.8
30	2.8	4.0

To meet the requirements of the lateral neck certification test:

- **The maximum head angle should be between 45.9 – 56.1 degrees.**
- **The peak moment shall be 14.85 – 18.15 Nm.**

15.8 Lumbar Spine Certification

15.8.1 GENERAL

The lumbar spine is tested with the same device as the neck. The direction of central block of the headform must be changed. To certify the lumbar spine, separate tests are defined for side and frontal impact. In each test the angle between the base and the headform is measured.

The headform orientation is measured using two rotational potentiometers. One is installed on the base of the spine-pendulum interface. The second one is attached to the test head. The sum of the two angles measured on the potentiometers is the head relative to the pendulum angle.

The data acquisition system and all instrumentation must comply with the requirements of SAE J211, version March 1995. All data channels should be filtered using a hardware filter prior to A/D conversion according to SAE J211, version March 1995.

The pendulum acceleration should be measured with an accelerometer which is located on the pendulum arm, 1657.4 mm from the pendulum pivot in accordance with the CFR 49 Part 572.

The Lumbar Spine test is a component test, which is performed using a pendulum as defined in CFR 49 part 572. The complete Lumbar Spine consists of the following parts:

Table 15-5 Lumbar Parts List

Part Number	Qty.	Description
010-6001	1	LUMBAR SPINE MOLDING
010-6100	1	LUMBAR SPINE CABLE
5001207	2	LUMBAR SPINE MOUNTING M6 X 55 SHCS
5000486	1	M8 NYLOK NUT
5000552	1	PLAIN WASHER
5000096	4	SCREW, FHCS M5 X 12
010-2007	1	LOAD CELL
5000002	4	SCREW, SHCS M5 X 12

15.9 Frontal Spine Test

15.9.1 SET-UP

1. **Remove the lumbar spine assembly, including the lower lumbar load cell (replacement), from the dummy.**
2. **Disassembly the disks of the headform and remount them in the correct position around the specific central block for Q10 TE-2650-14 for lumbar spine testing. See figure below.**
3. **Slide the lumbar spine-thorax interface bracket over the headform, such that the lumbar spine rubber column is symmetrically attached to the headform. Insert and tighten the two long M6 SHCS.**
4. **Attach the lumbar spine load cell replacement 010-2007 to the bottom plate of the lumbar spine using M5 x 12 SHCS.**
5. **Align the lumbar spine, making sure that longitudinal axis of the lumbar spine is in the direction of motion of the pendulum arm.**

6. **Attach the headform-spine system to the Part 572 pendulum arm. The front of the headform should point in the direction of motion of the pendulum. See figure below.**
7. **Install the potentiometers to the mounting interface and on the headform. Mount the balance weight for the potentiometer on the other side of the head. This ensures that the inertial properties of the head are symmetrical in the impact direction.**
8. **Insert the rod connecting the axes of the potentiometers and tighten the screw on the bottom-most axis (headform potentiometer) to secure the rod. The other end of the rod should be able to slide freely through the upper most transducer axis (pendulum base potentiometer). The rod must be protruding from both sides of the transducers axes equal length.**
9. **The minimum time interval to observe between tests on the lumbar spine is 30 minutes.**

Figure 15.6 Lumbar Spine Frontal Set-Up, View from Rear in Drop Position

15.9.2 PERFORMING THE TEST

1. **To stop the pendulum, attach honeycomb material to the pendulum anvil. Use 152.4 mm (6 in.) thick aluminum Hexcel density 28.8 Kg/m3 (1.8 lb/ft3) with a number cells appropriate to meet the pulse requirement in** Table 15-6 Pendulum Velocity**.**
2. **Auto-balancing and shunt calibration of the transducer signals should be performed with the pendulum arm in the vertical position.**
3. **Lift the pendulum up to its pre-test height and check that the head is in the correct initial position. Do not leave the head-spine system in this position for more than 1 minute, as the neck will start to deform due to the mass-gravity loading of the headform.**
4. **Release the pendulum.**

15.9.3 DATA PROCESSING

1. Filter the pendulum acceleration at CFC180.
2. Filter the potentiometer readings at CFC600.
3. Determine time zero of the impact by finding the 1 g deceleration level in the pendulum signal (after filtering).
4. Software zero all transducer readings by averaging the part of the signal before time zero and subtracting this from the transducer reading.
5. Integrate the pendulum acceleration to check the deceleration velocity of the pendulum. The velocity of the arm must be calculated at a point 1657.4 mm from the pendulum pivot point.
6. Sum the potentiometer signals to derive the total head relative to pendulum arm angle.

15.9.4 REQUIREMENTS

1. The impact velocity should be 4.4 ±0.1 m/s.
2. The pendulum velocity decrease should be as indicated in the table below.

Table 15-6 Pendulum Velocity

Time (ms)	Lower Limit (m/s)	Upper Limit (m/s)
10	0.9	1.9
20	2.3	3.4
30	3.4	4.6

To meet the requirements of the frontal lumbar spine certification test:

- **The maximum frontal rotation should be between 45.9 – 56.1 degrees.**
- **Time of maximum rotation 60.3 – 73.7 msec**

15.10 Lateral Spine Test

15.10.1 SET-UP

1. Remove the lumbar spine assembly, including the lower lumbar load cell (replacement), from the dummy.
2. Disassembly the disks of the headform and remount them in the correct position around the specific central block for Q10 TE-2650-14 for lumbar spine testing.
3. Slide the spine-thorax interface bracket end of lumbar spine over the headform central block such that the lumbar spine rubber column is symmetrically attached to the headform. Insert and tighten the two long M6 socket head screws.
4. Attach the lumbar spine load cell replacement 010-2007 to the bottom plate of the lumbar spine using M5 x 12 SHCS. Then attach the load cell to the pendulum interface plate. Align the lumbar spine and the interface, making sure that lateral axis of the headform is in the direction of movement of the pendulum arm.

5. Attach the headform-spine system to the part 572 pendulum arm. The side of the headform should point in the direction of motion of the pendulum. See figure below.
6. Install the potentiometers to the mounting interface and on the headform's central block. Mount the balance weight for the potentiometer on the side of the headform's central block. This ensures that the inertial properties of the head are symmetrical in the impact direction. Refer to figure below to indicate the proper position and orientation of the potentiometers.
7. Insert the rod connecting the axes of the potentiometers and tighten the screw on the bottom-most axis (headform potentiometer) to secure the rod. The other end of the rod should be able to slide freely through the upper most transducer axis (pendulum base potentiometer). The rod must be protruding from both sides of the transducers axes equal length.
8. The minimum time interval to observe between tests on the lumbar spine is 30 minutes.

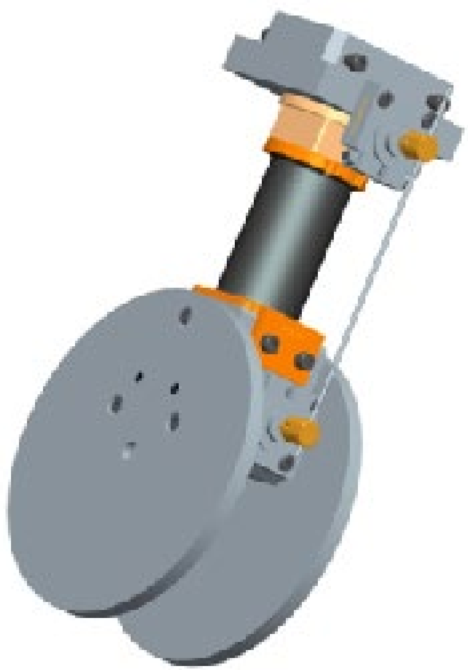


Figure 15.7 Q10 Lumbar Spine lateral set-up, view from rear in drop position

15.10.2 PERFORMING THE TEST

1. Attach honeycomb material to arrest the pendulum to meet the pulse.
2. Auto-balancing and shunt calibration of the transducer signals should be performed with the pendulum arm in the vertical position.
3. Lift the pendulum up to its pre-test height and check that the head is in the correct initial position. Do not leave the head-spine system in this position for more than 1 minute, as the neck will start to deform due to the mass-gravity loading of the headform.
4. Release the pendulum.

15.10.3 DATA PROCESSING

1. **Filter the pendulum acceleration at CFC180.**
2. **Filter the potentiometer readings at CFC600.**
3. **Determine time zero of the impact by finding the 1 g deceleration level in the pendulum signal (after filtering).**
4. **Software zero all transducer readings by averaging the part of the signal before time zero and subtracting this from the transducer reading.**
5. **Integrate the pendulum acceleration to check the deceleration velocity of the pendulum. The velocity of the arm must be calculated at a point 1657.4 mm from the pendulum pivot point.**
6. **Sum the potentiometer signals to derive the total head relative to pendulum arm angle.**

15.10.4 REQUIREMENTS

1. **The impact velocity should be 4.4 ± 0.1 m/s.**
2. **The pendulum velocity decrease should be as indicated in the table below.**

Table 15-7 Pendulum Velocity

Time (ms)	Lower Limit (m/s)	Upper Limit (m/s)
10	0.9	1.9
20	2.3	3.4
30	3.4	4.6

To meet the requirements of the lateral lumbar spine certification test:

- **The maximum lateral rotation should be between 45.9 – 56.1 degrees**
- **Time of maximum rotation 60.3 -73.7 msec**

15.11 Thorax Certification

15.11.1 GENERAL

A complete standard Q10 dummy, with the shoulder liner is used in this test. APTS sensors, hip shields and hip inserts must be removed for thorax certification. The dummy is tested with the suit. Prior to the test, the dummy should be inspected for possible damage. It is particularly important for the thorax tests to check the condition of the rib cage, the shoulder spine interface and the clavicle. No cracks or tears are allowed. Also check that all screws have been tightened. As the performance of several components will affect this full body thorax impact test, make sure that this test is performed as the last test in the certification procedure, where all dummy parts have passed their applicable certification tests successfully.

The data acquisition system and all instrumentation must comply with the requirements of SAE J211, version March 1995. All data channels should be filtered using a hardware filter prior to A/D conversion according to SAE J211, version March 1995.

15.12 Frontal Impact Thorax Test

15.12.1 INSTRUMENTATION

The dummy must be equipped with two IF-372 IR-TRACCs to measure frontal chest deflection. Use the 8.76 kg test probe as described in **Section 14.2.3 Full Body Pendulum**, equipped with an accelerometer to measure the impact deceleration. The impact velocity must be measured and recorded. This can be done with the speed vane on the test probe.

15.12.2 TEST PROCEDURE

1. **Dummy positioning**
   - **The dummy should be seated on a clean dry surface, consisting of two sandwiched flat plates of 2 mm Teflon sheet, with the legs stretched forward towards the impactor.**
   - **Place the dummy with its thoracic spine in a vertical orientation, within ±1 degree to the vertical. The Q10 is stable enough to sit with the leg stretched forward without outwards leg rotation.**
   - **Make sure the dummy is motionless.**
   - **Place the upper arms vertically alongside the body, and let the lower arms rotate downward to let the hands touch the seating surface.**
2. **Impactor alignment**
   - **Let the impactor hang in its lowest position. Check that the probe is in a horizontal position, that is, within ± 2 degrees.**
   - **The impactor front surface should be directly in front of the dummy sternum within 5 mm.**
   - **The height of the center line of the impactor over the seating surface should be chosen in such a way, that the center line of the impactor aligns with the sternum and is mid-way ±1 mm between the upper and lower IR-TRACC to rib cage attachment points (This is about 343 mm above the seating plane).**
   - **The center line of the Impactor should be in the mid-sagittal plane.**
3. **Make sure that the IR-TRACCs are mounted for frontal impact as the frontal impact test can cause damage to the IR-TRACCs when set-up in position for lateral impacts.**
4. **Measure and record the following signals:**
   - **Impact velocity with the speed vane on the probe.**
   - **Impactor acceleration**
   - **Upper and lower IR-TRACC displacements**
5. **The minimum time interval to observe between tests on the thorax is 30 minutes.**

15.12.3 DATA PROCESSING

1. **All data channels should be filtered at CFC600.**
2. **Set time zero at the 1 g deceleration level in the impactor signal (after filtering with CFC600 software filter).**
3. **Software zero all transducer readings by averaging the part of the signal before time zero and subtracting this from the transducer reading.**
4. **Calculate the Impactor force by multiplying the impactor acceleration (in m/s2) with the impactor mass (8.76 kg).**

15.12.4 REQUIREMENT

To pass the certification requirements for frontal thoracic impact, requirements 2 and 3 are provisional until final corridors are established. It can be anticipated that due to the 1.4 kg mass shift from pelvis to thorax the corridors for the maximum averaged upper and lower IR-TRACC deflection and the peak force should be re-established.

1. **The impactor velocity should be between 4.2 and 4.4 m/s.**
2. **The maximum averaged upper and lower thorax deflection should be between [-31.95] – [-39.05] mm (Provisional).**
3. **The peak force should be between [-1530] – [-1870] N (Provisional).**

15.13 Side Impact Thorax Test

15.13.1 INSTRUMENTATION

The dummy must be equipped with two IF-372 IR-TRACCs to measure lateral chest deflection (see "**IR-TRACC Position for Lateral Impact**" on page 24). The side being impacted in the tests must be the side that is certified.

Use the 8.76 kg test probe as described in **Section 14.2.3 Full Body Pendulum** equipped with an accelerometer to measure the impact deceleration. The impact velocity must be measured and recorded. This can be done with the speed vane on the test probe.

15.13.2 TEST PROCEDURE

1. **Dummy positioning**
   * **The dummy should be seated on a clean dry surface, consisting of two sandwiched flat plates of 2 mm Teflon sheet, with the legs stretched forward perpendicular to the impact direction.**
   * **Place the dummy with its thoracic spine in a vertical orientation, within ±1 degree with the vertical.**
   * **Make sure the dummy is motionless.**
   * **Place the upper arms vertically alongside the body, and let the lower arms rotate downward to let the hands touch the seating surface.**
   * **Lift the arm on the impact side above and over the head. Tape the arm to the head to make sure the impactor cannot come in contact with the arm.**
2. **Impactor alignment**
   * **Let the impactor hang in its lowest position. Check that the impactor is in a horizontal position (within ± 2 degrees).**
   * **The impactor front surface should be within 5 mm distance of the most lateral rib surface.**
   * **The height of the center line of the impactor over the seating surface should be chosen in such a way, that the center line of the impactor is aligned midway between the two IR-TRACC to rib cage attachment points at the side of the rib cage (This is about 308 mm above the seating plane).**
   * **The center line of the Impactor should be in line with the vertical plane through IR-TRACC to rib cage attachments at the side of the rib cage.**
3. **Make sure that the IR-TRACCs are mounted for lateral impact as the side impact test can cause damage to the IR-TRACCs when set-up in position for frontal impacts.**

4. **Measure and record the following signals:**
   * **Impact velocity with the speed vane on the probe.**
   * **Impactor acceleration**
   * **Upper and lower IR-TRACC displacements**
5. **The minimum time interval to observe between tests on the thorax is 30 minutes.**

15.13.3 DATA PROCESSING

1. **All data channels should be filtered at CFC600.**
2. **Set the time zero at the 1 g deceleration level in the impactor signal (after filtering with CFC600 software filter).**
3. **Software zero all transducer readings by averaging the part of the signal before time zero and subtracting this from the transducer reading.**
4. **Calculate the impactor force by multiplying the impactor acceleration (in m/s2) with the impactor mass (8.76 kg).**

15.13.4 REQUIREMENT

To pass the certification requirements for lateral thoracic impact, requirements 2 and 3 are provisional until final corridors are established. It can be anticipated that due to the 1.4 kg mass shift from pelvis to thorax the corridors for the maximum averaged upper and lower IR-TRACC deflection and the peak force should be re-established.

1. **The impactor velocity should be between 4.2 and 4.4 m/s.**
2. **The maximum averaged upper and lower IR-TRACC deflection should be between 24.39 – 29.81 mm (Provisional).**
3. **The peak force should be between 2025 – 2475 N (Provisional).**

15.14 Shoulder Lateral Impact Test/Application for Frontal Dummy with Full Arms

15.14.1 INSTRUMENTATION

Use the 8.76 kg test probe as described in **Section 14.2.3 Full Body Pendulum** equipped with an accelerometer to measure the impact deceleration. The impact velocity must be measured and recorded. This can be done with the speed vane on the test probe.

15.14.2 TEST PROCEDURE

1. This test should be performed with the dummy in the frontal configuration (with upper and lower arms installed) and with the neck shield installed.
2. Dummy positioning
   * The dummy should be seated on a clean dry surface, consisting of two sandwiched flat plates of 2 mm Teflon sheet, with the legs stretched forward perpendicular to the impact direction.
   * Place the dummy with its thoracic spine in a vertical orientation, within ±1 degree with the vertical.
   * Make sure the dummy is motionless.
   * Place the upper arms vertically alongside the body, and let the lower arms rotate downward to let the hands touch the seating surface.
   * Impactor alignment
   * Let the impactor hang in its lowest position. Check that the Impactor is in a horizontal position (within ± 2 degrees).
   * The impactor front surface should be within 5 mm distance of the most lateral shoulder surface.
   * The height of the center line of the impactor over the seating surface should be chosen in such a way, that the center line of the impactor is aligned with the shoulder joint (midway between the three shoulder joint screw locations in the upper arm (This is about 439 mm above the seating plane).
   * The center line of the Impactor should be in line with the vertical plane through the shoulder joint (midway between the three shoulder joint screw locations in the upper arm).
3. Measure and record the following signals:
   * Impact velocity with the speed vane on the probe.
   * Impactor acceleration
   * T1 acceleration in the Ay direction (measured on non-struck side).
4. The minimum time interval to observe between tests on the thorax is 30 minutes.

15.14.3 DATA PROCESSING

1. The Probe Force channel should be filtered at CFC600 and the T1 acceleration at CFC180.
2. Set the time zero at the 1 g deceleration level in the impactor signal (after filtering with CFC600 software filter).
3. Software zero all transducer readings by averaging the part of the signal before time zero and subtracting this from the transducer reading.
4. Calculate the impactor force by multiplying the impactor acceleration (in m/s2) with the impactor mass (8.76 kg).

15.14.4 REQUIREMENT

To pass the certification requirements for lateral shoulder impact, dummy with full arms, requirements 2 and 3 are provisional until final corridors are established. It can be anticipated that due to the 1.4 kg mass shift from pelvis to thorax the corridors for the T1 acceleration and the impactor force should be re-established

1. The impactor velocity should be between 4.2 and 4.4 m/s.
2. The maximum T1 acceleration should be between 48.0 – 68.0 G (Provisional).
3. The maximum impact force should be between 2385 – 2915 N (Provisional).

15.15 Side Impact Pelvis Test

15.15.1 INSTRUMENTATION

Use the 8.76 kg test probe as described in **Section 14.2.3 Full Body Pendulum** equipped with an accelerometer to measure the impact deceleration. The impact velocity must be measured and recorded. This can be done with the speed vane on the test probe.

15.15.2 TEST PROCEDURE

1. **Dummy positioning**
   * **The dummy should be seated on a clean dry surface, consisting of two sandwiched flat plates of 2 mm Teflon sheet, with the legs stretched forward perpendicular to the impact direction. To prevent curling of the Teflon sheet and potential interference with the probe, the dummy may be placed over the edge of the Teflon.**
   * **Place the dummy with its thoracic spine in a vertical orientation, within ±1 degree in X and Y from the vertical.**
   * **Align the legs so that the inner faces of the round part of the femur at the knee are approximately 98 mm apart. The toes and knees must be pointing upward. To ensure the legs are correctly positioned you can check by putting an Allen key into the knee pivot screw or leg attachment screw. The Allen key should be horizontal. Note: you cannot use a ball ended Allen key for this check.**
   * **Place the upper arms so that they are resting on the upper legs as shown in figure below.**
   * **Make sure the dummy is motionless.**

Figure 15.8 Front View of Pelvis Certification Setup

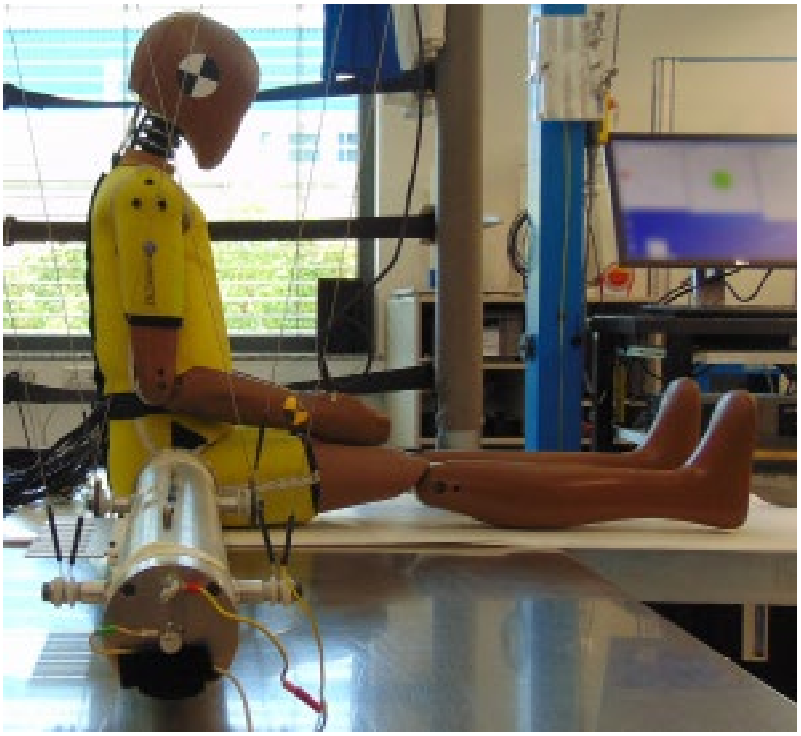


Figure 15.9 Side View of Pelvis Certification Setup

2. Impactor alignment

* Let the impactor hang in its lowest position. Check that the Impactor is in a horizontal position (within ± 2 degrees).
* The impactor front surface should be within 5 mm distance of the most lateral pelvis surface.
* The height of the center line of the impactor over the seating surface should be chosen in such a way, that the center line of the impactor is aligned with the H-point. This should be 66 mm above the Teflon sheeting and 358 mm from the knee pivot.
* The center line of the Impactor should be in line with the vertical plane through the H-point. There is a raised dimple in the flesh at the outer H-point impact point that is correctly positioned when the above dummy positioning is carried out.

3. Measure and record the following signals:

* Impact velocity with the speed vane on the probe.
* Impactor acceleration.
* Pubic Symphysis load obtained from the pubic load cell if fitted.

4. The minimum time interval to observe between tests on the thorax is 30 minutes.

15.15.3 DATA PROCESSING

1. **All data channels should be filtered at CFC600.**
2. **Set the time zero at the 1 g deceleration level in the impactor signal (after filtering with CFC600 software filter).**
3. **Software zero all transducer readings by averaging the part of the signal before time zero and subtracting this from the transducer reading.**
4. **Calculate the impactor force by multiplying the impactor acceleration (in m/s2) with the impactor mass (8.76 kg).**

15.15.4 REQUIREMENT

To pass the certification requirements for lateral thoracic impact, requirements 3 is provisional until final corridors are established. It can be anticipated that due to the 1.4 kg mass shift from pelvis to thorax the corridor for the impactor force should be re-established.

1. **The impactor velocity should be between 4.2 and 4.4 m/s.**
2. **The maximum Pubic Symphysis load requirement is under development, but the data should be recorded.**
3. **The maximum impact force should be between 3735 – 4565 N (Provisional)**

15.16 Abdomen Certification

15.16.1 GENERAL

The abdomen test is a component test. The abdomen should be removed from the dummy. The test equipment is described in **Section 14.2.4 Abdomen Test Rig** To test the correct performance of the dummy abdomen an “Additional weight” is placed on the top plate and the additional flat plate intrusion is measured.

15.16.2 INSTRUMENTATION

The only instrumentation necessary to perform this test is a caliper rule or dial test indicator to measure the distance difference between the two plate heights before and after application of the additional mass.

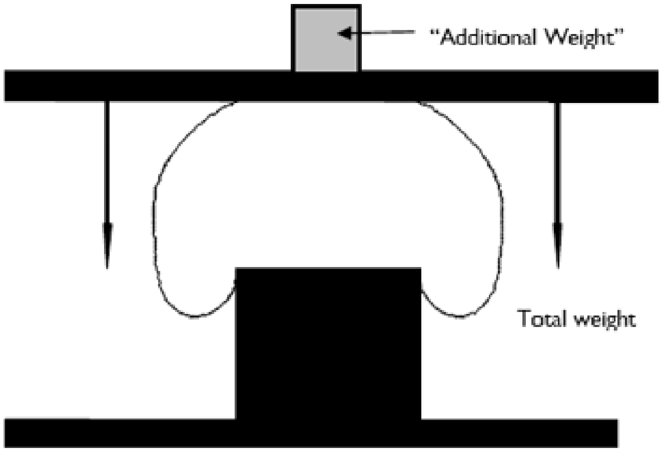


Figure 15.10 Abdomen Certification Test set-up

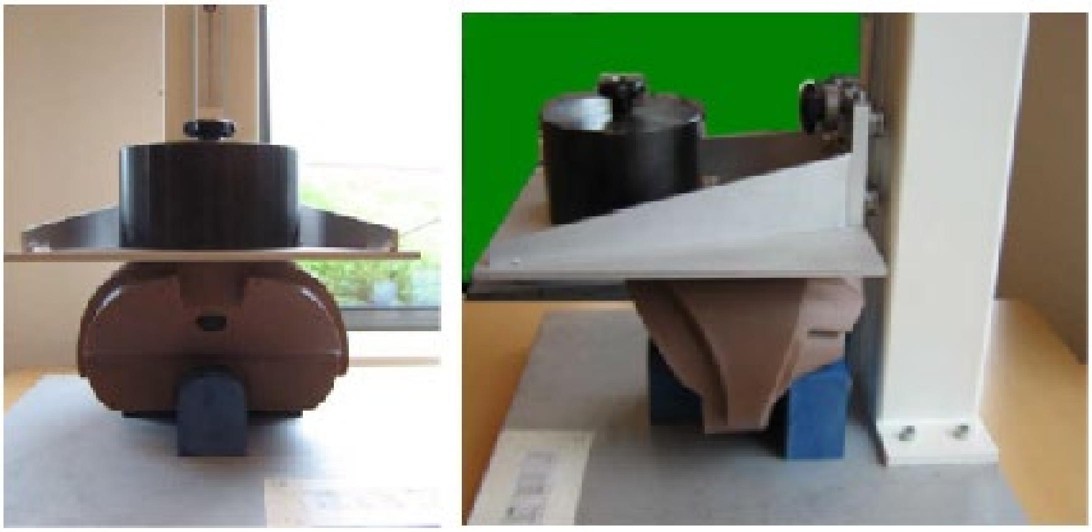


Figure 15.11 Abdomen Certification Test set-up

Table 15-8 Abdomen Certification Weights

Description	Q10 Weight
FLAT PLATE MASS	2.05 ± 0.025 kg.
ADDITIONAL MASS	8.05 ± 0.025 kg.
TOTAL MASS	10.10 ± 0.050 kg.
ABDOMEN SUPPORT PART NUMBER	TE-010-9910

15.16.3 TEST PROCEDURE

1. **Place the abdomen on the appropriate Q10 abdomen certification support (TE-010-9910). Ensure a good fit and orientation of the abdomen over the block. Lower the top plate (with a weight of 2.05 ±0.025 kg.) on the abdomen. Within 10 seconds determine this point as zero for the displacement measurement then apply an additional weight of 8.05 kg ±0.025 onto the top plate**
2. **Let the top plate compress the abdomen for a period of 2 minutes (± 10 sec.).**
3. **Read the measurement.**
4. **Remove the mass and top plate.**
5. **Observe an interval of at least 30 minutes between successive tests on the same abdomen.**

15.16.4 DATA PROCESSING

Subtract the final reading from the initial reading

15.16.5 REQUIREMENT

The deformation of the abdomen should be between 8.4 – 12.4 mm.

15.17 Shoulder Lateral Impact Test/Application for Side Impact Shoulder Kit

15.17.1 INSTRUMENTATION

Use the 8.76 kg test probe as described in **Section 14.2.3 Full Body Pendulum** equipped with an accelerometer to measure the impact deceleration. The impact velocity must be measured and recorded. This can be done with the speed vane on the test probe.

15.17.2 TEST PROCEDURE

1. **This test is performed with the Side Impact shoulder kit fitted (upper short arm) along with torso interface plate with flats for T1 accelerometer mounting and with the neck shield.**
2. **Dummy positioning**
   * **The dummy should be seated on a clean dry surface, consisting of two sandwiched flat plates of 2 mm Teflon sheet, with the legs stretched forward perpendicular to the impact direction.**
   * **Place the dummy with its thoracic spine in a vertical orientation, within ±1 degree with the vertical.**
   * **Make sure the dummy is motionless.**
   * **Place the upper arms vertically alongside the body.**
   * **Impactor alignment**
   * **Let the impactor hang in its lowest position. Check that the Impactor is in a horizontal position (within ± 2 degrees).**
   * **The impactor front surface should be within 5 mm distance of the most lateral shoulder surface.**
   * **The height of the centerline of the impactor over the seating surface should be chosen in such a way, that the centerline of the impactor is aligned with the shoulder joint. This is on the centerline of the two side holes at the top of the upper arm. These can be felt through the suit. (This is about 439 mm above the seating plane.)**
   * **The centerline of the Impactor should be in line with the vertical plane through the shoulder joint. Therefore the vertical center of the arm flesh.**
3. **Measure and record the following signals:**
   * **Impact velocity with the speed vane on the probe.**
   * **Impactor acceleration**
   * **T1 acceleration in the Ay direction (measured on non-struck side).**
4. **The minimum time interval to observe between tests on the thorax is 30 minutes.**

15.17.3 DATA PROCESSING

1. **The Probe Force channel should be filtered at CFC600 and the T1 acceleration at CFC180.**
2. **Set the time zero at the 1 g deceleration level in the impactor signal (after filtering with CFC600 software filter).**
3. **Software zero all transducer readings by averaging the part of the signal before time zero and subtracting this from the transducer reading.**
4. **Calculate the impactor force by multiplying the impactor acceleration (in m/s2) with the impactor mass (8.76 kg).**

15.17.4 REQUIREMENT

To pass the certification requirements for the Shoulder lateral impact test for Side Impact Shoulder Kit, requirements 2 and 3 are provisional until final corridors are established. It can be anticipated that due to the 1.4 kg mass shift from pelvis to thorax the corridors for the T1 acceleration and the impactor force should be re-established.

1. **The impactor velocity should be between 4.2 and 4.4 m/s.**
2. **The maximum T1 acceleration 41.4 to 50.6 G (Provisional)**
3. **The maximum impact force 2199 to 2688 N (Provisional)**

Mass Measurement

Masses specified are based on anthropometry requirements, but the values are adapted to a practical grouping of parts. Humanetics controls the actual total mass of the basic dummy to a much tighter tolerance than specified below which allows for wiring, customer DAS integrations and extended instrument options.

Table 16-1 Q10 Assembly Masses

Q10 Segment Assembly	Mass (kg)	Tolerance ±
HEAD & UPPER NECK LOAD CELL	3.695	0.10
NECK & INTERFACE	0.515	0.05
THORAX, NECK SHIELD, LOWER NECK LOAD CELL	5.88	0.20
PELVIS, ABDOMEN & LUMBAR SPINE	8.40	0.30
UPPER ARM (each)	1.09	0.05
LOWER ARM & HAND (each)	0.90	0.05
UPPER LEG (each)	3.71	0.10
LOWER LEG & FOOT (each)	2.53	0.12
SUIT	0.63	0.10
TOTAL	**35.58**	**1.39**

SECTION 17
External Measurement

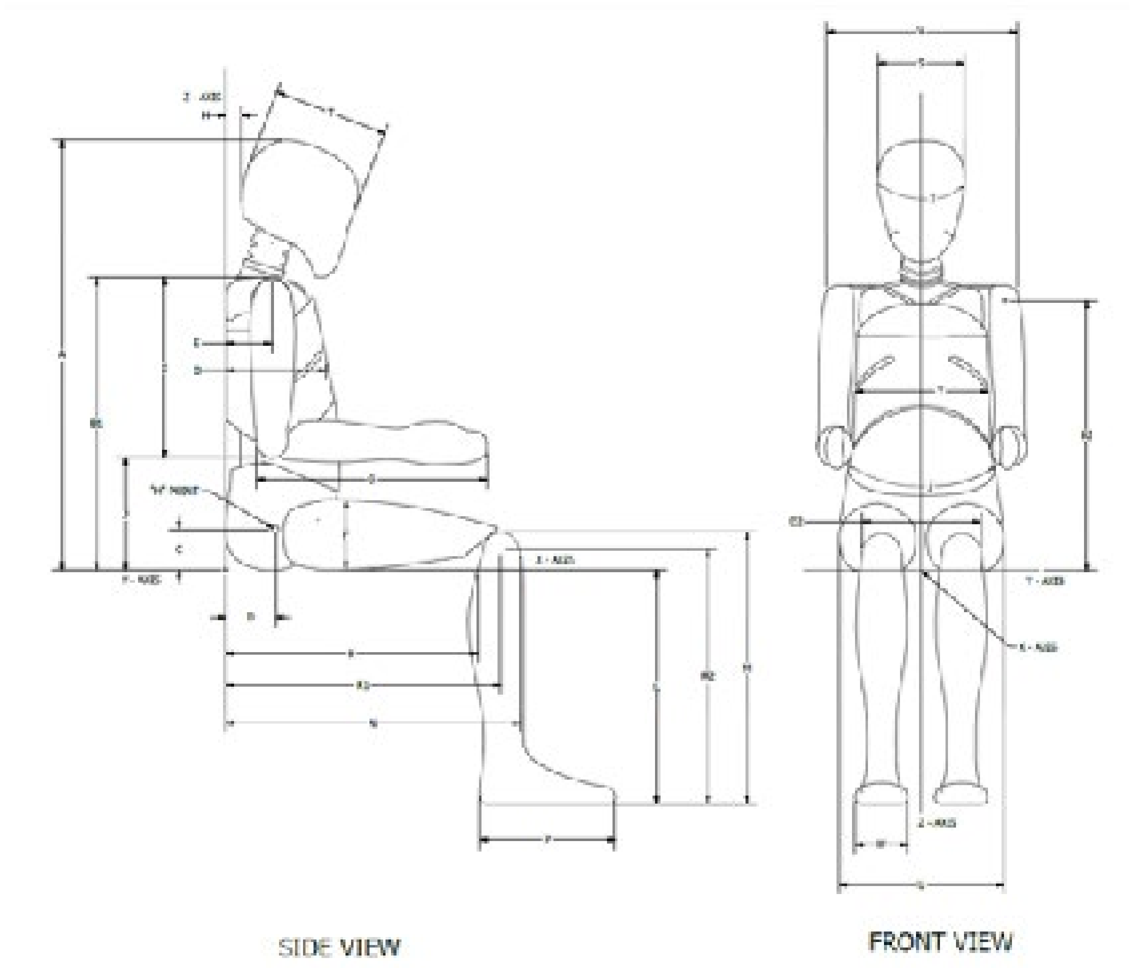


Figure 17.1 External Dimension

Table 17-2 External Dimensions

Symbol	Description	Spec. (mm)	Tolerance ± (mm)
A1	Total Sitting Height (head tilt forward 22°)	738.7	9
A2	Sitting Height (erected measured via T1)	750.4	9
A3	Sitting Height (erected measured via mid neck)	740.5	9
B1	Shoulder Height (top of arm)	472.6	7
B2	Shoulder Pivot Height	443.8	6
C	Hip Pivot Height	65.9	3
D1	Hip Pivot from Back-line	90.4	3
D2	Hip Joint Distance	132.0	3
E	Shoulder Pivot from Back-line	75.4	6
F	Thigh Height	114.0	3
G	Lower Arm & Hand Length	376.2	6

External Measurement

Symbol	Description	Spec. (mm)	Tolerance ± (mm)
H	Head Back from Back-line	37.6	3
I	Shoulder to Elbow Length	291.6	3
J	Elbow Rest Height	181.0	9
K	Buttock Popliteal Length	414.9	6
L	Popliteal Height	405.7	6
M	Floor to Top of Knee	451.0	6
N	Buttock to Knee Length	485.4	6
O	Chest Depth at Nipples	171.0	5
P	Foot Length	190.0	3
Q1	Standing Height (head tilt forward 22°)	1457.9	12
R1	Buttock to Knee Pivot Length	448.4	6
R2	Floor to Knee Pivot	422	6
S	Head Breadth	144	3
T	Head Depth	186.5	3
U	Hip Breadth	270	7
V	Shoulder Breadth	334.8	7
W	Foot Breadth	82	3
X	Head Circumference	534	6
Y1	Chest Circumference at Axilla Height	594.4	6
Y2	Chest Circumference at Nipples Height	623.6	6
Z	Waist Circumference (target: standing actual: sitting)	664.6	6

*Measurements are valid for dummy without suit and shoulder liner

SECTION 18

Dummy Setup and Positioning Procedure

18.1 Guidelines for set-up and positioning

This chapter provides some guidelines for setting up and positioning the dummy in the crash test environment. The outline presented here will be verified in a setup and positioning workshop to be organized by stakeholders from regulatory bodies, consumer organizations and car as well as child restraint system manufacturers. After this workshop the procedures given here are to be confirmed.

- **Before using a dummy in a test make sure that it is appropriately inspected and certified according to the required (company) quality procedures.**
- **Instrument the dummy with the required instrumentation to obtain the desired data recordings. (Check if the IR-TRACCs are mounted in the appropriate direction.)**
- **Set all extremity joints (Shoulders, Elbows, Hips and Knees) to the desired friction setting.**
- **Install the dummy in the crash test environment according to the test protocol.**

  Below is an extensive description of the dummy setup and positioning steps can be incorporated.

  - **Put the dummy on the Child Restraint System or seat**
  - **Push the lower torso and legs backward in the seat so that the back of the buttocks engages with the seat back**
  - **For frontal testing fit the hip shields 154 min apart. See section 11,** Figure 11.2 **and** Figure 11.3**.**
  - **Apply the seat belt in the appropriate way over the dummy and tighten it according to the test protocol**
  - **Ensure that the dummy is centered in the desired position**
  - **Put the legs straight forward with a distance of TBA mm between the knees**
  - **Let the upper arms align with the torso as suitable in the given seat environment.**
  - **Put the lower arms with the hands-on top of the upper leg thighs**
- **After setup and positioning the dummy and the seat belt, appropriate static measurements should be taken to control and document the dummy position and the seat belt routing.**

  Possible features that can be used:

  - **Head, Thorax and Pelvis tilt angles ϕx and ϕy. See figure below for head levelling fixture now standard in the tool kit. This is inserted into the holes in the top of the head and can be used for forward and side levelling. An inclinometer is placed on top of the tool.**
  - **Position measurement relative to the crash test environment features (tape measure) or a global coordinate system (Faro-Arm). To facilitate this, the dummy is equipped with numerous markers (see** Figure 18.1**).**
  - **Level indicator measurements on upper torso and extremities (see** Figure 18.1**).**

18.2 Marker and Instrumentation locations

In this section the location coordinates of the markers and the instrumentation is specified. Moreover, some relevant joint location coordinates (Shoulder and Hip joints) and dimensions (such as chest depth IR-TRACC length and Knee distance) are specified.

18.2.1 GENERAL

Coordinate Systems

The coordinates are specified in local coordinate systems per body part:

- **Head and Neck**

  Origin: Occipital Condoyle

  Directions: X-axis forward, Y-axis to the right, Z-axis downward (along the neck centerline which is tilt forward 27 degrees with respect to the thoracic spine)

- **Torso**

  Origin: In Erected seating the intersection of Seat back-, Seating- and Mid-sagittal-plane

  Directions: X-axis forward, Y-axis to the right, Z-axis downward

- **Arms**

  Origin: Elbow joint center, Upper arm bone vertical, Lower arm bone horizontal

  Directions: X-axis forward, Y-axis outward, Z-axis downward

- **Legs**

  Origin: Knee joint center, Upper leg bone horizontal, Lower leg bone vertical

  Directions: X-axis forward, Y-axis outward, Z-axis downward

Accuracy

The specified coordinates are theoretical values obtained from the 3D design model. In practice, parts production and dummy assembly will result in deviations. In general, the tolerance to be anticipated is ±5 mm. If soft parts such as neck, rib cage, lumbar spine and upper leg flesh are involved in the buildup of specified dimensions, the tolerance to be anticipated can increase up to ±9 mm. These values are specified between brackets.

18.2.2 MARKERS LOCATION COORDINATES AND RELEVANT DIMENSIONS

Markers on the dummy are depicted in **Figure 18.1** and listed in **Table 18-1** through **Table 18-6**. The markers on the dummy have different character. Anticipating the use of a 3D measuring device with a pointer ball (radius of 2 mm), the ball point center is specified. The different marker characters are:

- **Dimple**

  Ball diameter 4.1 mm and diameter at dummy surface 3.0 to 3.5 mm.

  Anticipated Ball Center (BC) 1.0 mm outside dummy contour.

- **Hex recess of screw head:**

  Hex 3 mm: Anticipated Ball Center (BC) 1.0 mm outside screw head top face

  Hex 4 and Hex 5 mm: Anticipated Ball Center (BC) 2.0 mm from bottom of Hex recess

- **Diameter hole 3.5 mm: Anticipated Ball Center (BC) 1.0 mm from screw tip**
- **Ball diameter 3 mm: Anticipated Ball Center (BC) 1.0 mm outside screw head top face (difficult to define).**

A Dummy Positioning System can also be used. This uses a high-resolution digital camera which can identify relevant point on the dummy simultaneously. The vehicle can be moved without affecting measurements. Dummy target adaptor kits are used to identify the relevant points. This is a quick and accurate way to position the dummy. See DPS on Humanetics website.

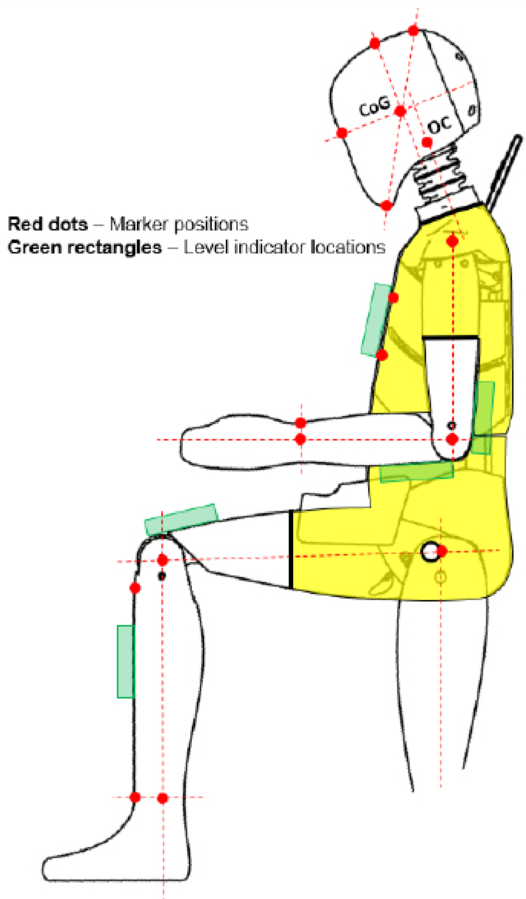


Figure 18.1 Marker Positions on Dummy

Table 18-1 Markers Head and Neck, Origin: Occipital Condoyle

Point Description	X (mm)	Y (mm)	Z (mm)	Remark
OCCIPITAL CONDYLE (OC) (UPPER NECK LOAD CELL CENTER)	0.0	0.0	0.0	
CENTER OF GRAVITY (CoG)	16.0	0.0	-50.9	
MARKER DIMPLES OC LEFT & RIGHT	0	±58.4	0	BC - DIMPLE
MARKER DIMPLES CoG LEFT & RIGHT	16.0	±70.0	-50.9	BC - DIMPLE
MARKER DIMPLE CoG TOP	16.0	0.0	-145.2	BC - DIMPLE
MARKER DIMPLE CoG FRONT	99.3	0.0	-50.9	BC - DIMPLE
MARKER DIMPLE TOP REAR (33° NOSE UP FROM VERTICAL)	-42.8	0.0	-141.4	BC - DIMPLE (TO BE IMPLEMENTED)
MARKER DIMPLE CHIN (33° NOSE UP FROM VERTICAL)	84.1	0.0	54.0	BC - DIMPLE (TO BE IMPLEMENTED)

Table 18-2 Markers Torso, Origin: Erect Seating, Intersection of Seat Back, Seating & Mid-sagittal-plane

Point Description	X (mm)	Y (mm)	Z (mm)	Remark
BALL CENTERS SHOULDER JOINTS	75.0	(±130.1)	(-443.8)	
SCREW HEAD RECESS UPPER IR-TRACC TO RIB ATTACHMENT (FRONTAL)	(154.7)	0.0	(-381.3)	BC - HEX 3 mm
SCREW HEAD RECESS UPPER IR-TRACC TO RIB ATTACHMENT (LATERAL)	(75.0)	(±108.0)	(-343.4)	BC - HEX 3 mm
SCREW HEAD RECESS LOWER IR-TRACC TO RIB ATTACHMENT (FRONTAL)	(170.7)	0.0	(-301.3)	BC - HEX 3 mm
SCREW HEAD RECESS LOWER IR-TRACC TO RIB ATTACHMENT (LATERAL)	(75.0)	(±112.0)	(-263.4)	BC - HEX 3 mm
CHEST DEPTH UPPER IR-TRACC (FRONTAL, NO SUIT)				DISTANCE 155.0 mm
CHEST DEPTH UPPER IR-TRACC (LATERAL LEFT TO RIGHT, NO SUIT)				DISTANCE 217.6 mm
CHEST DEPTH LOWER IR-TRACC (FRONTAL, NO SUIT)				DISTANCE 171.0 mm
CHEST DEPTH LOWER IR-TRACC (LATERAL LEFT TO RIGHT, NO SUIT)				DISTANCE 225.8 mm
BALL CENTERS HIP JOINT	90.2	±65.6	-66.1	

Table 18-3 Markers Arms, Origin: Elbow Joint Center, Upper Arm Bone Vertical & Horizontal

Point Description	X (mm)	Y (mm)	Z (mm)	Remark
SCREW HEAD RECESS TOP SCREW OF SHOULDER JOINT	0.0	-8.6	-257.8	BC - HEX 4 mm
SCREW HEAD RECESS ELBOW	0.0	16.7	0.0	BC - HEX 5 mm
BALL CENTER SHOULDER JOINT	0.0	-14.6	-238.0	BC - HEX 5 mm
MARKER DIMPLES CoG LEFT & RIGHT	16.0	±70.0	-50.9	BC - DIMPLE
MARKER DIMPLE WRIST (OUTER)	195.7	17.1	0.0	BC - DIMPLE
MARKER DIMPLE WRIST (TOP)	195.7	0.0	-24.4	BC - DIMPLE

Table 18-4 Markers Legs, Origin: Knee Joint Center, Upper Leg Bone Horizontal & Vertical

Point Description	X (mm)	Y (mm)	Z (mm)	Remark
MARKER BALL (D=3mm) H-POINT	(359.5)	(-68.8)	(8.5)	BC - BALL
SCREW HEAD RECESS KNEE (LHS, RHS OPPOSITE)	0.0	-25.7 OR 29	0.0	BC - D = 3.5 mm (LHS) OR BC - HEX 5 mm (RHS)
BALL CENTER HOP JOINT	-359.4	0.0	0.2	
MARKER DIMPLE TIBIA (FRONT NEAR KNEE)	36.2	0.0	30.0	BC - DIMPLE
MARKER DIMPLE TIBIA (FRONT MID TIBIA)	38.0	0.0	109.0	BC - DIMPLE
MARKER DIMPLE ANKLE (FRONT)	38.0	0.0	309.0	BC - DIMPLE
MARKER DIMPLE ANKLE (OUTER)	0.0	24.9	309.0	BC - DIMPLE
MARKER DIMPLE ANKLE (INNER)	0.0	-24.9	309.0	BC - DIMPLE
DISTANCE BETWEEN KNEE CENTERS AND TIBIA CENTER LINES				DISTANCE 130.7 mm
GAP BETWEEN KNEES				DISTANCE 67.5 mm

18.2.3 INSTRUMENTATION LOCATION COORDINATES AND RELEVANT DIMENSIONS

Table 18-5 Markers Head and Neck, Origin: Occipital Condoyle

Point Description	X (mm)	Y (mm)	Z (mm)	Remark
HEAD ACCELEROMETERS INTERSECTION POINT (CoG)	16.0	0.0	-50.9	
UPPER NECK LOAD CELL CENTER (AT THE OC)	0.0	0.0	0.0	
LOWER NECK LOAD CELL CENTER	0.0	0.0	(124.6)	
HEAD AND NECK FORWARD TILT		27°		

Table 18-6 Markers Torso, Origin: Erect Seating, Intersection of Seat Back, Seating & Mid-sagittal-plane

Point Description	X (mm)	Y (mm)	Z (mm)	Remark
LOWER NECK LOAD CELL CENTER	40.3	0.0	(-478.2)	
T4 ACCELEROMETERS INTERSECTION POINT	27.00	0.0	(-427.9)	
UPPER IR-TRACC LENGTH (FRONTAL)				DISTANCE 106.2 mm

Point Description	X (mm)	Y (mm)	Z (mm)	Remark
UPPER IR-TRACC HINGE POINT AT RIB SIDE (FRONTAL)	(136.2)	0.0	(-386.0)	
UPPER IR-TRACC HINGE POINT AT SPINE SIDE (FRONTAL)	30.0	0.0	(-386.0)	
UPPER IR-TRACC LENGTH (LATERAL)				DISTANCE 91.8 mm
UPPER IR-TRACC HINGE POINT AT RIB SIDE (LATERAL)	(75.0)	90.5	(-350.6)	
UPPER IR-TRACC HINGE POINT AT SPINE SIDE (LATERAL)	90.2	0.0	(-350.6)	
LOWER IR-TRACC LENGTH (FRONTAL)				DISTANCE 122.2 mm
LOWER IR-TRACC HINGE POINT AT RIB SIDE (FRONTAL)	(152.15)	0.0	(-306)	
LOWER IR-TRACC HINGE POINT AT SPINE SIDE (FRONTAL)	30.0	0.0	(-306)	
LOWER IR-TRACC LENGTH (LATERAL)				DISTANCE 95.8 mm
LOWER IR-TRACC HINGE POINT AT RIB SIDE (LATERAL)	(75.0)	94.6	(-270.6)	
LOWER IR-TRACC HINGE POINT AT SPINE SIDE (LATERAL)	90.1	0.0	(-270.6)	
LOWER LUMBAR LOAD CELL CENTER	47.6	0.0	-127.5	
PELVIS ACCELEROMETER INTERSECTION POINT	62.9	-0.8	-58.3	
PUBIC LOAD CELL CENTER	131.8	0.0	-55.0	
ILIAC TO SACRUM LOAD CELL CENTER	30.4	±17.7	-73.5	LOAD CELL TO BE DESIGNED

19.1 2D IR-TRACC 'Absolute Length' Verification

Euro NCAP implemented the WorldSID dummy with 2D IR-TRACCs in their 2015 protocols. The Euro NCAP injury parameter is based on the lateral compression of the ribs. This requires calculation of the rib position in a co-ordinate system fixed with respect to the thoracic spine. The Absolute Length Verification Procedure was developed to facilitate this and is applicable to the 2D IR-TRACCs implemented in the WorldSID dummies and the Q10 dummy. The 2D IR-TRACCs can be implemented in the Q10 dummy in left hand, right hand and in frontal orientation.

This manual section provides information how to implement the resulting verification and calibration parameters in the data acquisition system and/or post processing software dependent on the IR-TRACC orientation in the dummy.

There are two important benefits of Absolute Length Verification.

- **The output of the 2D IR-TRACC makes that the actual rib position is known at any time. This for instance allows checking the rib position between tests and allows to check if the dummy has deformation with respect to previous tests. A deviation may indicate a problem with rib permanent set or incorrect calibration parameters.**
- **When changing over the IR-TRACC position from Left side to Right side, one only has to correct the Reference angle parameter in DAS or post process; all other calibration parameters and post processing formulas will remain the same and are independent of the orientation of the IR-TRACC.**

IMPORTANT NOTE: the Absolute Length Verification procedure shall be carried out after replacement of a ball joint or angle sensor, as these items affect Absolute Intercept and Reference Angle and Polarity.

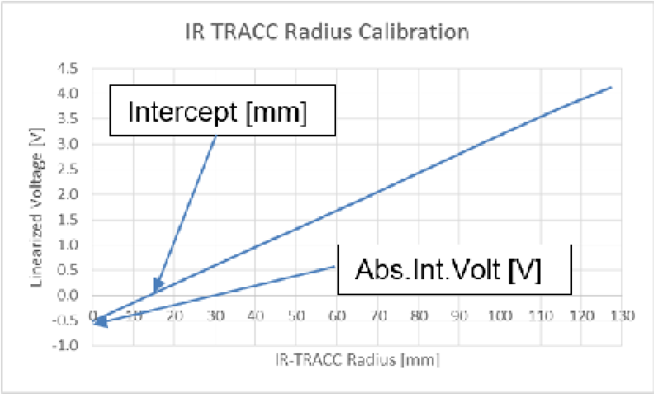
19.2 Theory of the Procedure

When the 2D IR-TRACC absolute length is not implemented the data of length and angle are represented in a polar co-ordinate system which is not accurately defined nor fixed. The Absolute Length Verification defines the coordinate system according SAE-J211 at the spine and fixes individual sensor parameters to this coordinate system. The relevant parameters of individual sensors are determined at the assembly level in a reproducible and traceable verification procedure. The verification parameters are given in the purple fields of the verification sheet, see figure below.

2D IR-TRACC ASSEMBLY- ABSOLUTE LENGTH VERIFICATION SHEET Applies for Right Hand Side IR-TRACC Orientation							**Calculate IRTRACC Radius using formula: R = (Vsensor ^ -0.5) * 27.16+14.06**		
IR-TRACC		**Angle Sensor**			**Date**	06-Mar-15	**Absolute Length Calibration Factors**		
Test No.	21315DT4252	**Test Nr.**	21315DT1574		**TEST No.**	7936	**Linearization exponent**		**-0.5000**
Model No.	IF-372-R2	**Model / SN**	3720-11		**Technician**	Helmut L[illegible]th	**Calibration Factor [mm/V]**		**27.1558**
Serial No.	DT4252	**Ang cal/polarit**	**0.003141**	**V_{sen}/V_{exc}/deg**	**Temp / Hum**	22,1/30,[illegible]	**Absolute Intercept [mm]**		**14.06**
Calibration Range [mm]	**87**	**Excitation [V]**	**5.0002**	90	**REF Length [mm]**	**105**	127.23	Inv CF [V/mm] 0.03682	Abs.Interc.[V] -0.51739
V_{REF} Length [V]	**0.0892**	**V_{REF} Angle [V]**	**0.0454**	**$\varphi Offset_{Sensor}$ [deg]**	**2.89**	**φ_{IRT} [deg]**	**R [mm]**	**x [mm]**	**y [mm]**
V_{REF} Tubes In [V]	0.0893	V_{REF} far [V]	0.0425	**φ_{REF} RIGHT**	**-87.11**	89.8	104.9	0.3	104.9
V_{REF} Tubes Out [V]	0.0890	V_{REF} near [V]	0.0482	**Ang cal/polarity**	**0.003141**	90.2	105.1	-0.3	105.1
IR-TRACC pos1 [V]	0.0782	**Ang pos1 [V]**	-0.2480	**φ_{REF} LEFT**	**92.89**	71.3	111.2	35.6	105.3
IR-TRACC pos2 [V]	0.0000	**Ang pos2 [V]**	0.0000	**φ_{REF} FRONT**	**2.89**	87.1			

Figure 19.1 Example 2D-IR-TRACC Assembly Absolute Length Verification Sheet

The length calibration factors are also given in inverse units: the Inverse CF (slope) in [V/mm] and the Absolute Intercept Voltage [V]. The relation between Intercept in mm and Volts is given in figure below.



Absolute Length Calibration Factors		
Linearization exponent		-0.5000
Calibration Factor [mm/V]		27.0425
Absolute Intercept [mm]		14.44
127.40	Inv CF V/mm 0.0369788	Abs.Int.Volt -0.533592

Figure 19.2 Relation Between Absolute Intercept in mm and Volts & Values in Verification Sheet

When implemented the parameters Linearization Exponent, Calibration Factor and Absolute Intercept give the calibrated Radius of the IR-TRACC (pivot-to-pivot length). The angle sensor Calibration Factor, Polarity and Offset determine the IR-TRACC angle in the co-ordinate system. The polar coordinates Radius and Angle can be converted to the Cartesian coordinates x and y by using the trigonometric functions sine and cosine. This is further defined in paragraph 16.3.

In the Q10 the 2D IR-TRACCs are implemented in various orientations in the dummy:

- **Frontal upper and lower with potentiometer down (IR-TRACC upside down)**
- **Left side and right side upper with potentiometer down (IR-TRACC upside down)**
- **Left side and right side lower with potentiometer up**

The procedure described in this section was developed with the intention to keep trigonometric functions for post processing identical and independent of the orientation of the IR-TRACC in the dummy.

The chosen coordinate system follows SAE-J211. In this coordinate system the x and y coordinates are positive in right hand and frontal quadrant of the dummy, and the angle is 0 when aligned with the positive x-axis and increasing according the right-hand rule (corkscrew). The figure below shows an example of the IR-TRACC in frontal impact mounting position. The angle sensor is downwards so upside down with respect to the absolute length verification.

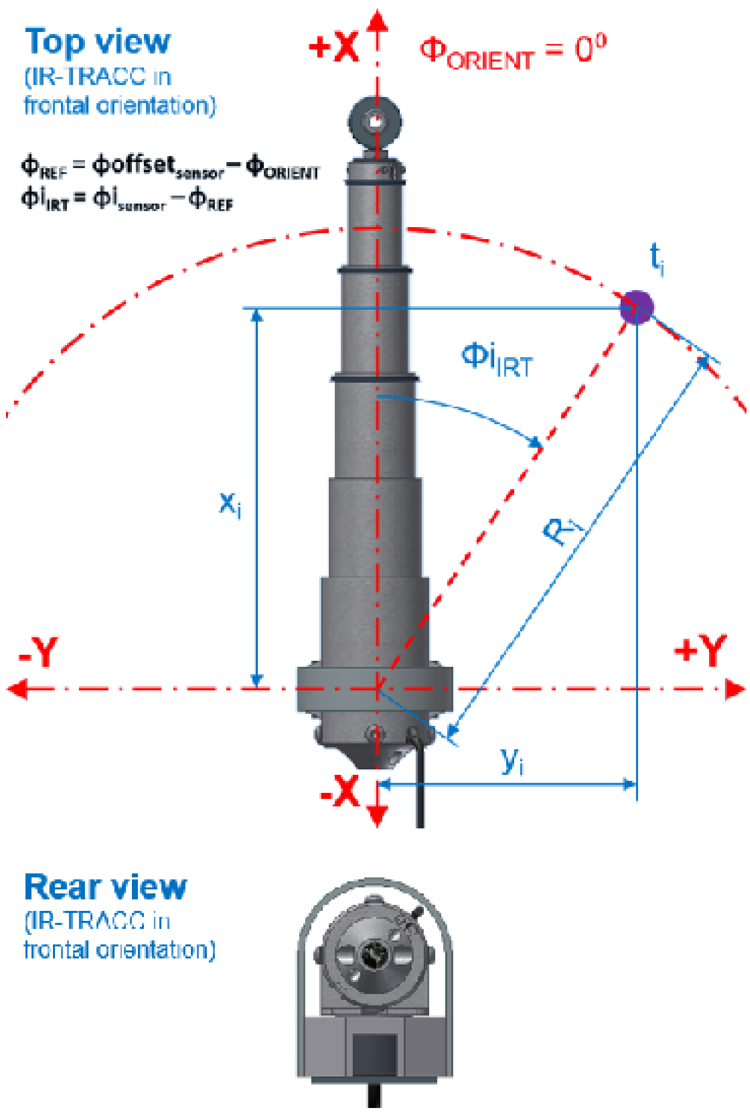


Figure 19.3 2D IR-TRACC Assembly

The IR-TRACC orientation is reflected in two parameters: the Polarity of the angle sensor defines the positive direction of the angle and the Orientation Angle ϕORIENT defines the IR-TRACC orientation angle with respect to the spine box (In the figure above, the IR-TRACC is in frontal impact orientation, ϕORIENT = 0°).

The Absolute Length Verification procedure takes data in the standard orientation and the angle sensor facing up. In this position the polarity (+/- sign for positive angle) and the Offset angle of the sensor, ϕoffsetsensor are determined. The Reference angle ϕREF takes in account the Orientation angle and the Offset angle. The definitions are given in the figure below.

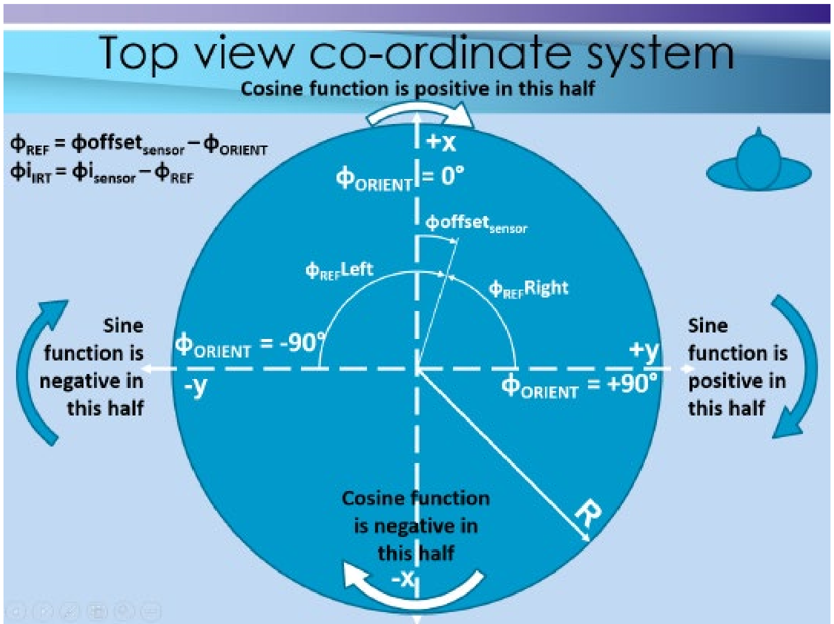


Figure 19.4 Orientation Angle, Offset Angle, and Reference Angle Definitions

In some dummy applications or positions, the 2D IR-TRACC is mounted upside down. When this is the case (angle sensor below the IR-TRACC), the polarity of the angle sensor needs to flip sign (from + to -, or from – to +) to achieve positive output according the coordinate system. As the angle polarity and offset angle are linked, flipping the polarity has an effect on the offset angle.

The five possible orientations in Q10 are:

1. **Angle sensor below the IR-TRACC**
   a. Left upper
   b. Frontal upper and lower
   c. Right upper
2. **Angle sensor on top the of IR-TRACC**
   a. Left lower
   b. Right lower

Based on the values obtained in the standard orientation, the verification sheet gives Reference Angle ϕREF and Polarity for all possible IRTRACC orientations in the dummy. When you implement a sensor in the dummy and the data acquisition system, or change the orientation of the sensor inside the dummy, apply the following sequence:

a. **Check the pertaining verification sheet for the serial number of the sensor;**
b. **Take notice of the sensor orientation in the dummy (left, right or front and up or down);**
c. **Select in the table the values for Reference Angle ϕREF and Polarity pertaining to the required orientation;**
d. **Also note the values are given in two units: degree and radian. Make sure you select the correct unit.**
e. **Enter the values in the DAS and/or post processing software.**

The figure below shows an example verification sheet.

Note: Apply the numbers of the verification sheet per sensor serial number, not the numbers in this example.

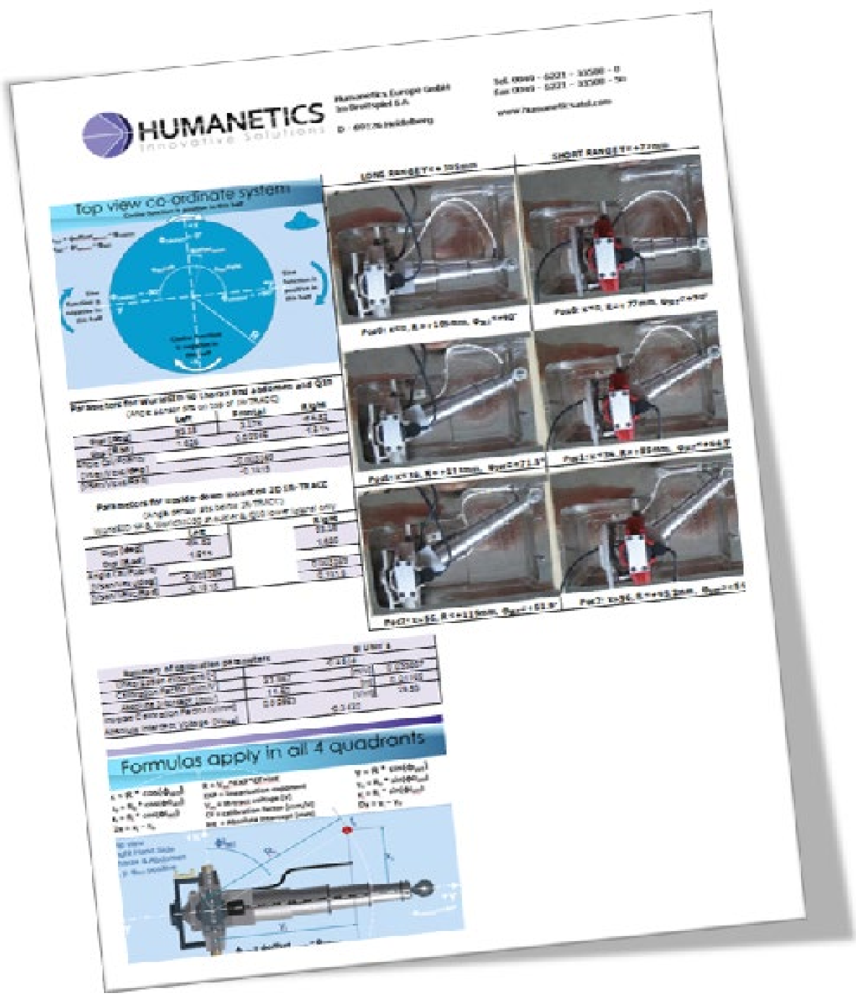


Figure 19.5 Verification Sheet Example

19.3 Data Post Processing

Figure 19.3 above shows the 2D IR-TRACC in the frontal orientation in the local spine co-ordinate system. The formulas to calculate the position of the rib in x and y co-ordinates from the sensor Radius and Angle are given below. The parameters in the formulas are defined in the table below and **Figure 19.4** above. The calculation formulas are applicable in all 4 quadrants of the co-ordinate system, provided that the correct Reference angle and polarity are implemented according the assembly orientation.

IMPORTANT NOTE: the IR-TRACC is a none-linear device and the offset at time 0 shall not be zero-ed by the data acquisition system, as this will invalidate the IR-TRACC measurement beyond recovery. Neither the angle channel shall be zero-ed, as the angle is fixed to the co-ordinate system. If offset zero-ing at t0 is defaulted by the DAS, then the IR-TRACC and angle voltages at t0 must be stored along with the data set.

Table 19-1 Calculation Parameters, Symbols, and Description

PARAMETER	DESCRIPTION
t0 , ti [s]	Time zero, Time i
VIRT [V or LSB]	IR-TRACC output
EXP	Linearization exponent IR-TRACC output
Calibration Factor [mm/V]	Linearized voltage calibration factor IR-TRACC
Absolute Intercept [mm]	IR-TRACC offset length in pivot co-ordinate system
R, R0, Ri [mm]	Sensor Radius at t0, at ti
x, x0, xi [mm]	x- co-ordinate, x at t0, x at ti
y, y0, yi [mm]	y- co-ordinate, y at t0, y at ti
Dxi [mm]	Deflection in x direction at ti
Dyi [mm]	Deflection in y direction at ti
ϕORIENT [degrees]	Orientation angle of assembled IR-TRACC, see **Figure 19.3**
ϕoffsetsensor [degrees]	Sensor offset angle Absolute Length Calibration, see **Figure 19.3**
ϕREF [degrees]	Reference angle, see **Figure 19.3**
ϕsensor , ϕ0sensor , ϕisensor [degrees]	Angle sensor output, at t0, at ti
ϕIRT, ϕ0IRT, ϕiIRT [degrees]	IR-TRACC angle along z-axis, at t0 and at ti

Calculation formulae

R = (VIRT^EXP) * (Calibration Factor) + Absolute Intercept [mm]

ϕREF = ϕoffsetsensor – ϕORIENT [deg]

ϕiIRT = ϕisensor – ϕREF,   ϕ0IRT = ϕ0sensor - ϕREF [deg]

x = R * cos(ϕIRT),   x0 = R0 * cos(ϕ0IRT),   xi = Ri * cos(ϕiIRT) [mm]

Dx = xi – x0 [mm]

y = R * sin(ϕIRT),   y0 = R0 * sin(ϕ0IRT),   yi = Ri * sin(ϕiIRT) [mm]

Dy = yi – y0 [mm]

Table 19-2 Example ISO codes for Upper and Lower 2D IR-TRACCs in SI Units

PARAMETER	CHANNEL DESCRIPTION	ISO CODE (EXAMPLE FOR FRONTAL)
VIRT [V]	Raw IR-TRACC output	?? CHST UP 00 QA VO 0 P ?? CHST LO 00 QA VO 0 P
VIRT [LSB]	Raw IR-TRACC output	Define new code for LSB
EXP	CONSTANT Cal factor Linearization exponent	.Power func exponent (header)
Calibration Factor [m/VEXP]	CONSTANT Cal factor Linearized voltage	.Power func sensitivity (header)
Absolute Intercept [m]	CONSTANT Cal factor offset length	.Power func eng offset (header)
Electrical offset [V]	CONSTANT	.Power func electr offset (header)
Electrical offset [LSB]	CONSTANT	.Power func electr offset (header)
R [m]	Absolute Length (IR-TRACC Radius)	?? CHST UP 00 QA DC 0 P
ϕisensor [Rad]	Raw Angle sensor output	Not needed for export
Angle Cal/polarity [Rad/V]	polynomial coefficient (linear)	Inverse polynom coeff C (header)
ϕREF [Rad]	CONSTANT Reference angle	Inverse polynom coeff M (header)
		.Transfer function used (header)
ϕiIRT [Rad]	Calculated [Filtered?] IR-TRACC z-angle w.r.t. dummy co-ordinate system	?? CHST UP 00 QA AN Z? ?? CHST LO 00 QA AN Z?
x [m]	Calculated [Filtered?] x- co-ordinate	?? CHST UP 00 QA DC X? ?? CHST LO 00 QA DC X?
y [m]	Calculated [Filtered?] y- co-ordinate	?? CHST UP 00 QA DC Y? ?? CHST LO 00 QA DC Y?
Dxi [m]	Calculated [Filtered?] x Deflection	?? CHST UP 00 QA DS X? ?? CHST LO 00 QA DS X?
Dyi [m]	Calculated [Filtered?] y Deflection	?? CHST UP 00 QA DS Y? ?? CHST LO 00 QA DS Y?

19.4 Checking Polarity

After implementation of the verification and calibration parameters and channel post processing according the calibration sheet, it is important to check the polarities and output of sensors in the dummy with a live Data Acquisition System (DAS) and active post processing of data channels. Check the polarities in on-line measurement mode by manipulating the dummy. The correct polarities are given in **Table 19-2**. The typical value stated in the **Table 19-2** is the expected output when the IR-TRACC is assembled in the dummy. The values are indicative and may vary, for instance, when the dummy is seated in a vehicle, ribs are rotated forward because of seat interaction, or mild permanent set has occurred on the ribs.

If one (or more) of the polarities is (are) not matching, all calibration parameters should be checked and corrected. If no error can be found there may be a polarity switched somewhere in the measurement chain. It is recommended to perform (repeat) the Absolute Length verification procedure using the exact same measurement chain as used for dummy data acquisition. The figure below shows the Q10 2D IR-TRACCs in lateral left-hand side impact configuration; Top picture: upper IR-TRACC (angle sensor below IR-TRACC); Bottom picture: lower IR-TRACC (angle sensor above IR-TRACC)

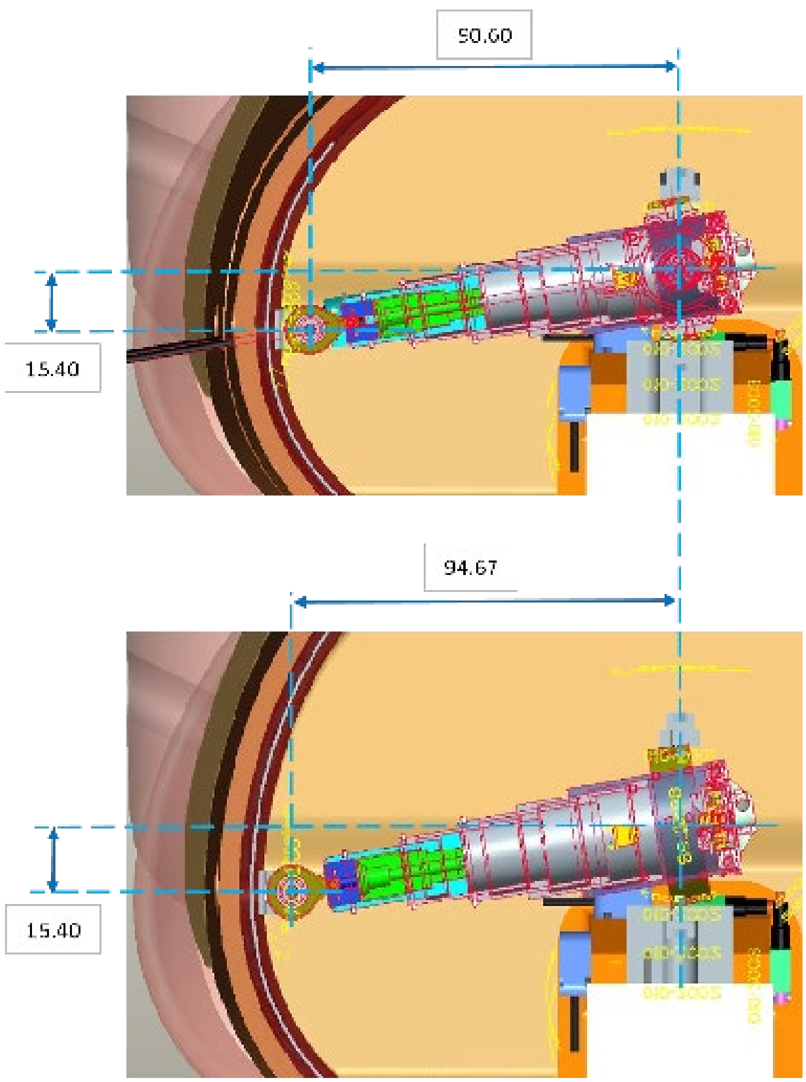


Figure 19.6 2D IR-TRACCs in Lateral LH Side Impact Configuration

Table 19-3 Dummy Manipulations & Parameter Responses (after post processing)

PARAMETER	POSITION	MANIPULATION	EXPECTED OUTPUT	STARTING VALUE* UPPER IR-TRACC	STARTING VALUE* LOWER IR-TRACC
Angle ϕIRT [degrees]	FRONTAL	PUSH RIB CAGE RIGHT	ANGLE INCREASES (TO ZERO)	~0	~0
	LEFT	PUSH RIB CAGE FORWARD	ANGLE INCREASES (TO ZERO)	~-99	~-99
	RIGHT		ANGLE DECREASES (TO ZERO)	~+99	~+99
X [mm]	FRONTAL	COMPRESS RIB CAGE	X DECREASES (TO ZERO)	~+106	~+122
	LEFT	PUSH RIB CAGE FORWARD	X INCREASES (TO ZERO)	-15	-15
	RIGHT		X INCREASES (TO ZERO)	~-15	~-15
Y [mm]	FRONTAL	PUSH RIB CAGE RIGHT	Y INCREASES (TO ZERO)	~0	~0
	LEFT	COMPRESS RIB CAGE	Y INCREASES (TO ZERO)	~-91	~-95
	RIGHT		Y DECREASES (TO ZERO)	~+91	~+95
RADIUS R [mm]	FRONTAL	COMPRESS RIB CAGE	R DECREASES (TO ZERO)	~106	~122
	LEFT	PUSH RIB CAGE FORWARD	R DECREASES (TO ZERO)	~92	~96
	RIGHT		R DECREASES (TO ZERO)	~92	~96

**Note:* *Starting values are indicative , actual values may vary*

Q10 Side Impact Shoulder Kit

For improved biofidelity a side impact shoulder kit was developed, ref. Carroll et. al. 'Side impact shoulder for the Q10 dummy – design and evaluation', proceedings of the 2014 IRCOBI Conference, 10-12 September 2014, Berlin. The kit is recommended to be used in full scale side impact testing.

20.1 Side Impact Kit Description

Q10 side impact kit shoulder parts consist of:

1. **T1 accelerometer plate.**
2. **Scapula right hand and left hand with recess for load cell or structural replacement which is attached with one M6 screw and clamped by the structural replacement load cell.**
3. **The structural replacement load cell is attached with three M5 countersunk screws.**

   (Caution: When the load cell is fitted, it is not suitable for use in frontal impact tests).
4. **Shoulder joint parts:**

   a. Bronze shoulder joint block with two set screws to apply friction to the joint for flexion and extension range of motion.

   b. One attachment screw and steel washer plus waved washer to eliminate end play.
5. **Upper arm solid flesh part with integral plastic bone inside, attached with two shoulder screws.**

The figure below shows the Q10 Side Impact Shoulder Kit Parts, 012-4500.

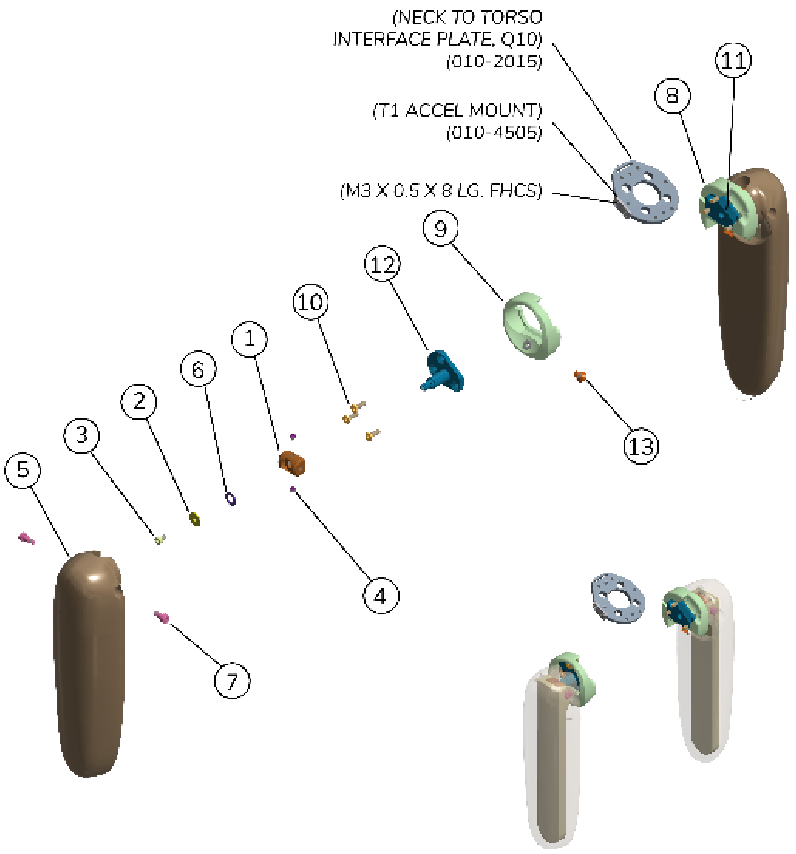


Figure 20.1 Q10 Side Impact Kit Shoulder Parts

SECTION 20

Q10 Side Impact Shoulder Kit

Table 20-1 Side Impact Kit Shoulder Parts List

Item	Qty.	Part Number	Description
1	2	010-4503	SHOULDER PIVOT - SIDE IMPACT
2	2	010-4504	SHOULDER WASHER - SIDE IMPACT
3	2	5000743	M5 X 0.8 X 8 LG. LHCS
4	4	5000995	M6 X 1 X 6 LG. SSSNP
5	2	010-4510	ARM ASSEMBLY MOLDING - SIDE IMPACT
6	2	500248	M8 WAVE WASHER SS
7	4	5001273	6 X 7 LG. PRECISION SHSS SS
8	1	010-4521	SHOULDER JOINT HOUSING 2020 LEFT, SIDE IMPACT
9	1	010-4522	SHOULDER JOINT HOUSING 2020 RIGHT, SIDE IMPACT
10	6	5000467	M5 X 0.8 X 16 LG. FHCS
11	1	10979	STRUCTURAL REPLACEMENT, Q10 L.H. SHOULDER
12	1	10969	STRUCTURAL REPLACEMENT, Q10 R.H. SHOULDER
13	2	5000139	M6 X 1 X 12 LG. FHCS

20.2 Assembly and Disassembly

The Q10 Side Impact Kit (012-4500) should be assembled as described below. There can be two starting conditions depending on the service build level (SBL):

1. **Q10 frontal with the old rubber shoulder interface part and the old lower neck interface plate SBL A and B.**
2. **Q10 frontal with the new standard rubber shoulder interface part and lower neck interface plate SBL C or above December 2013.**

20.2.1. STARTING CONDITION WITH OLD SBL A SHOULDER INTERFACE PART AND LOWER NECK INTERFACE PLATE

1. **Remove the suit from the shoulder area**
2. **Remove the neck shield**
3. **Remove the rubber shoulder interfaces and arm by:**
   a. Detaching the slotted screw, that attach the clavicle to rubber shoulder Interface parts.
   b. Detaching the four SHCS, that attach the rubber shoulder interface part to the thoracic spine.
4. **Install the complete Q10 side impact kit arm and rubber shoulder interface part assembly on the dummy by:**
   a. Attaching the four SHCS, that attach the rubber shoulder interface part to the thoracic spine and
   b. Attach the slotted screws that attach clavicle to rubber shoulder interface part.
5. **Remove the Lower Neck Interface plate by:**
   a. Detaching the head and neck assembly by removing the four SHCS of lower neck.
   b. Detaching the four SHCS of lower neck load cell to thoracic spine attachment.
   c. Detaching the four FHCS of lower neck load cell to interface plate.

6. **Install the lower neck interface plate (with mount provisions for a T1 accelerometer) by:**
   a. Attaching the four FHCS of lower neck load cell to interface plate.
   b. Attaching the four SHCS of lower neck load cell to thoracic spine
   c. Attaching the head and neck assembly by fitting the four SHCS of lower neck to interface plate.
7. **Install the neck shield**
8. **Refit the suit.**

20.2.2 STARTING CONDITION WITH NEW SHOULDER INTERFACE PART AND LOWER NECK INTERFACE PLATE

1. **Remove the Suit from the shoulder area.**
2. **Remove the arm attachment pin by:**
   a. Detaching the M8 FHCS in the arm pit
   b. Pulling out the arm attachment pin from the scapula.
3. **Remove the scapula from the rubber shoulder interface part by detaching the three M5 FHCS**
4. **Remove the Q10 Side Impact upper arm from the shoulder kit assembly by detaching the two M5 shoulder screws. If the kit is not assembled, assemble as per** Figure 20.2 **and** Figure 20.3 **below, without arm.**
5. **Attach the Q10 side impact kit without arm by:**
   a. Installation of the three M5 FHCS through the shoulder load cell flange.
   b. Installation of one M6 FHCS through the lug of the rubber shoulder interface part at the arm pit in to the nut molded in the scapula.
6. **Attach the side impact upper arm on the shoulder joint by installing the two M5 shoulder screws.**
7. **The arm friction should be set 1 g with the arm at 45⁰ forward. The shoulder screws need to be removed and replaced if the friction needs adjusting. Adjust friction using the M5 SHCS.**
8. **Refit the suit**

20.3 Instrumentation

The Q10 side impact shoulder kit facilitates provisions for three sensors:

1. Three axis (Fx, Fy and Fz) shoulder joint load cell (capacity: 2000N, 4000N, 2000N)
   (Caution: This load cell is not suitable for use in frontal impact tests)
2. Accelerometer (Ay) to rubber shoulder interface end plate (inside, see **Figure 20.2** below)
3. Accelerometer (Ay) to the lower neck interface plate (called T1 location, see **Figure 20.3** below)

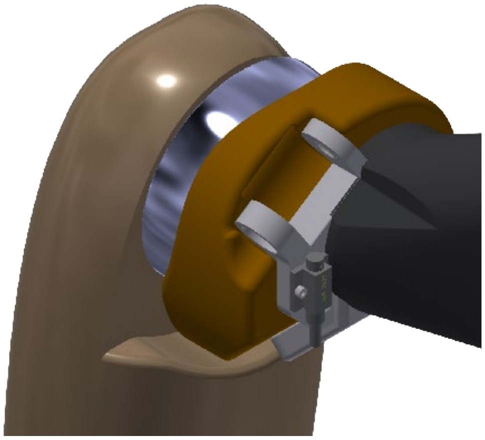


Figure 20.2 Q10 Side Impact Kit with Shoulder Joint Accelerometer Ay

Figure 20.3 Q10 Side Impact Kit with T1 Ay Accelerometers Installed

Q10 2020 Kit

21.1 Introduction

The Q10 2020 configuration is designed as a kit that can be implemented to the Q10 production version dummy produced since 2012. To change a standard production version Q10 in to a Q10 2020 the following parts have to be removed and added. The 23 parts to be added are available as a kit part number 010-4450. The 65 shore D red Hip shields (LHS: 010-9220 and RHS: 010-9221) are not shown in the picture and table below.

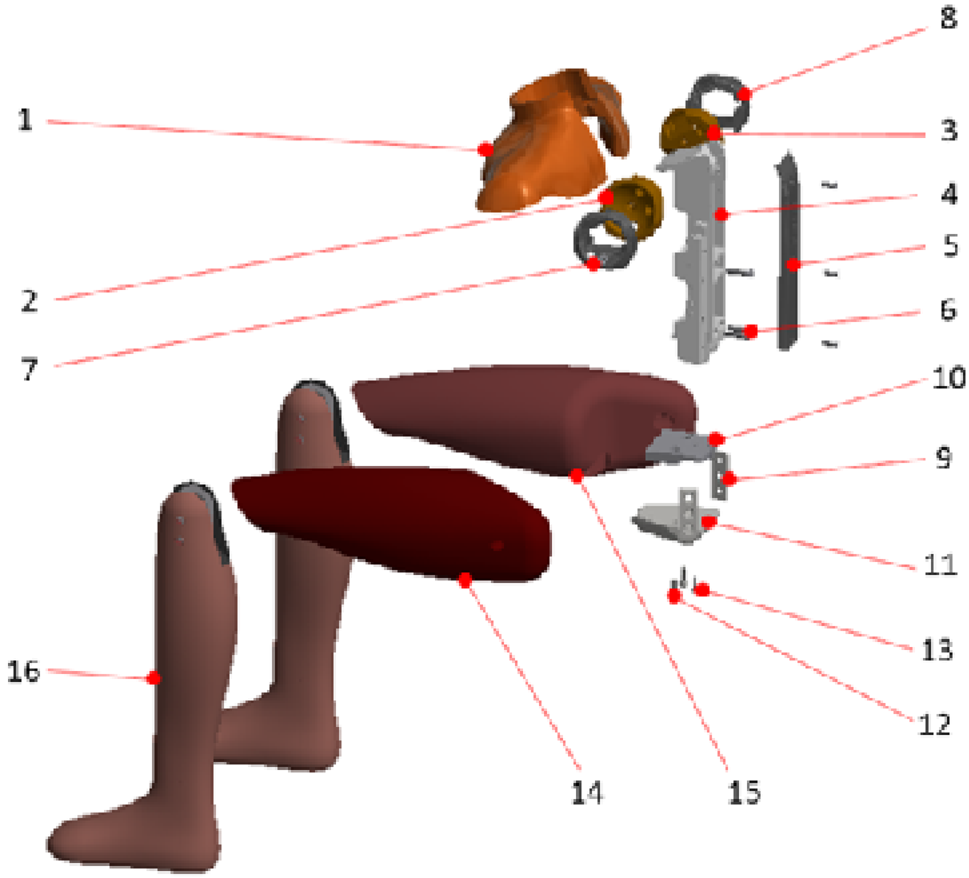


Figure 21.1 Q10 2020 Kit

Q10 2020 Kit

Table 21-1 Parts Removed and Added for Kit

Description	Remove Part #	Mass (Gram)	Description	Add Part #	Mass (Gram)	Delta (Gram)
THORAX						
NECK SHIELD	010-3800	335	SHOULDER LINER	010-3513	547	+1405
SCAPULA, LEFT	010-3301	88.5	SHOULDER JOINT HOUSING 2020, LEFT	010-3311	57	
SCAPULA, RIGHT	010-3302	88.5	SHOULDER JOINT HOUSING 2020, RIGHT	010-3312	57	
SPINEBOX, Q10	010-4001	752	SPINEBOX, Q10	010-4451	2010	
BACK PLATE	010-4107	32	BACK PLATE 2020	010-4452	33	
M5 X 0.8 X 45 LG. SHCS ZINC	5001202	8	M5 X 0.8 X 25 LG. SHCS	5000721	5	
SCAPULAR LEFT - SIDE IMPACT	010-4501	75	SHOULDER JOINT HOUSING 2020, LEFT	010-4521	38	For side impact kit
SCAPULAR RIGHT - SIDE IMPACT	010-4502	75	SHOULDER JOINT HOUSING 2020, RIGHT	010-4522	38	
PELVIS						
RETAINING PLATE, PELVIS BONE, Q10	010-7009	120	RETAINING PLATE 2020 PELVIS BONE	010-7214	56	-1409
SACRUM TOP BALLAST, Q10	010-7201	826	SACRUM TOP PLATE, 2020	010-7211	263	
SACRUM BOTTOM PLATE, Q10	010-7202	1310	SACRUM BOTTOM PLATE 2020	010-7213	529	
M6 X 1.0 X 20 LG. SHCS ZINC	5001183	6	M6 X 1 X 22 LG. SHCS	5000282	5	
M4 X 0.7 X 20 LG. SHCS ZINC	5001189	1	M4 X 0.7 X 18 LG. SHCS	5001147	1	
LEGS						
UPPER LEG FLESH, LEFT, Q10	010-9107	2850	UPPER LEG FLESH 2020, LEFT	010-9230	2850	Mass neutral
UPPER LEG FLESH, RIGHT Q10	010-9207	2850	UPPER LEG FLESH 2020, RIGHT	010-9231	2850	
LOWER LEG ASSEMBLY, Q10	010-9202	5060	LOWER LEG ASSEMBLY 2020	010-9222	5060	Mass neutral

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For additional information on Humanetics and its products and services, please refer to our website
or contact:

Humanetics
23300 Haggerty Road
Farmington Hills, Michigan 48335 USA
Telephone: +1 (248) 778-2000
Fax: +1 (248) 778-2001

SECTION 24

Update Log

Table 24-1 Update Log

Revision Level	Revision Date	Revision Author	Revision Description
1	OCT 2020	MB, MGT	Initial Release

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