

MVNX EXPORT · VERSION 4 · FILE STRUCTURE

Understanding the MVNX File

A plain-language guide to the contents of an MVNX export, section by section.



1 Introduction

In MVN you can export your recording as an MVNX file (MVN Open XML format). It is a human-readable XML file that can be opened directly in programs such as Microsoft Excel, Python, MATLAB, and C-Motion Visual 3D.

You decide which data goes into the file by clicking "Show options" in the export window. The items you can switch on or off include:

- Position, Orientation, Velocity and Angular Velocity
- Acceleration and Angular Acceleration
- Global Position (GNSS), Center of Mass and Joint Angle
- Time Code, Contact Data and External Data
- Motion Tracker Free Acceleration, Orientation and Magnetic Field

You can also choose the MVNX version and apply a frame skip to reduce the frame rate (downsampling) of the exported file.

2 Initialization

The file opens with some general information about the recording before any movement data appears.

It begins with the XML version, followed by the root element that references the file's schema and the MVNX version. Next comes a field recording the MVN software version and build used to produce the file, along with any comments added to the original recording.

After this is the session information, which includes:

Field	Description
Suit label	The name of the MVN System
Sample frequency	The frame rate used
Segment count	The number of segments calculated, which indicates a full- or half-body recording
Recording date	The date the recording took place (based on local time)
Original file name	The filename of the original recording the file is based on
Comment	Any comment the user added
Body model	Which biomechanical model was used, shown as a number (MVN 2025.0 and newer): 0 = Legacy (the model used before the female/male split), 1 = Female, and 2 = Male.

3 Segments

The segments section describes the shape of the body model. For each segment it lists the positions of its connecting joints and its anatomical landmarks, measured relative to that segment's own origin.

The standard biomechanical model contains 23 segments:

Number	Segment Label
1	Pelvis
2	L5
3	L3
4	T12
5	T8
6	Neck
7	Head

8	Right Shoulder
9	Right Upper Arm
10	Right Forearm
11	Right Hand
12	Left Shoulder
13	Left Upper Arm
14	Left Forearm
15	Left Hand
16	Right Upper Leg
17	Right Lower Leg
18	Right Foot
19	Right Toe
20	Left Upper Leg
21	Left Lower Leg
22	Left Foot
23	Left Toe

Joint points are prefixed with a "j" and anatomical landmark points with a "p". Each segment has a label and an ID. For example, the right upper leg lists points such as the right hip and right knee:

```
segment label = "RightUpperLeg" id = "16"
  point label = "jRightHip" → position 0.000, 0.000, 0.000
  point label = "jRightKnee" → position 0.000, 0.000, -0.423
```

4 Sensor Data

The sensors section is simply a list of the body locations measured by the motion trackers (MTs), given by segment name.

A standard setup includes 17 trackers:

Number	Tracker
1	Pelvis
2	T8
3	Head
4	RightShoulder
5	RightUpperArm
6	RightForeArm
7	RightHand
8	LeftShoulder
9	LeftUpperArm
10	LeftForeArm

11	LeftHand
12	RightUpperLeg
13	RightLowerLeg
14	RightFoot
15	LeftUpperLeg
16	LeftLowerLeg
17	LeftFoot

5 Joints Data

The joints section lists each joint and the two points that it connects. Every joint joins a point on one segment to the matching point on its neighbour.

For example, the left hip joint connects the hip point on the pelvis to the hip point on the left upper leg. The biomechanical model is made up of 22 joints, each modelled with 3 degrees of freedom:

Index	Joint	Description
1	jL5S1	Joint between the lumbar spine segment 5 and sacral spine 1
2	jL4L3	Joint between the lumbar spine segment 4 and lumbar spine segment 3
3	jL1T12	Joint between the lumbar spine segment 1 and thoracic spine segment 12
4	jT9T8	Joint between the thoracic spine segment 9 and thoracic spine segment 8
5	jT1C7	Joint between the thoracic spine segment 1 and cervical spine segment 7
6	jC1Head	Joint between the cervical spine segment 1 and the head segment
7	jRightT4Shoulder	Joint between the thoracic spine segment 4 and the right shoulder MVN segment
8	jRightShoulder	Shoulder joint angle between the MVN shoulder segment and the upper arm, corresponding to the glenohumeral joint (GH).
9	jRightElbow	Joint between the upper arm and the forearm. The joint origin is the midpoint between the epicondyles in MVN.
10	jRightWrist	Joint between the forearm and the hand. In MVN, the joint center is the midpoint between the styloids.
11	jLeftT4Shoulder	Joint between the thoracic spine segment 4 and the left shoulder MVN segment
12	jLeftShoulder	Shoulder joint angle between the MVN shoulder segment and the upper arm, corresponding to the glenohumeral joint (GH).
13	jLeftElbow	Joint between the upper arm and the forearm. The joint origin is the midpoint between the epicondyles in MVN.
14	jLeftWrist	Joint between the forearm and the hand. In MVN, the joint center is the midpoint between the styloids.
15	jRightHip	Joint between the pelvis and upper leg. Center of rotation of the right hip joint.
16	jRightKnee	Joint between the upper leg and lower leg. Located in between lateral tibial condyle (LC) and medial tibial condyle (MC). Both condyles in MVN are assumed to be at the same height.
17	jRightAnkle	Joint between the lower leg and foot. Middle point between the lateral and medial malleoli. The malleoli are assumed to be at the same height in MVN.

18	jRightBallFoot	Joint between the foot and the calculated toe.
19	jLeftHip	Joint between the pelvis and upper leg. Center of rotation of the left hip joint.
20	jLeftKnee	Joint between the upper leg and lower leg. Located in between lateral tibial condyle (LC) and medial tibial condyle (MC). Both condyles in MVN are assumed to be at the same height.
21	jLeftAnkle	Joint between the lower leg and foot. Middle point between the lateral and medial malleoli. The malleoli are assumed to be at the same height in MVN.
22	jLeftBallFoot	Joint between the foot and the calculated toe.

6 Ergonomic Joint Data

The ergonomic joint angles section lists a specific set of joint angles used for ergonomic analysis. For each one it names the parent segment and child segment that form the joint.

Joint	Description
Head_T8	Rotation of the head with respect to the trunk (T8)
T8_Left_UpperArm	Rotation of the arm with respect to the trunk (T8) instead of the scapula
Pelvis_T8	Rotation of the trunk (T8) with respect to the pelvis
Vertical_Pelvis	Rotation of the pelvis with respect to the vertical axis
Vertical_T8	Rotation of the trunk (T8) with respect to the vertical axis

7 Foot Contact Detection

The foot contact definition section lists the foot contact points the file tracks. For every frame, each point is marked 1 if it is touching the ground or 0 if it is not.

Contact point	Index
Left foot - heel	0
Left foot - toe	1
Right foot - heel	2
Right foot - toe	3

Note. The way contact points work in the MVNX file is different from how they appear inside MVN. In MVN, several segments can have contact points and they sit on bony landmarks. In the MVNX file there are only these four contact points, and they are not placed on the bony landmarks.

8 External Data

Since MVN 2020.2, you can also export external data such as EMG (muscle-activity) signals in the MVNX file. For each channel, the file records the frame rate, an ID, a name, and the source.

The measurements themselves are then stored per channel, each with its channel number and sample number.

Note. External data may run at a different frame rate than the MVN data, because it uses the external system's own rate. For example, an EMG system might output at 2148 Hz.

9 Frames

The frames section holds the actual recorded movement data, frame by frame. It opens by stating how many

segments, sensors, and joints are included, and it also contains the calibration-pose data.

There are a few different frame types:

- **Identity** — the null pose, where every segment is lined up with the global axes.
- **T-pose** — the positions and orientations of all segments in the T-pose; these deviate slightly from the identity pose.
- **T-pose (ISB)** — the same T-pose, but using the MVN anatomical frame for the segments. This frame is what's used to calculate the joint angles.
- **Normal** — the frames recorded during the actual session.

Each normal frame carries the full set of per-frame data streams you chose to export — orientation, position, velocity, acceleration, joint angles, foot contacts, sensor data, center of mass, and so on. The exact list of these values, with their formats and units, is given in section 9.2.

9.1 How time is recorded

Each frame is stamped with timing information:

Field	What it means
time	The elapsed time of the frame. Each step depends on the frame rate — for example, at 240 Hz each frame is about 4.16 milliseconds apart.
index	The original frame number.
tc	The time code — the real-world time the frame was recorded, useful for syncing with other equipment. If no time code is present, it is based on Global Time (GMT+0).
ms	The absolute time in milliseconds, measured from 1 January 1970.

9.2 Parameters and their units

The table below lists every data parameter that can appear in a frame, the shape of its values, and its unit of measurement.

Parameter	Format	Units	What it describes
BODY SEGMENT DATA (PER SEGMENT)			
Orientation	4 values (quaternion)	—	Orientation of the segment relative to the global frame.
Position	3 values (x, y, z)	metres (m)	Position of the segment's origin in the global frame.
Velocity	3 values (x, y, z)	m/s	Velocity of the segment's origin in the global frame.
Acceleration	3 values (x, y, z)	m/s ²	Acceleration of the segment's origin in the global frame.
Angular velocity	3 values (x, y, z)	rad/s	Rotational speed of the segment in the global frame.
Angular acceleration	3 values (x, y, z)	rad/s ²	Rotational acceleration of the segment's origin in the global frame.
Center of Mass	3 values (x, y, z)	metres (m)	Position of the body's center of mass in the global frame. (Velocity and acceleration also included from MVN 2020.2.)
JOINT DATA			
Joint angle	3 values (x, y, z)	degrees	Joint angle, calculated with the

			ZXY convention.
Joint angle (XZY)	3 values (x, y, z)	degrees	Joint angle using the XZY convention. Provided for all joints but commonly used only for the shoulders.
Ergonomic joint angle	3 values (x, y, z)	degrees	Ergonomic joint angle, calculated with the ZXY convention.
Ergonomic joint angle (XZY)	3 values (x, y, z)	degrees	Ergonomic joint angle, calculated with the XZY convention.
SENSOR / MOTION TRACKER DATA (PER TRACKER)			
Sensor orientation	4 values (quaternion)	—	Orientation of the tracker in the global frame.
Sensor free acceleration	3 values (x, y, z)	m/s ²	Free acceleration measured by the tracker.
Sensor magnetic field	3 values (x, y, z)	arbitrary units	Magnetic field measured by the tracker.
OTHER DATA			
Foot contacts	4 values (yes/no)	0 or 1	Whether each foot contact point was detected on the ground in that frame.
External data	1 value	millivolts (mV)	Electromyography (EMG) data, used to measure muscle activity.

A note on angular velocity. On-screen graphs in MVN show angular velocity in degrees per second, but in the MVNX file it is exported in radians per second.

This guide explains the data and structure of the MVNX (MVN Open XML) Version 4 export format, based on the MVNX Version 4 file-structure documentation, the MVN User Manual, and the Xsens Biomechanical Model documentation. It is written as a plain-language reference; for full technical detail, including the underlying XML, see the source documentation.