

## Segment specifications for kinematic models of insects

### Kinematic chains

Main kinematic chain: cs0 – T3 (– T2) – T1 – Hd

Side chains:           T#.cs – R# – cox – fem – tib – tar (right leg)  
                           T#.cs – L# – cox – fem – tib – tar (left leg)  
                           Hd.cs – ant# – scp – ped                    (antenna)

**Table I: Segments**

<b>T3</b>	metathorax
<b>T2</b>	mesothorax
<b>T1</b>	prothorax
<b>Hd</b>	head
<b>antR</b>	right antenna
<b>antL</b>	left antenna
<b>R1, R2, R3</b>	Right leg, number 1, 2, or 3 indicates front, middle or hind leg
<b>L1, L2, L3</b>	Left leg, number 1, 2, or 3 indicates front, middle or hind leg
<b>Cox</b>	Coxa
<b>Fem</b>	Femur
<b>Tib</b>	Tibia
<b>Tar</b>	Tarsus
<b>Scp</b>	Scapus
<b>Ped</b>	Pedicellus

**Table II: Segment properties**

<b>cs</b>	Segment coordinate system (cs0: external reference coordinate system)
<b>pos</b>	position in external coordinates (except for L#/R#, where POS is in local coordinates)
<b>angle</b>	joint angles (corresponding to single degrees of freedom)
<b>dir</b>	Direction vector
<b>front</b>	Front end
<b>LENGTH</b>	Segment length
<b>WIDTH</b>	Segment width
<b>COXDIST</b>	Ventral base distance between the coxae
<b>CLAW</b>	Length of claw
<b>SIDE</b>	Side of the body (relative to sagittal plane; right = 1, left = 0)
<b>REF</b>	Reference coordinate system, as defined by marker positions on segments
<b>BIAS</b>	Bias rotation angles for backrotation of REF into the true segment coordinate system
<b>ROTX</b>	Rotation range of x axis
<b>ROTY</b>	Rotation range of y axis
<b>ROTZ</b>	Rotation range of z axis
<b>ROTSEQ</b>	Sequential order of rotations (equiv. to degrees of freedom)
<b>M1, M2, M3</b>	Copordinates of first, second and third marker on the segment

Table III: Properties of individual segment types (main chain)

	T3	R2/L2, R3/L3	T2, T1	R1/L1	Hd	antR/antL
	<i>cs0</i>	<i>T3.cs</i>	<i>T3.cs, T2.cs</i>	<i>T1.cs</i>	<i>T1.cs</i>	<i>Hd.cs</i>
cs	o		o		o	
pos/POS	o	◆	o	◆	o	◆
angle	o		o		o	
dir						o
front					o	
LENGTH	◆		◆		◆	◆
WIDTH	◆		◆		◆	
COXDIST	◆					
SIDE		◆		◆		◆
REF	●		●		●	
BIAS	●		●		●	
ROTX	◆					
ROTY	◆		◆		◆	
ROTZ	◆		◆		◆	
ROTSEQ	ZYX		ZY		ZY	
M1	◆		◆		◆	◆
M2	◆					
M3	◆					

Table IV: Properties of individual segment types (side chains)

	cox	fem	tib	tar	scp	ped
	<i>T3.cs</i>	<i>R#/L#.cox.cs</i>	<i>R#/L#.fem.cs</i>	<i>R#/L#.tib.cs</i>	<i>ant#.cs</i>	<i>ant#.cs</i>
cs	o	o	o		o	o
pos	o	o	o	o	o	o
angle	o	o	o		◆,o	◆,o
LENGTH	◆	◆	◆	◆	◆	◆
WIDTH	◆	◆	◆			
CLAW				◆		
REF		●	●			
BIAS		●	●			
ROTX	◆					
ROTY	◆	◆	◆		◆	◆
ROTZ	◆					
ROTSEQ	ZXY	Y	Y		ZXY	XY
M1		◆	◆			◆

## Legend to symbols

- o Variable, calculated during runtime (variable names in lower case)
- Constant, calculated during runtime (constant names in UPPER CASE)
- ◆ Constant, preset by calibration or by convention (constant names in UPPER CASE)

**Table V: Contact.LEG (e.g. R1) properties**

<b>time</b>	o	Beginning and end of stance phases in frames (touch-down (td) and lift-off)
<b>duration</b>	o	Duration of stance phase and the swing phase (before touch-down) in seconds
<b>pos</b>	o	Position of the tibia tarsus joint (TT-joint) in external coordinates (x,y,z)
<b>target</b>	o	Position of the anterior TT-joint in external coordinates (x,y,z)
<b>relpos</b>	o	Position of the TT-joint in the body (T3) coordinates (x,y,z) at td (time: i, 1)
<b>reltarget</b>	o	Position of the anterior TT-joint in body (T3) coordinates (x,y,z) at td (time: i, 1)
<b>liftpos</b>	o	Position of the TT-joint in the body (T3) coordinates (x,y,z) at lift-off (time: i, 2)
<b>surface</b>	o	Supporting surface of the setup (number, distance between surface and TT-joint)
<b>class</b>	o	Step class, defined by start and target surface 2 <sup>nd</sup> column: "high step" indication (high = 1, low = 0)
<b>height</b>	o	Step height in mm and range or the height of the swing before touch-down
<b>searching</b>	o	1 <sup>st</sup> column: searching movements (0 = no searching; 1 = searching); 2 <sup>nd</sup> and 3 <sup>rd</sup> column: parameters of the searching movement: peak height and peak duration 4 <sup>th</sup> column: searching movements of the ipsilateral anterior leg (1 = searching)
<b>INFO</b>	◆	N_ANIMAL, N_SESSION, N_CONDITION, N_TRIAL, N_ABLATION, N_SIDE

Table VI: Experiment properties

<b>USER</b>	◆	User
<b>EXPERIMENTER</b>	◆	Experimenter
<b>EXPERIMENT_NAME</b>	◆	Name of the experiment if available
<b>SPECIES</b>	◆	Genus of the animal
<b>AGE</b>	◆	Ontogenetic stage of the animal
<b>SEX</b>	◆	Sex of the animal
<b>N_ANIMAL</b>	◆	Number of the animal
<b>N_SESSION</b>	◆	Number of the session
<b>N_CONDITION</b>	◆	Specification of the experimental condition, e.g. step height in mm: 0/8/24/48
<b>N_ABLATION</b>	◆	Experimental treatment 0 no Ablation, intact animals, 1 trochanteral hairs shaved, identification in the filename 'ts' 2 coxal hairs shaved, identification in the filename 'cs' 3 claw ablated, identification in the filename 'ca' 4 tarsus ablated, identification in the filename 'ta' 5 tarsus blocked, identification in the filename 'tb' 6 antennae cut and visual cue 'ac' 7 visual cue 'vc' 8 antennae cut, no visual cue 'an' 9 wire condition, no contact with antennae 'WC' (or 'WB') + '_00_' 10 wire condition, one contact with antennae 'WC' + '_01_' 11 wire condition, two or more contacts with antennae 'WC' + '_02_'
<b>N_TRIAL</b>	◆	Number of the trial
<b>N_FRAMES</b>	◆	Number of frames
<b>N_MARKER</b>	◆	Number of markers attached to the animal
<b>DATE</b>	◆	Date of the experiment, format: yymmdd
<b>FREQUENCY</b>	◆	Sample frequency of the Vicon data, the side view cameras and the analog data if available.
<b>FILTER</b>	◆	Kind of filtering with cut-off frequency, e.g. Butterworth 20Hz
<b>SCALE_FACTOR</b>	◆	Factor used for scaling the marker position data received from Vicon
<b>ANIMAL_ID</b>	◆	Number of the animal as char (e.g. '01', '11')
<b>SESSION_ID</b>	◆	Number of the session as char (e.g. '1', '2')
<b>INFO_FRAME</b>	◆	Number of the animal, the session, the condition, the trial and the ablation for each frame

**Table VII: Gait properties**

<b>pattern</b>	o	Status of each leg, 0 for swing, 1 for stance phase as matrix: (R1/R2/R3/L1/L2/L3)
<b>incontact</b>	o	Number of legs which are in stance phase
<b>velocity</b>	o	Velocity of T3.pos (absolute value) [mm/s]
<b>vel_legs</b>	o	Velocity of each TT-joint (:, 1:6) [mm/s], binned according to column 7

**Table VIII: Setup properties**

<b>med</b>	o	Median position of each setup marker in the order described by 'LABEL'
<b>std</b>	o	Standard deviation of the position of each setup marker
<b>range</b>	o	Range of the position of each setup marker
<b>LABEL</b>	◆	Names of the setup markers