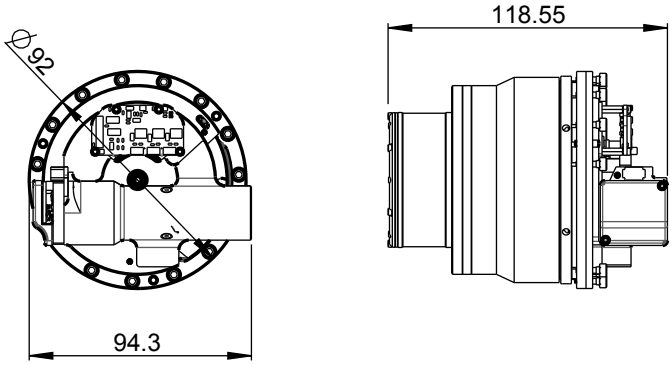
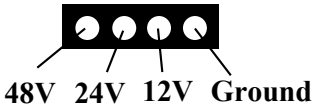
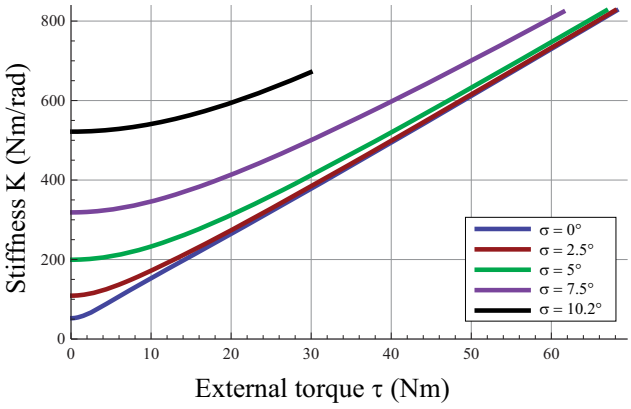
DLR Floating Spring Joint (FSJ)

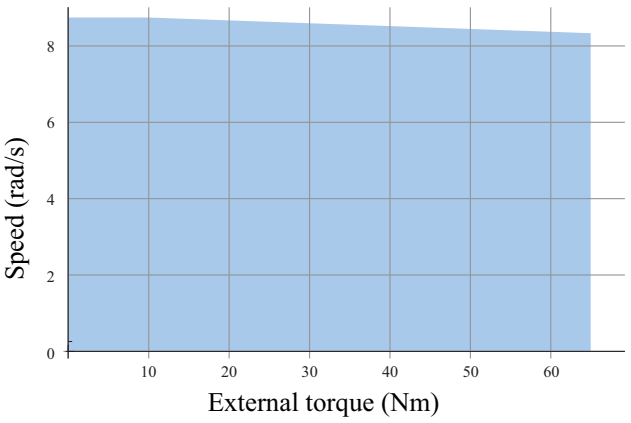
Adjustable Stiffness Joint

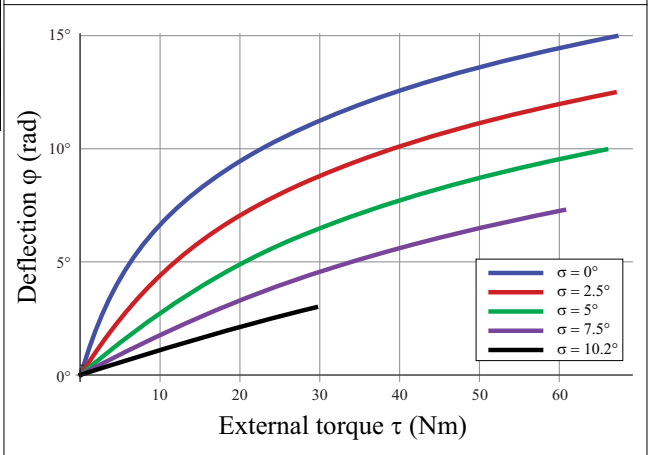


Operating Data				
#	(quantity)		(unit)	(value)
Mechanical				
1	Continuous Output Power		[W]	266.4
2	Nominal Torque		[Nm]	31.3
3	Nominal Speed		[rad/s]	8.51
4	Nominal Stiffness Variation Time	with no load	[s]	0.33
5		with nominal torque	[s]	0.33
6	Peak (Maximum) Torque		[Nm]	67
7	Maximum Speed		[rad/s]	8.51
8	Maximum Stiffness		[Nm/rad]	826
9	Minimum Stiffness		[Nm/rad]	52.4
10	Maximum Elastic Energy		[J]	5.3
11	Maximum Torque Hysteresis		[%]	20
12	Maximum deflection	with max. stiffness	[°]	3
13		with min. stiffness	[°]	15
14	Active Rotation Angle		[°]	180
15	Angular Resolution		[°]	0.0031
16	Weight		[Kg]	1,41
Electrical				
17	Nominal Voltage		[V]	48; 24
18	Nominal Current		[A]	10; 3
19	Maximum Current		[A]	24; 9
Control				
20	Voltage Supply		[V]	12
21	Nominal Current		[A]	1
22	I/O protocol		[]	spacewire









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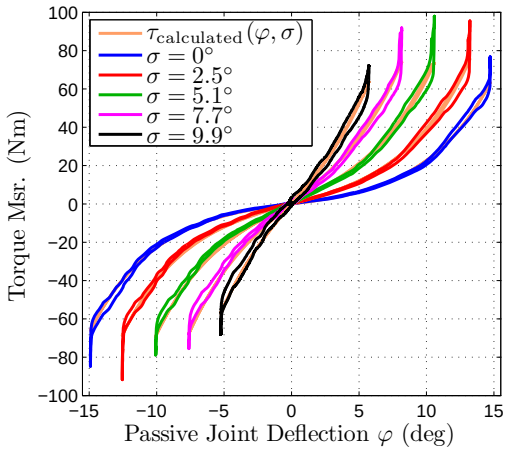
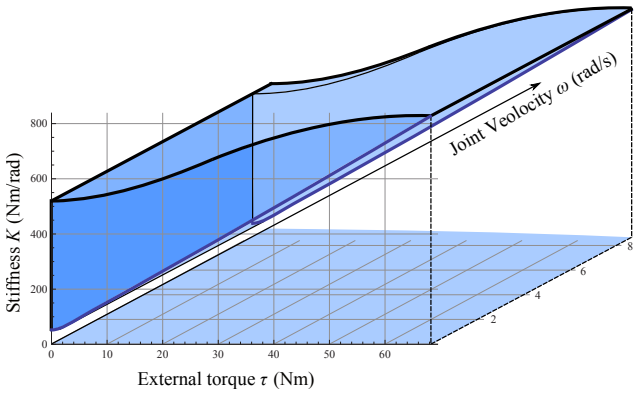
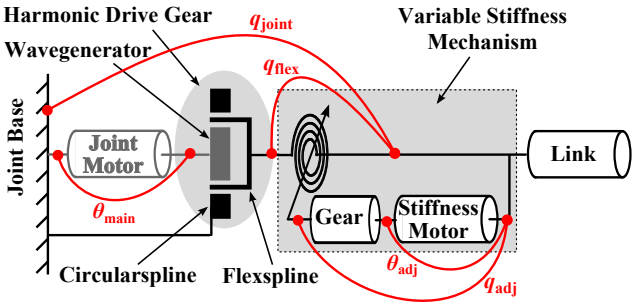
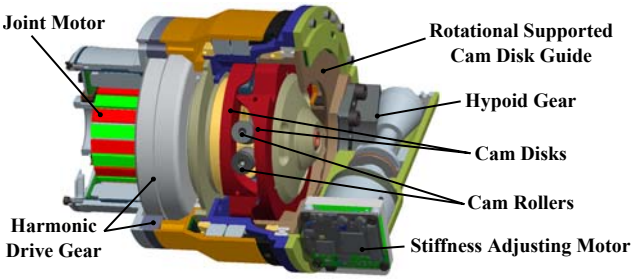
Additional Characteristics

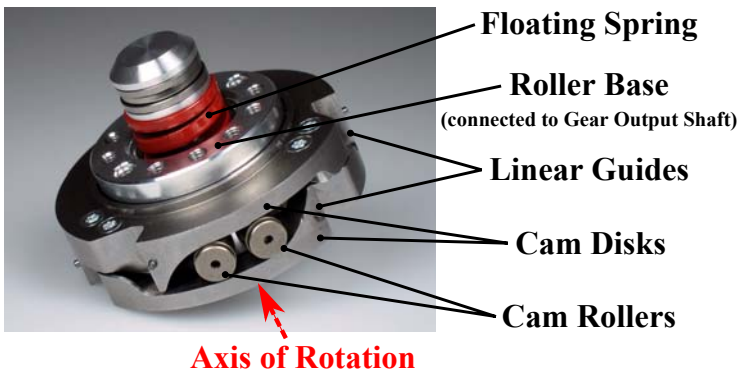




Additional sensors data			
#	(quantity)	(unit)	(value)
a0	**Sensor θ_{main}**		
a1	Resolution	[bit]	12
a2	Range	[turns]	multi
a3	I/O protocol		Biss
b0	**Sensor θ_{adj}**		
bx	Resolution	[bit]	12
by	Range	[turns]	multi
bz	I/O protocol		Biss
c0	**Sensor q_{joint}**		
cx	Resolution	[bit]	16
cy	Range	[°]	205
cz	I/O protocol		Biss
d0	**Sensor q_{flex}**		
dx	Resolution	[bit]	15
dy	Range	[°]	30
dz	I/O protocol		Biss
e0	**Sensor q_{adj}**		
ex	Resolution	[bit]	13
ey	Range	[°]	23
ez	I/O protocol		Biss







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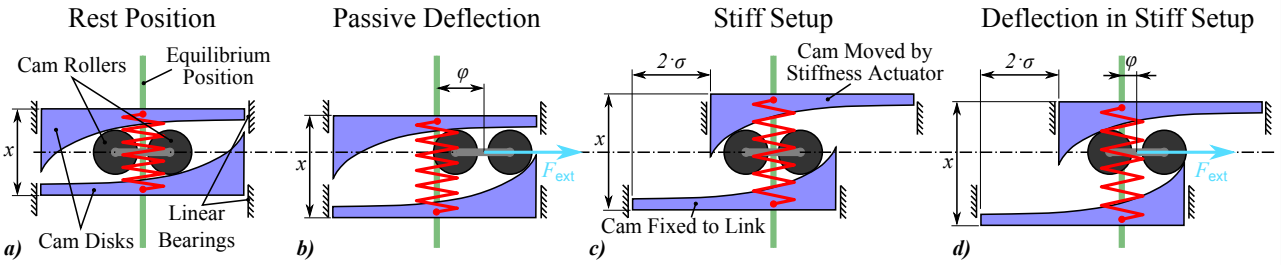
Model



Mathematical model

101	Recoil Point Function	$\varepsilon(q_{main}, q_{adj}) = q_{main} - \frac{1}{2} q_{adj}$
102	Energy Function	$H(q_{main}, q_{adj}, q_{joint}) = \int_0^{\varphi} \tau \, d\varphi$
103	Output Torque Function	$\tau(q_{main}, q_{adj}, q_{joint}) = 218 \cdot (\dot{x}(\varphi+\sigma) - \dot{x}(-\varphi+\sigma)) \cdot (x(\varphi+\sigma) + x(-\varphi+\sigma))$
104	Output Stiffness Function	$k(q_{main}, q_{adj}, q_{joint}) = 218 \cdot ((\dot{x}(\varphi+\sigma) - \dot{x}(-\varphi+\sigma))^2 + (x(\varphi+\sigma) + x(-\varphi+\sigma))(\ddot{x}(\varphi+\sigma) + \ddot{x}(-\varphi+\sigma)))$

$$q_{main} = -80 \cdot \theta_{main}$$

Passive joint deflection $\varphi = q_{flex} - (\varepsilon - q_{main})$ and stiffness preset $\sigma = \frac{1}{2} q_{adj}$.

The cam disc shape $x(\varphi, \sigma)$ was numerically calculated. $\dot{x}(\varphi, \sigma) = \frac{\partial x}{\partial \varphi}$, $\ddot{x}(\varphi, \sigma) = \frac{\partial \dot{x}}{\partial \varphi}$.