Explanations are given when pointing on the cell

TX40 CS8C technical data sheet

Line

Arm specifications

Line			Unit	Joint 1	Joint 2	Joint 3	Joint 4	Joint 5	Joint 6
1	Working range (S)		°	360	250	276	540	253,5	540
2	Positive working range		°	180	125	138	270	133,5	270
3	Negative working range		°	-180	-125	-138	-270	-120	-270
4	Acceleration time		s	0,276	0,276	0,206	0,213	0,254	0,152
5	Acceleration angle		°	39,567	39,567	44,367	43,667	40,667	53,333
6	Angular joint speed (nominal speed)		°/s	287	287	431	410	320	700
7	Overspeed		°/s	373	373	559	910	416	910
8	Angular joint acceleration		°/s²	1373	1373	3096	2802	1707	8167

Line			Nominal speed (NS)	Reduced speed (RS)
9	Payload	kg	**1,700**	**2,000**
10	Offset from center of wrist	m	**0,135**	**0,135**
11	Offset from axis of joint 6	m	**0,030**	**0,030**
12	I/5	kg.m²	**0,033**	**0,100**
13	I/6	kg.m²	**0,002**	**0,030**

Gear characteristics

Line			Unit	Joint 1	Joint 2	Joint 3	Joint 4	Joint 5	Joint 6
14	Gear ratio (G)			-32,0000	-32,0000	45,0000	48,0000	45,0000	32,0000
15	*Formula*						*32*1,5*		
16	Coupling	*yes=1/no=0*		0	0	0	0	1	1
17	Dynamic efficiency (gearbox only)			0,75	0,75	0,50	0,50	0,50	0,63
18	Static efficiency (gearbox only)			0,70	0,70	0,50	0,50	0,50	0,63

Encoder characteristics

Line			Unit	Joint 1	Joint 2	Joint 3	Joint 4	Joint 5	Joint 6
19	Encoder ratio (H)			-3,0000	-3,0000	1,0000	1,0000	1,0000	1,0000
20	Encoder resolution (E)		cnt/rev	65536	65536	65536	65536	65536	65536
21	Angular resolution	*360/(E*G*H)*	°/cnt	0,000057	0,000057	0,000122	0,000114	0,000122	0,000172
22	Joint to flange distance (F)		mm	515	515	290	65	65	0
23	Flange linear resolution	*(2 ΠF)/(E*G*H)*	mm	0,0005	0,0005	0,0006	0,0001	0,0001	0,0000

Arm center of gravity & inertias

	Base	Joint 1	Joint 2	Joint 3	Joint 4	Joint 5	Joint 6

24	Mass of components	*kg*	4,200	10,500	3,600	4,070	3,620	1,020	0,200

	Position of the center of gravity:		**Base**	**A1G1**	**A2G2**	**A3G3**	**A4G4**	**A5G5**	**A6G6**
25	x	*m*	-0,008	0,000	0,109	-0,006	0,002	0,003	0,000
26	y	*m*	-0,033	0,020	-0,002	0,008	0,004	0,000	0,000
27	z	*m*	0,167	0,089	0,045	-0,050	0,081	-0,001	0,042

			Base	**Joint 1**	**Joint 2**	**Joint 3**	**Joint 4**	**Joint 5**	**Joint 6**
	Inertias:								
28	Axx	*kg.m²*	0,012	0,055	0,009	0,012	0,013	0,001	0,000
29	Byy	*kg.m²*	0,012	0,047	0,038	0,012	0,014	0,001	0,000
30	Czz	*kg.m²*	0,007	0,035	0,040	0,004	0,004	0,001	0,000
31	Dyz	*kg.m²*	0,000	0,003	0,000	-0,001	0,001	0,000	0,000
32	Ezx	*kg.m²*	-0,001	0,000	0,002	0,001	0,000	0,000	0,000
33	Fxy	*kg.m²*	0,000	0,000	0,000	0,000	0,000	0,000	0,000
34	**Total inertia** (from motor side) *(à vide)*	10^{-6} *kg.m²*		1450	1350	101	25,3	8,65	8,2

	Joint position:		**OA1**	**A1A2**	**A2A3**	**A3A4**	**A4A5**	**A5A6**
35	x	*m*	0,000	0,000	0,225	0,037	0,000	0,000
36	y	*m*	0,000	0,089	0,000	0,000	0,000	0,000
37	z	*m*	0,188	0,132	0,037	-0,091	0,188	0,000

	Balancing system:	**Stiffness k** *N.m*	**Radius r** *m*	**Lifting beam distance L** *m*	**Preload Pc** *N*
38	Joint 2	0,000	0,000	0,000	0,000

Amplifier

		Unit	**Joint 1**	**Joint 2**	**Joint 3**	**Joint 4**	**Joint 5**	**Joint 6**
39	Amplifier type 325V		4/9	4/9	4/9	4/9	4/9	4/9

Motor specifications

40	Ke (Vrms between phases at 1,000 rpm)	*V*	62,4	62,4	34,7	14,60	14,60	14,60
41	Kt	*N.m/A*	1,03	1,03	0,57	0,24	0,24	0,24
42	Number of poles pairs (paires de poles)							
43	Motor rotor inertia (without screw)	10^{-6} *kg.m²*	354	354	39,9	6,03	12,57	6,05
44	Maximum motor speed (CdC)	*rev/min*	1990	1990	4193	7280	3120	5440
45	Nominal amplifier current **(I)**	*A*	4	4	4	4	4	4
46	Avail. motor/ampli. peak torque	*N.m*	4,12	4,12	2,30	0,96	0,96	0,96
47	Motor static torque (CdC)	*N.m*	1,85	1,85	0,68	0,19	0,19	0,07
48	Motor brake torque (Cmini.x3 pour 1 et 2 et Cmini. Pour 3&45&6)	*N.m*	6,00	6,00	0,27	-	0,10	-
49	Avail. motor/ampli. nominal torque *(0,01654*I*Ke)*	*N.m*	4,13	4,13	2,30	0,97	0,97	0,97
50	Motor nominal torque (CdC)	*N.m*	1,77	1,77	0,63	0,19	0,16	0,16

Results

				Joint 1	Joint 2	Joint 3	Joint 4	Joint 5	Joint 6
51	Motor speed (nomin. speed)	without interaction	*rev/min*	1530,67	1530,67	3232,50	3280,00	2400,00	3733,33
52		with interaction	*rev/min*	-	-	-	-	-	5440,00

				Joint 1		Joint 2		Joint 3		Joint 4		Joint 5		Joint 6	
				NS	RS	NS	RS	NS	RS	NS	RS	NS	RS	NS	RS
53	Requir. gearbox dyn. torque	*(SP60 pour charge maxi)*	*N.m*	71,30	50,20	114,25	102,00	49,11	47,21	13,16	18,85	19,74	22,40	3,50	6,13
54	Requir. motor dyn. torque	*Req. gearbox dyn. torque/G/ dyn. efficiency*	*N.m*	2,94	2,09	5,06	4,25	2,26	2,10	0,68	0,91	0,91	1,04	0,21	0,38
55	Theor. requir. dyn. current		*A*												
56	Measur. requir. dyn. current		*A*												
57	Requir. gearbox stat. torque		*N.m*		0,00		41,30		13,90		3,00		3,40		0,60
58	Requir. motor stat. torque	*Req. gearbox stat. torque/G/ stat. effic.*	*N.m*	#######	0,00	#######	1,84	#######	0,68	#######	0,19	#######	0,18	#######	0,07
59	Required static current		*A*												
60	Required braking torque		*N.m*												

Line 43: "Motor rotor inertia"

$Iz = \int (y^2 + x^2)\, dm$

z: axis of rotation / axe de rotation

dm: mass element / élément de masse

Lines 28 to 34: "Inertias"

A joint is defined by:

A: its axis of rotation

X Y Z: its frame T

G: its center of gravity

I: its matrix of inertia

It is made up of n components (Ci) of mass (mi), center of gravity (gi) and matrix of inertia (Ii)

[I]: joint matrix at location G expressed in frame T

[Ii]: Ci component matrix at location gi expressed in frame T

L'articulation est définie par :

A: son axe de rotation

X Y Z: son repère T

G: son centre de gravité

I: sa matrice d'inertie

Elle est constituée de n composants (Ci) de masse (mi), de centre de gravité (gi) et de matrice d'inertie (Ii)

[I]: matrice de l'articulation au point G exprimée dans le repère T

[Ii]: matrice du composant (Ci) au point gi exprimée dans le repère T

[Ii] =

[I] =

Axx = $\sum$ Ai + mi ($y^2i + z^2i$)

Dyz = $\sum$ Di + mi yi zi

Byy = $\sum$ Bi + mi ($z^2i + x^2i$) **Ezx** = $\sum$ Ei + mi zi xi
Czz = $\sum$ Ci + mi ($x^2i + y^2i$) **Fxy** = $\sum$ Fi + mi xi yi

xi yi zi: coordinates of the Ggi distance / coordonnées de la distance Ggi

Ai = $\int (y^2 + z^2)\, dmi$ **Di** = $\int yz.dmi$
Bi = $\int (x^2 + z^2)\, dmi$ **Ei** = $\int zx.dmi$
Ci = $\int (x^2 + y^2)\, dmi$ **Fi** = $\int xy.dmi$

x y z: coordinates of the gi dmi distance (dmi = element of mass mi)
coordonnées de la distance gi dmi (dmi = élément de la masse mi)

& drawings

Line 38: "Balancing system (joint 2)"

k: spring stiffness / raideur des ressorts

r: eccentric misalignment, fixed distance & position
excentration de l'excentrique, distance & position fixes
$r = A_2B_1 = A_2D$

P_c: spring preload / précharge des ressorts

L: fixed distance between the 2 spring fixation points
distance fixe entre les 2 points de fixation des ressorts
$L = C_1D$

Calculation of torque (M) working on joint 2 / Calcul du couple (M) agissant sur l'axe 2

This torque is generated by the action of the springs during the rotation of joint 2 around A2.
Il est engendré par l'action des ressorts lors de la rotation de l'axe 2 autour de A2.

a: joint angle of rotation / angle de rotation de l'articulation
a_0 = 0°: floor-mounted arm / le bras est en position "sol"
a_0 = 180°: ceiling-mounted arm / le bras est en position "plafond"

$M = F \times A_2G$
$M = F \times A_2C_1 \sin b$
$F = kx + P_c$ $\quad x = B_1C_1 - C_1D = B_1C_1 - L$
$A_2C_1 = r + L$

$B_1C_1 =$
$B_1C_1 =$

$b = \text{Arc sin}$

$B_1E = r \sin(a_0 + a)$
$EC_1 = ED + DC_1 = ED + L$
$ED = r - r \cos(a_0 + a)$
$ED = r(1 - \cos(a_0 + a))$

Units (short reminder)

mm	Millimeter / Millimètre *1 mm = 0,001 m*	*(length / longueur)*
m	Meter / Mètre	*(length / longueur)*
N	Newton	*(strength / force)*
N.m	Newton.meter / Newton.mètre	*(torque / couple)*
°	Joint degree / Degré d'angle *1° = π/180 rad*	*(angle)*
rad	Radian	*(angle)*
rev	Revolution / Tour *1 rev = 360° or 2πrad*	
cnt	Encoder count / Unité codeur	

V	Volt	*(voltage / tension)*
A	Amp / Ampère	*(current / courant)*
kg	Kilogram / Kilogramme	*(mass / masse)*
kg.m²	Kilogram per square meter / Kilogramme par mètre carré	(inertia / inertie)
min	Minute *1 min = 60 s*	*(time / temps)*
s	Second / Seconde	*(time / temps)*