Thickness mm	CRGO Grade	Assumed kg/dm3	Maximum Core Loss		Minimum Induction at 800 A /m T
			At 1.5T	At 1.7T	
0.23	23ZDKH90	7.65		0.9	1.88
0.23 - 0.009	23ZH90			0.9	1.88
	23ZH95			0.95	1.88
	M-0H			1	1.88
	M-1	7.65	0.71	1.06	1.8
	M-2		0.75	1.12	1.8
	M-3		0.79	1.04	1.8
0.27 - 0.0106	27ZDKH95	7.65		0.95	1.88
	27ZH95			0.95	1.88
	27ZH100			1	1.8
	M-0H			1.03	1.88
	M-1H	7.65		1.09	1.88
	M-3		0.83	1.21	1.8
	M-4		0.89	1.27	1.8
0.3 - 0.0118	30ZH100			1	1.88
	M-0H			1.05	1.88
	M-1H			1.11	1.88
	M-2H	7.65		1.17	1.88
	M-3		0.85	1.23	1.8
	M-4		0.9	1.32	1.8
	M-5		0.97	1.39	1.8
	M-1H			1.16	1.88
	M-2H			1.16	1.88
	M-3H			1.28	1.88
	M-5		1.01	1.45	1.8
	M-6		1.11	1.57	1.8

Important physical properties of CRGO	
Resistivity micro Ohm-centimeter	48.00
Ultimate Tensile Strength 0° to Rolling Direction Kg/mm2	32.60
Ultimate Tensile Strength 90° to Rolling Direction Kg/mm2	38.20
Stacking factor % M4 (.27 mm)	96.00
Stacking factor % M5 (.30 mm)	96.50
Stacking factor % M6 (.35 mm)	97.00
CRGO materials come either in the form of coils or sheets. Given below the details of dimensions and tolerances as per JIS C 3553.	

Dimensions and Tolerances of CRGO		
CRGO COILS	Thickness	0.18 mm (0.0071 in.)
		0.20 mm (0.0079 in.), 0.23 mm (0.0091 in.)
		0.27 mm (0.0106 in.), 0.30 mm (0.0118 in.)
		0.35 mm (0.0138 in.)
	Width	914 mm (36 in.), and 1000 mm (39 in.)
	(Standard width available with range)	from 50 mm(2 in.), to 1.050mm (41 in.)
	Inside Coil Diameter	508 mm (20 in.)
Sheets	Thickness	0.30 mm (0.0118 in.), 0.35 mm (0.0138 in.)
	Width	914 mm (36 in.), and 1000 mm (39 in.)
	Length	Length will be available according to negotiation

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CRGO Tolerances in Dimensions & Shape of CRGO

conform to JIS C 2553.

Width mm	Thickness mm	TOLERANCE				
		Thickness mm	Deviation of thickness in transverse direction mm	Width mm	Camber in any 2 metres (Slit Products) mm	Shear Burr mm
150 or under	0.18	0.02	0.02 or under	0.2	1.0 or under	0.04 or under
	0.2	0.02				
	0.23	0.02				
	0.27	0.03				
	0.3	0.03				
	0.35	0.03				
over 150 to 400	0.18	+0.02 +0.02	0.02 or under	0.3		
	0.2	0.02				
	0.23	0.03				
	0.27	0.03				
	0.3	0.03				
	0.35					
over 400 to 750	0.18	0.02	0.03 or under	0.5		
	0.2	0.02				
	0.23	0.02				
	0.27	0.03				
	0.3	0.03				
	0.35	0.03				
over 750	0.18	0.02	0.03 or under	0.6		
	0.2	0.02				
	0.23	0.02				
	0.27	0.03				
	0.3	0.03				
	0.35	0.03				

Note : Stipulation of camber shall be applied only for the steel strips (width 75mm over).

Besides the Watt Losses at specific flux densities of 1.5 T and 1.7 T CRGO manufacturers also give curves of indicating Watt Losses ad A.C. Magnetization at various flux densities. These curves are of immense help to Transformer designers, and available on request.

Conventional **CRGO** materials (M4, M5, M6) are used regularly for cores in Transformers. However recently due to environmental protection, energy savings are becoming a very important factor and minimizing care loss in Transformers is becoming a must. Nippon Steel Corporation has come out with low loss Hi-B materials, which guarantee low Watt Losses at 1.5 Tesla flux density. Such materials are called Hi-B materials. Table 3 gives magnetic properties of Hi-B material. Popular Hi-B grades used in India are 23 MOH & 27 MOH Watt.

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Hi - B CRGO MATERIALS :

Thickness		Grade	Core Loss						Lamination Factor
			Max.	Typical				Typical	Typical
mm	mil		W (W/Kg)	W (W/Kg)	W (W/Kg)	W (W/Kg)	W (W/Kg)	B (T)	%
0.23	9	23ZDKH85	0.85	0.57	0.78	0.34	0.46	1.91	97.5
		23ZDKH90	0.9	0.58	0.8	0.35	0.48	1.91	
		23ZDMH85	0.85	0.57	0.78	0.34	0.46	1.91	97.4
		23ZDMH90	0.9	0.59	0.81	0.35	0.48	1.91	
		23ZH90	0.9	0.63	0.87	0.37	0.51	1.92	97.7
		23ZH95	0.95	0.64	0.9	0.38	0.53	1.92	
		23M-OH	1	0.66	0.93	0.39	0.54	1.92	
0.27	11	27ZDKH90	0.9	0.62	0.84	0.38	0.53	1.92	98
		27ZDKH95	0.95	0.65	0.88	0.39	0.52	1.91	
		27ZDMH90	0.9	0.62	0.84	0.38	0.53	1.91	97.9
		27ZDMH95	0.95	0.65	0.88	0.39	0.53	1.91	
		27ZH95	0.95	0.69	0.93	0.41	0.55	1.91	98.1
		27M-OH	1.03	0.72	0.99	0.43	0.59	1.91	
		27M-1H	1.09	0.74	1.03	0.44	0.61	1.91	
0.3	12	30ZH100	1	0.73	0.98	0.44	0.58	1.92	98.3
		30M-OH	1.05	0.74	1.01	0.44	0.6	1.91	
0.35	11	35M-1H	1.16	0.85	1.13	0.52	0.68	1.92	98.5

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CRGO BIS Standard Grade, Mill Equivalent Grades Of Various CRGO Producing Mills

New Grades of CRGO as per BIS	AK Steel	COGENT	JFE	NIPPON	POSCO	TKES
23HP 85d	TCH 0DR	M085-23P	23JGSD85	23ZDKH85	23PHD85	H 085-23
23HP 90d	TCH 0 C	M090-23P	23JGSD90	23ZDKH95	23PHD90	H 090-23
23CG 110	23M3 110	M110-23S	23JG 110			C 110-23
23CG 120		M120-23S		23M3		C 120-23
27HP 90d	TCH 1DR	M090-27P	27JGSD90	27ZDKH90	27PHD 90	H 090-27
27HP 95d		M095-27P	27JGSD95	27ZDKH95	27PHD 95	H 095-27
27HP 100	TCH1C	M100-27P	27JGH 100	27MOH	27PH 100	H 103-27
27HP 110			27JGH 110	27ZH 110	27PG 110	
27CG 120	27M4 120	M120-27S	27JG 120	27M4	27PG 120	C 120-27
27CG 130	27M4 130	M130-27S	27JG 130			C 130-27
30HP 105	TCH 2 Carlite	M105-30P	30JGH 105	30MOH	30PH 105	H 105-30
30CG 120	30M5 120	M120-30S	30JG 120		30PG 120	
30CG 130	30M5 130	M130-30S	30JG 130	30M5	30PG 130	C 130-30
30CG 140		M140-30S	30JG 140		30PG 140	C 140-30
35CG 145		M150-35S	35 JG 145	35M6	30PG 145	C 150-35
35CG 155			35JG 155		30PG 155	C 165-35

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CRGO IS 3024 : 2015

Table 1 Magnetic Properties of Conventional Grain Oriented CRGO

(Clauses 4.2, 5.2, 8.1 and 8.2)

CRGO Grade	Nominal Thickness mm	Maximum Specific Core Loss at 1.5 T W/kg		Maximum Specific Total Loss at 1.7 T W/kg 50 Hz	Minimum Polarization in Tesla at a Field Strength of 800 A/m	Minimum Stacking Factor
		50 Hz	60 Hz			
[1]	[2]	[3]	[4]	[5]	[6]	[7]
23CG110	0.23	0.73	0.96	1.1	1.78	0.945
23CG120	0.23	0.77	1.01	1.2	1.78	0.945
23CG127	0.23	0.8	1.03	1.27	1.75	0.945
27CG120	0.27	0.8	1.07	1.2	1.78	0.95
27CG130	0.27	0.85	1.12	1.3	1.78	0.95
27CG140	0.27	0.89	1.15	1.4	1.75	0.95
30CG120	0.3	0.83	1.09	1.2	1.78	0.955
30CG130	0.3	0.85	1.15	1.3	1.78	0.955
30CG140	0.3	0.92	1.21	1.4	1.78	0.955
30CG150	0.3	0.97	1.25	1.5	1.75	0.955
35CG145	0.35	1.03	1.36	1.45	1.78	0.96
35CG155	0.35	1.07	1.41	1.55	1.78	0.96
35CG165	0.35	1.11	1.52	1.65	1.75	0.96

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NOTE – Normally the CRGO tests should be performed at 50Hz. However, countries where power supply at 50 Hz is not available, testing may be carried out at 60 Hz and accordingly product shall conform to the specified values given in the above Table. However , in all such cases, the product shall also conform to the specified values of above Table of CRGO when tested in importing country having power supply at 50 Hz.

8.3 In the case of Epstein CRGO strips lamination, samples are sheared develop magnetic property at 780ºC to 840ºC. In the longitudinal to the rolling direction and then CRGO lamination stress case of single sheet test specimens, they shall not be relief annealed in a neutral or reducing atmosphere to heat treated.

Table 2 Magnetic Properties of High Permeability Grain Oriented (Clauses 4.2, 5.2, 8.1 and 8.2)

HIB CRGO Grade	Nominal Thickness mm	Maximum Specific Total Loss at 1.7 T W/kg		Minimum Polarization in Tesla at a Field Strength of 800 A/m	Minimum Stacking Factor
		50Hz	60Hz		
[1]	[2]	[3]	[4]	[5]	[6]
23HP75d	0.23	0.75	0.99	1.85	0.945
23HP80d	0.23	0.8	1.04	1.85	0.945
23HP85d	0.23	0.85	1.12	1.85	0.945
23HP90d	0.23	0.9	1.19	1.85	0.945
23HP95	0.23	0.95	1.25	1.85	0.945
23HP100	0.23	1	1.32	1.85	0.945
27HP85d	0.27	0.85	1.12	1.85	0.95
27HP90d	0.27	0.9	1.19	1.85	0.95
27HP95d	0.27	0.95	1.25	1.85	0.95
27HP100	0.27	1	1.32	1.88	0.95
27HP110	0.27	1.1	1.45	1.88	0.95
30HP95	0.3	0.95	1.25	1.88	0.955
30HP100	0.3	1	1.32	1.88	0.955
30HP105	0.3	1.05	1.38	1.88	0.955
30HP110	0.3	1.1	1.46	1.88	0.955
30HP120	0.3	1.2	1.58	1.88	0.955
35HP110	0.35	1.1	1.45	1.88	0.96
35HP115	0.35	1.15	1.51	1.88	0.96
35HP125	0.35	1.25	1.64	1.88	0.96
35HP135	0.35	1.35	1.77	1.88	0.96

NOTES

1. Normally grain oriented steel CRGO tes should be performed at 50 Hz. However, countries where power supply at 50 Hz is not available, testing may be carried out a 60 Hz and accordingly product shall conform to the specified values given in th above Table. However, in all such cases,th CRGO product shall also conform to the specified values of above Table of CRGO when tested in importing country having power supply at 50 Hz.

2. High permeability CRGO grades may be delivered in domain refined condition (reference suffixd). The magnetic properties of some domain refined materi may deteriorate when the material is subjected to heat treatment.

3. In case where material gets deteriorate when subjected to heat treatment, the domain refined CRGO grades need to be checked by Single Sheet method as given in **14.5** and as per IS649. For other CRGO lamination or cores grades /other types of domain refined CRGO grades which do no deteriorate when subjected to heat treatment, the test method shall be as Epstein as given in **14.1** and as per IS 64 CRGO.

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