



ISO 9001 Certified

NATIONAL ELECTRONIC ALLOYS

Specialty Metal Service Center • Dedicated to Customer Service & Quality

Nickel Iron Alloy Comparison Chart

(For reference only)

CHEMICAL COMPOSITION %							
Chemical Element	Percentage	ASTM F15 Alloy					36 Alloy (Invar)
		(Kovar)	52 Alloy	48 Alloy	46 Alloy	42 Alloy	
Iron	Nominal	Bal	Bal	Bal	Bal	Bal	Bal
Nickel	Nominal	29	50.5	48	46	41	35
Cobalt	Nominal	17					0.50
Manganese	Max.	0.50	0.60	0.80	0.80	0.80	0.60
Silicon	Max.	0.20	0.30	0.30	0.30	0.30	0.40
Carbon	Max.	0.04	0.05	0.05	0.05	0.05	0.05
Aluminum	Max.	0.10	0.10	0.10	0.10	0.10	0.10
Magnesium	Max.	0.10					0.10
Zirconium	Max.	0.10					0.10
Titanium	Max.	0.10					0.10
Copper	Max.	0.20					
Chromium	Max.	0.20	0.25	0.25	0.25	0.25	0.25
Molybdenum	Max.	0.20					
Phosphorus	Max.		0.025	0.025	0.025	0.025	0.015
Sulfur	Max.		0.025	0.025	0.025	0.025	0.015

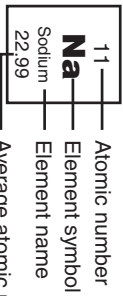
PHYSICAL PROPERTIES							
Property	Unit	ASTM F15 Alloy					36 Alloy (Invar)
		(Kovar)	52 Alloy	48 Alloy	46 Alloy	42 Alloy	
Density	Lbs/in ²	0.302	0.300	0.298	0.295	0.293	0.291
Specific Gravity		8.36	8.30	8.25	8.17	8.12	8.05
Specific Heat				0.12	0.12	0.12	0.123
Curie Temperature	°F	815	986	880	860	716	535
Melting Point	°F	2640	2600	2600	2600	2600	2600
Electrical Resistivity	Ohm-cir mil/ft	294	260	290	277	430	495
Thermal Conductivity	BTU/in/ft ² /hr/°F	120	97	90	79.2	74.5	72.6

Temp. range - °C	Linear coefficient of thermal expansion cm. per cm. per °C x 10 ⁻⁶						
	Kovar - 1	52 Alloy - 2	48 Alloy - 3	46 Alloy - 4	42 Alloy - 5	42-6 Alloy - 6	Invar - 7
30-150	—	—	—	—	—	—	1.2 - 2.7
30-200	—	—	—	—	—	—	—
30-300	—	—	—	—	4.0 - 4.7	—	—
30-350	—	—	—	7.1 - 7.8	—	8.5 - 9.2	—
30-400	4.6 - 5.2	—	8.2 - 9.2	—	—	—	—
30-425	—	—	—	—	—	9.7 - 10.4	—
30-450	5.1 - 5.5	9.6 - 10.1	—	—	6.7 - 7.4	—	—
30-500	—	—	—	8.2 - 8.9	—	—	—
30-550	—	10.2 - 10.7	9.6 - 10.3	—	—	—	—

MECHANICAL PROPERTIES (As Annealed)							
Tensile Strength	PSI x 1000	75	80	79	80	82	65
Yield Strength	PSI x 1000	50	40	36	35	40	40
Elongation	% in 2"	30	35	30	30	30	35
Hardness	Rockwell B	80	80	80	80	80	80
Elastic Modulus	psi x 10(-6)			24	21	21.5	20.5

PERIODIC TABLE OF ELEMENTS

1 1A	1 H Hydrogen 1.01	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
2	3 Li Lithium 6.94	4 Be Beryllium 9.01	5	6	7	8	9	10	11 1B	12 2B	13 B Boron 10.81	14 C Carbon 12.01	15 N Nitrogen 14.01	16 O Oxygen 16.00	17 F Fluorine 19.00	18 Ne Neon 20.18		
3	11 Na Sodium 22.99	12 Mg Magnesium 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 9B	10	11 Al Aluminum 26.98	12 Si Silicon 28.09	13 P Phosphorus 30.97	14 S Sulfur 32.07	15 Cl Chlorine 35.45	16 Ar Argon 39.95		
4	19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
5	37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29
6	55 Cs Cesium 132.91	56 Ba Barium 137.33	57 La Lanthanum 138.91	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
7	87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (269)	109 Mt Meitnerium (268)									



58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97
90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

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