ARNOLD MAGNETIC TECHNOLOGIES

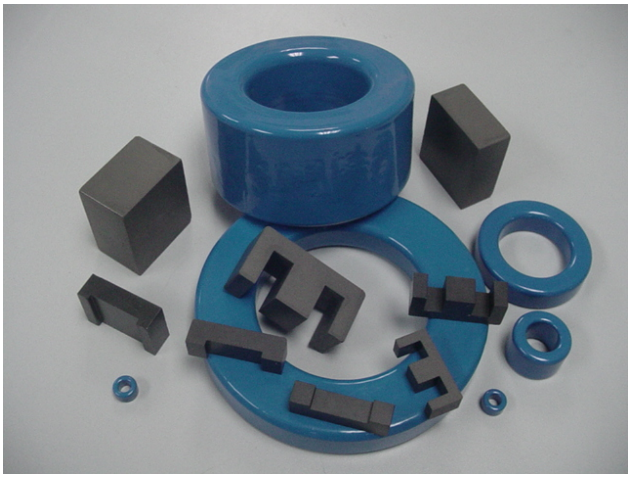
Technical Bulletin

Iron-Silicon (Fe-Si™) Powder Cores

INTRODUCTION

Arnold Magnetics, a world leader in magnetic alloy powder products such as MPP, High-Flux™ and Super-MSS™, now offers a new series of powder cores using an Iron-Silicon alloy under the trade name Fe-Si™. The 6.5 wt% Iron-Silicon material is a well known alloy and offers significant advantages, displaying excellent soft magnetic properties such as high saturation magnetization, near zero magnetostriction and higher resistivity.

The Fe-Si™ series powder cores are manufactured from a complex composition of Iron-Silicon powdered particles, compacted into geometries such as toroid, block, E or U-core shapes. The powder metal compaction process produces a product with excellent core loss performance compared with the conventional silicon-iron tape wound core due to the distributed air gap feature.



Fe-Si™ powder cores have a typical 15,000 Gauss saturation flux density and core losses significantly lower than iron powder cores at high frequencies.

The combination of high saturation flux density and high DC bias makes Iron-Silicon powder cores an ideal choice for higher power densities: where a low number of winding turns, low core loss and smaller size are required in today's power supply systems - especially in high energy storage applications.

The curie temperature of the Iron-Silicon powder material is over 500 ºC. High temperature operation of the cores does not significantly affect the magnetic properties. There are no organic binders within Fe-Si™ cores. They are, therefore, not subject to thermal aging when operated at elevated temperatures.

Fe-Si™ series cores can provide a 30% reduction in volume compared to Iron powder cores and are the best solution for large-current applications at a competitive price.

General Material Properties	
Composition	Iron-Silicon Alloy
Material Code	FS
Permeability	14μ to 147μ
Bmax	15,000 Gauss
Core Loss (1,000 G, 50 kHz)	400-800 mW/cc
Curie Temperature	500 ºC
Operating Temperature	-30 to 200 ºC
Frequency Range	1 MHz
Relative Cost	Low

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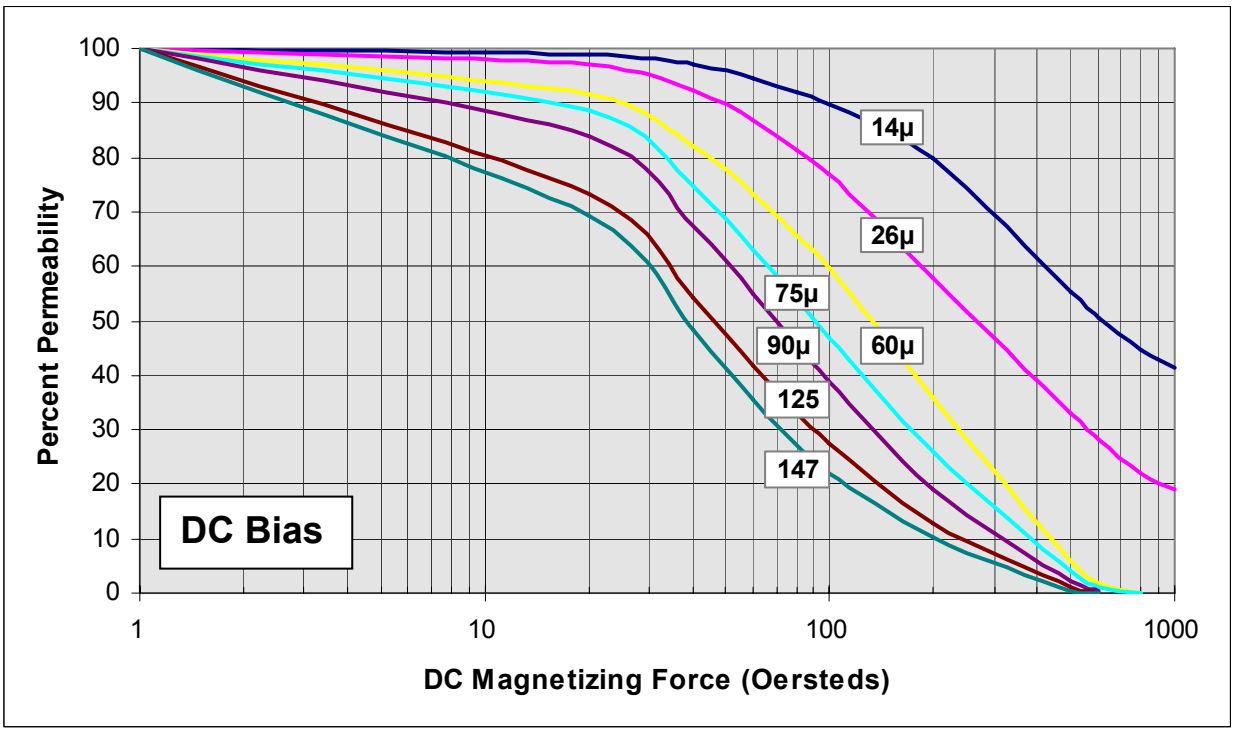
Typical Applications

- SMPS choke inductors
- PFC inductors
- VRM inductors
- Boost reactor
- Smoothing choke for Inverter
- Switching Regulator Inductors
- In Line Noise Filters
- >50 KVA UPS choke inductors

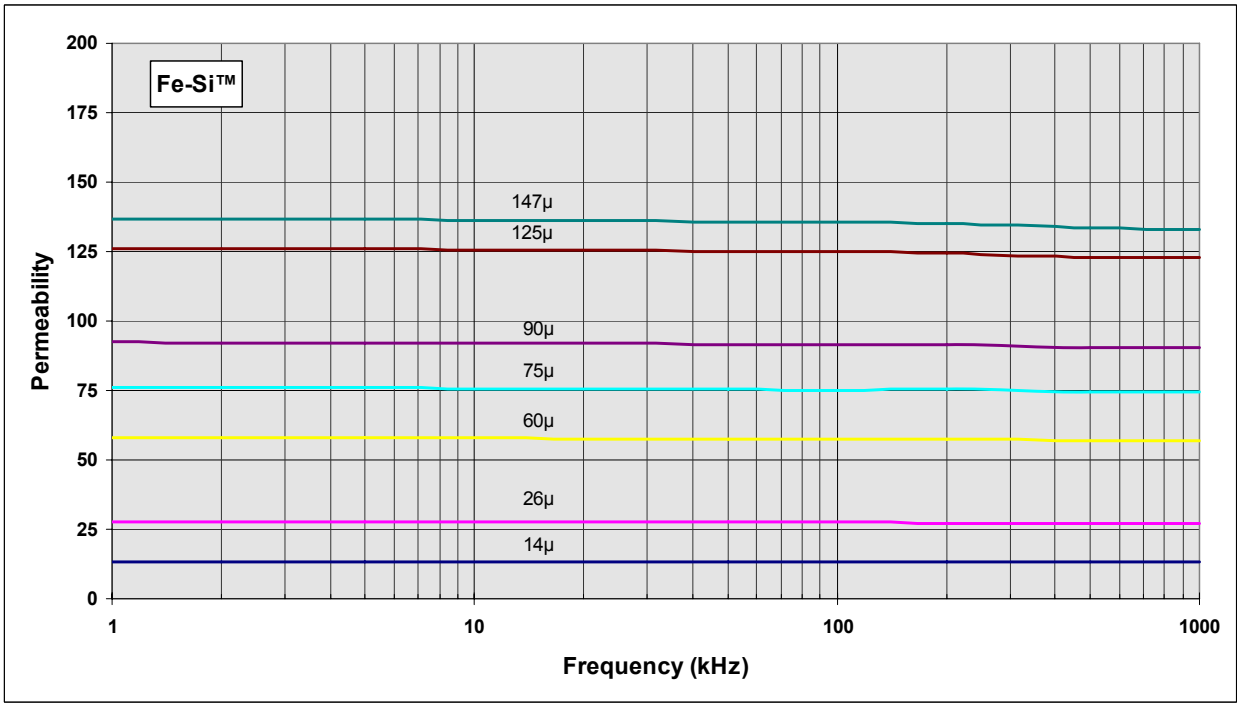
Benefits

- High saturation flux density
- Very high DC biasing Performance
- Lower cost than SMSS or similar materials
- Manufactured into various shapes (e.g. E, U, toroid, block cores)
- Maximum operating temperature of 200 ° C

The DC bias curves (below) demonstrate that Iron-Silicon powder is excellent when compared with SMSS (Sendust) and Iron powder of similar permeabilities and size. The curves presented here were measured based on standard 1.06 inch OD toroid core samples using a signal of 10 kHz and 100 mA AC.

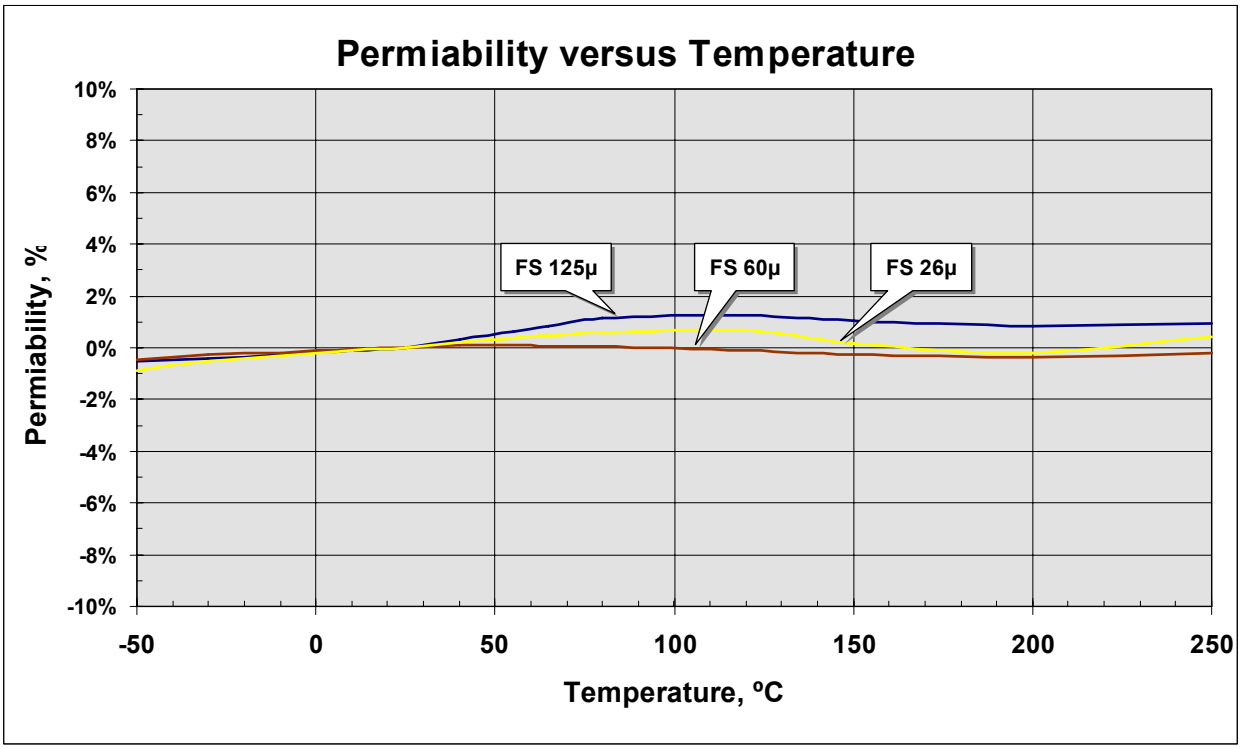


The inductance versus frequency graph demonstrates the near linear performance of Iron-Silicon powder cores to 1 MHz. Roll-off in permeability from low frequencies to 1 MHz is less than 2.0 percent!

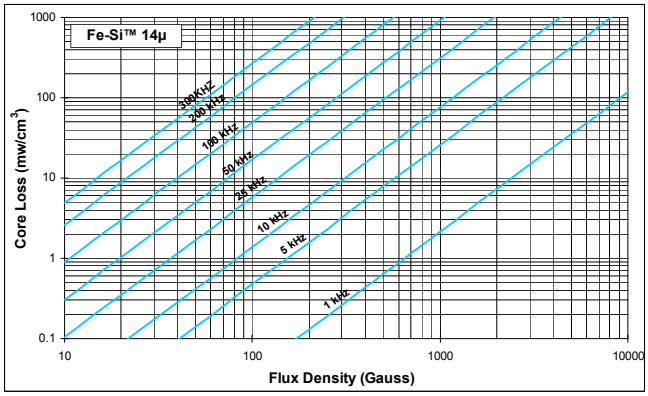


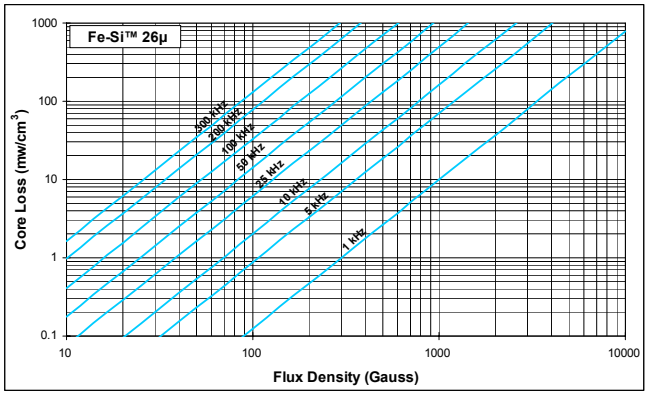
Permeability versus Temperature

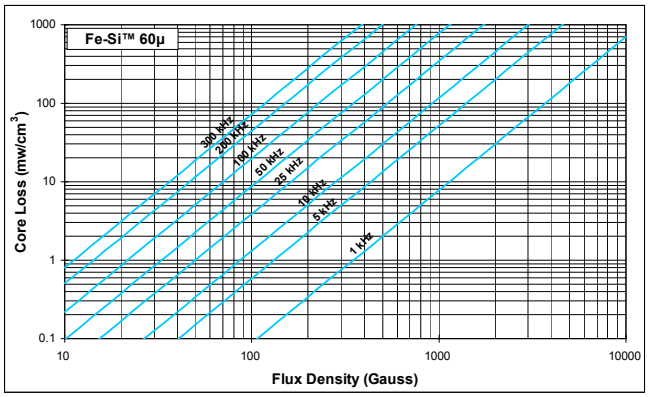
Arnold Fe-Si™ cores are extremely stable with temperature.

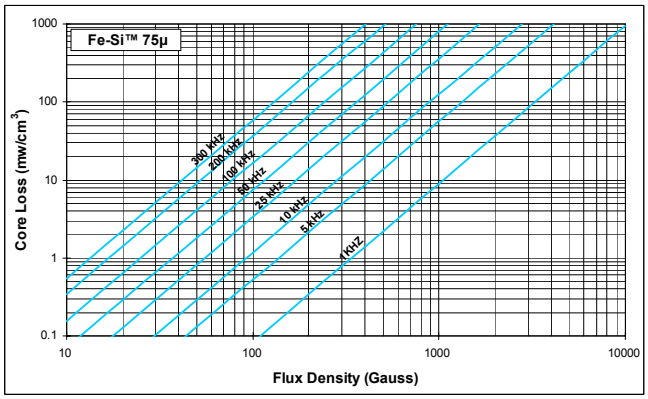


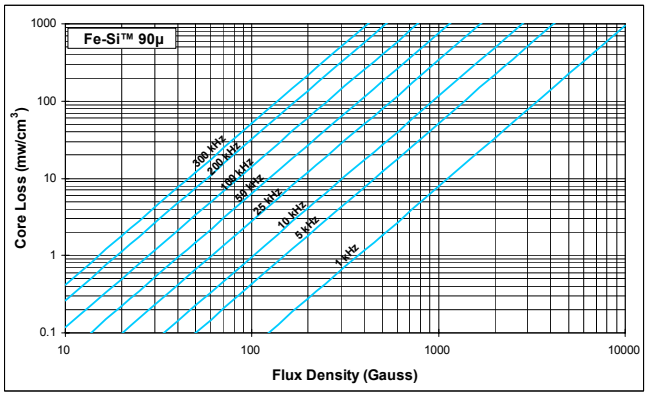
Typical Core Loss Curves

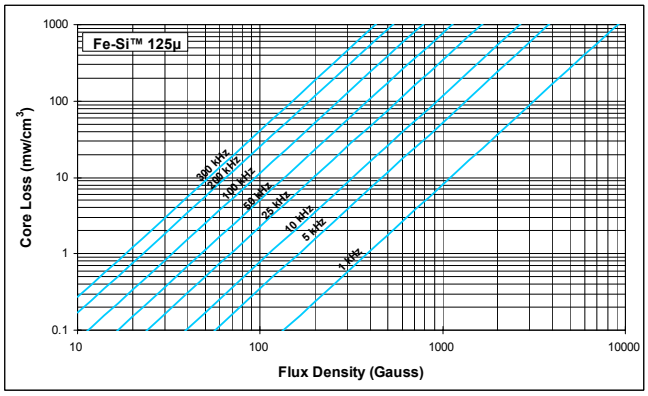


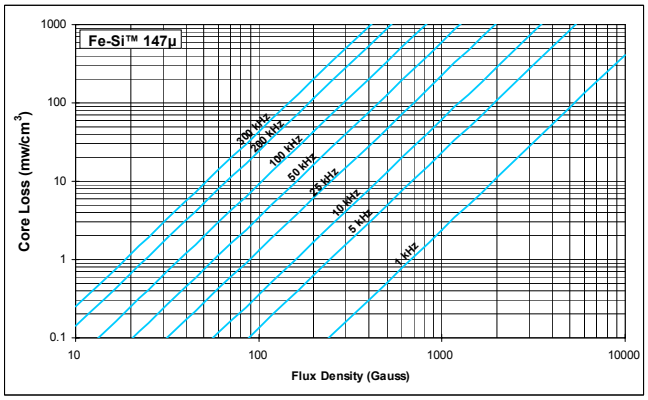






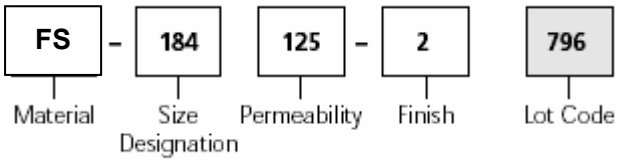






Toroid Core Part Number Construction

Part numbers for Arnold Fe-Si™ cores are constructed as shown below.

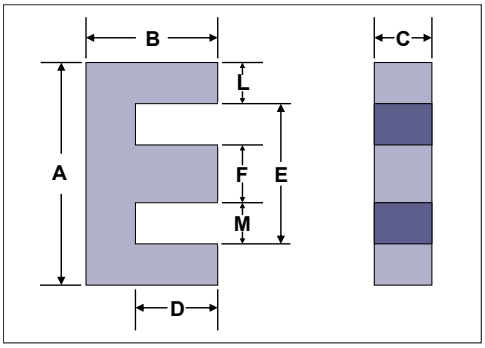


Iron-Silicon (Fe-Si™) Toroidal Core Series Size table

O.D.(inch)	I.D.(inch)	HGT(inch)	Radius(inch)	Area (cm^2)	Lm (cm)	Volume (cm^3)
0. 140	0. 070	0. 060	0. 008	0. 0137	0. 817	0. 010746
0. 155	0. 087	0. 100	0. 008	0. 0211	0. 942	0. 01967
0. 183	0. 093	0. 100	0. 008	0. 0285	1. 061	0. 0302
0. 250	0. 110	0. 110	0. 016	0. 0476	1. 363	0. 064219
0. 260	0. 105	0. 100	0. 016	0. 0476	1. 363	0. 063971
0. 260	0. 105	0. 180	0. 016	0. 088600	1. 364	0. 12086
0. 260	0. 105	0. 188	0. 016	0. 092	1. 363	0. 1254
0. 277	0. 156	0. 175	0. 016	0. 0669	1. 682	0. 1125
0. 277	0. 156	0. 200	0. 016	0. 07497	1. 682	0. 126069
0. 310	0. 156	0. 125	0. 016	0. 0615	1. 787	0. 1099
0. 380	0. 188	0. 125	0. 016	0. 0752	2. 177	0. 1639
0. 380	0. 188	0. 156	0. 016	0. 0945	2. 177	0. 206
0. 400	0. 200	0. 097	0. 008	0. 061697	2. 302	0. 142026
0. 400	0. 200	0. 156	0. 016	0. 1	2. 38	0. 238
0. 440	0. 250	0. 156	0. 016	0. 0906	2. 69	0. 2437
0. 500	0. 300	0. 187	0. 031	0. 114	3. 124	0. 35568
0. 655	0. 400	0. 250	0. 031	0. 192	4. 11	0. 7891
0. 680	0. 380	0. 250	0. 031	0. 232	4. 14	0. 9605
0. 800	0. 500	0. 250	0. 031	0. 226	5. 093	1. 151
0. 900	0. 550	0. 300	0. 031	0. 331	5. 671	1. 8771
0. 928	0. 567	0. 350	0. 031	0. 388	5. 88	2. 2814
0. 928	0. 636	0. 300	0. 031	0. 27726	6. 1669	1. 7098
1. 060	0. 580	0. 340	0. 063	0. 49671	6. 352	3. 1551
1. 060	0. 580	0. 440	0. 063	0. 654	6. 352	4. 154
1. 300	0. 785	0. 345	0. 063	0. 55116	8. 147	4. 4902
1. 300	0. 785	0. 420	0. 063	0. 672	8. 147	5. 4768
1. 300	0. 785	0. 440	0. 063	0. 6981	8. 147	5. 687
1. 350	0. 920	0. 350	0. 063	0. 454	8. 948	4. 0633
1. 410	0. 880	0. 412	0. 063	0. 678	8. 98	6. 0884
1. 570	0. 950	0. 570	0. 094	1. 072	9. 848	10. 5485
1. 840	0. 950	0. 710	0. 094	1. 99	10. 743	21. 373
1. 840	1. 130	0. 600	0. 094	1. 34	11. 62	15. 584
2. 000	1. 250	0. 530	0. 094	1. 251	12. 733	15. 9296
2. 250	1. 039	0. 600	0. 094	2. 2871	12. 506	28. 603
2. 250	1. 400	0. 550	0. 094	1. 444	14. 296	20. 65
3. 063	1. 938	0. 500	0. 094	1. 7729	19. 612	34. 77
3. 063	1. 938	0. 625	0. 094	2. 2192	19. 612	43. 523
4. 000	2. 250	0. 535	0. 125	2. 9716	24. 271	72. 122
4. 000	2. 250	0. 650	0. 125	3. 5226	24. 271	85. 495
5. 218	3. 094	0. 800	0. 125	5. 3471	33. 12	173. 4
5. 218	3. 094	1. 000	0. 125	6. 71	32. 429	217. 58
5. 218	3. 715	0. 998	0. 015	4. 835	35. 302	170. 686

Arnold Magnetics can supply a wide range of standard toroid O.D. sizes from 0.14 inch (3.6 mm) to 5.218 inch (133 mm), as with Arnold MPP, High-Flux™ and Super-MSS™ powder core series. Arnold is also capable of providing non-standard, customer-specified physical dimensions.

E-Core Part Number Construction



Iron-Silicon (Fe-Si™) E-Core Series Size table

PART NO.	UNIT	A	B	C	D(min)	E(min)	F	L(nom)	M(min)
EFS-1306	in	0.500±.010	0.252±.004	0.140±.006	0.178	0.35	0.140±.005	0.07	0.104
	(mm)	(12.70)	(6.40)	(3.56)	(4.42)	(8.89)	(3.56)	(1.78)	(2.64)
EFS-1908	in	0.760±.012	0.319±.007	0.188±.006	0.218	0.548	0.188±.005	0.094	0.183
	(mm)	(19.30)	(8.10)	(4.78)	(5.54)	(13.90)	(4.78)	(2.39)	(4.65)
EFS-2510	in	1.000±.015	0.375±.007	0.250±.004	0.245	0.740	0.250±.005	0.125	0.246
	(mm)	(25.40)	(9.50)	(6.50)	(6.20)	(18.80)	(6.20)	(3.20)	(6.30)
EFS-3015	in	1.185±.018	0.591±.009	0.278±.006	0.376	0.768	0.274±.008	0.201	0.254
	(mm)	(30.10)	(15.01)	(7.06)	(9.70)	(19.50)	(6.96)	(5.11)	(6.46)
EFS-3514	in	1.360±.020	0.557±.009	0.368±.007	0.378	0.995	0.367±.008	0.175	0.310
	(mm)	(34.50)	(14.10)	(9.40)	(9.60)	(25.30)	(9.30)	(4.40)	(7.90)
EFS-4117	in	1.609±.024	0.650±.011	0.493±.007	0.409	1.115	0.493±.008	0.238	0.310
	(mm)	(40.90)	(16.50)	(12.50)	(10.40)	(28.30)	(12.50)	(6.00)	(7.90)
EFS-4321	in	1.687±.025	0.830±.013	0.424±.010	0.587	1.195	0.468±.010	0.234	0.365
	(mm)	(42.80)	(21.10)	(10.80)	(15.00)	(30.40)	(11.90)	(5.95)	(9.27)
EFS-4322	in	1.687±.025	0.830±.013	0.608±.010	0.587	1.195	0.468±.010	0.234	0.365
	(mm)	(42.80)	(21.10)	(15.40)	(15.00)	(30.40)	(11.90)	(5.95)	(9.27)
EFS-4323	in	1.687±.025	0.830±.013	0.788±.010	0.587	1.195	0.468±.010	0.234	0.365
	(mm)	(42.80)	(21.10)	(20.00)	(15.00)	(30.40)	(11.90)	(5.95)	(9.27)

Add material code to part number, e.g., for 60μ the complete part number is EFS-2510-060.

Arnold is also capable of providing non-standard; customer-specified physical dimensions and geometries for E, U and block cores.

ARNOLD MAGNETIC TECHNOLOGIES

Arnold Magnetics Limited
D6 Xintang Industrial Zone
Baishixia, Fuyong Town
Baoan, Shenzhen, Guangdong, PRC

For more information contact us at:

UNITED STATES
Rochester, NY USA
800-893-9127

EUROPE
Barlborough, UK
(+44) 1246-570-500

ASIA
Hong Kong, China
(+852) 3106-3737