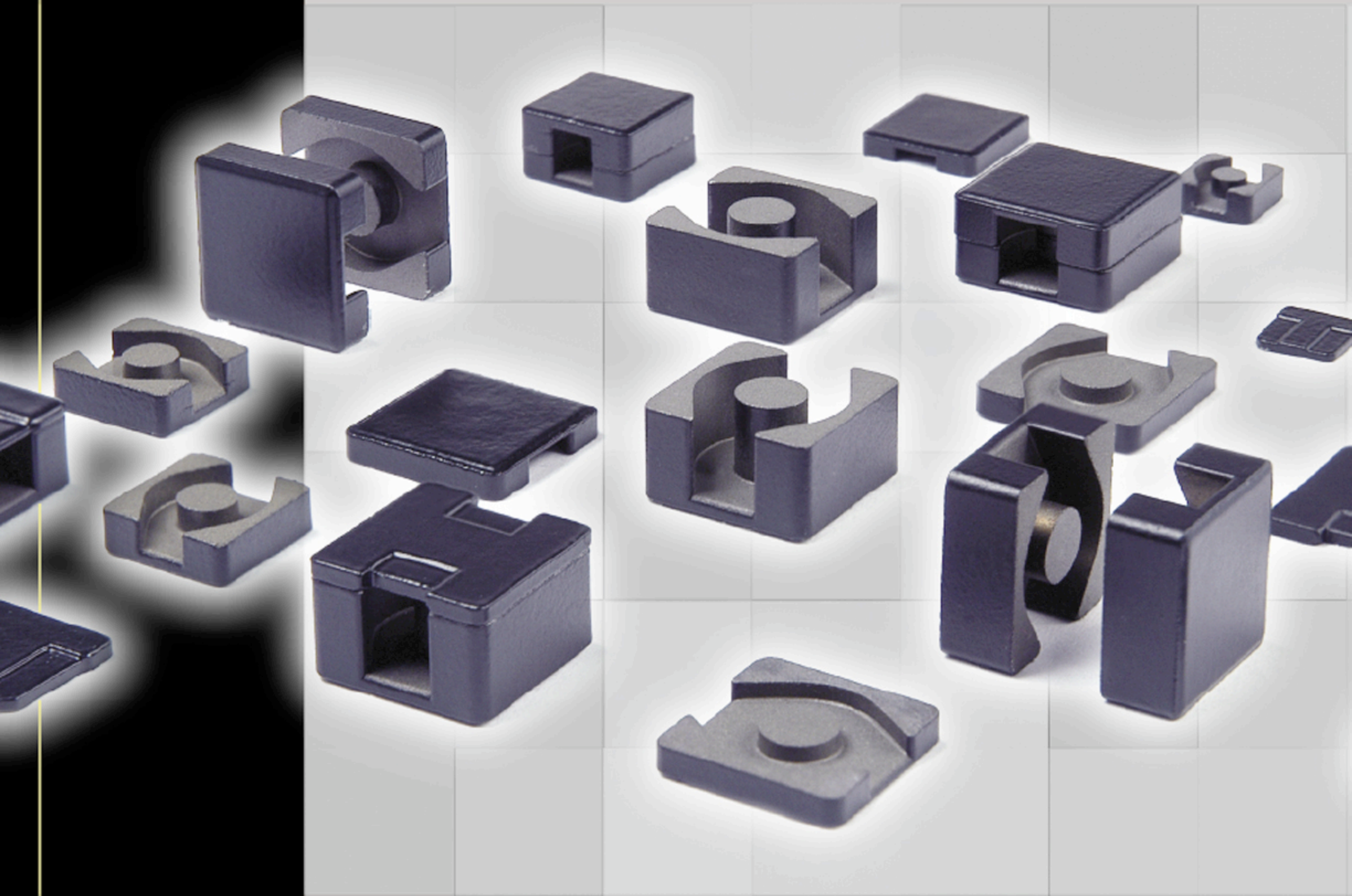
MICROCUBES

Cores for SMD and High Power Inductors



Issue A
April 2005

MICROMETALS
IRON POWDER CORES

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CONTENTS

INTRODUCTION

Micrometals new series of cores for high density inductors are well-suited for either through-hole or surface mount applications. The geometries shown in this catalog are offered in traditional iron powder -52 Material or magnetic alloy powder -65 Material. Generally, cost sensitive applications will utilize -52 Material with round wire and through-hole mounting. Space sensitive applications will use -65 Material with helical wound flat wire with bent leads for surface mounting. In addition to the two materials listed in this catalog, Micrometals can provide any standard material listed in our Power Conversion Catalog or limited materials listed in our 200C Series of high temperature materials.

GENERAL MATERIAL PROPERTIES

Material Mix No.	Reference Permeability (μ_0)	Material Density (g/cm^3)	Relative Cost	Magnetic Tolerance
-52	75	7.0	1.0	±10%
-65	45	6.4	1.2	±10%

CORE LOSS COMPARISON (mW/cm^3)

Material Mix No.	60Hz @500mT	1kHz @150mT	10kHz @50mT	50kHz @22.5mT	100kHz @14mT	500kHz @5mT	1MHz @4mT
-52	30	56	68	72	58	63	134
-65	54	88	77	54	33	23	48

SAMPLES & ENGINEERING KITS

Micrometals will gladly extend sample cores and design assistance to aid in your core selection. Contact the factory regarding available engineering kits.

WARRANTY

Parts are warranted to conform to the specifications in the latest issue of this catalog. Micrometals' liability is limited to return of parts and repayment of price; or replacement of nonconforming parts. Notice of nonconformance must be made within 30 days after delivery. Before using these products, buyer agrees to determine suitability of the product for their intended use or application. Micrometals shall not be liable for any other loss or damage, including but not limited to incidental or consequential damages.

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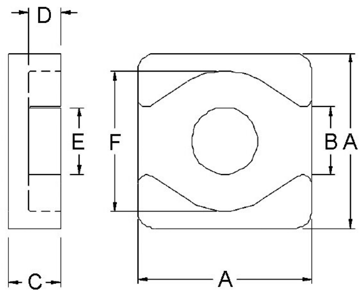

Figure 1

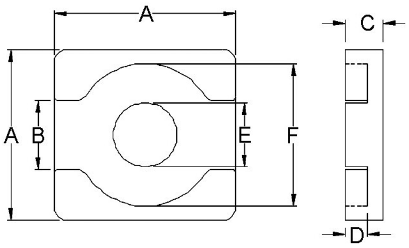

Figure 2

TYPICAL PART NO.

HC 127 A 44 A - 65 07 0

- Core Geometry
- "A" Dim. in XX.Xmm
- Variation in "B", "E" & "F"
- "C" Dimension in X.Xmm
- Code for Variation in "C" & "D"
- Micrometals Mix No.
- Approximate Gap in .XXmm
- Coating Color Indicator

MICROMETALS Part No.	Figure	A mm	B mm	C mm	D mm	E mm	F mm	Gap mm
		± 0.15	± 0.20	± 0.10	± 0.10	± 0.10	± 0.15	ref
HC065A19A-65000	1	6.50	2.30	1.90	1.00	2.10	5.00	0.00
HC065A29A-65000	1	6.50	2.30	2.90	2.00	2.10	5.00	0.00
		± 0.15	± 0.20	± 0.10	± 0.10	± 0.10	± 0.15	ref
HC065B19A-65000	1	6.50	2.30	1.90	1.00	2.70	5.20	0.00
HC065B27A-65000	1	6.50	2.30	2.70	1.75	2.70	5.20	0.00
HC065B38A-52000	1	6.50	2.30	3.75	2.70	2.70	5.20	0.00
HC065B38A-65000	1	6.50	2.30	3.75	2.70	2.70	5.20	0.00
		± 0.20	± 0.20	± 0.10	± 0.10	± 0.10	± 0.15	ref
HC098A30A-65000	1	9.80	3.70	3.00	1.90	3.40	7.90	0.00
HC098A61A-65000	1	9.80	3.70	6.10	5.00	3.40	7.90	0.00
		± 0.20	± 0.20	± 0.10	± 0.10	± 0.10	± 0.15	ref
HC101A27A-52000	1	10.05	3.90	2.65	1.85	3.40	8.40	0.00
HC101A35A-52000	1	10.05	3.90	3.50	2.70	3.40	8.40	0.00
		± 0.20	± 0.20	± 0.10	± 0.10	± 0.10	± 0.15	ref
HC101B23A-65000	1	10.05	3.60	2.30	1.40	3.95	8.20	0.00
HC101B26A-65000	1	10.05	3.60	2.60	1.50	3.95	8.20	0.00
HC101B30A-65000	1	10.05	3.60	3.00	1.90	3.95	8.20	0.00
HC101B35A-52000	1	10.05	3.60	3.45	2.45	3.95	8.20	0.00
HC101B35A-65000	1	10.05	3.60	3.45	2.45	3.95	8.20	0.00
HC101B36A-65000	1	10.05	3.60	3.60	2.40	3.95	8.20	0.00
HC101B39A-65000	1	10.05	3.60	3.90	2.80	3.95	8.20	0.00
HC101B44A-52000	1	10.05	3.60	4.40	3.30	3.95	8.20	0.00
HC101B44A-65000	1	10.05	3.60	4.40	3.30	3.95	8.20	0.00
HC101B47A-65000	1	10.05	3.60	4.70	3.50	3.95	8.20	0.00
		± 0.20	± 0.20	± 0.15	± 0.15	± 0.10	± 0.15	ref
HC101B52A-65000	1	10.05	3.60	5.20	4.20	3.95	8.20	0.00
HC101B58A-65000	1	10.05	3.60	5.75	4.80	3.95	8.20	0.00
HC101B63A-52000	1	10.05	3.60	6.30	5.10	3.95	8.20	0.00
		± 0.20	± 0.20	± 0.10	± 0.10	± 0.10	± 0.15	ref
HC101C20A-65000	1	10.05	3.60	2.00	1.20	3.70	8.20	0.00
HC101C25A-65000	1	10.05	3.60	2.50	1.55	3.70	8.20	0.00
HC101C27A-65000	1	10.05	3.60	2.65	1.65	3.70	8.20	0.00
HC101C32A-65000	1	10.05	3.60	3.20	2.20	3.70	8.20	0.00
HC101C39A-65000	1	10.05	3.60	3.90	2.90	3.70	8.20	0.00
HC101C47A-65000	1	10.05	3.60	4.70	3.50	3.70	8.20	0.00

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HC CORES

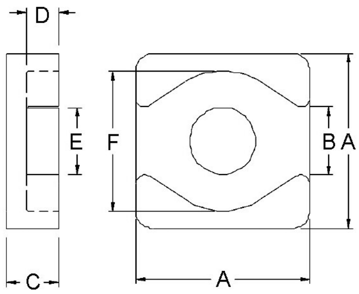

Figure 1

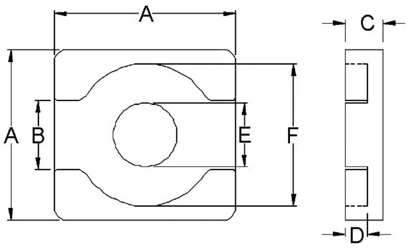

Figure 2

TYPICAL PART NO.

HC 127 A 44 A - 65 07 0

- Core Geometry (HC)
- "A" Dim. in XX.Xmm (127)
- Variation in "B", "E" & "F" (A)
- "C" Dimension in X.Xmm (44)
- Code for Variation in "C" & "D" (A)
- Micrometals Mix No. (65)
- Approximate Gap in .XXmm (07)
- Coating Color Indicator (0)

MICROMETALS Part No.	Figure	A mm	B mm	C mm	D mm	E mm	F mm	Gap mm
		± 0.20	± 0.20	± 0.10	± 0.10	± 0.10	± 0.15	ref
HC101D58A-65000	1	10.05	3.60	5.80	4.80	3.90	8.20	0.00
		± 0.25	± 0.25	± 0.10	± 0.10	± 0.10	± 0.15	ref
HC123A34A-65000	2	12.30	4.50	3.40	2.40	4.80	10.40	0.00
HC123A48A-65000	2	12.30	4.50	4.80	3.60	4.80	10.40	0.00
		± 0.25	± 0.25	± 0.10	± 0.10	± 0.10	± 0.15	ref
HC127A25A-65000	1	12.70	4.70	2.50	1.50	4.85	10.40	0.00
HC127A28A-65000	1	12.70	4.70	2.80	1.80	4.85	10.40	0.00
HC127A33A-65000	1	12.70	4.70	3.30	2.15	4.85	10.40	0.00
HC127A34A-52000	1	12.70	4.70	3.40	2.40	4.85	10.40	0.00
HC127A35A-65000	1	12.70	4.70	3.45	2.30	4.85	10.40	0.00
HC127A37A-65000	1	12.70	4.70	3.70	2.50	4.85	10.40	0.00
HC127A40B-65000	1	12.70	4.70	4.00	2.70	4.85	10.40	0.00
HC127A43A-65000	1	12.70	4.70	4.25	2.85	4.85	10.40	0.00
HC127A44A-65000	1	12.70	4.70	4.35	3.10	4.85	10.40	0.00
HC127A44B-65000	1	12.70	4.70	4.40	3.10	4.85	10.40	0.00
HC127A48A-65000	1	12.70	4.70	4.80	3.60	4.85	10.40	0.00
HC127A49A-65000	1	12.70	4.70	4.85	3.55	4.85	10.40	0.00
		± 0.25	± 0.25	± 0.15	± 0.15	± 0.10	± 0.15	ref
HC127A55A-65000	1	12.70	4.70	5.50	4.30	4.85	10.40	0.00
HC127A60A-65000	1	12.70	4.70	6.00	4.80	4.85	10.40	0.00
HC127A69A-65080	1	12.70	4.70	6.90	5.70	4.85	10.40	0.00
HC127A75A-52090	1	12.70	4.70	7.50	6.20	4.85	10.40	0.00
		± 0.25	± 0.25	± 0.10	± 0.15	± 0.10	± 0.15	ref
HC127B34A-65000	1	12.70	4.70	3.40	2.35	5.20	10.40	0.00
HC127B47A-65000	1	12.70	4.70	4.70	3.40	5.20	10.40	0.00
		± 0.25	± 0.25	± 0.15	± 0.15	± 0.10	± 0.15	ref
HC129A45A-65000	2	12.90	4.75	4.50	3.30	5.55	10.40	0.00
HC129A60A-65000	2	12.90	4.75	6.00	4.80	5.55	10.40	0.00
HC129A74A-52000	2	12.90	4.75	7.40	6.15	5.55	10.40	0.00
HC129A74A-65000	2	12.90	4.75	7.40	6.15	5.55	10.40	0.00

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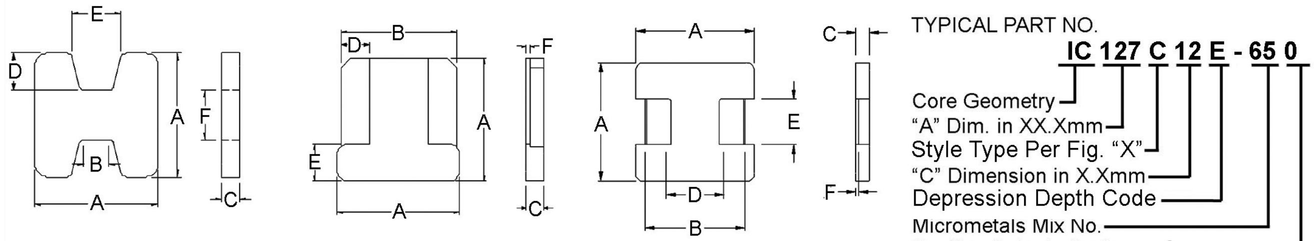

Figure A   Figure B   Figure C

MICROMETALS Part No.	Figure	A mm	B mm	C mm	D mm	E mm	F mm
		± 0.15	± 0.15	± 0.10	± 0.25	± 0.25	± 0.05
IC065B09C-650	B	6.50	6.25	0.85	1.90	2.20	0.15
IC065B10C-650	B	6.50	6.25	0.95	1.90	2.20	0.15
IC065B10C-520	B	6.50	6.25	0.95	1.90	2.20	0.15
		± 0.20	± 0.20	± 0.10	± 0.30	± 0.30	± 0.05
IC098B12E-650	B	9.80	9.40	1.20	2.50	3.00	0.25
IC098B15P-650	B	9.80	9.40	1.50	0.00	3.00	0.00
		± 0.20	± 0.20	± 0.10	± 0.30	± 0.30	± 0.05
IC101B10D-520	B	10.05	9.50	1.00	2.60	3.30	0.20
IC101B11D-650	B	10.05	9.50	1.10	2.60	3.30	0.20
IC101B12E-650	B	10.05	9.50	1.20	2.60	3.30	0.25
IC101B13G-650	B	10.05	9.50	1.25	2.60	3.30	0.35
IC101B12P-650	B	10.05	9.50	1.20	0.00	3.30	0.00
IC101B13J-650	B	10.05	9.50	1.30	2.60	3.30	0.45
IC101B13P-520	B	10.05	9.50	1.30	0.00	3.30	0.00
		± 0.20	± 0.20	± 0.10	± 0.30	± 0.30	± 0.05
IC101C11D-520	C	10.05	9.60	1.10	4.10	3.80	0.20
IC101C11D-650	C	10.05	9.60	1.10	4.10	3.80	0.20
IC101C13D-650	C	10.05	9.60	1.25	4.10	3.80	0.20
IC101C14D-650	C	10.05	9.60	1.35	4.10	3.80	0.20
		± 0.25	min	± 0.10	min	min	± 0.25
IC127A12P-520	A	12.70	2.90	1.20	3.40	5.20	5.20
IC127A12P-650	A	12.70	2.90	1.20	3.40	5.20	5.20
IC127A15P-650	A	12.70	2.90	1.50	3.40	5.20	5.20
		± 0.25	± 0.25	± 0.10	± 0.35	± 0.35	± 0.05
IC127B10F-520	B	12.70	12.20	1.00	3.20	4.10	0.30
IC127B11D-650	B	12.70	12.20	1.10	3.20	4.10	0.20
IC127B12D-650	B	12.70	12.20	1.20	3.20	4.10	0.20
IC127B12F-650	B	12.70	12.20	1.20	3.20	4.10	0.30
IC127B14F-650	B	12.70	12.20	1.40	3.20	4.10	0.30
IC127B15G-650	B	12.70	12.20	1.50	3.20	4.10	0.35
IC127B15P-650	B	12.70	12.20	1.50	0.00	4.10	0.00
IC127B16H-650	B	12.70	12.20	1.60	3.20	4.10	0.40

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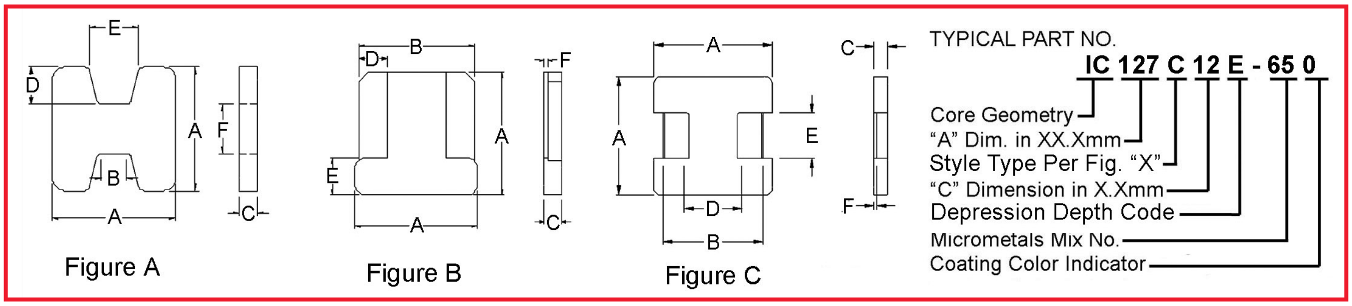
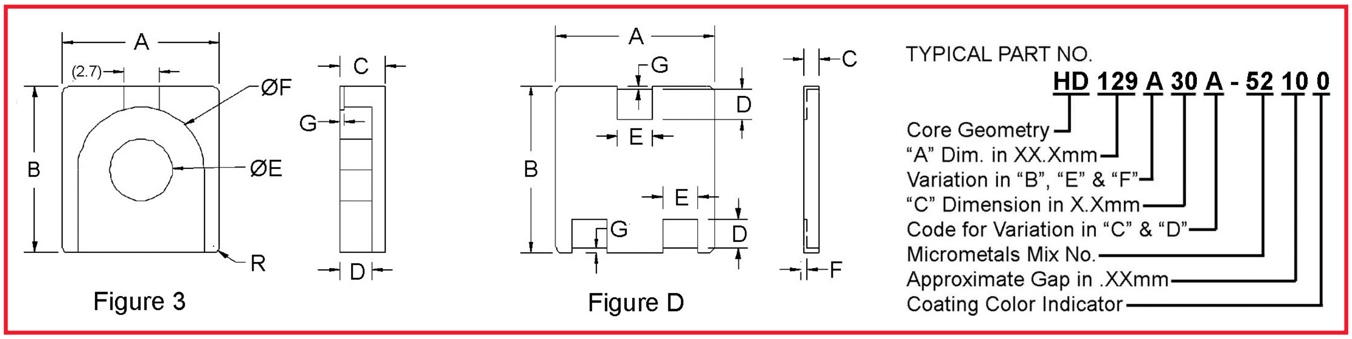
IC CORES



MICROMETALS Part No.	Figure	A mm	B mm	C mm	D mm	E mm	F mm
		± 0.25	± 0.25	± 0.10	± 0.35	± 0.35	± 0.05
IC127C12E-650	C	12.70	10.70	1.20	5.90	4.40	0.23
IC127C13E-650	C	12.70	10.70	1.25	5.90	4.40	0.23
IC127C14G-520	C	12.70	10.70	1.35	5.90	4.40	0.35
IC127C14G-650	C	12.70	10.70	1.35	5.90	4.40	0.35
IC127C14E-650	C	12.70	10.70	1.40	5.90	4.40	0.23
IC127C15E-650	C	12.70	10.70	1.50	5.90	4.40	0.23
		± 0.25	± 0.25	± 0.10	± 0.35	± 0.35	± 0.05
IC129B15H-520	B	12.90	12.40	1.50	3.40	4.30	0.40
IC129B15H-650	B	12.90	12.40	1.50	3.40	4.30	0.40

HD & ID CORES



MICROMETALS Part No.	Figure	A mm	B mm	C mm	D mm	E mm	F mm	G mm
		± 0.20	± 0.20	± 0.15	± 0.15	± 0.10	± 0.15	ref
HD102A30A-52000	3	10.20	10.20	3.00	2.00	4.00	8.20	0.55
HD102A45A-52000	3	10.20	10.20	4.50	3.50	4.00	8.20	0.55
HD102A69A-52000	3	10.20	10.20	6.90	5.60	4.00	8.20	0.55
		± 0.20	± 0.20	± 0.10	ref	ref	ref	ref
ID102A12G-520	D	10.20	10.20	1.20	3.00	2.80	0.35	0.35
ID102A15G-520	D	10.20	10.20	1.50	3.00	2.80	0.35	0.35
		± 0.25	± 0.25	± 0.15	± 0.15	± 0.10	± 0.15	ref
HD119A36A-52000	3	11.90	12.70	3.55	2.55	4.70	9.60	0.55
HD119A50A-52000	3	11.90	12.70	5.00	4.00	4.70	9.60	0.55
		± 0.25	± 0.25	± 0.10	ref	ref	ref	ref
ID119A11E-520	D	11.90	12.70	1.10	2.55	2.70	0.25	0.30
		± 0.25	± 0.25	± 0.15	± 0.15	± 0.10	± 0.15	ref
HD129A35A-52000	3	12.90	12.90	3.50	2.50	4.90	10.80	0.55
HD129A50A-52000	3	12.90	12.90	5.00	4.00	4.90	10.80	0.55
HD129A79A-52000	3	12.90	12.90	7.90	6.75	4.90	10.80	0.55
		± 0.25	± 0.25	± 0.10	ref	ref	ref	ref
ID129A12G-520	D	12.90	12.90	1.20	3.00	3.00	0.35	0.35
ID129A15G-520	D	12.90	12.90	1.50	3.00	3.00	0.35	0.35

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MICROCUBES APPLICATION INTRODUCTION

As frequencies have increased and voltages decreased, there is an increasing need for low inductance, high current inductors. Micrometals new MicroCubes for SMD and High Density Power Inductors offer an attractive solution for these applications. Typical uses include multiphase voltage regulated modules (VRM), point of load (POL) power supplies, and other DC/DC applications.

MicroCubes unique geometry offer several advantages:

- Shape allows for efficient board utilization
- Ideal for low profile applications
- Higher power density
- Pre-wound coils eliminate the need for manual winding of large wire with improved uniformity
- Shielded to minimize EMI
- Good heat dissipation
- Flexibility in termination techniques with either through-hole or surface mount options
- Suited for pick-and-place manufacturing

With rising currents forcing the use of larger wire sizes, it has become increasingly difficult to wind toroidal cores. With MicroCubes, pre-wound coils allow the use of heavy gauge copper without stressing the core. This eliminates manual winding, increases uniformity, lowers labor costs, and eliminates the need to adjust the positioning of turns.

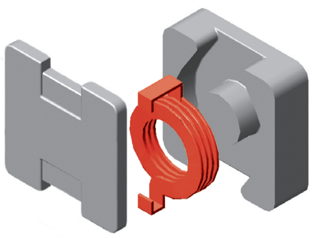

Figure 1

MicroCubes are ideal for flat edge-wound coils (Figure 1). Flat coils are made from rectangular copper wound helically with specialized equipment. The rectangular copper wire fills the winding area more efficiently that round wire. This allows for a lower DCR and/or a lower profile coil. The flat coil provides a self-terminating lead for ease of use in surface mount applications. The depressions provided in the IC and ID cores are intended for this purpose.

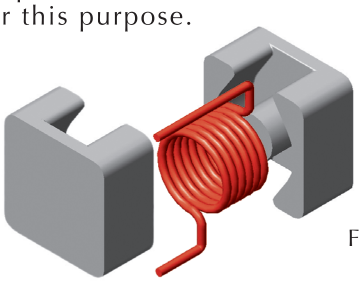

Figure 2

For cost-sensitive applications where optimal power densities are not required, traditional round wire can be utilized (Figure 2). This is most convenient for through-hole mounting, but it is possible to flatten round wire at the end for surface mount terminations. MicroCubes can either be used for horizontal mounting with both leads exiting from the same side which typically use an HC/HC pair, or vertical mounting where the leads exit on opposite sides of the core. These can use either the HC/HC or HC/IC combination depending on the total height. In general, an HC/IC will be the less costly.

The following two pages contain pertinent details for application pairs where most of the parts contained on pages 1-4 are represented. All pair sets are listed ungapped at the maximum A_L value. It is possible to provide any pair with a lower than listed A_L value by introducing a gap in the center post to achieve the required performance. This gap can be accomplished during the pressing process adding no additional cost. The approximate gap is represented in the part number in .XX mm. For example the HC127A44A-65**00**0 will have no gap whereas HC127A44A-65**07**0 specifies an approximate .07mm gap per part.

Saturation curves and curve-fit formulas are provided on pages 8 and 9. MicroCubes will respond to DC bias as a function of the unbiased effective permeability of the pairing and the DC Magnetizing Force in ampere-turns/cm. The curves for the -52 Material are also dependent on the path length of the pairing.

Refer to the design examples on pages 10-11 for an illustration of tailoring the A_L value to a specific application as well as the use of the saturation information shown on pages 8-9.

The A_L values listed are typical for an ungapped set when tested with windings of 2.5 turns or more. Applications using fewer turns will typically measure higher inductance than calculated due to increased leakage effects.

In addition to the listed catalog parts, Micrometals can customize the height ("C" dimension) and depth ("D" dimension) of cores to meet specific requirements. The corresponding magnetic dimensions can be provided upon request.

The MicroCubes listed in this catalog are offered in two core materials, the magnetic alloy -65 Material, and the iron powder -52 Material. The -65 has extremely stable performance at elevated temperatures along with lower core losses at high frequencies than the -52 Material. The -52 offers excellent performance with DC bias and is an economic alternative to the -65 material for less thermally demanding applications. MicroCubes can also be pressed in other popular Micrometals materials such as -8 Material and -70 Material to improve high frequency losses.

The cores come with a standard black coating on the outer surfaces signified by the last digit of the part number; alternate colors are available.

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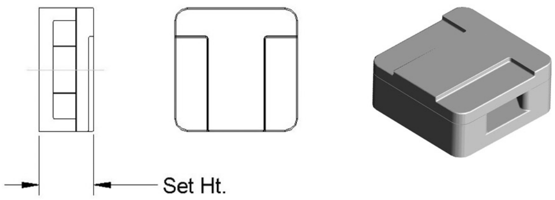
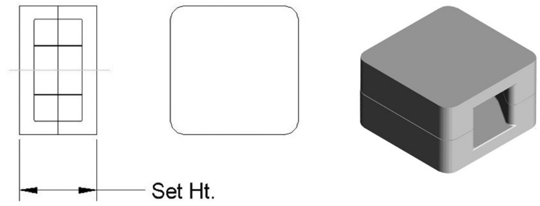
MICROCUBE SET PROPERTIES



HC/IC Set



HC/HC Set

MICROMETALS 1st Part No.	MICROMETALS 2nd Part No.	Set Ht max mm	A_L* nH/N^2	Eff. Perm μ_{eff_o}	Magnetic Dimensions ℓ cm	A cm^2	V cm^3	Window cm^2	Surface cm^2
HC065A19A-65000	IC065B09C-650	2.95	53.5	45.0	1.00	0.095	0.089	0.015	1.56
HC065A29A-65000	IC065B09C-650	3.95	45.8	45.0	1.20	0.097	0.107	0.029	1.82
HC065B19A-65000	IC065B09C-650	2.95	58.6	45.0	0.98	0.101	0.091	0.013	1.56
HC065B27A-65000	IC065B10C-650	3.85	53.1	45.0	1.14	0.107	0.113	0.022	1.79
HC065B38A-52000	IC065B10C-520	4.90	57.2	55.0	1.34	0.111	0.137	0.034	2.07
HC065B38A-65000	IC065B10C-650	4.90	46.8	45.0	1.34	0.111	0.137	0.034	2.07
HC098A30A-65000	IC098B12E-650	4.40	71.3	45.0	1.59	0.201	0.291	0.043	3.57
HC098A61A-65000	IC098B15P-650	7.80	56.2	45.0	2.25	0.224	0.461	0.113	4.90
HC098A61A-65000	HC098A61A-65000	12.40	38.9	45.0	3.21	0.221	0.640	0.225	6.70
HC101A27A-52000	IC101B10D-520	3.85	84.3	60.0	1.62	0.181	0.251	0.046	3.49
HC101A35A-52000	IC101B10D-520	4.70	78.7	60.0	1.79	0.187	0.288	0.068	3.83
HC101B23A-65000	IC101B11D-650	3.60	78.0	45.0	1.46	0.201	0.260	0.030	3.39
HC101B26A-65000	IC101B12E-650	4.00	80.8	45.0	1.51	0.216	0.293	0.032	3.55
HC101B30A-65000	IC101B12E-650	4.40	77.8	45.0	1.59	0.218	0.313	0.040	3.71
HC101B35A-52000	IC101B10D-520	4.65	94.9	60.0	1.67	0.210	0.313	0.052	3.81
HC101B35A-65000	IC101C11D-650	4.75	72.1	45.0	1.68	0.214	0.322	0.052	3.85
HC101B36A-65000	IC101B12E-650	5.00	75.1	45.0	1.70	0.226	0.348	0.051	3.95
HC101B39A-65000	IC101B12E-650	5.30	71.5	45.0	1.77	0.224	0.358	0.060	4.07
HC101B44A-52000	IC101C11D-520	5.70	82.9	55.0	1.86	0.223	0.375	0.070	4.23
HC101B44A-65000	IC101C11D-650	5.70	67.8	45.0	1.86	0.223	0.375	0.070	4.23
HC101B47A-65000	IC101B12E-650	6.10	68.0	45.0	1.92	0.231	0.403	0.074	4.39
HC101B52A-65000	IC101C11D-650	6.55	62.3	45.0	2.03	0.224	0.409	0.089	4.55
HC101B58A-65000	IC101B12P-650	7.25	60.2	45.0	2.16	0.230	0.450	0.102	4.83
HC101B36A-65000	HC101B36A-65000	7.40	61.5	45.0	2.19	0.238	0.476	0.102	4.91
HC101B63A-52000	IC101B13P-520	7.85	67.3	50.0	2.26	0.242	0.500	0.108	5.08
HC101B52A-65000	HC101B52A-65000	10.70	46.6	45.0	2.87	0.236	0.614	0.179	6.20
HC101C20A-65000	IC101C11D-650	3.30	75.0	45.0	1.44	0.190	0.236	0.027	3.27
HC101C25A-65000	IC101C11D-650	3.80	74.6	45.0	1.52	0.201	0.268	0.035	3.47
HC101C27A-65000	IC101C11D-650	3.95	74.5	45.0	1.55	0.204	0.278	0.037	3.53
HC101C32A-65000	IC101C11D-650	4.50	70.9	45.0	1.66	0.207	0.304	0.050	3.75
HC101C39A-65000	IC101C11D-650	5.20	66.7	45.0	1.80	0.212	0.338	0.065	4.03
HC101C47A-65000	IC101B12E-650	6.10	65.5	45.0	1.94	0.225	0.394	0.079	4.39
HC101C47A-65000	HC101C47A-65000	9.60	50.6	45.0	2.65	0.237	0.574	0.158	5.80
HC101D58A-65000	IC101B12P-650	7.25	60.0	45.0	2.17	0.230	0.452	0.103	4.83

* A_L value listed with no gap.

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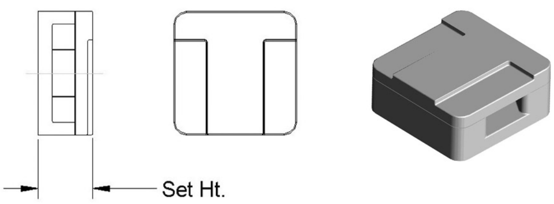
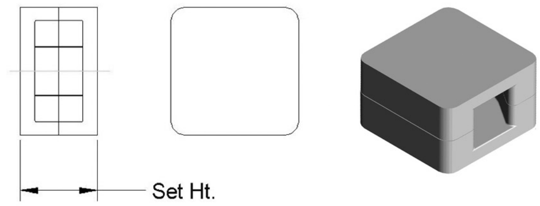


HC/IC Set



HC/HC Set

MICROMETALS 1st Part No.	MICROMETALS 2nd Part No.	Set Ht max mm	A_L* nH/N^2	Eff. Perm μ_{eff_o}	Magnetic Dimensions ℓ cm	A cm^2	V cm^3	Window cm^2	Surface cm^2
HC123A34A-65000	IC123B12D-650	4.80	83.2	45.0	1.97	0.289	0.357	0.067	5.29
HC123A48A-65000	IC123B12D-650	6.20	78.6	45.0	2.23	0.309	0.406	0.101	5.98
HC127A25A-65000	IC127B11D-650	3.80	91.8	45.0	1.77	0.287	0.438	0.042	4.85
HC127A28A-65000	IC127B12F-650	4.20	91.0	45.0	1.84	0.296	0.471	0.050	5.05
HC127A34A-52000	IC127B10F-520	4.60	113.7	60.0	1.94	0.292	0.486	0.067	5.25
HC127A33A-65000	IC127B12D-650	4.70	91.3	45.0	1.93	0.311	0.528	0.060	5.30
HC127A35A-65000	IC127B12F-650	4.85	90.0	45.0	1.95	0.311	0.534	0.064	5.37
HC127A37A-65000	IC127B12D-650	5.10	89.6	45.0	2.00	0.317	0.563	0.069	5.49
HC127A40B-65000	IC127B12D-650	5.40	89.6	45.0	2.05	0.325	0.594	0.075	5.64
HC127A44A-65000	IC127C12E-650	5.75	86.6	45.0	2.12	0.325	0.615	0.086	5.82
HC127A43A-65000	IC127C14E-650	5.85	91.5	45.0	2.11	0.341	0.650	0.079	5.86
HC127A44B-65000	IC127B15H-650	6.10	89.4	45.0	2.15	0.340	0.661	0.086	5.99
HC127A48A-65000	IC127C12E-650	6.20	83.3	45.0	2.22	0.327	0.645	0.100	6.04
HC127A49A-65000	IC127C12E-650	6.25	84.5	45.0	2.22	0.332	0.657	0.099	6.06
HC127A55A-65000	IC127C12E-650	6.95	79.7	45.0	2.36	0.332	0.699	0.119	6.38
HC127A35A-65000	HC127A35A-65000	7.10	78.0	45.0	2.42	0.334	0.718	0.128	6.48
HC127A60A-65000	IC127C12E-650	7.45	77.3	45.0	2.46	0.336	0.737	0.133	6.63
HC127A69A-65000	IC127B15P-650	8.65	75.5	45.0	2.68	0.357	0.866	0.158	7.23
HC127A75A-52000	IC127A12P-520	8.95	77.8	50.0	2.72	0.336	0.807	0.172	7.38
HC127B34A-65000	IC127C12E-650	4.80	93.0	45.0	1.92	0.316	0.516	0.061	5.34
HC127B47A-65000	IC127C14E-650	6.30	91.1	45.0	2.17	0.350	0.668	0.088	6.09
HC129A45A-65000	IC127C12E-650	5.90	95.8	45.0	2.09	0.354	0.677	0.080	6.27
HC129A60A-65000	IC129B15H-650	7.75	88.7	45.0	2.41	0.378	0.850	0.116	7.20
HC129A74A-52000	IC129B15H-520	9.15	91.0	50.0	2.69	0.389	0.980	0.149	7.92
HC129A74A-65000	IC129B15H-650	9.15	81.9	45.0	2.69	0.389	0.980	0.149	7.92
HC129A45A-65000	HC129A45A-65000	9.20	78.6	45.0	2.75	0.383	0.987	0.160	7.97
HD102A30A-52000	ID102A12G-520	4.40	111.0	60.0	1.44	0.212	0.326	0.042	3.79
HD102A45A-52000	ID102A12G-520	5.90	86.2	55.0	1.74	0.217	0.398	0.063	4.41
HD102A69A-52000	ID102A15G-520	8.65	67.6	50.0	2.22	0.239	0.562	0.118	5.51
HD119A36A-52000	ID119A11E-520	4.90	127.5	60.0	1.68	0.284	0.499	0.063	5.26
HD119A50A-52000	ID119A11E-520	6.35	103.5	55.0	1.97	0.295	0.603	0.098	6.02
HD129A35A-52000	ID129A12G-520	4.95	111.4	55.0	1.80	0.290	0.541	0.059	5.75
HD129A50A-52000	ID129A15G-520	6.45	89.2	50.0	2.10	0.298	0.645	0.089	6.68
HD129A79A-52000	ID129A15G-520	9.65	68.4	45.0	2.70	0.326	0.912	0.199	8.18

* A_L value listed with no gap.

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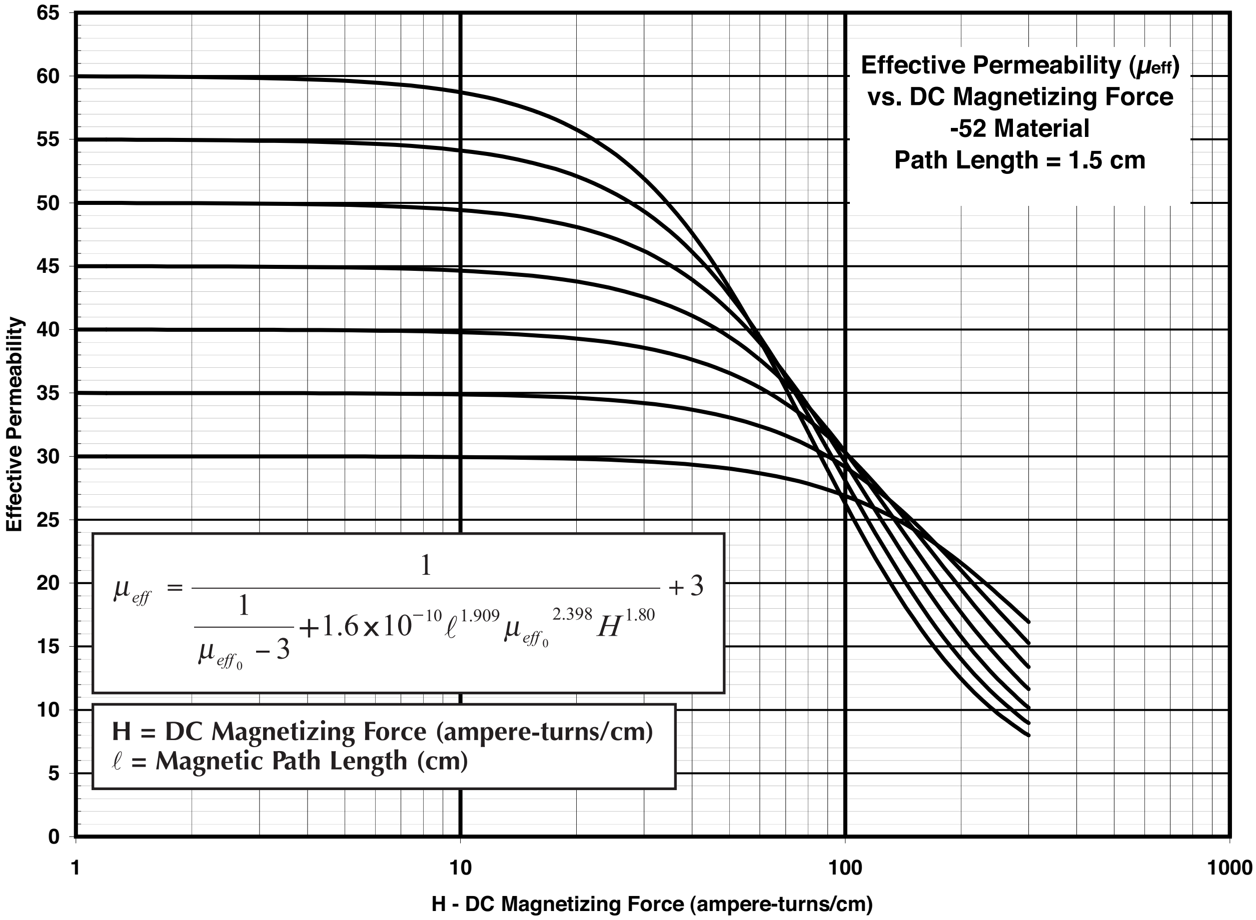
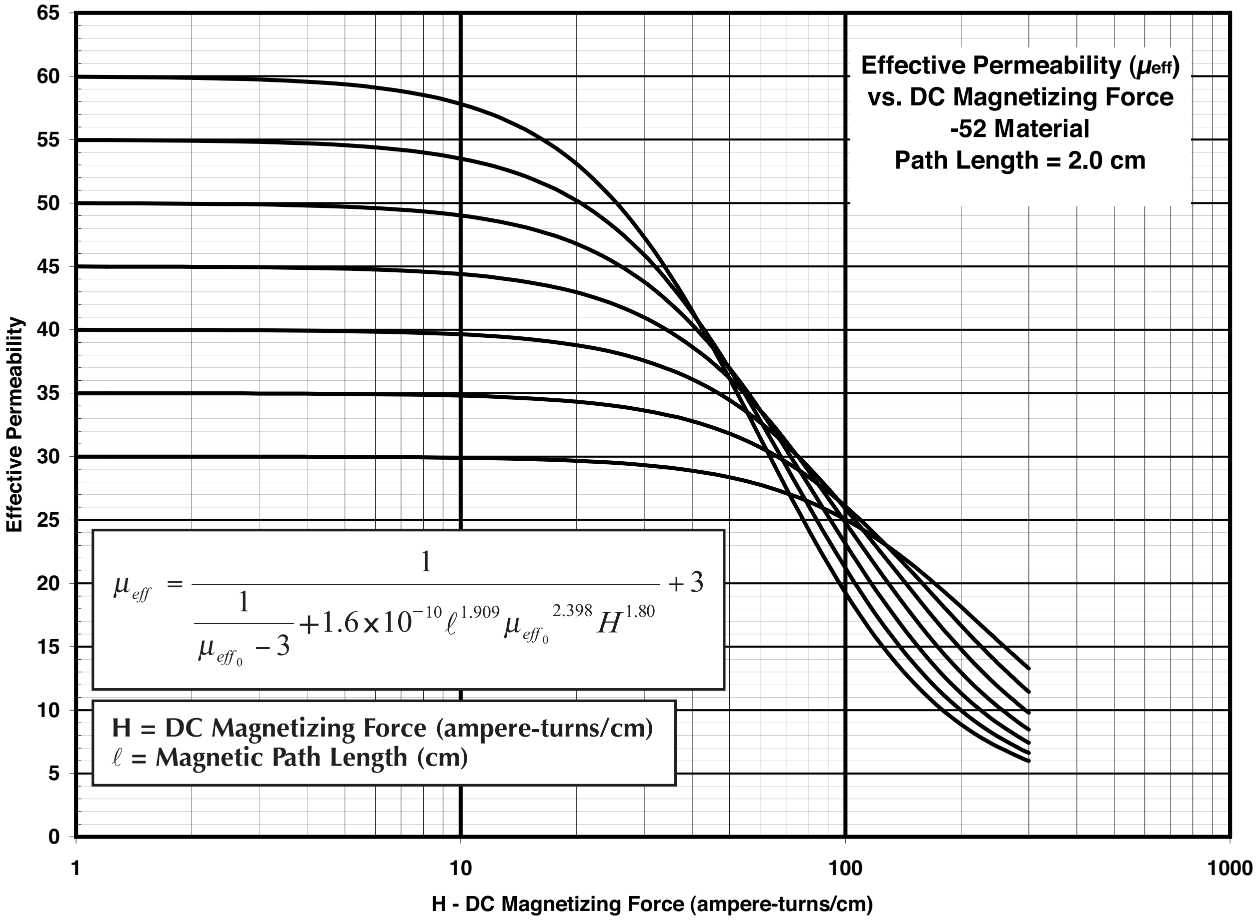
DC SATURATION





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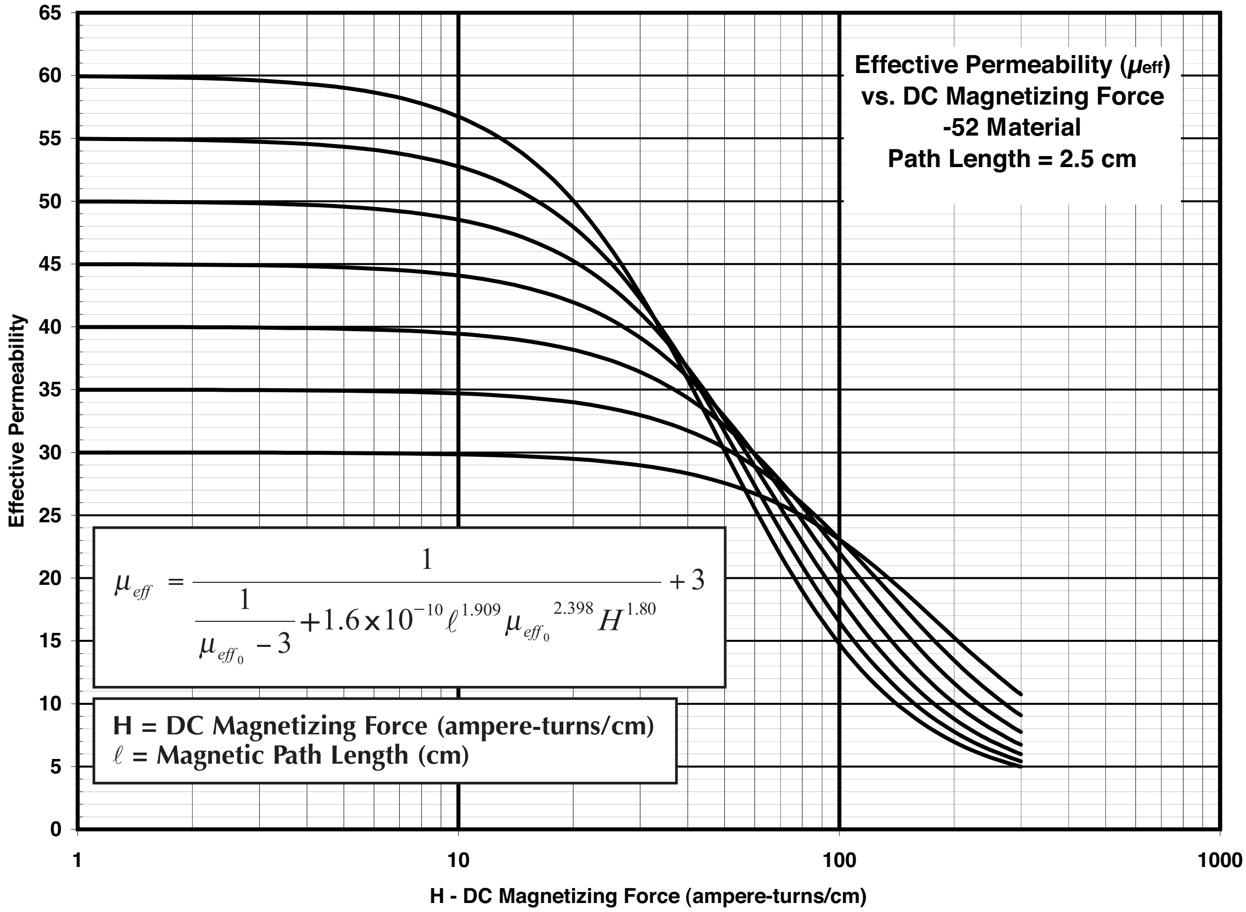

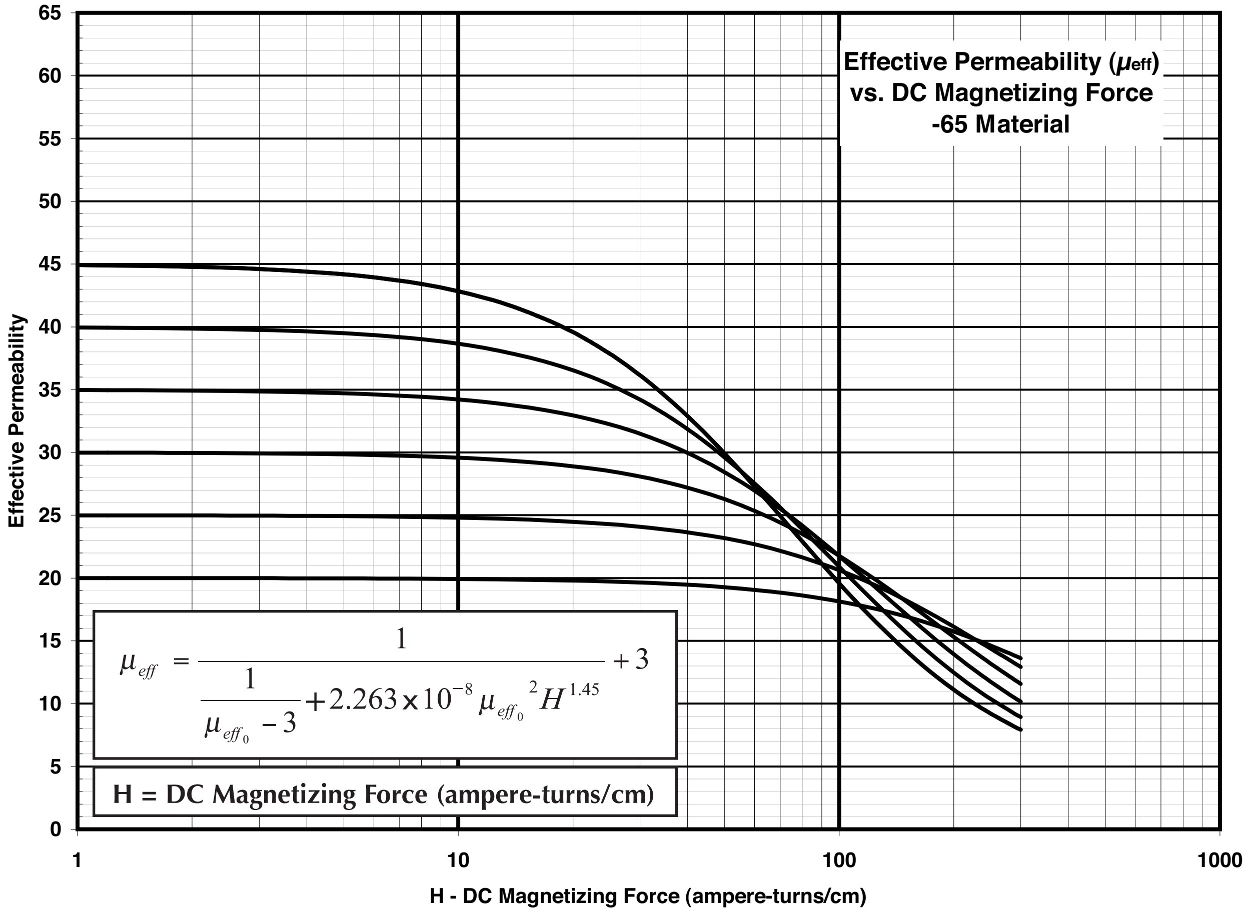

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MICROCUBE DESIGN EXAMPLES

The following section will step through a few design examples using MicroCubes.

EXAMPLE #1:

Consider the following design requirements:

- L_o = 470nH +15%/-10% (540-423nH)
- L@40 amps DC = 370nH +20%/-10% (444-333nH)
- Max Ht. = 6.0 mm
- Max Footprint = 13.5 mm x 13.5 mm

First select an appropriately sized MicroCube set from the catalog listing. For this example, the pairing of part numbers HC127A44A-65000 and IC127C12E-650 from page 7 is selected as it is 12.7mm square with a maximum height 5.75mm meeting the size requirement.

Included in the pairing information is the A_L value of 86.6 nH/N2 and effective permeability of 45 for the ungapped set. From this, the number of turns needed to meet the unbiased inductance (L_o) of 470 nH can be calculated as follows:

$$N = \left(\frac{L(nH)}{A_L}\right)^{1/2} = \left(\frac{470}{86.6}\right)^{1/2} = 2.3 \text{ turns}$$

The number of turns is rounded up to 2.5 turns since this core set requires integer + 1/2 turn windings. The A_L value required to get the needed 470 nH with 2.5 turns is then calculated via:

$$A_{L_{required}} = \frac{L(nH)}{N^2} = \frac{470}{(2.5)^2} = 75.2\frac{nH}{N^2}$$

From the required A_L value and the listed magnetic dimensions for this pairing, the corresponding effective permeability of the gapped set can then calculated using:

$$\mu_{\text{eff}_0} = \frac{A_L \cdot \ell}{4\pi \cdot A} = \frac{(75.2)(2.12)}{4\pi(0.325)} = 39.0$$

Micrometals can then determine the typical gap needed to achieve this desired A_L value. In this case, it is .07mm yielding a part number for the HC core of: HC127A44A-65070

The DC Magnetizing Force with 2.5 turns and 40 amps DC is then calculated by using the following:

$$H_{DC} = \frac{N \cdot I}{\ell} = \frac{(2.5)(40)}{2.12} = 47.2 \text{ A/cm}$$

Determine the DC biased permeability by starting with the unbiased effective permeability value of 39.0 as determined above. From this and the H_{DC} just calculated, use the graph or formula at the bottom of page 9 for the –65 Material to determine the effective permeability with DC which yields a value of 30.0.

The inductance with DC bias is then calculated by multiplying the unbiased inductance by the ratio of biased to unbiased effective permeabilities, as seen in the following:

$$L_{40A_{DC}} = \left(\frac{\mu_{eff\,40A_{DC}}}{\mu_{eff_0}}\right)(L_0) = \left(\frac{30.0}{39.0}\right)(470)$$
$$= 361nH \text{ (target 444 - 333)}$$

Using this winding and core pairing with the properly selected gap, the design constraints have been satisfied.

EXAMPLE #2:

This next example illustrates what can be done to make adjustments to meet design constraints. Consider the following design parameters:

- L_o = 1.0μH = 1000nH ±15% (850-1150nH)
- L@25 amps DC = 850nH minimum
- L@40 amps DCsurge = 750nH minimum
- Max Ht. = 6.0mm
- Max Footprint = 13.5 mm x 13.5 mm

Once again start with the same core pairing of part numbers HC127A44A65000 and IC127C12E-650 since the size requirements are the same as in the previous example.

As before, the number of turns needed to reach 1000 nH with the ungapped set can be calculated as follows:

$$N = \left(\frac{L(nH)}{A_L}\right)^{1/2} = \left(\frac{1000}{86.6}\right)^{1/2} = 3.4 \text{ turns}$$

The number of turns is rounded up to 3.5 turns. The A_L value required is then calculated via:

$$A_{L_{required}} = \frac{L(nH)}{N^2} = \frac{1000}{(3.5)^2} = 81.6\frac{nH}{N^2}$$

From the calculated A_L value, the effective permeability of the gapped set needs to be calculated. In this example, rather than using the approach used in the first example that uses the magnetic dimensions, it will be determined by using the ratio of the gapped A_L value to the ungapped A_L value as follows:

$$\mu_{\text{eff}_0} = \frac{A_{L_{gapped}}}{A_{L_{ungapped}}}\left(\mu_{eff_{ungapped}}\right) = \frac{(81.6)}{(86.6)}(45.0) = 42.4$$

Micrometals can then determine the proper gap that needs to be used to produce this desired A_L value. In this case it is .05mm giving core part numbers HC127A44A-65050 and IC127C12E-650 to achieve the A_L value of 81.6 nH/N2 and an effective permeability of 42.4.

The DC Magnetizing Force is then calculated using the following:

$$H_{DC} = \frac{N \cdot I}{\ell} = \frac{(3.5)(25)}{2.12} = 41.3 \text{ A/cm}$$

By utilizing the formula for Effective permeability vs. DC Magnetizing Force for –65 Material found at the bottom of page 9, the effective permeability under DC bias can be calculated to be 32.1 as follows:

$$\mu_{eff} = \frac{1}{\left(\frac{1}{42.4-3}\right) + (2.263\times10^{-8})(42.4^2)(41.3^{1.45})} + 3$$

$$=32.1$$

The inductance under DC bias is then calculated by multiplying the unbiased inductance by the ratio of biased to unbiased effective permeabilities, as seen in the following:

$$L_{40A_{DC}} = \left(\frac{\mu_{eff\,25A_{DC}}}{\mu_{eff_0}}\right)(L_0) = \left(\frac{31.9}{42.4}\right)(1000)$$

$$= 757nH \text{ (target 850 minimum)}$$

This design falls short of the design requirements at 25 amps DC as well as at 40 amps DC, where the same technique gives a biased inductance of 618nH which is short of the 750nH minimum target.

While it may seem that a higher permeability is the way to meet this requirement, the opposite is actually the case. If the design is then re-evaluated using 4.5 turns instead of 3.5 turns, the A_L value required is then calculated via:

$$A_{L_{required}} = \frac{L(nH)}{N^2} = \frac{1000}{(4.5)^2} = 49.4\frac{nH}{N^2}$$

From the calculated A_L value, the effective permeability of the gapped pair can then be calculated as:

$$\mu_{eff_0} = \frac{A_{L_{gapped}}}{A_{L_{ungapped}}}\left(\mu_{eff_{ungapped}}\right) = \frac{(49.4)}{(86.6)}(45.0) = 25.7$$

Micrometals can then determine the proper gap giving a core pairing of part numbers HC127A44A-65330 and IC127C12E-650 to achieve the A_L value of 49.4 nH/N2 and an effective permeability of 25.7.

The DC Magnetizing Force is then calculated using the following:

$$H_{DC} = \frac{N \cdot I}{\ell} = \frac{(4.5)(25)}{2.12} = 53.1 \text{ A/cm}$$

By utilizing the formula for Effective permeability vs. DC Magnetizing Force for –65 Material found at the bottom of page 9, the effective permeability with 25 amps DC bias can be calculated to be 23.5. At 40 amps DC bias, the effective permeability works out to be 21.7.

Applying the 25 amp ratio of 23.5/25.7 and the 40 amp ratio of 21.7/25.7 to the unbiased inductance of 1000 nH gives the following biased inductances:

Core Pair: HC127A44A-65330 and IC127C12E-650
N = 4.5 turns
L_o = 1000nH
L@25 amps DC = 914nH meeting the required 850 nH
L@40 amps DC surge = 844nH meeting 750 nH min

All of the design requirements are now satisfied. However, it should be noted that this 4.5 turn coil will have about 60% higher copper loss than a 3.5 turn coil. This is due to the increased length and reduced cross-section of copper. If this copper loss cannot be tolerated, one option would be to increase the window area by increasing the maximum height of the inductor.

The existing core choice lists a window area of .086 cm^2. Increasing this value by 60% yields .138 cm^2 and will allow for adequate copper to significantly reduce the DCR . From the listing on page 7, the MicroCube set of HC127A60A-65000 and IC127C12E-650 will be selected with a window area of .133 cm^2.

The previous calculation techniques can be used to achieve the following design:

Core Pair: HC127A60A-65250 and IC127C12E-650
N = 4.5 turns
L_o = 1000nH
L@25 amps DC = 902nH
L@40 amps DCsurge = 824nH

The listed individual part numbers and sets shown in this catalog are intended simply as an example of typical parts available. The nature of these applications is highly specialized and inquiries for unique sizes with specific electrical requirements are welcome.

The design aids illustrated here will be included in future versions of the Micrometals Inductor Design Software allowing for thermal aging analysis. In the meantime, please contact the factory for assistance.

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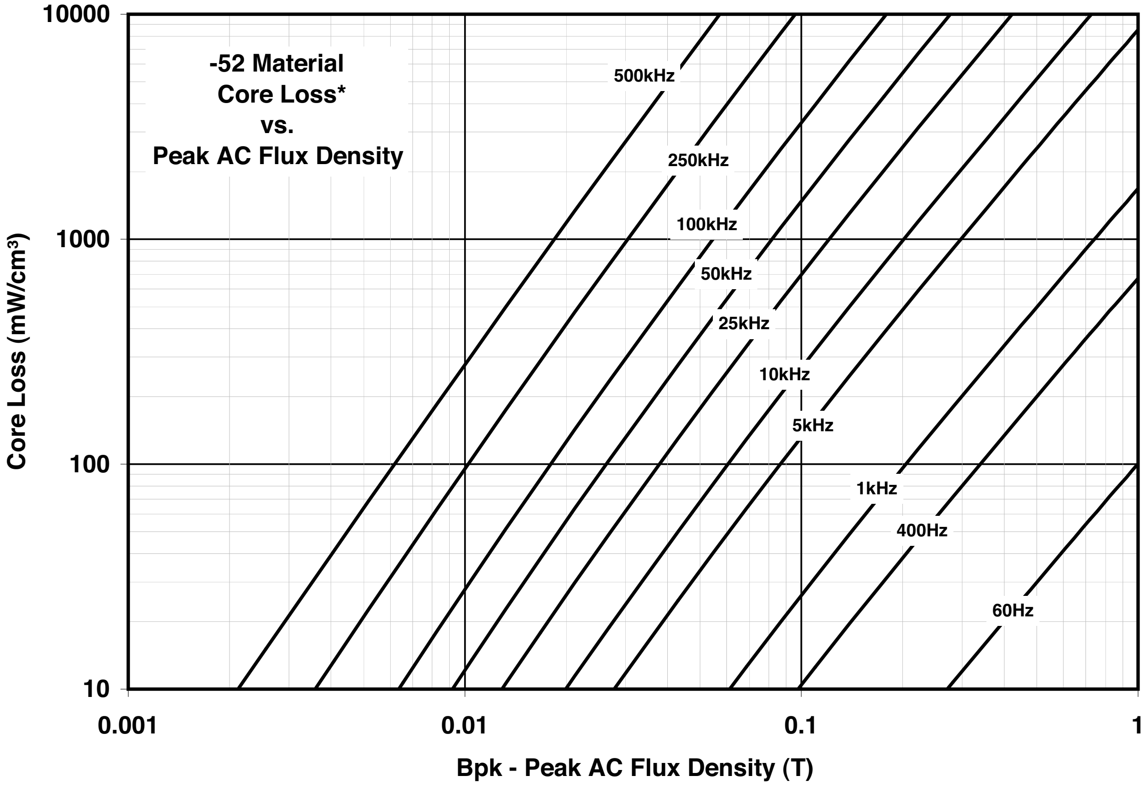
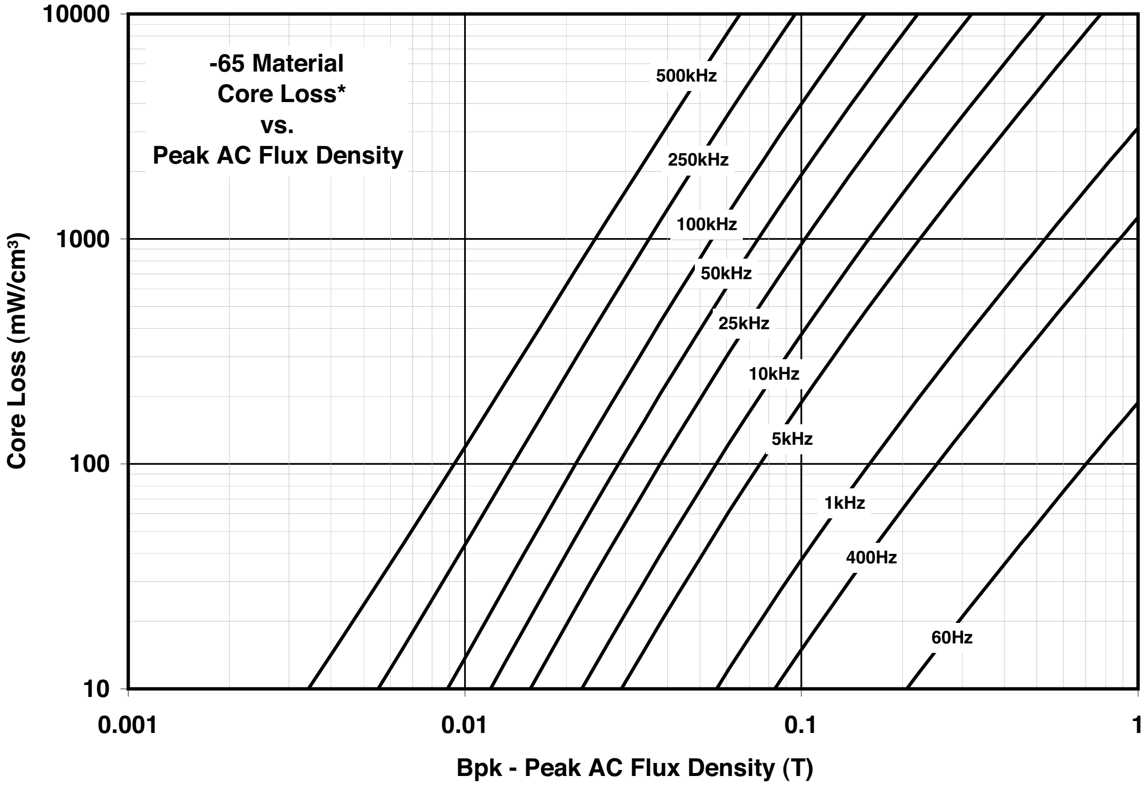
CORE LOSS





* Core loss information based on toroidal measurements

$$CL(mW/cm^3) = \frac{f}{\frac{a}{B^3} + \frac{b}{B^{2.3}} + \frac{c}{B^{1.65}}} + (d f^2 B^2)$$

Where: CL = Core Loss
B = Peak AC Flux Density (tesla)
f = frequency (Hz)

Material	a	b	c	d
-52	1.00×10^{-3}	6.94×10^{-2}	5.72×10^{-1}	6.90×10^{-6}
-65	6.90×10^{-3}	3.79×10^{-2}	2.76×10^{-1}	2.50×10^{-6}

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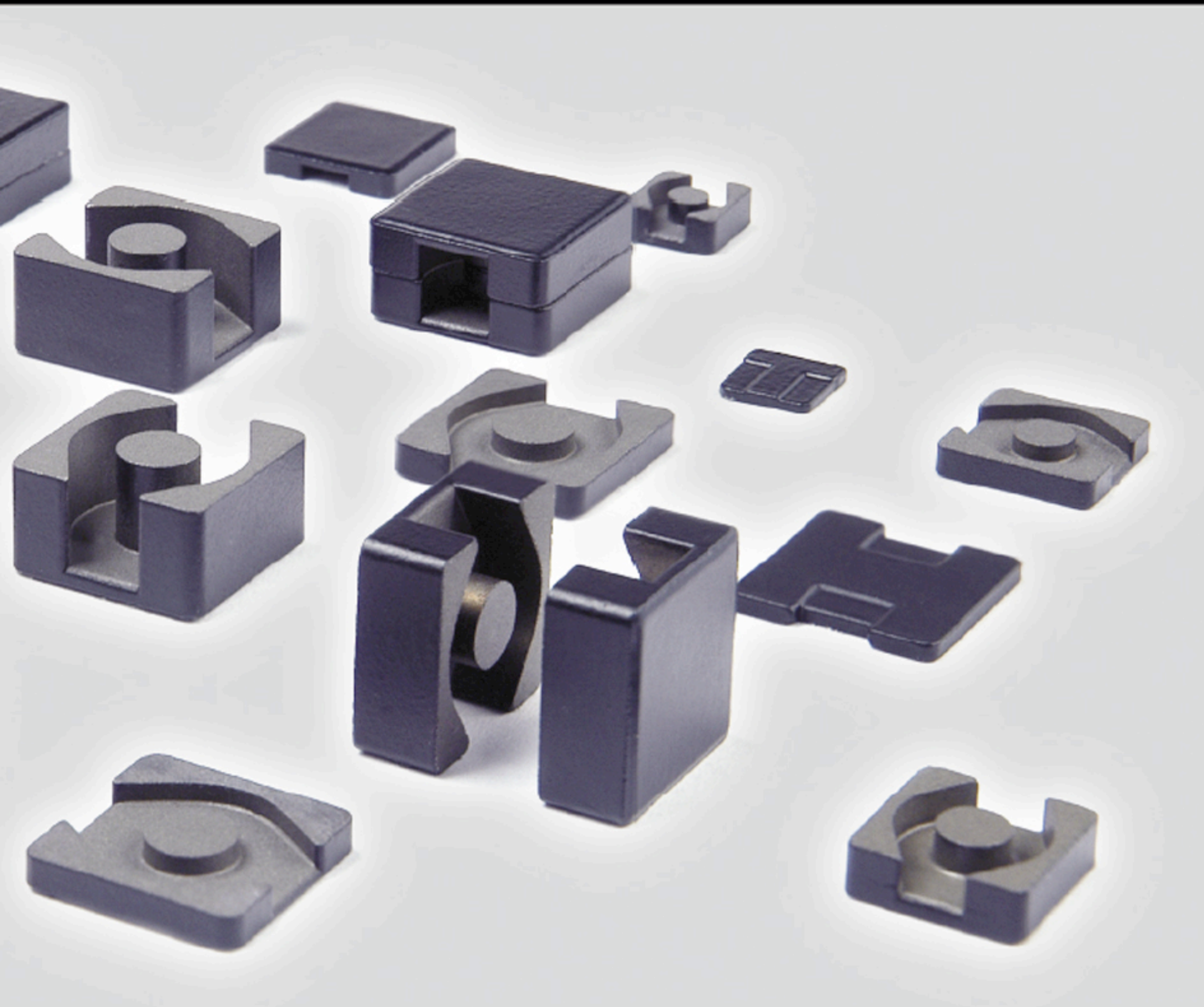

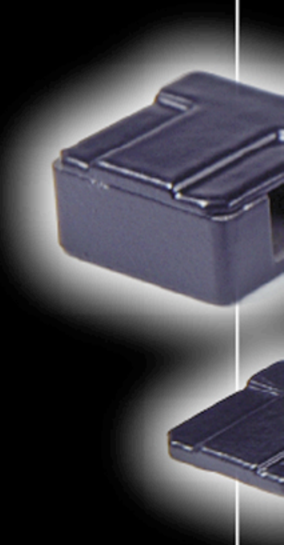

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