SCHWARZBECK MESS - ELEKTRONIK

An der Klinge 29 D-69250 Schönau Tel.: 06228/1001 Fax.: (49)6228/1003

Helmholtz-Spulenpaar HHS 5230-100
Helmholtz Coil Pair HHS 5230-100

Technische Daten:		***Specifications:***
Kantenlänge:	3 m	*Square Side Length:*
Windungszahl (pro Spule):	100	*Number of turns (per Coil):*
Maximaler Spulenstrom:	16 A / 5 min.	*Maximum Coil Current:*
Spulenstrom, nominell:	8 A cont.	*Nominal Coil Current:*
Spulenabstand einstellbar:	D > 1.13 m	*Coil Spacings:*
Spulenabstand für beste Feldhomogenität:	D = 1.8 m	*Coil Spacing for best Field Uniformity:*
Max. Magn. Feldstärke:	650 A/m @ D=1.8 m	*Maximum Magnetic Field Strength:*
Magn. Nennfeldstärke:	325 A/m @ D=1.8 m	*Nominal Magnetic Field Strength:*
Magn. Feldstärke bei 1 A Spulenstrom:	50.8 A/m @ D=1.13 m 37.6 A/m @ D=2 m 10.3 A/m @ D=5 m	*Magnetic Fieldstrength, 1 A Coil Current:*
Erforderlicher Strom für 1 A/m:	19.7 mA @ D=1.13 m 26.6 mA @ D=2 m 97.1 mA @ D=5 m	*Current required for 1 A/m:*
Abmessungen:	W: 2.0 x H: 3.10 x B: 3.18	*Mechanical Dimensions:*
Bodenabstand:	0.12 m	*Ground Clearance:*
Anschlüsse: Laborbuchsen mit kombinierter Flügelklemme	4 mm	*Terminals: 4 mm female with universal wing terminal*
Nutzbarer Frequenzbereich:	DC - 5 kHz	*Usable Frequency Range:*
Induktivität (pro Spule):	100 mH	*Inductance (per Coil):*
Wirkwiderstand (pro Spule):	6 Ω	*Resistance (per Coil):*
Windungskapazität (pro Spule):	1.4 nF	*Coil Capacitance (per Coil):*
Resonanzfrequenz (pro Spule):	> 10 kHz, typ. 13 kHz	*Resonant Frequency (per Coil):*
Gewicht: (pro Spule):	190 kg	*Weight (per Coil):*

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Anwendung:

Das Helmholtz-Spulenpaar eignet sich zur Erzeugung exakt definierter magnetischer Felder von DC bis etwa 5 kHz z.B. nach SAE J551-17. Die erzeugte Feldstärke steht in streng linearem Zusammenhang zum Spulenstrom. Aus der Spulengeometrie, dem Strom und der Windungszahl lässt sich die resultierende Feldstärke exakt analytisch (oder auch numerisch) berechnen. Die HHS 5230-100 ist aufgrund ihrer Größe ideal für Störfestigkeitsprüfungen gegen Magnetfelder im Automotive Bereich einsetzbar. Aufgrund der großzügig dimensionierten Bewicklung lassen sich (kurzzeitig) magnetische Felder über 800 A/m erzeugen. Typische Anwendungsfälle sind Immunitätsprüfungen an ganzen Fahrzeugen nach SAEJ551-17 (Vehicle Electromagnetic Immunity – Power Line Magnetic Fields). Bei der Felderzeugung mit Helmholtzspulen ist die magnetische Feldstärke streng proportional zum Spulenstrom. Letztendlich läßt sich die Kalibrierung der Magnetfeldstärke auf eine Strommessung (oder z.B. auf den Spannungsabfall an einem bekannten Vorwiderstand) zurückführen. Die Helmholtzspule selbst muss nicht kalibriert werden. Alternativ kann die Feldstärke auch mit Hilfe einer kleinen Feld-Sensorspule bestimmt werden.

Inbetriebnahme:

Der Aufbau der Spule erfolgt nach der Anleitung „Montageanleitung Helmholtz-Spulenpaar HHS 5230“

Die Helmholtzspule sollte in ausreichendem Abstand von möglichen Magnetfeldquellen (z.B. Transformatoren in Netzteilen von Messgeräten, stromdurchflossene Leiter, Bildschirme, Oszillografenröhren, Elektromotore, Lautsprecher uvm...) auf einem glatten tragfähigen Boden positioniert werden. Alle magnetischen Metallteile (d.h. Eisen / Stahl, Kobalt und Nickel) sollten aus der unmittelbaren Spulenumgebung entfernt werden. Die Anschlussleitungen vom Generator zur Helmholtzspule sollten verdrillt werden, um unerwünschte Einkopplungen magnetischer Flüsse zu vermeiden. Die Klemmen der Spule 1 sind mit Kennbuchstaben A und B, die Klemmen der Spule 2 mit C und D gekennzeichnet. Beim Betrieb der Spulen ist darauf zu achten, dass alle 4 Klemmen in eine Richtung zeigen, andernfalls entsteht in Spulenmitte eine Magnetfeld-Auslöschung.

Application:

The Helmholtz-Coils are especially designed to generate precisely defined magnetic fields from DC to ca. 5 kHz, e.g. according to SAE J551-17. The generated fields are in a strongly linear relation to the coil current. The field strength can be calculated exactly by analytical (or numerical) methods, based on the coils' geometry, the number of turns and the coil current. Therefore the HHS 5230-100 is ideally suited for immunity testing against magnetic fields in the automotive sector. Due to the generously dimensioned winding packets it is possible to generate magnetic fields up to approx. 800 A/m for short times. Typical applications are magnetic immunity testing to whole vehicles according to SAEJ551-17 (Vehicle Electromagnetic Immunity – Power Line Magnetic Fields). When generating magnetic fields with Helmholtz coils the coil current is directly proportional to the magnetic fieldstrength.

The calibration of the magnetic field is finally traceable to a current measurement (or to a voltage drop across a known resistor). The Helmholtz Coil itself does not require a calibration. Alternatively a small loop sensor can be used to determine the actual field strength.

Installation:

The setup of the coils is described in the following part of the manual: “Assembly Instructions for Helmholtz Coil Pair HHS 5230”

The Helmholtz-Coils should be installed on the floor in a sufficiently large seperation from sources of unintentional magnetic fields, e.g. transformers in power supplies, conductors carrying high currents, computer monitors, loudspeakers, cathode ray tubes (CRT) and more.... All kind of magnetic material (e.g. steel, Nickel, Cobalt) should be removed from the near surrounding of the coil. The wires which are used to connect the current source with the Helmholtz-Coil should be twisted to avoid an unwanted injection of magnetic flux.

The coil terminals are assigned with the characters A, B, C and D.

During operation of the coils the terminals must show in one direction. Otherwise there will be a deletion of the magnetic field in the middle between the coils.

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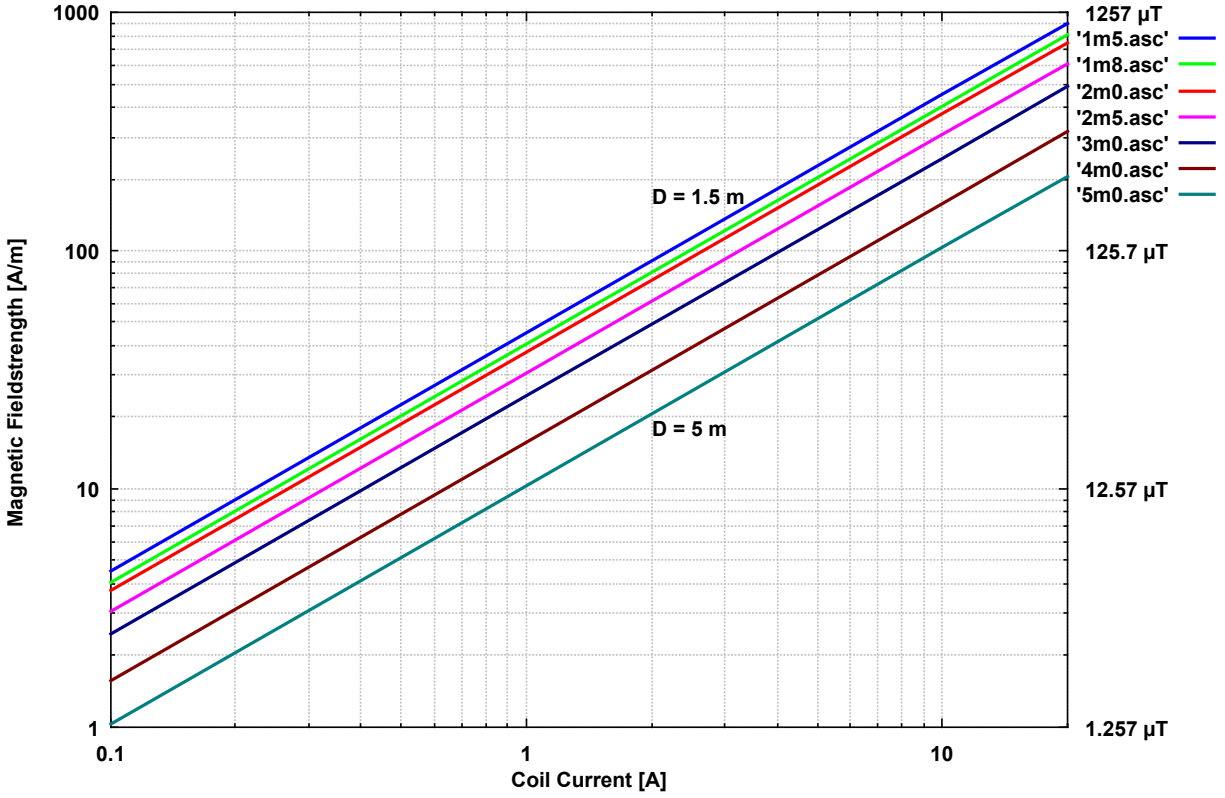
Helmholtz Coil Pair HHS 5230-100

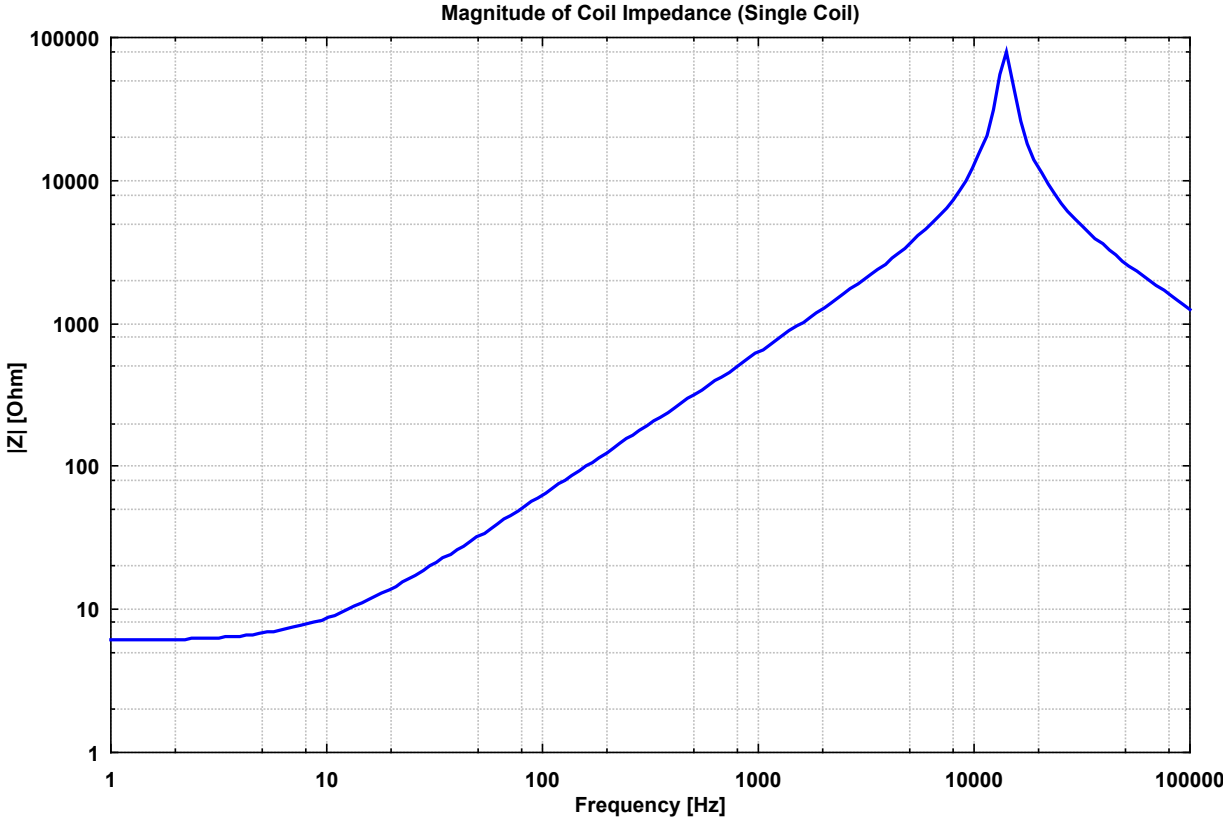
Magnetische Feldstärke und Spulenstrom

Magnetic Fieldstrength at different Coil Spacings D



Betrag der Impedanz (Einzelspule)

Magnitude of Coil Impedance (Single Coil)



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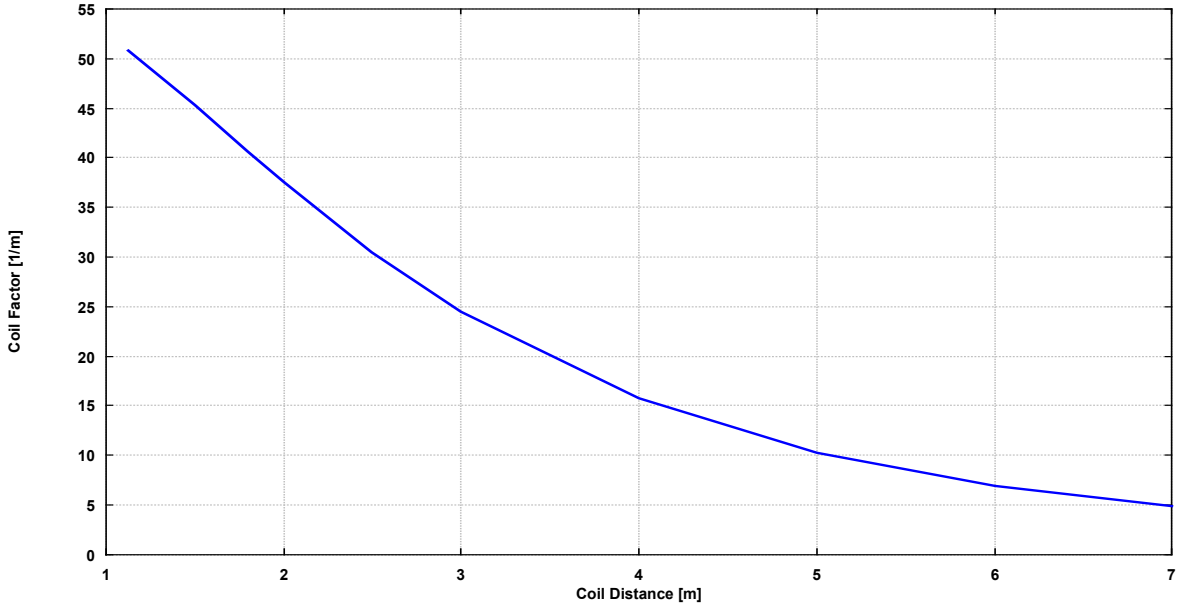
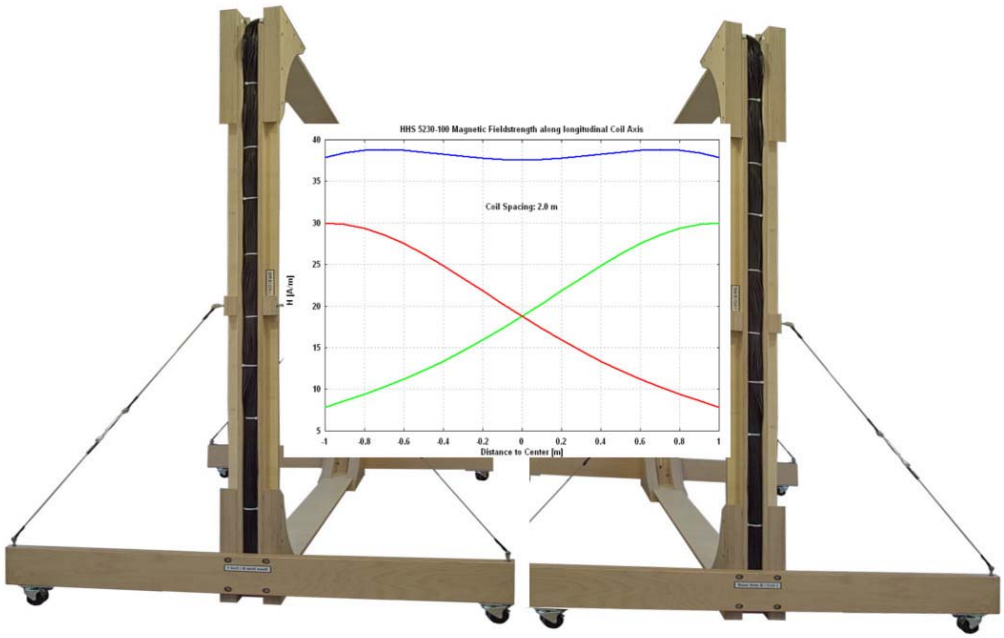
Coil factors for different coil separations:

Coil Separation [m]	Coil Factor[1] [1/m]	Coil Factor[1] [dB 1/m]
1.13	50.79	34.1
1.5	45.27	33.1
1.8	40.63	32.2
2.0	37.59	31.5
2.5	30.52	29.7
3.0	24.50	27.8
4.0	15.72	23.9
5.0	10.28	20.2
6.0	6.93	16.8
7.0	4.83	13.7

[1] The magnetic field strength is measured in the middle between the Helmholtz coils.





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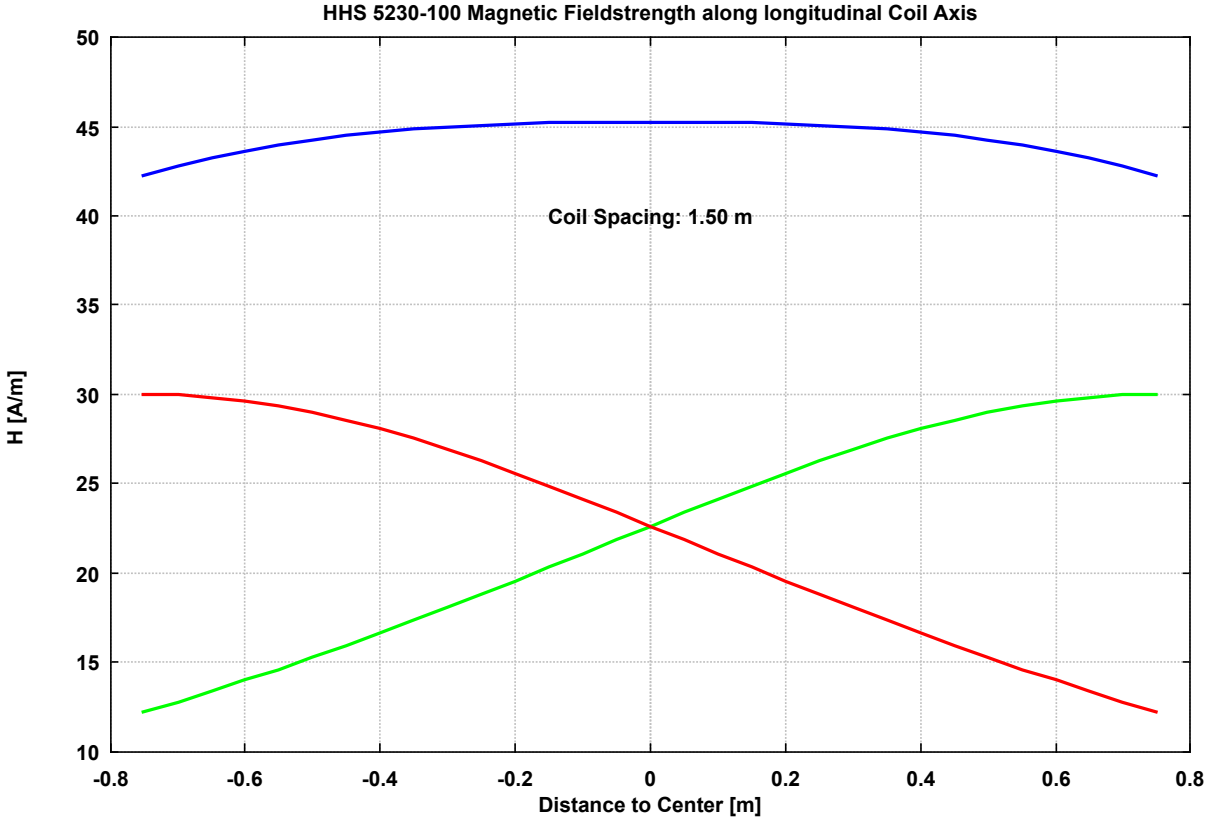
Helmholtz Coil Pair HHS 5230-100



Längskomponente der magnetischen Feldstärke entlang der Spulenlängsachse ***Magnet. Fieldstrength, longitudinal component along rotational axis***						
Distance to Center	H1 A/m	H2 A/m	**Htot A/m**	H1 dBµA/m	H2 dBµA/m	**Htot dBµA/m**
0.00	22.6354	22.6354	**45.2707**	147.10	147.10	**153.12**
0.05	23.4025	21.8617	**45.2641**	147.39	146.79	**153.12**
0.10	24.1575	21.0863	**45.2439**	147.66	146.48	**153.11**
0.15	24.8945	20.3139	**45.2085**	147.92	146.16	**153.10**
0.20	25.6073	19.5483	**45.1556**	148.17	145.82	**153.09**
0.25	26.2891	18.7931	**45.0822**	148.40	145.48	**153.08**
0.30	26.9333	18.0511	**44.9843**	148.61	145.13	**153.06**
0.35	27.5329	17.3248	**44.8577**	148.80	144.77	**153.04**
0.40	28.0813	16.6163	**44.6977**	148.97	144.41	**153.01**
0.45	28.5720	15.9273	**44.4993**	149.12	144.04	**152.97**
0.50	28.9988	15.2590	**44.2578**	149.25	143.67	**152.92**
0.55	29.3562	14.6124	**43.9685**	149.35	143.29	**152.86**
0.60	29.6394	13.9880	**43.6274**	149.44	142.92	**152.80**
0.65	29.8446	13.3864	**43.2310**	149.50	142.53	**152.72**
0.70	29.9689	12.8077	**42.7766**	149.53	142.15	**152.62**
0.75	30.0105	12.2517	**42.2623**	149.55	141.76	**152.52**
Spulenstrom: 1 A, Spulenabstand: 1.5 m *Coil Current: 1 A, Coil Separation: 1.5 m*						

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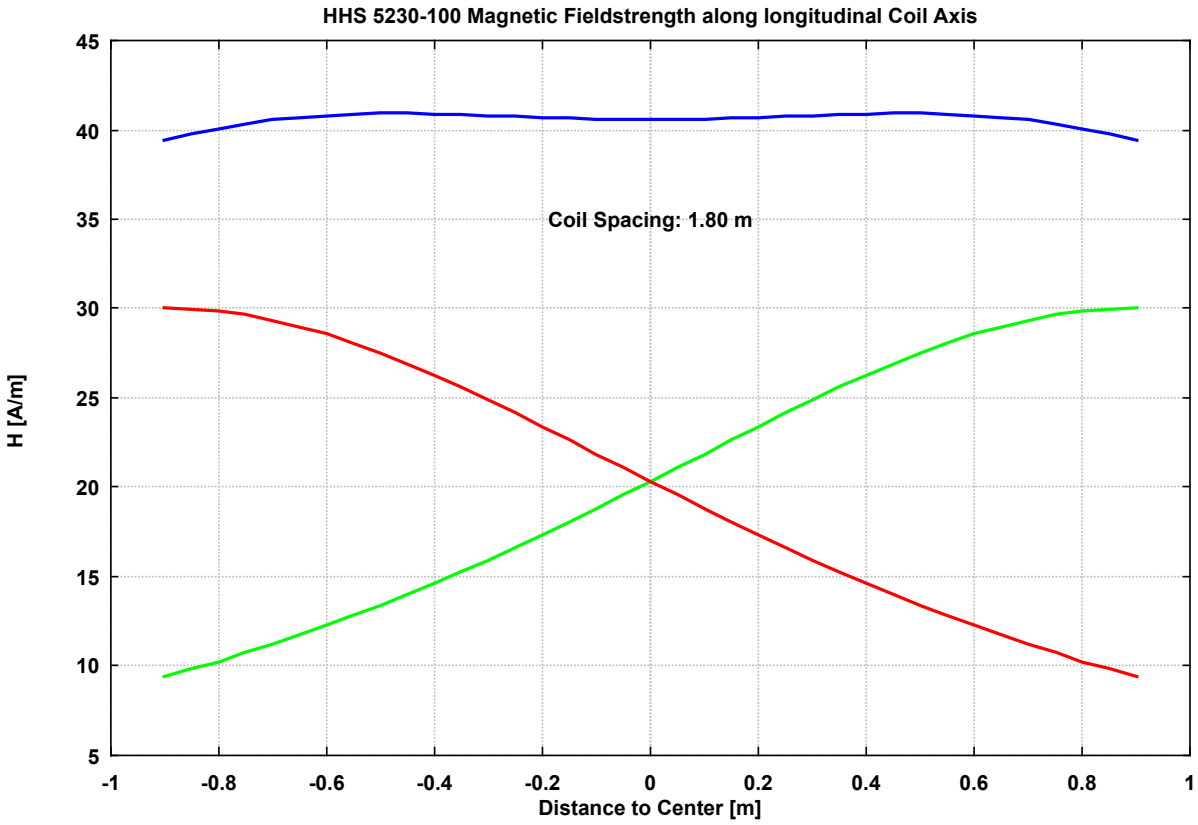

Längskomponente der magnetischen Feldstärke entlang der Spulenlängsachse ***Magnet. Fieldstrength, longitudinal component along rotational axis***						
Distance to Center	H1 A/m	H2 A/m	**Htot A/m**	H1 dBµA/m	H2 dBµA/m	**Htot dBµA/m**
0.00	20.3139	20.3139	**40.6278**	146.16	146.16	**152.18**
0.05	21.0864	19.5483	**40.6347**	146.48	145.82	**152.18**
0.10	21.8617	18.7931	**40.6547**	146.79	145.48	**152.18**
0.15	22.6354	18.0511	**40.6864**	147.10	145.13	**152.19**
0.20	23.4025	17.3248	**40.7273**	147.39	144.77	**152.20**
0.25	24.1575	16.6163	**40.7738**	147.66	144.41	**152.21**
0.30	24.8945	15.9273	**40.8219**	147.92	144.04	**152.22**
0.35	25.6073	15.2590	**40.8663**	148.17	143.67	**152.23**
0.40	26.2891	14.6124	**40.9015**	148.40	143.29	**152.23**
0.45	26.9333	13.9880	**40.9213**	148.61	142.92	**152.24**
0.50	27.5329	13.3864	**40.9193**	148.80	142.53	**152.24**
0.55	28.0813	12.8077	**40.8890**	148.97	142.15	**152.23**
0.60	28.5720	12.2517	**40.8237**	149.12	141.76	**152.22**
0.65	28.9988	11.7185	**40.7173**	149.25	141.38	**152.20**
0.70	29.3562	11.2077	**40.5638**	149.35	140.99	**152.16**
0.75	29.6394	10.7187	**40.3581**	149.44	140.60	**152.12**
0.80	29.8446	10.2513	**40.0959**	149.50	140.22	**152.06**
0.85	29.9689	9.8046	**39.7735**	149.53	139.83	**151.99**
0.90	30.0105	9.3782	**39.3887**	149.55	139.44	**151.91**
Spulenstrom: 1 A, Spulenabstand: 1.8 m *Coil Current: 1 A, Coil Separation: 1.8 m*						

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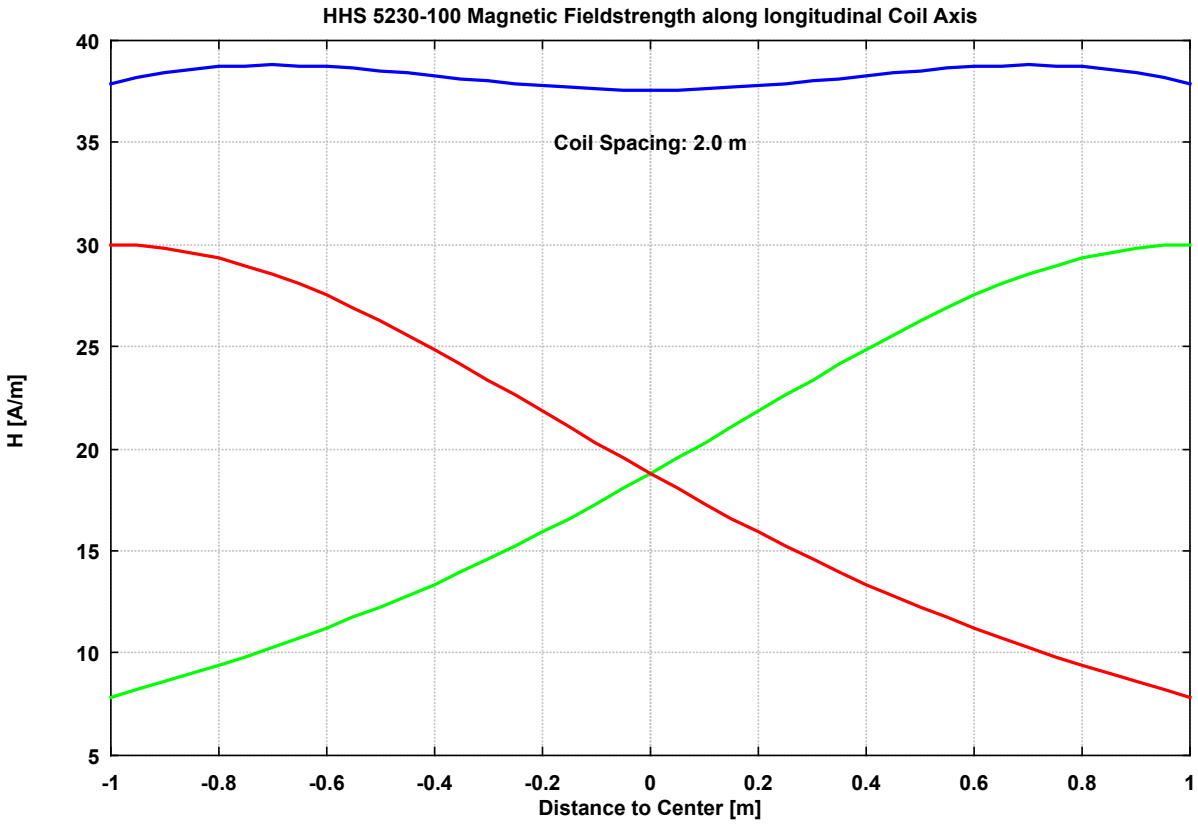

Längskomponente der magnetischen Feldstärke entlang der Spulenlängsachse *Magnet. Fieldstrength, longitudinal component along rotational axis*						
Distance to Center	H1 A/m	H2 A/m	**Htot A/m**	H1 dBµA/m	H2 dBµA/m	**Htot dBµA/m**
0.00	18.7931	18.7931	**37.5861**	145.48	145.48	**151.50**
0.05	19.5483	18.0511	**37.5994**	145.82	145.13	**151.50**
0.10	20.3139	17.3248	**37.6387**	146.16	144.77	**151.51**
0.15	21.0864	16.6163	**37.7027**	146.48	144.41	**151.53**
0.20	21.8617	15.9273	**37.7890**	146.79	144.04	**151.55**
0.25	22.6354	15.2590	**37.8944**	147.10	143.67	**151.57**
0.30	23.4025	14.6124	**38.0149**	147.39	143.29	**151.60**
0.35	24.1575	13.9880	**38.1455**	147.66	142.92	**151.63**
0.40	24.8945	13.3864	**38.2809**	147.92	142.53	**151.66**
0.45	25.6073	12.8077	**38.4149**	148.17	142.15	**151.69**
0.50	26.2891	12.2517	**38.5409**	148.40	141.76	**151.72**
0.55	26.9333	11.7185	**38.6518**	148.61	141.38	**151.74**
0.60	27.5329	11.2077	**38.7406**	148.80	140.99	**151.76**
0.65	28.0813	10.7187	**38.8001**	148.97	140.60	**151.78**
0.70	28.5720	10.2513	**38.8232**	149.12	140.22	**151.78**
0.75	28.9988	9.8046	**38.8034**	149.25	139.83	**151.78**
0.80	29.3562	9.3782	**38.7344**	149.35	139.44	**151.76**
0.85	29.6394	8.9713	**38.6107**	149.44	139.06	**151.73**
0.90	29.8446	8.5833	**38.4279**	149.50	138.67	**151.69**
0.95	29.9689	8.2134	**38.1823**	149.53	138.29	**151.64**
1.00	30.0105	7.8609	**37.8714**	149.55	137.91	**151.57**
Spulenstrom: 1 A, Spulenabstand: 2.0 m *Coil Current: 1 A, Coil Separation: 2.0 m*						

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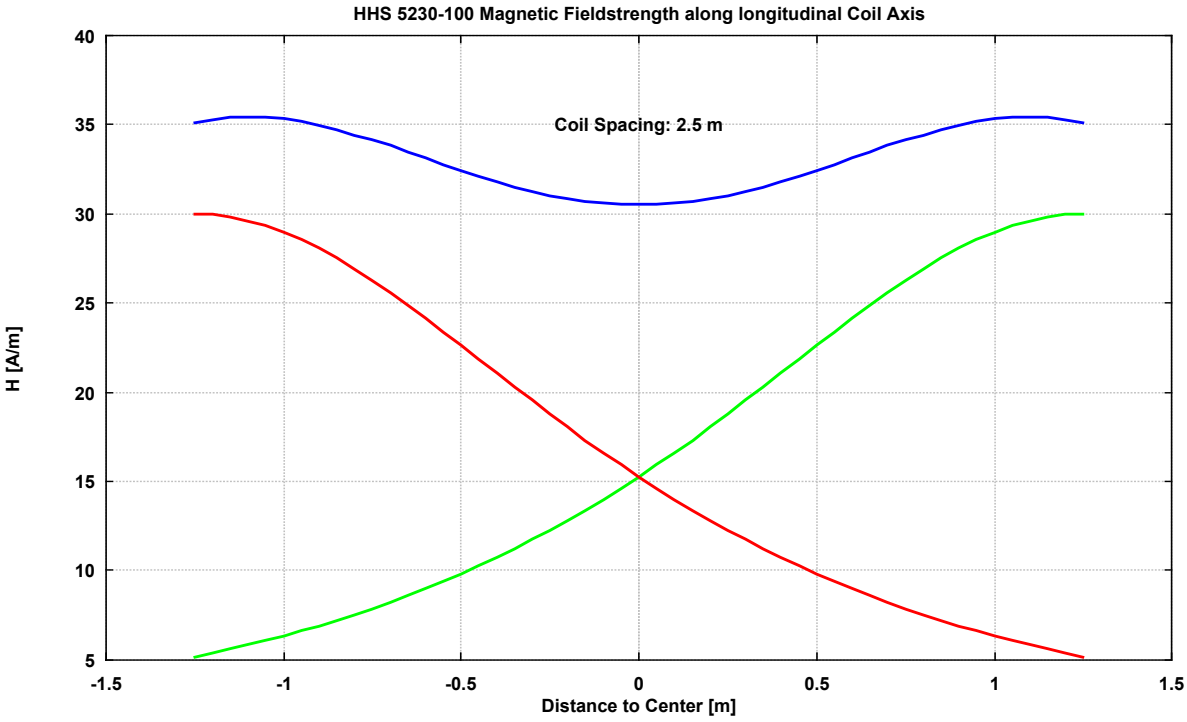

Längskomponente der magnetischen Feldstärke entlang der Spulenlängsachse *Magnet. Fieldstrength, longitudinal component along rotational axis*						
Distance to Center	H1 A/m	H2 A/m	**Htot A/m**	H1 dBµA/m	H2 dBµA/m	**Htot dBµA/m**
0.00	15.2590	15.2590	**30.5181**	143.67	143.67	**149.69**
0.05	15.9273	14.6124	**30.5397**	144.04	143.29	**149.70**
0.10	16.6163	13.9880	**30.6044**	144.41	142.92	**149.72**
0.15	17.3248	13.3864	**30.7112**	144.77	142.53	**149.75**
0.20	18.0511	12.8077	**30.8587**	145.13	142.15	**149.79**
0.25	18.7931	12.2518	**31.0448**	145.48	141.76	**149.84**
0.30	19.5483	11.7185	**31.2669**	145.82	141.38	**149.90**
0.35	20.3139	11.2077	**31.5216**	146.16	140.99	**149.97**
0.40	21.0863	10.7187	**31.8051**	146.48	140.60	**150.05**
0.45	21.8617	10.2513	**32.1129**	146.79	140.22	**150.13**
0.50	22.6354	9.8046	**32.4400**	147.10	139.83	**150.22**
0.55	23.4025	9.3782	**32.7807**	147.39	139.44	**150.31**
0.60	24.1575	8.9713	**33.1288**	147.66	139.06	**150.40**
0.65	24.8945	8.5833	**33.4778**	147.92	138.67	**150.50**
0.70	25.6073	8.2134	**33.8207**	148.17	138.29	**150.58**
0.75	26.2891	7.8609	**34.1500**	148.40	137.91	**150.67**
0.80	26.9333	7.5251	**34.4584**	148.61	137.53	**150.75**
0.85	27.5329	7.2053	**34.7382**	148.80	137.15	**150.82**
0.90	28.0813	6.9007	**34.9820**	148.97	136.78	**150.88**
0.95	28.5720	6.6106	**35.1826**	149.12	136.40	**150.93**
1.00	28.9988	6.3345	**35.3332**	149.25	136.03	**150.96**
1.05	29.3562	6.0716	**35.4277**	149.35	135.67	**150.99**
1.10	29.6394	5.8212	**35.4606**	149.44	135.30	**150.99**
1.15	29.8446	5.5829	**35.4275**	149.50	134.94	**150.99**
1.20	29.9689	5.3559	**35.3248**	149.53	134.58	**150.96**
1.25	30.0105	5.1397	**35.1503**	149.55	134.22	**150.92**
Spulenstrom: 1 A, Spulenabstand: 2.5 m *Coil Current: 1 A, Coil Separation: 2.5 m*						

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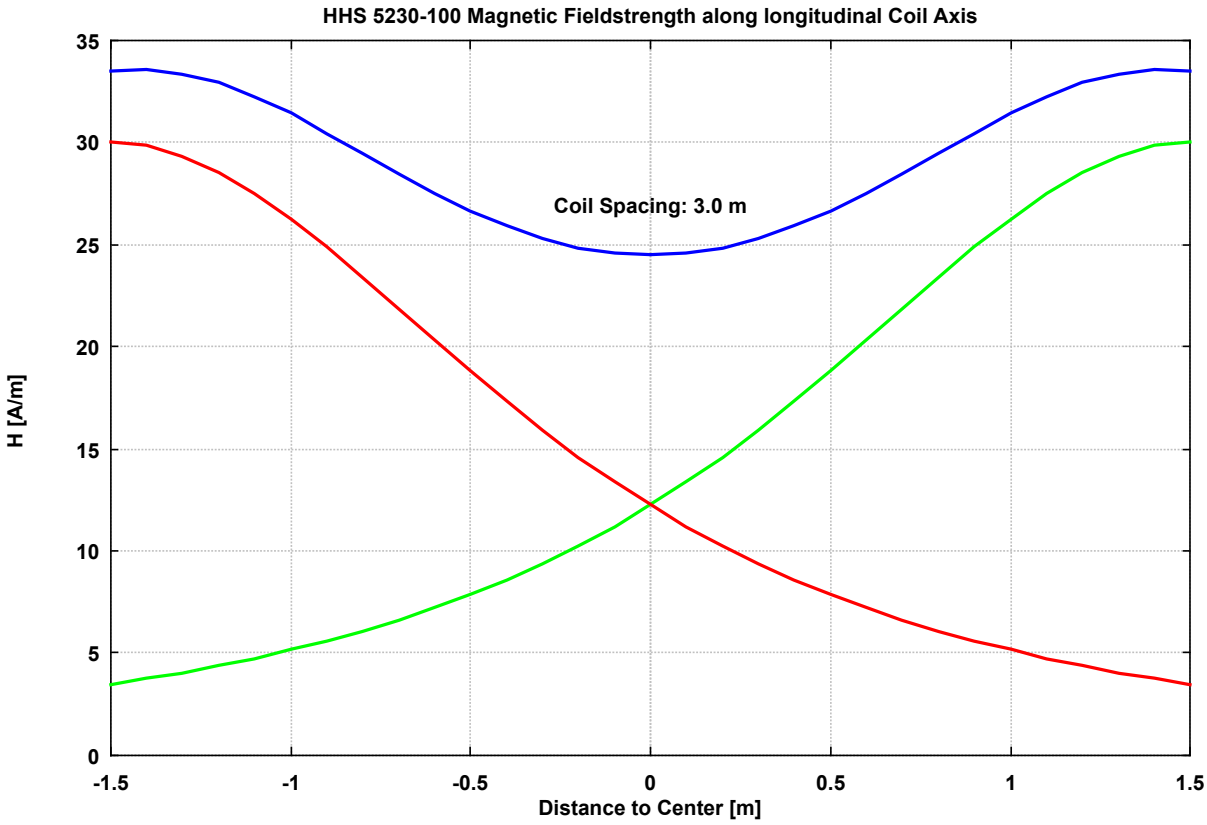

Längskomponente der magnetischen Feldstärke entlang der Spulenlängsachse *Magnet. Fieldstrength, longitudinal component along rotational axis*						
Distance to Center	H1 A/m	H2 A/m	**Htot A/m**	H1 dBµA/m	H2 dBµA/m	**Htot dBµA/m**
0.00	12.2518	12.2517	**24.5035**	141.76	141.76	**147.78**
0.10	13.3864	11.2077	**24.5941**	142.53	140.99	**147.82**
0.20	14.6124	10.2513	**24.8636**	143.29	140.22	**147.91**
0.30	15.9273	9.3782	**25.3055**	144.04	139.44	**148.06**
0.40	17.3248	8.5833	**25.9081**	144.77	138.67	**148.27**
0.50	18.7931	7.8609	**26.6540**	145.48	137.91	**148.52**
0.60	20.3139	7.2053	**27.5192**	146.16	137.15	**148.79**
0.70	21.8617	6.6106	**28.4723**	146.79	136.40	**149.09**
0.80	23.4025	6.0716	**29.4740**	147.39	135.67	**149.39**
0.90	24.8945	5.5829	**30.4774**	147.92	134.94	**149.68**
1.00	26.2891	5.1397	**31.4288**	148.40	134.22	**149.95**
1.10	27.5329	4.7377	**32.2706**	148.80	133.51	**150.18**
1.20	28.5720	4.3728	**32.9448**	149.12	132.82	**150.36**
1.30	29.3562	4.0412	**33.3974**	149.35	132.13	**150.47**
1.40	29.8446	3.7397	**33.5844**	149.50	131.46	**150.52**
1.50	30.0105	3.4653	**33.4759**	149.55	130.79	**150.49**
Spulenstrom: 1 A, Spulenabstand: 3.0 m *Coil Current: 1 A, Coil Separation: 3.0 m*						

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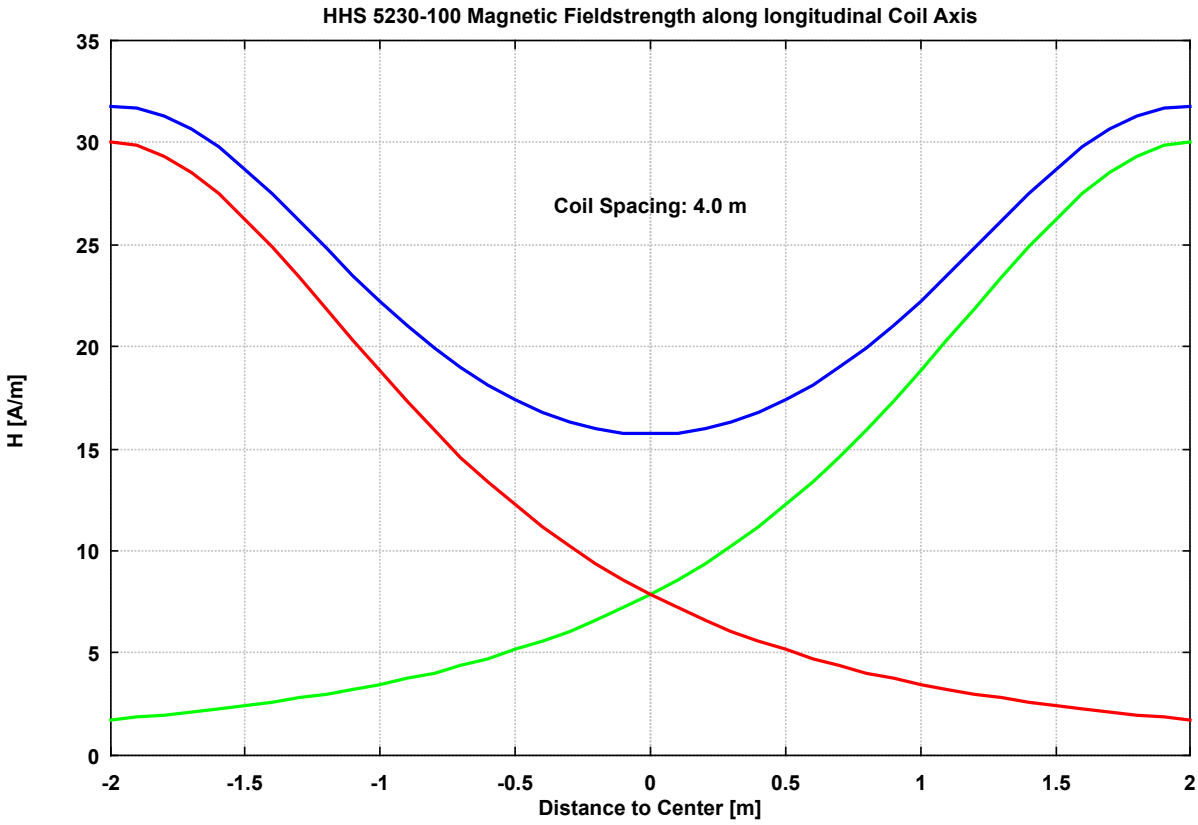
Helmholtz-Spulenpaar HHS 5230-100

Helmholtz Coil Pair HHS 5230-100



Längskomponente der magnetischen Feldstärke entlang der Spulenlängsachse *Magnet. Fieldstrength, longitudinal component along rotational axis*						
Distance to Center	H1 A/m	H2 A/m	**Htot A/m**	H1 dBµA/m	H2 dBµA/m	**Htot dBµA/m**
0.00	7.8609	7.8609	**15.7218**	137.91	137.91	**143.93**
0.10	8.5833	7.2053	**15.7886**	138.67	137.15	**143.97**
0.20	9.3782	6.6106	**15.9888**	139.44	136.40	**144.08**
0.30	10.2513	6.0716	**16.3228**	140.22	135.67	**144.26**
0.40	11.2077	5.5829	**16.7905**	140.99	134.94	**144.50**
0.50	12.2518	5.1397	**17.3915**	141.76	134.22	**144.81**
0.60	13.3864	4.7377	**18.1241**	142.53	133.51	**145.17**
0.70	14.6124	4.3728	**18.9852**	143.29	132.82	**145.57**
0.80	15.9273	4.0412	**19.9686**	144.04	132.13	**146.01**
0.90	17.3248	3.7397	**21.0646**	144.77	131.46	**146.47**
1.00	18.7931	3.4653	**22.2584**	145.48	130.79	**146.95**
1.10	20.3139	3.2152	**23.5292**	146.16	130.14	**147.43**
1.20	21.8617	2.9871	**24.8488**	146.79	129.51	**147.91**
1.30	23.4025	2.7787	**26.1812**	147.39	128.88	**148.36**
1.40	24.8945	2.5882	**27.4827**	147.92	128.26	**148.78**
1.50	26.2891	2.4137	**28.7028**	148.40	127.65	**149.16**
1.60	27.5329	2.2538	**29.7867**	148.80	127.06	**149.48**
1.70	28.5720	2.1070	**30.6790**	149.12	126.47	**149.74**
1.80	29.3562	1.9720	**31.3282**	149.35	125.90	**149.92**
1.90	29.8446	1.8479	**31.6925**	149.50	125.33	**150.02**
2.00	30.0105	1.7335	**31.7440**	149.55	124.78	**150.03**
Spulenstrom: 1 A, Spulenabstand: 4.0 m *Coil Current: 1 A, Coil Separation: 4.0 m*						

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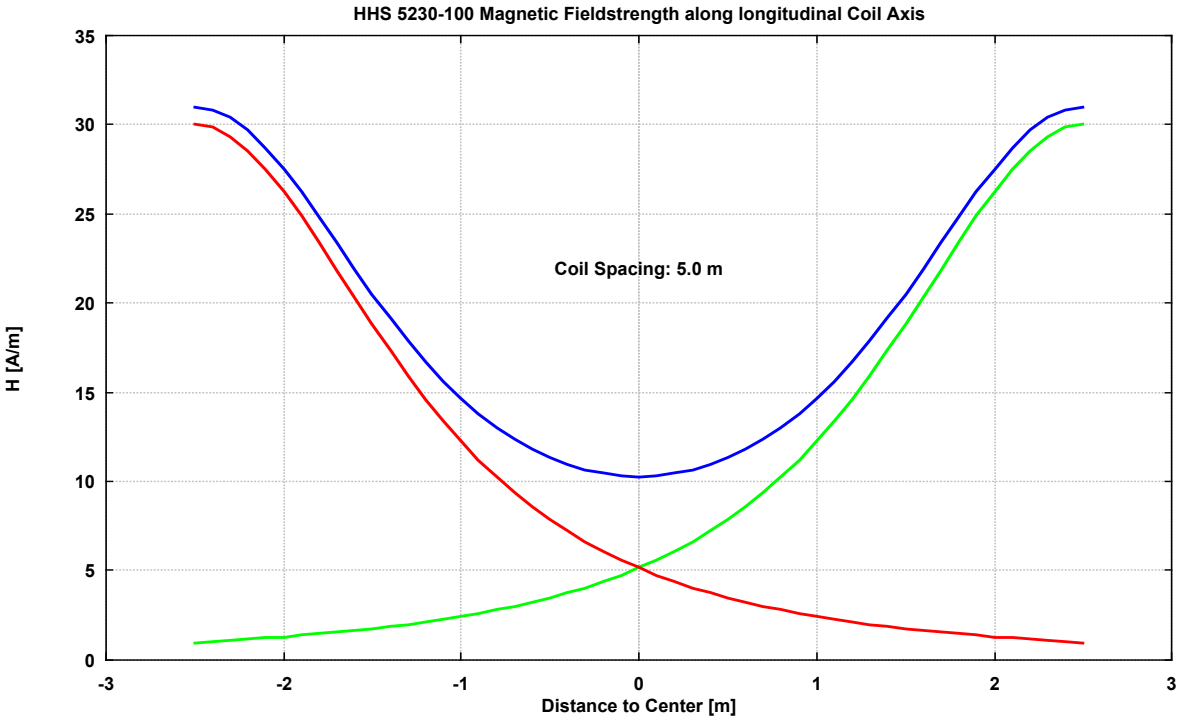

Längskomponente der magnetischen Feldstärke entlang der Spulenlängsachse *Magnet. Fieldstrength, longitudinal component along rotational axis*						
Distance to Center	H1 A/m	H2 A/m	**Htot A/m**	H1 dBµA/m	H2 dBµA/m	**Htot dBµA/m**
0.00	5.1397	5.1397	**10.2794**	134.22	134.22	**140.24**
0.10	5.5829	4.7377	**10.3206**	134.94	133.51	**140.27**
0.20	6.0716	4.3728	**10.4443**	135.67	132.82	**140.38**
0.30	6.6106	4.0412	**10.6519**	136.40	132.13	**140.55**
0.40	7.2053	3.7397	**10.9450**	137.15	131.46	**140.78**
0.50	7.8609	3.4653	**11.3262**	137.91	130.79	**141.08**
0.60	8.5833	3.2152	**11.7985**	138.67	130.14	**141.44**
0.70	9.3782	2.9871	**12.3653**	139.44	129.51	**141.84**
0.80	10.2513	2.7787	**13.0300**	140.22	128.88	**142.30**
0.90	11.2077	2.5882	**13.7959**	140.99	128.26	**142.79**
1.00	12.2517	2.4137	**14.6655**	141.76	127.65	**143.33**
1.10	13.3864	2.2538	**15.6402**	142.53	127.06	**143.88**
1.20	14.6124	2.1070	**16.7193**	143.29	126.47	**144.46**
1.30	15.9273	1.9720	**17.8994**	144.04	125.90	**145.06**
1.40	17.3248	1.8479	**19.1727**	144.77	125.33	**145.65**
1.50	18.7931	1.7335	**20.5266**	145.48	124.78	**146.25**
1.60	20.3139	1.6280	**21.9419**	146.16	124.23	**146.83**
1.70	21.8617	1.5305	**23.3922**	146.79	123.70	**147.38**
1.80	23.4025	1.4404	**24.8429**	147.39	123.17	**147.90**
1.90	24.8945	1.3570	**26.2515**	147.92	122.65	**148.38**
2.00	26.2891	1.2797	**27.5688**	148.40	122.14	**148.81**
2.10	27.5329	1.2079	**28.7408**	148.80	121.64	**149.17**
2.20	28.5720	1.1413	**29.7132**	149.12	121.15	**149.46**
2.30	29.3561	1.0793	**30.4354**	149.35	120.66	**149.67**
2.40	29.8446	1.0216	**30.8662**	149.50	120.19	**149.79**
2.50	30.0105	0.9678	**30.9783**	149.55	119.72	**149.82**
Spulenstrom: 1 A, Spulenabstand: 5.0 m *Coil Current: 1 A, Coil Separation: 5.0 m*						