EN 61000-4-39:2017
Transmit and Sense Coils
User Manual

Revision History

Issue:	Modification	Date:	Modified By:
1.0	First Issue	21/01/22	N/A
1.1	Added 65A/m guidance	20/06/22	PG

Safety Precautions

Indicates a caution

The low frequency transmit coil (9kHz – 150 kHz) is rated to approximately 15A. Currents in excess of this will cause a significant heating effect on the coil and should be avoided.

The product should be cleaned with a damp cloth. Avoid cleaning solvents as these could damage the polyester enamel of the main transmit windings.

ICNRPB Guidelines for protection of workers and general public should be followed for exposure to magnetic fields when using this equipment. Hold the coil using the supplied handle and avoid exposure to the head and torso during use.

The transmit Coils are single layer enamel insulated and are not suitable for high voltage applications.

Contents

Contact Details

In the event of an equipment failure, need for repair or any other general enquiry please use the following contact details:

The Conformity Assessment Business

4 Dorcan Business Village Murdock Road, Dorcan, Swindon, England, SN3 5HY

info@conformity-assessment.com

+ 44 (0) 1704 821376

+ 44 (0) 7943 405145

Waste Electrical Equipment (WEE)

The Conformity Assessment Business undertake to accept this equipment at its end of life for recycling.

Introduction

The Conformity Assessment Business EN61000-4-39:2017 test set consists of two transmit coils, and two complimentary electrostatically shielded sensor coils designed as per section 6.1 of the standard. These cover the frequency ranges 9 kHz - 150 kHz and 150 kHz - 26 MHz.

For the high frequency transmit coil, an additional coupling network is supplied to enable the 7.5 A/m test level of EN60601-1-2 to be met. This should be connected in-line at the transmit probe head end.

The low frequency transmit coil is designed to be driven by a low output impedance amplifier capable of delivering the required drive current. The high frequency transmit coil and matching network is designed to be driven by a 50 Ohm RF amplifier, maximum 30W input to achieve the required 7.5A/m when using the supplied matching network.

Specification

Low Frequency Transmit Coil (CAB4-3912)

Frequency: 9 KHz to 150 kHz

Main Diameter: 120 mm

Maximum Current: 15 A

Number of turns: 20

Wire Diameter: 2.1 mm

Connection Type: Banana 4mm

High Frequency Transmit Coil (CAB4-3910)

Frequency: 150 kHz to 26 MHz

Main Diameter: 100 mm

Number of Turns: 3

Wire Diameter: 1mm

Connection type: ‘N’ type Coaxial

Low Frequency Sense Coil (CABLSLF)

Frequency: 9 KHz to 150 kHz

Diameter to centre of the coil: 40 mm

Number of turns: 51

Wire type: 7/41 LITZ

Winding Type: Electrostatically shielded

High Frequency Sense Coil (CABLSHF)

Frequency: 150 KHz to 26 MHz

Diameter to centre of the coil: 41 mm

Number of turns: 1

Wire type: 0.5 mm single core

Winding Type: Electrostatically shielded

Level Setting

The sensor coils are designed to be inset into the transmit guide plates for the purpose of level setting. The sense coils should be connected to an oscilloscope using a suitable BNC coaxial cable. The oscilloscope should be set to 1 MΩ input impedance (do not use 50 Ω input setting when using the formula given below).

For level setting at 13.56 MHz with the high frequency transmit coil, the matching network must be used. This should be connected at the probe end of the cable and not the amplifier end.

During testing, the retaining nuts and sensor coils should be removed from the guide plates.

It is recommended that the sensor coils are calibrated before use and the calibration factors provided are used to establish the field level. However, the following formula can be used to establish the field strength in Tesla for each of the sensor coils, coil construction can affect the overall conversion factor and these formula and conversion factors are provided for information only:

$$B(T) = \frac{e_i}{2\pi NAf}$$

Where:

B = Flux Density in Tesla
e_i = Induced open circuit voltage
N = Number of turns in the coil
A = Area of the coil in m^2
f = Frequency (Hz)

For the low frequency sense coil (40 mm diameter), this formula can be shortened as follows:

$$B(T) = \frac{e_i}{2\ x\ \pi\ x\ 51\ x\ \pi\ x\ 0.02^2\ x\ f} = \frac{e_i}{0.403f}$$

As an example:

Using the above formula, for testing to the medical standard with a frequency of 134.2 kHz and a Limit of 65 A/m this would be:

$$81.9\ uT\ (81.9\ x\ 10^{-6}) = \frac{e_i}{0.403\ x\ 134.2\ kHz}$$

$$\mathbf{81.9\ uT\ x\ 0.403\ x\ 134200} = \textit{4.43 V (rms) measured on the oscilloscope}$$

For the high frequency sense coil (41 mm diameter), this formula can be shortened as follows:

$$B(T) = \frac{e_i}{2\ x\ \pi\ x\ 1\ x\ \pi\ x\ 0.0205^2\ x\ f} = \frac{e_i}{0.00829f}$$

As an example:

Using the above formula, for testing to the medical standard with a frequency of 13.56MHz and a Limit of 7.5 A/m this would be:

$$9\ uT\ (9\ x\ 10^{-6}) = \frac{e_i}{0.00829\ x\ 13.56\ MHz}$$

$$\mathbf{9\ uT\ x\ 0.00829\ x\ 13560000 =}\ \textit{1.01V (rms) measured on the oscilloscope}$$

Note:

Taking into account loop inductance, resistance and a load impedance of 1 MΩ, the theoretical **conversion factor is 8.9 pT per microvolt** measured on the oscilloscope for the high frequency sense probe at 13.56MHz

Conversion from Tesla to A/m is as follows:

1 A/m = 1.26 μT

APPENDIX A – Probe Conversion Factors

Note: The sensor probes should be calibrated to establish an exact set of correction factors. The tables below give correction factors for the High Frequency and low frequency sensor based on theoretical calculation. Probe construction and design can affect these factors and therefore these factors should be used for guidance only.

Conversion Table For 150 kHz to 30 MHz sensor probe

The following conversion table accounts for a probe winding resistance of 0.05 Ω and 97.7nH inductance to give the following correction factor in pT / μV and dB(pT/μV). These correction factors are valid for measurements into an oscilloscope set to 1 MΩ Input and using an RMS measurement.

Frequency (Hz)	Correction (pT per μV)	Correction dB(pT per μV)
150000.00	804.18	58.11
200000.00	603.14	55.61
300000.00	402.09	52.09
400000.00	301.57	49.59
500000.00	241.25	47.65
600000.00	201.05	46.07
700000.00	172.32	44.73
800000.00	150.78	43.57
900000.00	134.03	42.54
1000000.00	120.63	41.63
2000000.00	60.31	35.61
3000000.00	40.21	32.09
4000000.00	30.16	29.59
5000000.00	24.13	27.65
6000000.00	20.10	26.07
7000000.00	17.23	24.73
8000000.00	15.08	23.57
9000000.00	13.40	22.54
10000000.00	12.06	21.63
12000000.00	10.05	20.05
13560000.00	8.90	18.98
16000000.00	7.54	17.55
18000000.00	6.70	16.52
20000000.00	6.03	15.61
25000000.00	4.83	13.67

Conversion Table For 9kHz to 150kHz sensor probe

The following conversion table accounts for a probe winding resistance of 4.05 Ω and 105 μH inductance to give the following correction factor in pT / μV and dB(pT/μV). These correction factors are valid for measurements into an oscilloscope set to 1 MΩ Input and using an RMS measurement.

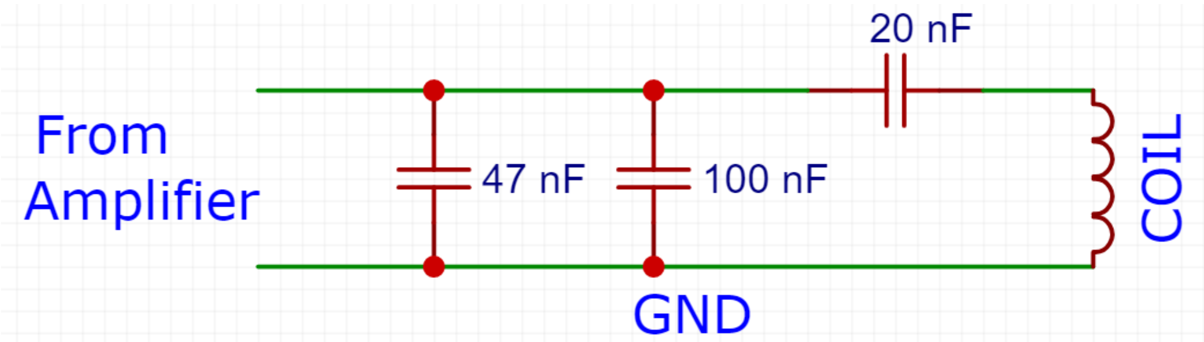
Frequency (Hz)	Correction (pT per μV)	Correction dB(pT per μV)
9000	277.60	48.87
10000	249.84	47.95
11000	227.14	47.13
12000	208.21	46.37
13000	192.20	45.68
14000	178.48	45.03
15000	166.59	44.43
16000	156.18	43.87
17000	147.00	43.35
18000	138.84	42.85
19000	131.54	42.38
20000	124.97	41.94
21000	119.02	41.51
22000	113.62	41.11
23000	108.68	40.72
24000	104.16	40.35
25000	100.00	40.00
26000	96.16	39.66
27000	92.60	39.33
28000	89.30	39.02
29000	86.23	38.71
30000	83.36	38.42
31000	80.68	38.14
32000	78.16	37.86
33000	75.80	37.59
34000	73.58	37.33
35000	71.48	37.08
36000	69.50	36.84
37000	67.63	36.60
38000	65.85	36.37
39000	64.17	36.15
40000	62.57	35.93
41000	61.05	35.71
42000	59.61	35.51
43000	58.23	35.30
44000	56.91	35.10
45000	55.65	34.91
46000	54.45	34.72
47000	53.29	34.53
48000	52.19	34.35
49000	51.13	34.17
50000	50.11	34.00
51000	49.14	33.83
52000	48.20	33.66
53000	47.29	33.50
54000	46.42	33.33
55000	45.59	33.18
56000	44.78	33.02
57000	44.00	32.87
58000	43.25	32.72
59000	42.52	32.57
60000	41.82	32.43
61000	41.14	32.28
62000	40.48	32.14
63000	39.84	32.01
64000	39.23	31.87
65000	38.63	31.74
66000	38.05	31.61
67000	37.49	31.48
68000	36.94	31.35
69000	36.41	31.22
70000	35.90	31.10
71000	35.40	30.98
72000	34.91	30.86
73000	34.44	30.74
74000	33.98	30.62

Frequency (Hz)	Correction (pT per µV)	Correction dB(pT per µV)
75000	33.53	30.51
76000	33.10	30.40
77000	32.67	30.28
78000	32.26	30.17
79000	31.86	30.06
80000	31.47	29.96
81000	31.08	29.85
82000	30.71	29.75
83000	30.35	29.64
84000	29.99	29.54
85000	29.64	29.44
86000	29.31	29.34
87000	28.98	29.24
88000	28.65	29.14
89000	28.34	29.05
90000	28.03	28.95
91000	27.73	28.86
92000	27.43	28.76
93000	27.14	28.67
94000	26.86	28.58
95000	26.58	28.49
96000	26.31	28.40
97000	26.05	28.31
98000	25.79	28.23
99000	25.53	28.14
100000	25.28	28.06
101000	25.04	27.97
102000	24.80	27.89
103000	24.56	27.81
104000	24.33	27.72
105000	24.11	27.64
106000	23.89	27.56
107000	23.67	27.48
108000	23.45	27.40
109000	23.25	27.33
110000	23.04	27.25
111000	22.84	27.17
112000	22.64	27.10
113000	22.45	27.02
114000	22.26	26.95
115000	22.07	26.88
116000	21.88	26.80
117000	21.70	26.73
118000	21.52	26.66
119000	21.35	26.59
120000	21.18	26.52
121000	21.01	26.45
122000	20.84	26.38
123000	20.68	26.31
124000	20.52	26.24
125000	20.36	26.18
126000	20.20	26.11
127000	20.05	26.04
128000	19.90	25.98
129000	19.75	25.91
130000	19.61	25.85
131000	19.46	25.78
132000	19.32	25.72
133000	19.18	25.66
134000	19.04	25.60
135000	18.91	25.53
136000	18.78	25.47
137000	18.65	25.41
138000	18.52	25.35
139000	18.39	25.29
140000	18.26	25.23
141000	18.14	25.17
142000	18.02	25.11
143000	17.90	25.06
144000	17.78	25.00
145000	17.66	24.94
146000	17.55	24.88
147000	17.44	24.83
148000	17.32	24.77
149000	17.21	24.72
150000	17.10	24.66

APPENDIX B – 65A/m Medical Test Level

This information is provided for guidance only.

For testing to EN60601-1-2 at 134 kHz it is difficult to achieve the required field strength without some specific tuning of the transmit coil. The following components serve to match the amplifier to the coil and provide a good resonance at 134.2 kHz. This allows the test level to be achieved using a standard 50Ω RF amplifier rated at 75-100W:



Components should be suitably rated for applied voltage and preferably ceramic.