Induction Magnetometer LEMI-118

User Manual

S/N 006, 010, 012, 013, 014, 015

LVIV

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Contents

1. Introduction

Induction coil magnetometer LEMI-118 is intended for the study of the magnetic field fluctuation in the frequency band 1 – 70000 Hz in field environment. It can be used both as a part of magnetic measuring system and autonomously with any analogue or digital registration unit.

2. Main Technical Parameters

Frequency band of received signals	1 – 70000 Hz
Shape of transfer function	linear – flat
Transfer function corner frequency	20 Hz
Transformation factor[1] at differential output (pins A and G) at linear part[2] (1 – 20 Hz) at flat part[3] (20 – 70000 Hz)	 f ·mV/(nT·Hz) 20 mV/nT
Transformation factor error : at flat part of band pass without edges at full band pass edges and corner frequencies	 ≤ ±0.3 dB ≤ 3 dB
Magnetic noise level, $pT \cdot Hz^{-1/2}$: at 1 Hz at 10 Hz at 10 kHz at 100 kHz	 ≤ 5 ≤ 0.2 ≤ 0.005 ≤ 0.01
Recommended length of connecting cable	≤ 20 m
Recommended output load	C≤ 0.001 mkF R≥ 10 kOhm
Power supply voltage	± (6…12) V
Maximum output voltage	± 2.5 V
Current consumption	± 15 mA
Physical dimensions	l = 850 mm d = 46 mm
Mass	≤ 1.7 kg

Notes:

[1] The experimentally derived transfer function values are given in Appendix A.

[2] For frequency band between1 and 20 Hz, transformation factor depends on the frequency **f** of the measured signal.

[3] For frequency band between 20 and 70000 Hz, transformation factor remainsthe same for the measured signal within this frequency band.

3. Delivery Set

The magnetometer delivery set includes:

№	Item	Quantity
1	Induction Magnetometer LEMI-118	6
2	Connector MS3116 Cable Mount Straight Plugs 12-8P Insert Combo	6
3	Technical Description and Operation Manual	1

4. Service and warranty

4.1. The term of warranty is 18 months after delivery if all requirements of the present instruction such as applied voltage, weather conditions, vibrations and shocks are observed. During this term the manufacturer is liable to repair any defects that may occur through no fault of the consumer or force majeure, or in the case when repair is not possible, to change the device by other equivalent specimen.

4.2. The manufacturer accepts to make free service and repair of the magnetometer if necessary for still two years after guarantee termination. However, the user must cover the cost of all necessary spare parts and transportation/visit fees.

4.3. The repair time at the manufacturer must be no longer than 45 working days.

Delivery date: 10.12.2010

V. Pronenko

Signature

All questions as to the magnetometer structure and operation have to be addressed to the designer: pron@isr.lviv.ua.

5. Structure and Operation

5.1. The induction coil magnetometer LEMI-118 (further – IM) consists of induction coil sensor and electronic unit both of which are located inside common protective housing. The front panel of IM has a MS3112E12-8S connector for cable coupling.

5.2. The sensor part consists of the magnetic core, the main winding W2 and the magnetic feedback winding W1 (Fig.1). The magnetic core is made of a number of μ-metal tapes, which are insulated one from another and installed inside the protective tube on which both windings are made. A set of electrostatic screens are installed to reduce the interference to a negligible minimum value.

5.3. The electronic unit consists of two circuit boards which are fixed to the internal part of the magnetometer front panel. A simplified functional diagram of the unit is presented in Fig. 1.

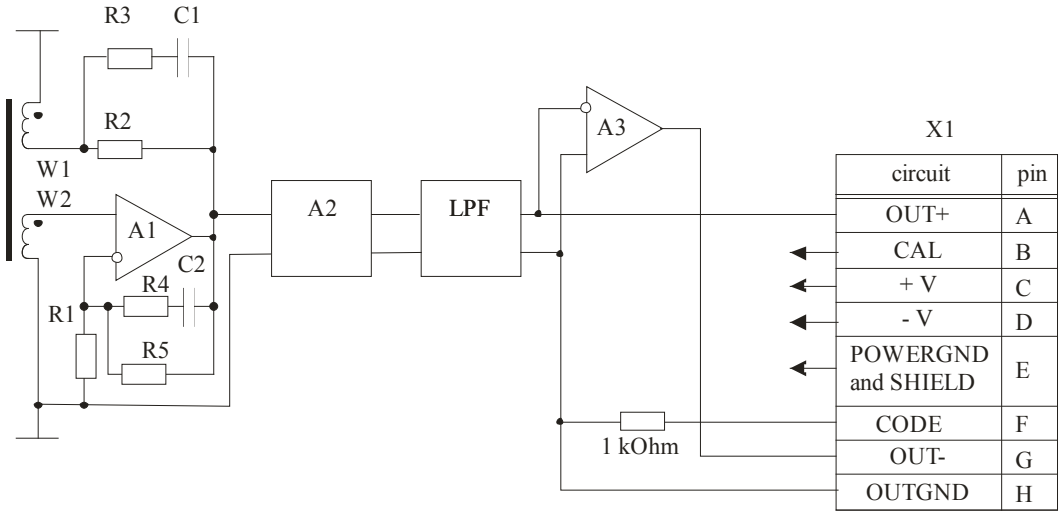


Fig.1. Simplified functional diagram of induction coil magnetometer LEMI-118

The output signal of main winding W2 is coupled to ultra low-noise input amplifier A1. The local feedback loop consisting of components R1, R4, R5, and C2 of amplifier A1 is fixing the total IM amplification factor at low frequencies to approximately 200.

The output of A1 amplifier through the correction circuit R2, R3, and C1 is coupled to the magnetic flux feedback winding W1. Magnetic and local feedback circuits help to develop flat part of IM transfer function within the frequency band from 20 to ~ 70000 Hz.

The output of A1 is also connected to an additional amplifier A2 with a correction circuit. Amplifier A2 is connected to a 6-th order LPF filter. Symmetrical output voltage is formed by the inverter A3.

CAUTION: The A1 amplifier input is protected from damage by moderate overloading signals but not from strong ones, such as nearby lightning!

5.4. The external housing of the induction coil magnetometer has a tubular shape and is made of a fiberglas tube with built-in electrostatic screen. The housing is also covered by a protective plastic tube to withstand environmental exposure, shocks and vibrations within allowed limits without damage. The front panel which carries the cable connector, electronic unit and induction coil sensor with all windings can be removed in order to access the IM interior.

The sensor and cable connector are hermetically sealed. It allows operation of LEMI-118 sensor at humidity up to 100 %,

But do not immerse the sensor into water!

NOTE: ***Opening the sensor housing before the end of the warranty term without written permission from the manufacturer cancels all guarantee obligations of the latter.***

5.5. The recommended connecting cable length has to be shorter than 20 meters to avoid losses in cable at high frequency.

6. Preparation for Operation

6.1. Read the manual, check the delivery set and inspect the IM exterior for damages that might have occurred during shipping.

6.2. Couple the sensor to a measuring device and a power supply.

CAUTION: Be careful when connecting the magnetometer to the power supply! It is not protected against wrong polarity!

6.3. The LEMI-118 magnetometer is ready for operation within three minutes after power is applied.

7. Utilization and Transportation

7.1. The utilization conditions of LEMI-118 magnetometer are:

temperature	-10 ºC to +50ºC
humidity	up to 100%
pressure	700 to 1100 hPa

7.2. Although the IM housing is hermetically sealed, it is not advisable to expose the device to heavy rain or immerse it in water.

7.3. Avoid shocks to the magnetometer of more than 10 g and vibrations in frequency band 1–1000 Hz with acceleration more than 5 g.

7.4. Do not pull the cable to retrieve the magnetometer as the connector or cable can be damaged.

Appendix A. Transformation factor values

The first line contains frequency in Hz, the following lines contain transformation factor (S) values in mV/nT and phase shift in degrees of angle between input and output signals. Both are measured with error <3%.

LEMI-118 #6

f, Hz	1.3	2.3	4.3	8.3	13	20	43	83
S, mV/nT	1.3	2.31	4.24	7.76	10.95	14.21	18.17	19.47
Phase, °	92	87	80	69	57	45	24	13

f, Hz	117	217	417	617	817	1000	2000	4000
S, mV/nT	19.63	19.80	19.96	19.96	19.96	19.96	20.12	19.96
Phase, °	9	5	2	0	-1	-2	-5	-12

f, kHz	6	10	15	20	25	30	35	40
S, mV/nT	19.96	19.78	19.78	19.78	19.96	20.12	19.96	19.31
Phase, °	-18	-29	-42	-55	-72	-88	-106	-124

f, kHz	45	50	55	60	65	70	80	100
S, mV/nT	18.66	17.96	17.29	16.61	15.28	13.56	9.61	3.79
Phase, °	-140	-157	-174	-193	-212	-231	-270	-326

LEMI-118 #10

f, Hz	1.3	2.3	4.3	8.3	13	20	43	83
S, mV/nT	1.27	2.25	4.18	7.70	10.98	14.23	18.4	19.31
Phase, °	92	87	80	69	57	45	24	13

f, Hz	117	217	417	617	817	1000	2000	4000
S, mV/nT	19.80	19.96	19.96	19.96	19.96	19.96	20.12	20.12
Phase, °	9	5	2	0	-1	-2	-5	-11

f, kHz	6	10	15	20	25	30	35	40
S, mV/nT	19.96	19.80	19.63	19.63	19.63	19.48	18.99	18.34
Phase, °	-17	-29	-43	-58	-74	-90	-106	-122

f, kHz	45	50	55	60	65	70	80	100
S, mV/nT	17.85	17.62	17.23	16.44	15.20	13.53	9.57	3.74
Phase, °	-138	-154	-171	-191	-212	-230	-268	-329

LEMI-118 #12

f, Hz	1.3	2.3	4.3	8.3	13	20	43	83
S, mV/nT	1.25	2.23	4.15	7.68	10.84	14.12	18.17	19.64
Phase, °	92	87	80	69	57	45	24	13

f, Hz	117	217	417	617	817	1000	2000	4000
S, mV/nT	19.80	19.96	20.12	20.12	20.12	20.12	20.12	20.12
Phase, °	9	5	2	0	-1	-2	-6	-12

f, kHz	6	10	15	20	25	30	35	40
S, mV/nT	20.12	19.80	19.80	19.80	19.80	19.63	18.99	18.31
Phase, °	-17	-29	-43	-57	-73	-89	-105	-121

f, kHz	45	50	55	60	65	70	80	100
S, mV/nT	18.44	18.06	17.72	16.74	15.49	13.70	9.75	3.77
Phase, °	-138	-154	-172	-192	-212	-231	-269	-328

LEMI-118 #13

f, Hz	1.3	2.3	4.3	8.3	13	20	43	83
S, mV/nT	1.27	2.22	4.18	7.64	10.92	14.17	18.05	19.18
Phase, °	92	87	80	68	58	46	26	14

f, Hz	117	217	417	617	817	1000	2000	4000
S, mV/nT	19.50	19.83	19.83	19.83	19.83	19.83	20.12	19.83
Phase, °	9	5	2	0	-1	-2	-5	-11

f, kHz	6	10	15	20	25	30	35	40
S, mV/nT	19.83	19.66	19.66	19.66	19.66	20.01	19.83	18.35
Phase, °	-17	-29	-43	-57	-73	-89	-105	-121

f, kHz	45	50	55	60	65	70	80	100
S, mV/nT	18.70	18.20	17.55	16.56	15.25	13.55	9.63	3.86
Phase, °	-140	-156	-173	-192	-211	-232	-268	-328

LEMI-118 #14

f, Hz	1.3	2.3	4.3	8.3	13	20	43	83
S, mV/nT	1.27	2.23	4.18	7.64	10.98	14.21	`17.86	19.31
Phase, °	92	87	80	69	57	45	24	13

f, Hz	117	217	417	617	817	1000	2000	4000
S, mV/nT	19.66	19.83	19.96	19.96	19.96	20.12	20.12	20.12
Phase, °	9	5	1	0	-1	-2	-5	-11

f, kHz	6	10	15	20	25	30	35	40
S, mV/nT	19.96	19.96	19.96	19.96	20.11	20.28	19.79	18.98
Phase, °	-17	-29	-44	-57	-73	-89	-107	-124

f, kHz	45	50	55	60	65	70	80	100
S, mV/nT	18.20	17.71	17.06	16.17	14.94	13.28	9.44	3.7
Phase, °	-140	-156	-174	-191	-211	-232	-268	-326

LEMI-118 #15

f, Hz	1.3	2.3	4.3	8.3	13	20	43	83
S, mV/nT	1.27	2.22	4.18	7.64	10.92	14.17	18.17	19.47
Phase, °	92	87	80	68	58	46	26	14

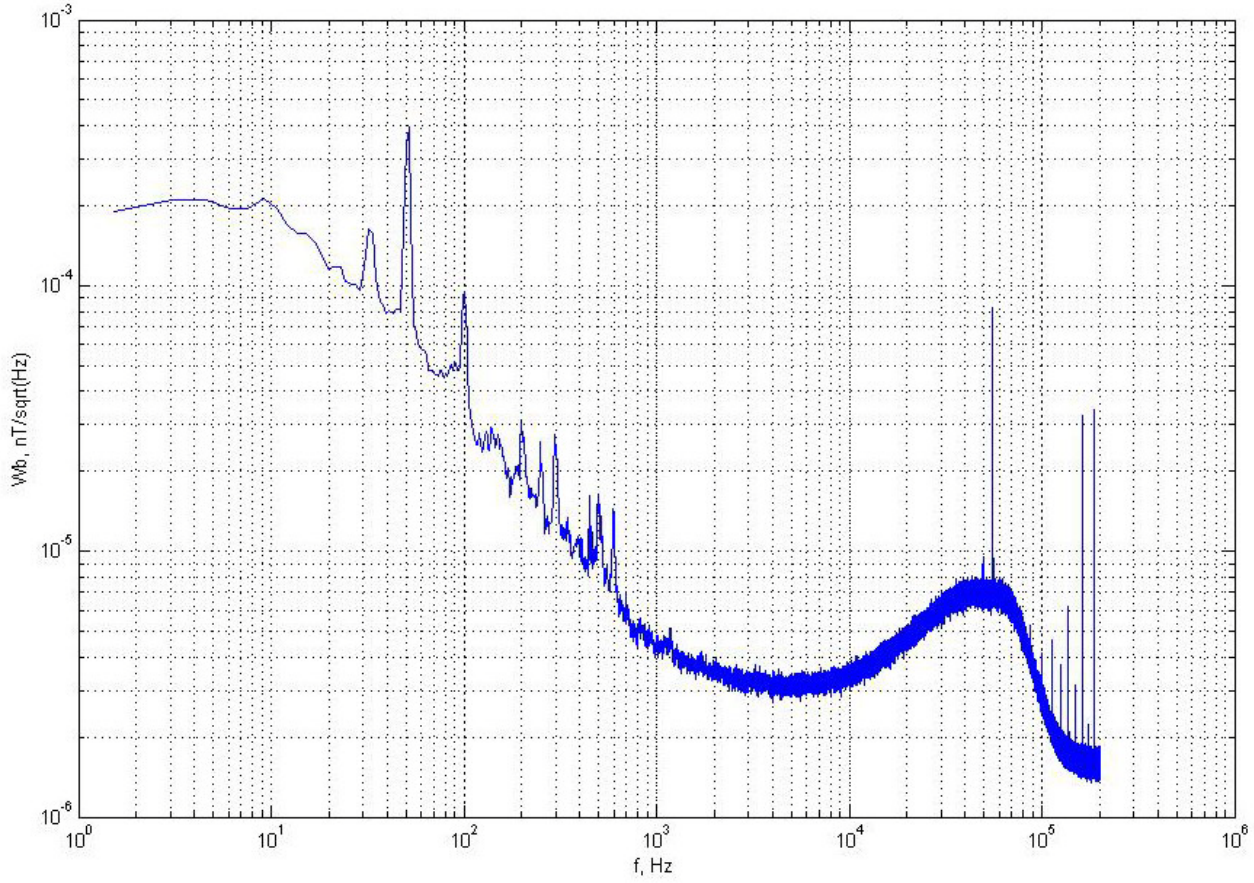
f, Hz	117	217	417	617	817	1000	2000	4000
S, mV/nT	19.63	19.80	19.96	19.96	19.96	19.96	20.12	19.96
Phase, °	9	5	2	0	-1	-2	-5	-12

f, kHz	6	10	15	20	25	30	35	40
S, mV/nT	19.80	19.63	19.63	19.63	19.63	19.31	18.66	18.21
Phase, °	-17	-29	-44	-58	-74	-91	-107	-122

f, kHz	45	50	55	60	65	70	80	100
S, mV/nT	17.89	17.72	17.40	16.58	15.37	13.56	9.45	3.54
Phase, °	-137	-153	-172	-191	-212	-232	-271	-332

Appendix B.

Typical noise spectral density



Noise spectral density was measured in an electrostatic shield in laboratory conditions.

Appendix C.

Recommendations for selecting the measurements site and conditions

1) The measurement should be carried out in electromagnetically clean place, which means, to take into account possible magnetic signals fromnearby thunderstorms, and solar bursts etc. The sensor should also be located as far as possible from power lines and large ferromagnetic objects. It is difficult to give recommendations about the exact distance, because it depends on magnetic moment of the objects;however, the minimum distance should be about 20 m. For example, at the sensor output, we clearly observed the action of opening and closing the car door at the distance of about 35 meters. Do not select measurement sites that are near big trees - strong wind may produce soil oscillations and consequently sensor vibrations. The distance between each of the three sensors in a three-component set has to be more than 1 meter, recommended about 2.5 meters.

2) Every effort should be made to provide a stable position for the sensor (e.g., the 1" rotation of the sensor in the Earth magnetic field may produce ~250 pT of parasitic signal!). In order to ensure a stable position, it is usually necessary to bury the sensor in the ground and install a temporary station, or to make beds (holes) with concrete walls for permanent installations. If there are possible microseisms in the region, it is advisable to fill the concrete bed to half of its depth with elastic material such as soft polyurethane, and to put the sensor on top of it,.A sack of sand above the sensor would help to keep the sensor stable . The first three to five meters of cable connected to the sensor must also be buried. Ensure that the sensor is protected from rain if possible. These installation procedures can avoiding avoid influence due to blowing wind and decreases sensor temperature fluctuations. If burying the sensor and cable is not possible, it is advisable that you construct a foundation under the sensor such as a concrete brick or plate, then put a sack of sand above it, and then a wind and rain protection above the equipment.

3) Proceed as follows to connect the sensor to the acquisition system. Prepare a sensor cable shorter than 20 m, which should contain three twisted wires for the power supply, shielded twisted wires pair for the signal and one wire for analog ground.

4) It is important that a good quality power supply be used, especially when working in high-frequency range. The best way to ensure this is to use a battery placed on an insulating support such as polyethylene film.

5) When using DC-DC transformers in the receiving equipment, ensure that they do not produce noise, especially spikes, in their input circuits.

6) Grounding of the analog ground and common power supply lines is necessary and it is advisable that this grounding be made according to "star" system - in one point, use a buried copper stick to connect all other possible ground wires together.