HFCS

High Frequency Current Source

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DESCRIPTION:

The HFCS - High Frequency Current Source is a bipolar current source capable to deliver up to 10App in a frequency range from 20Hz to more than 1MHz (figures 1 and 2).

Figure 1. Front view of the HFCS

Figure 2 . Back view of the HFCS

The input signal (Vin) to the system is an AC voltage, with the amplitude of up to 5Vpp (pp: peak-peak) generated by a conventional signal generator. This signal is amplified and fed to a Bipolar current source, capable of driving AC current up to 10App @ R_{LOAD}=0Ω, in the frequency range 20Hz to more than 1MHz. The Bipolar current source delivers a current into miniaturized Helmholtz coils or any other load. For precise measurement of the output (Helmholtz coil) current, a shunt-type current monitor is available.

FEATURES:

KEY FEAUTURES

- AC output current in range from 0 – 10App.
- Frequency bandwith from 20Hz to more than 1MHz
- Output connector: Centronics-socket, female, 36 pins.
- Control voltage from a standard signal generator, max. input voltage 5Vpp.
- BNC input connector, 50Ω
- Differential monitor output, BR2 Bayonet coupling twinax connector.
- Monitor output sensitivity 0.5V/A
- IEC mains socket with an integrated fuse
- Power supply 90-260VAC, 50-60Hz
- Protective fuses: 3.15A@115Vac or 1.6A@230Vac

ABSOLUTE MAXIMUM RATINGS [1] [2]:

In accordance with the absolute maximum rating system (IEC60134).

Symbol	Parameter	Min.	Typ.	Max.	Units	Remarks
T_{stg}	Storage Temperature	-40		+100	°C	
T_{amb}	Ambient Temperature	+10		+35	°C	
V_{in}	Input voltage			6	V_{pp}	
V_{SUP}	Supply Voltage	90		260	V_{ac}	
I_{OUT}	Continous output current		10		A_{pp}	R_{Load} = 0Ω

[1] Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits.

[2] The output may be shorted.

Stresses beyond those listed under "Absolute maximum ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS:

Symbol	Parameter	Min.	Typ.	Max.	Units	Remarks
T_{amb}	Ambient Temperature	+20	+25	+30	°C	
V_{cc}	Supply Voltage	100		240	V_{ac}	

HFCS design:

The HFCS consists of several bloks:

- The main board 1
- The main board 2
- 4 bipolar current sources
- The current monitor board
- The indication boar
- Two 5V/30A switch power supplies
- The EMI filter

The simplified block diagram of the HFCS is illustrated on figure 3.

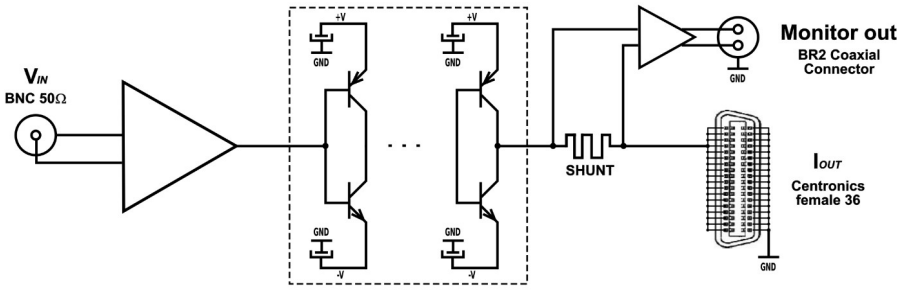

Figure 3. The HFCS block diagram

The main board 2

The main board 1 connects all modules to make high frequency current source. Using the main board 2, input AC signal is connected to the input of the bipolar current sources (amplifier boards). The fan for cooling the bipolar current sources is mounted on the main board 2.

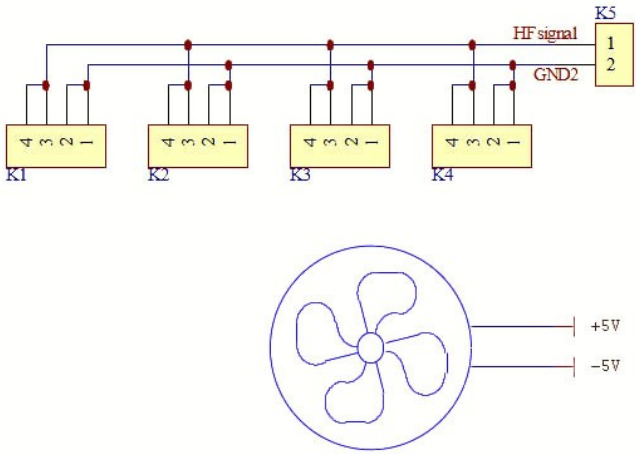

Figure 4. The main board 2 schematic

During the design, we carefully routed all PCB tracks to avoid external disturbance

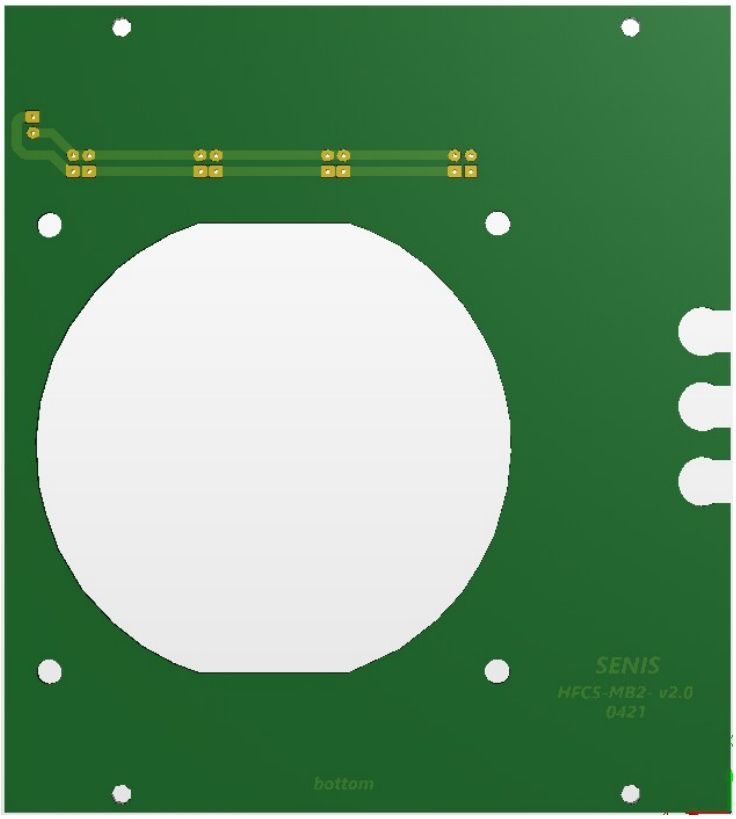

Figure 5. The main board 2 PCB layout

The main board 1

The main board 1 connects the other electronic parts. Before all, the modules are supplied by the main board 1.

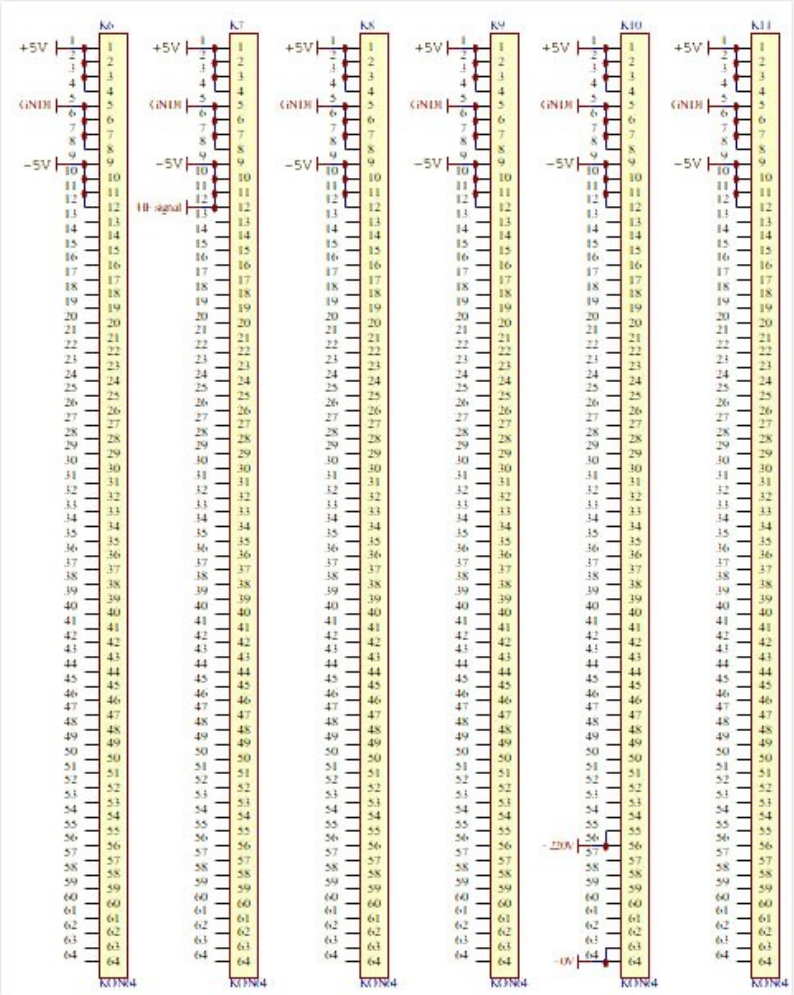

Figure 6. The main board 1 schematic

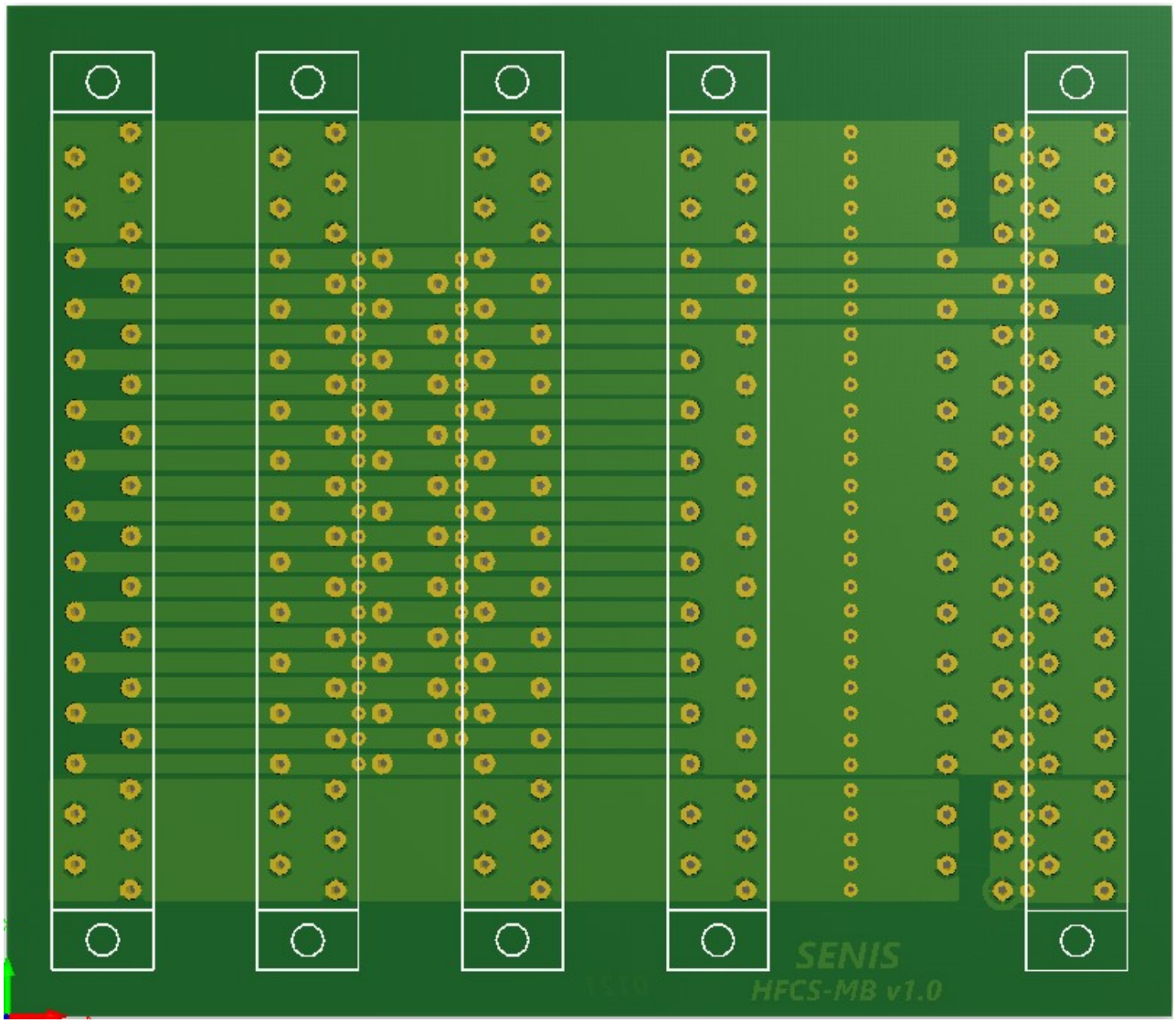

Figure 7. The main board 1 PCB layout

The bipolar current source

The bipolar current source is designed as a push-pull couple. Seven pairs of complementary transistors are connected in-parallel. The driving of the transistor pairs is executed by the input buffer (LMH6321). The role of the capacitor C5 is to eliminate the offset on the input. Note that the current through the transistors doesn't depend on the input signal, i.e. it always has a permanent value. Because of that, the transistor heating is also permanent and doesn't depend on the output loading. The PCB for the bipolar current source is made as a laminated bus-bar. In this way, the inductance of the system is reduced to the minimum. The resistance of the contacts and the skin-effect are reduced by using a double-row multi-polar connectors. The HFCS contains 4 such bipolar current sources.

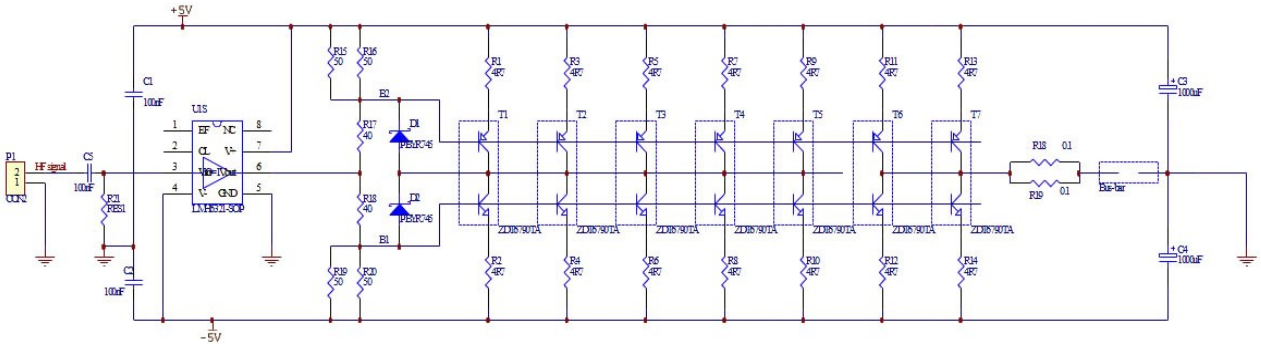

Figure 8. The bipolar current source schematics

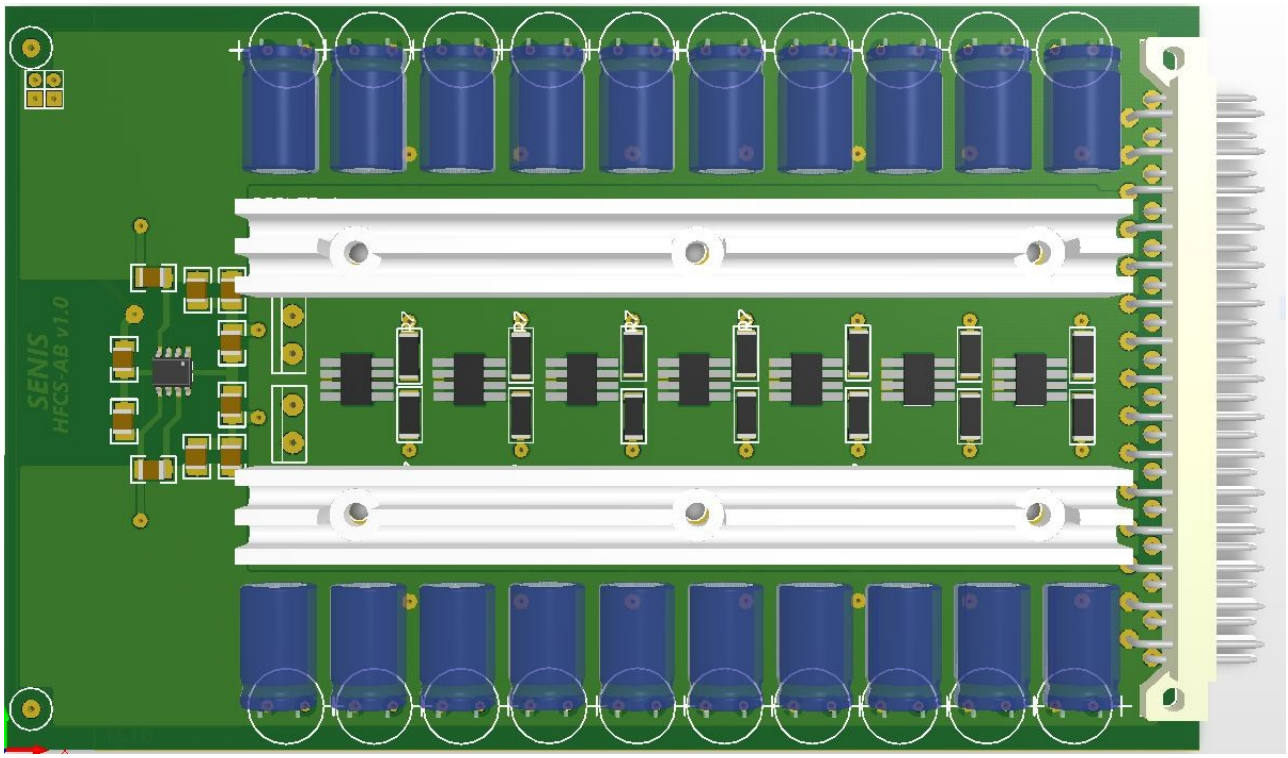

Figure 9.The bipolar current source PCB layout

Characteristics:

Max. output ac current $I_{ac\_max}=10A_{pp}$ @ $R_{LOAD}=0\Omega$ and f from 20Hz to 1MHz

The current monitor

The measuring of the current supplied by the bipolar current source is realized by the low-inductive shunt resistors R5 and R6 connected in-parallel. The measured current produces a voltage drop on these resistors, that is amplified by the fully differential amplifier THS4130. The differential output of this amplifier is accessible to the user via the BR2 Bayonet coupling twinax connector on the front side (front panel). The PCB is structured as a laminated bus bar.

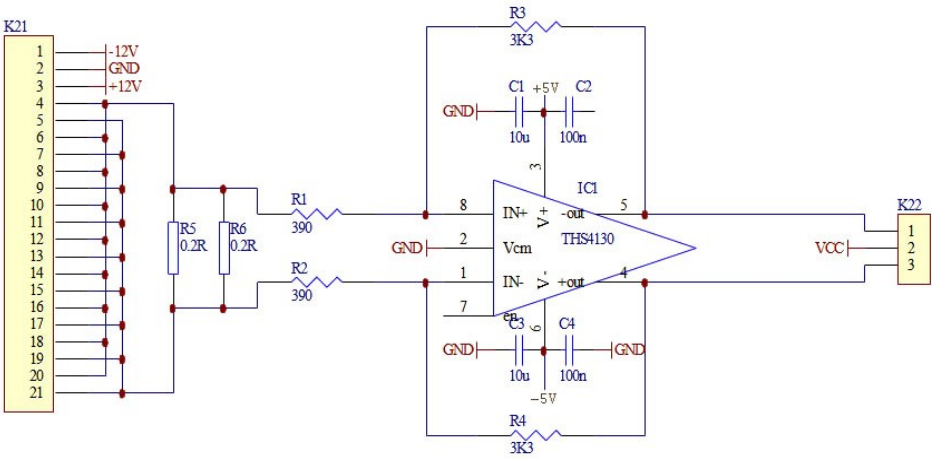

Figure 10. The current monitor

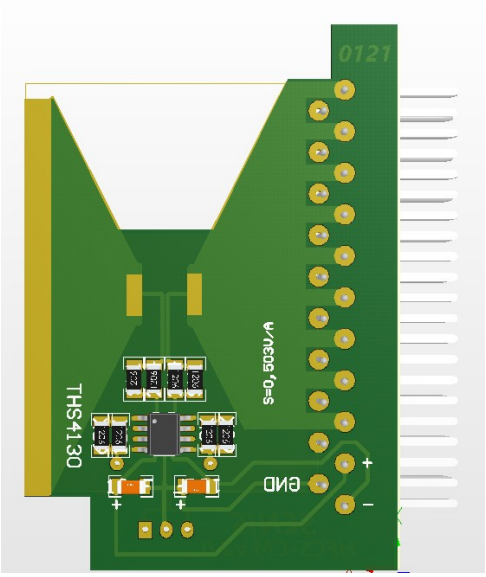

Figure 11. The current monitor PCB layout

CONNECTORS LAYOUT AND PIN DESCRIPTION

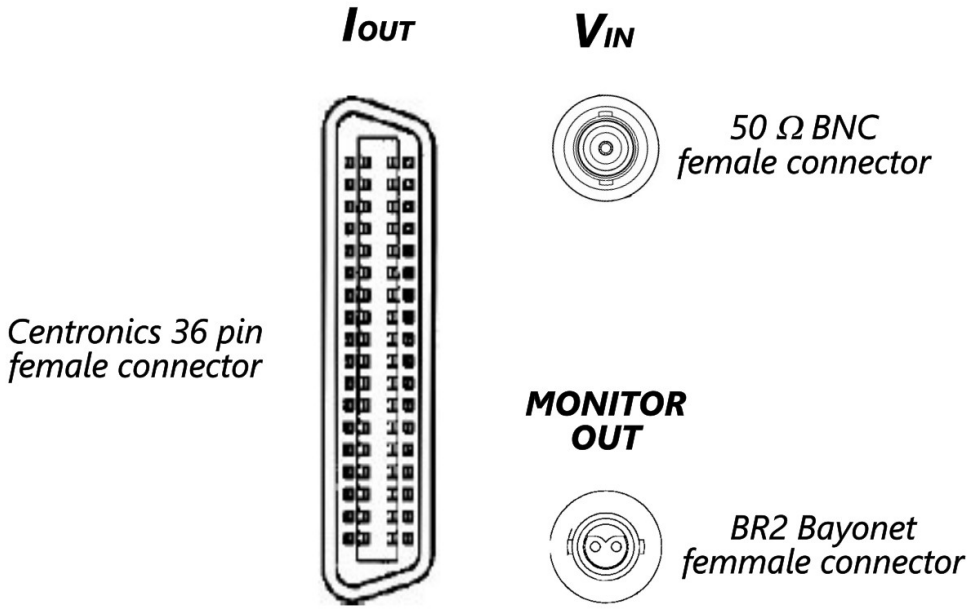

Figure 12. The front panel connectors layout

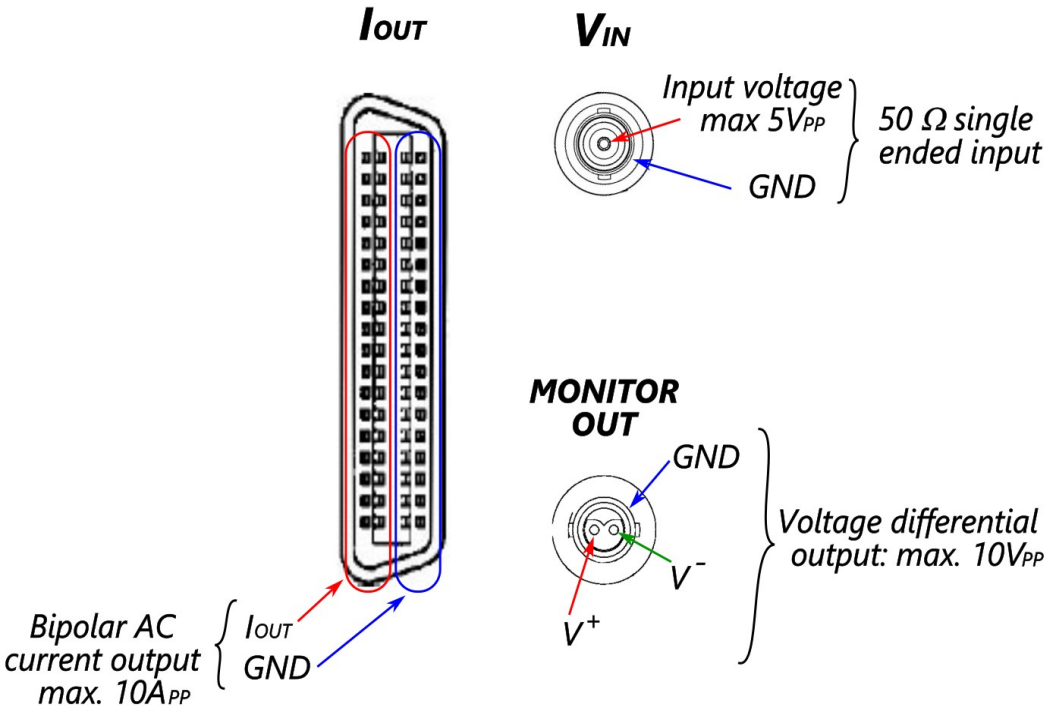

Figure 13. The front panel connectors pin description

HE HFCS DIMENSIONS (dimensions are in mm):

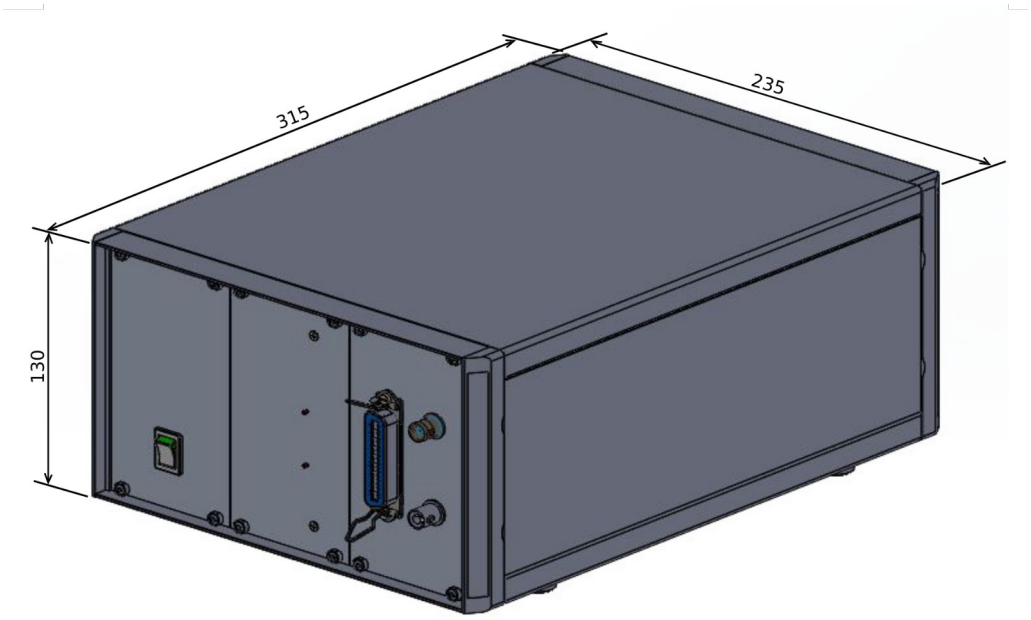

Figure 14. External dimensions

Symbol	Parameter	Value	Units
W	Width	235	mm
H	Height	130	mm
D	Depth	315	mm
M	Mass	4.75	Kg

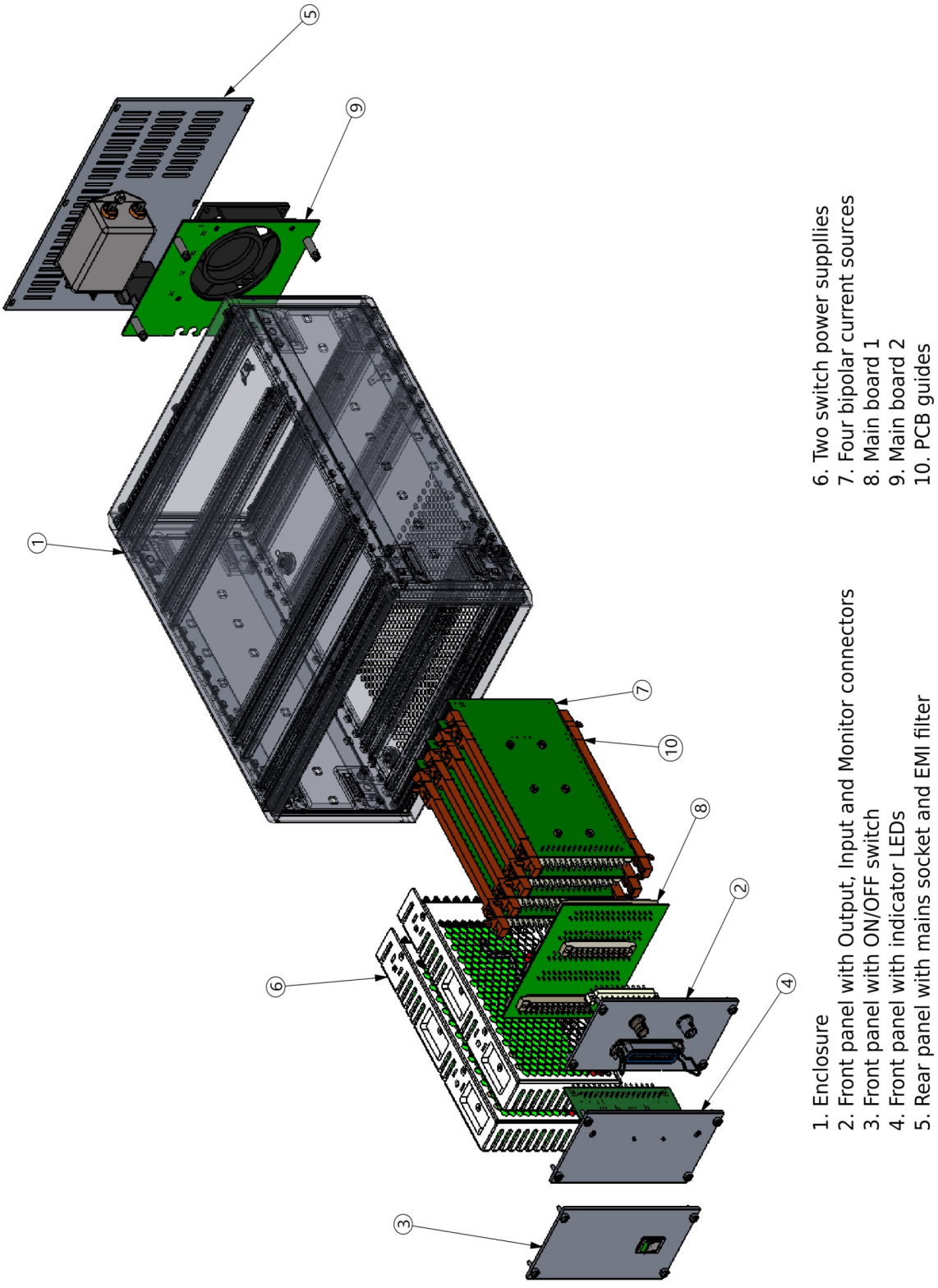

Figure 15. The HFCS explode view

ACCESSORIES

There are two available accessories:

- The output extension cord
- The Mini Helmholtz coil

THE OUTPUT EXTENSION CORD

The output extension cord is designed as the very thin laminated bus-bar. With the help of laminated bus-bar technology the inductance of almost 1m long the extension cord is low as 90nH. Both ends of the extension cord are terminated with the suitable Centronics 36 connectors, at one side is the male Centronics and on other side is the female Centronics connector.

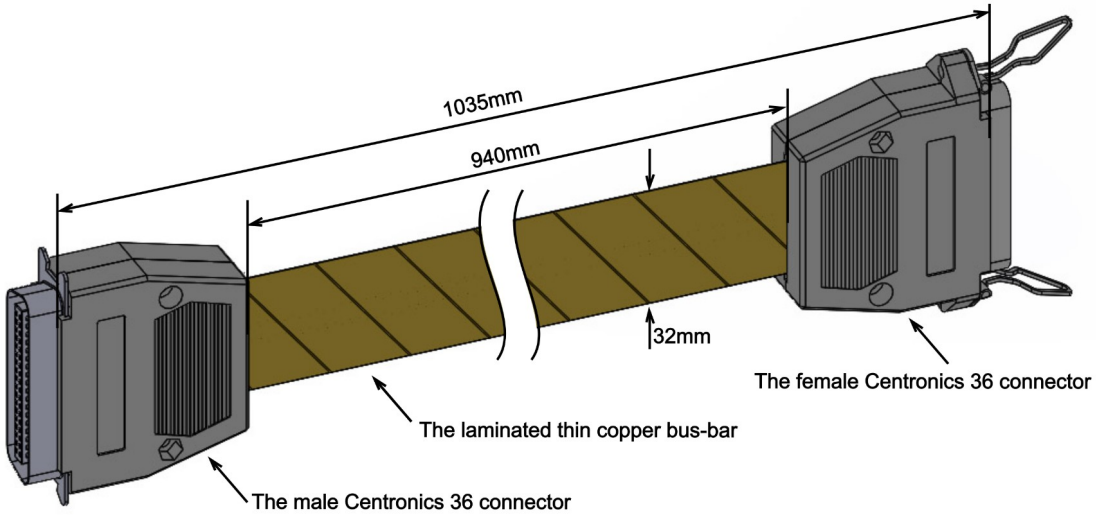

Figure 16. The extension cord made as the thin laminated bus-bar

Symbol	Parameter	Min.	Typ.	Max.	Units	Remarks
L	Cord inductance	-	90	-	nH	
C	Cord capacitance	-	1.1	-	nF	
R	Cord resistance	-	34	-	mΩ	

note: All parameters are measured at room temperature of 23°C with HAMEG LCR METER HM8018

THE MINIHELMHOLTZ MHC-x_x

Description:

Mini Helmholtz Coil is made as combination of two one-turn coils integrated on two printed circuit boards. They can be connected to a current source by IEEE 1284 (36 pins male) connector, as shown on Figure 17.
Considering the dimensions of the Helmholtz Coils and the maximal current, the magnetic flux density in the middle point between the used coils is:

$$B = \left(\frac{4}{5}\right)^{\frac{3}{2}} \frac{\mu_0 NI}{r} = k \cdot I$$

N - number of winding of each coil (in our case, N = 1)

μ_o - magnetic permeability in vacuum ($\mu_o = 4\pi 10^{-7}$ Tm/A)

r - the radius of the Helmholtz coils (in our case is r = 4 mm)

Key features & typical applications:

- Generation of high magnetic fields (up to 2.25mT) in a small volume
- Very high frequency bandwidth: DC – 1MHz
- Very low impedance: R = 0.1Ω , L = 0.3µH, C = 1pF
- Characterization of magnetic field sensors
- Application in laboratories for research and development, etc

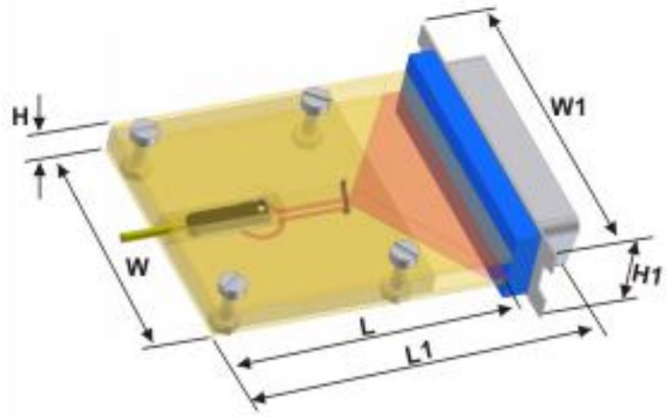

Figure 17. Dimensions of MHC-x_x

Specifications (MHC-8_1):

Symbol	Parameter	Min.	Typ.	Max.	Units	Remarks
I_{PP}	Max. curent	-	10	-	A	
K	Coil constant	-	$2.25*10^{-4}$	-	T/A	
D	Coil diameter	-	8	-	mm	
N	Number of turns	-	1	-	-	
R	Coil resistance	-	0.1	-	Ω	
L	Coil inductance	-	0.3	-	µH	
C	Capacitance	-	1	-	$_P$F	

Dimensions (MHC-x_x):

Symbol	Parameter	Min.	Typ.	Max.	Units	Remarks
L	Lenght	59.5	60	60.5	mm	
L_1	Overall length	79	80	81	mm	
H	Hight	6	6.5	7	mm	
H_1	Overall hight	15	15.5	16	mm	
W	Width	49.5	50	50.5	mm	
W_1	Overall width	61.5	62	62.5	mm	