THE COIL DOCTOR

- **Control system based on ESP32-S2 CPU with Wifi**
- **Power output signal (Sine, Triangle, Square) up to 2.5 MHz**
- **PWM output signal up to 300 kHz**
- **0...18V Vpp for sine and triangle**
- **0...22V Vpp for square wave**
- **0...12V Vpp for PWM wave**
- **Protection against overload and short circuit**
- **True alternate output, with frequency, amplitude and offset adjustment**
- **Output signal current up to 1000 mA**
- **Touch keyboard and rotary encoder**
- **Measurement of inductance and saturation current of an inductor**
- **Regulated and protected power supply: 1.2V ... 12.5 VDC / 1.25 A**
- **Supply voltage: 115V / 230V AC**

https://www.ledoelectronics.com

- **Maximum power consumption: 24W**

The Coil Doctor is a very compact and lightweight instrument manufactured by Ledoelectronics, which offers three functions:

1. Power signal generator up to 2.5 MHz

2. Inductor meter that, in addition to measuring the inductance, also graphs the magnetization curve.

3. Regulated voltage source from 1.2V to 12.5VDC and 1.25A

All integrated into a TFT color screen, so all functions are accessible via a rotary encoder and touch panel.

SIGNAL GENERATOR

Based on the popular AD9833 programmable synthesizer with 25 MHz crystal. The output frequency:

$$F_{OUT} = \frac{25\ MHz\ x\ REG\_VAL}{2^{28}} \quad [\text{Hz}]$$

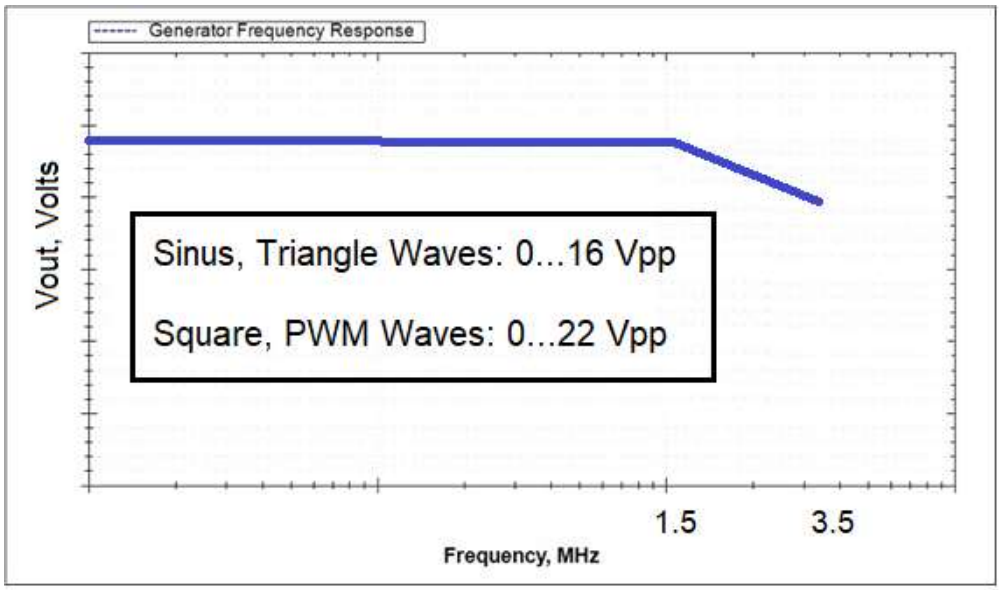


Fig.1. Amplitude / frequency curve of the signal generator.

Unlike most of the existing function generators on the market, this one has the LT1210 amplifier capable of supplying an output current of up to 1 A, so it can be very useful in a wide range of applications, such as checking of amplifiers, filters, coils, capacitors, determination of resonant frequency, pulse transformers testing, etc.

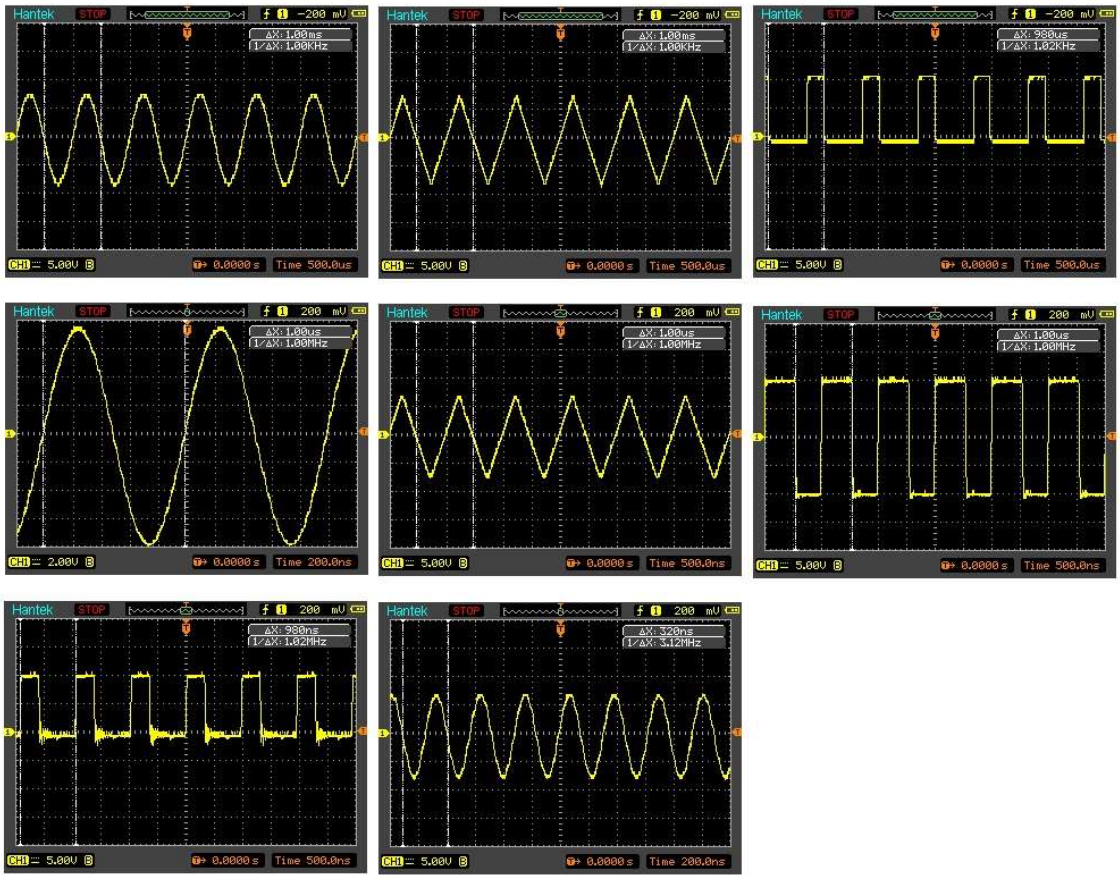


Fig.2. Different waves generated by the equipment.

The output frequency can be modified from its minimum value of 1Hz to a maximum of 2.5 MHz, using the rotary encoder on the front of the equipment. This operation can be performed in fine mode or coarse mode. The frequency can also be entered precisely, using a tactile keyboard, which can be invoked by tapping on the top of the screen. The duty cycle of the PWM signal can only be changed using the rotary encoder.

Fig.3. Setting a specific frequency, using the keyboard.

he amplitude and offset of the output signal can be adjusted using the two potentiometers on the right on the front of the unit.

The type of curve and the frequency range can be modified by repeatedly pressing the buttons on the touch screen.

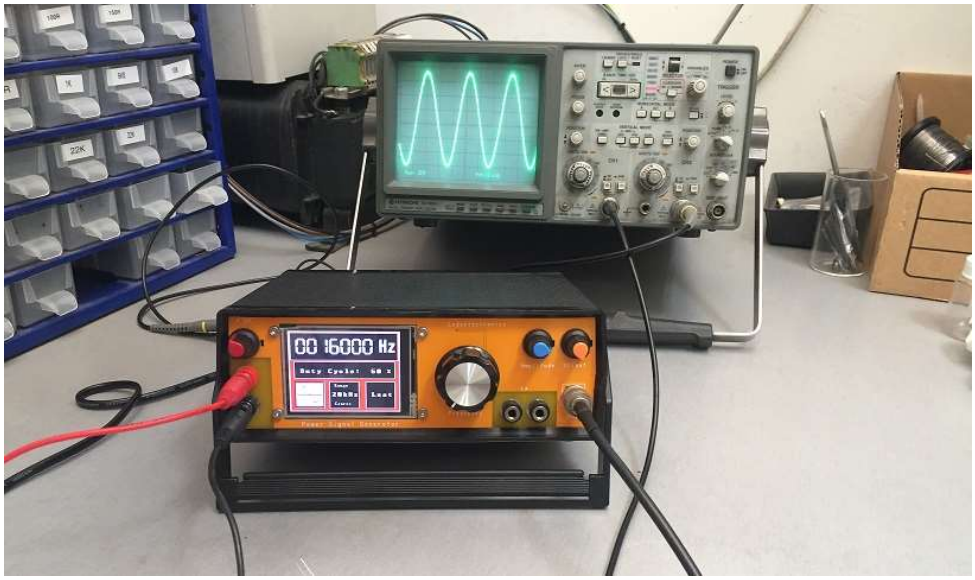


Fig.4. Sine Function.

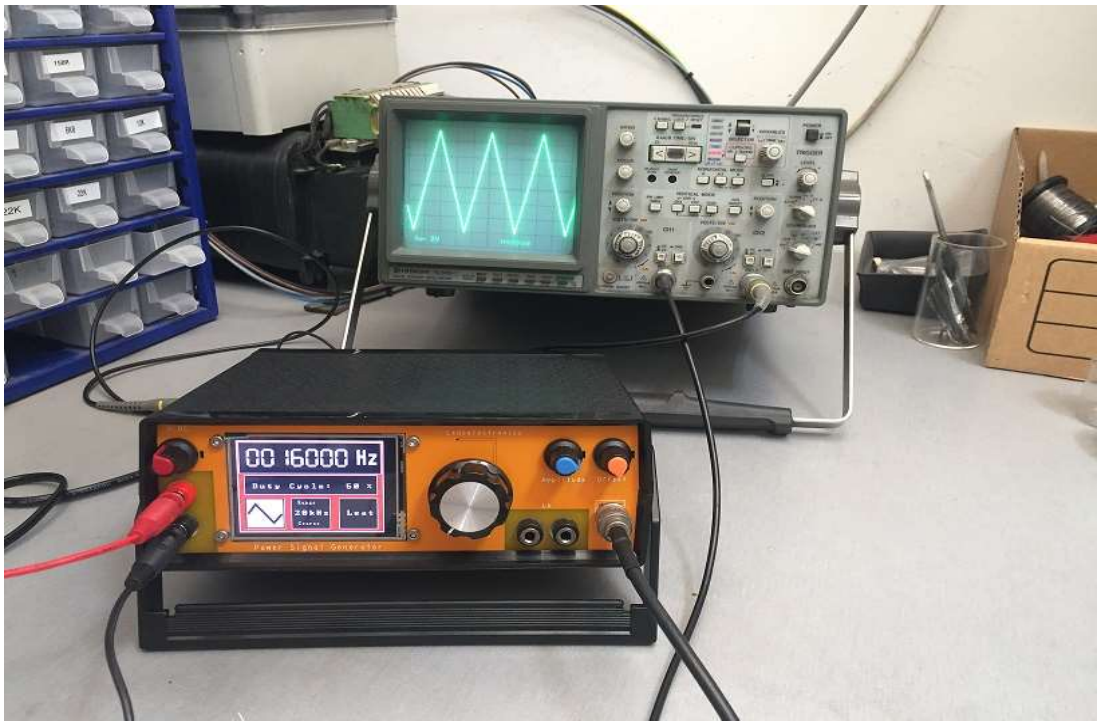


Fig.5. Triangular wave.

Fig.6. PWM signal.

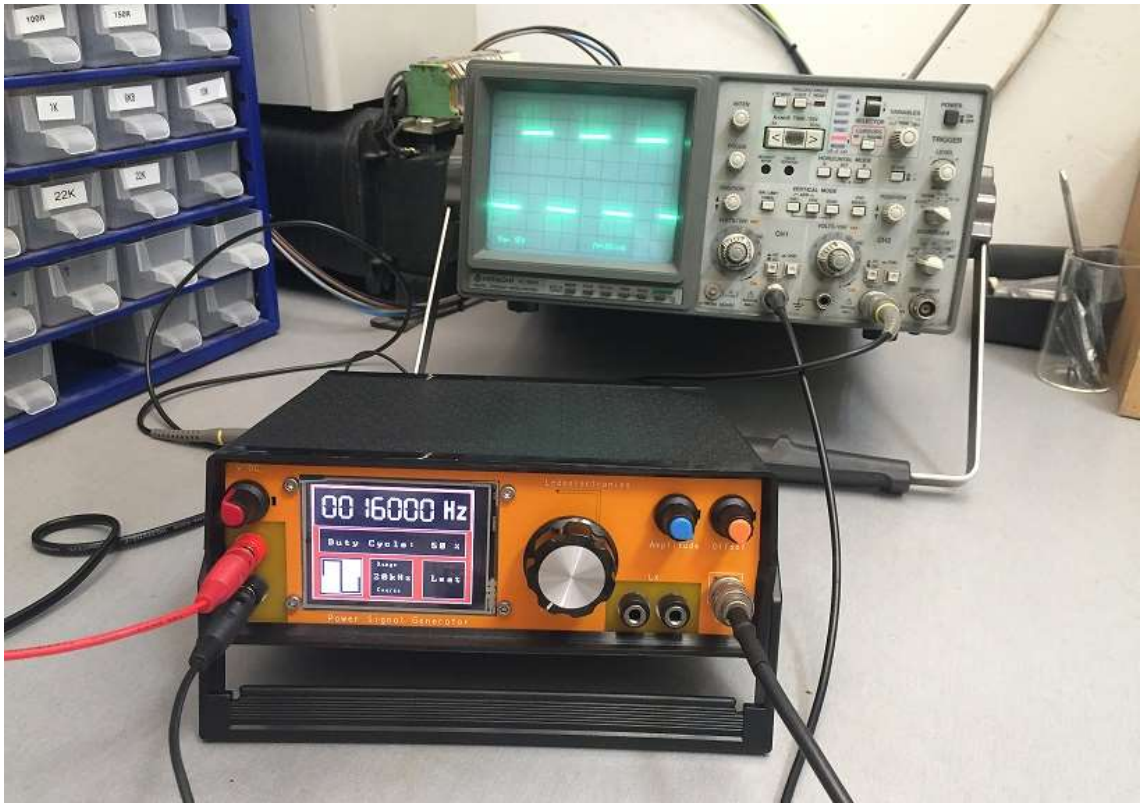


Fig.7. Square wave.

Function Generator Specifications

Output waves	Sine, Triangular, Square, PWM
Frequency interval	1 Hz…2.5 MHz
Frequency resolution	1 Hz (limitado por software)
Duty Cycle Adjustment (PWM)	1…99 %
Maximal amplitude (Sine and Triangular)	18 Vpp
Maximal amplitude (Square wave)	22 Vpp
Maximal amplitude (PWM)	12 Vpp
Amplifier Output resistance	5 Ohms
Output connector impedance	50 Ohms
Maximal Output current	1 A
Amplitude reguation	0…22 Vpp
Offset regulation	-1V…+1V
Harmonic distortion	0.5 %
Signal to noise ratio	45 dB
Frequency stability	40 ppm / ºC
Edge time Square Wave and PWM	200 ns
Output protection	Overheating, overload, short circuit

INDUCTOR METER

This module is a novelty, and allows not only to measure the inductance of an inductor, but also its behavior at different currents, which is of vital importance, since we can determine the saturation current of the core. The maximum check current is 24 A peak.

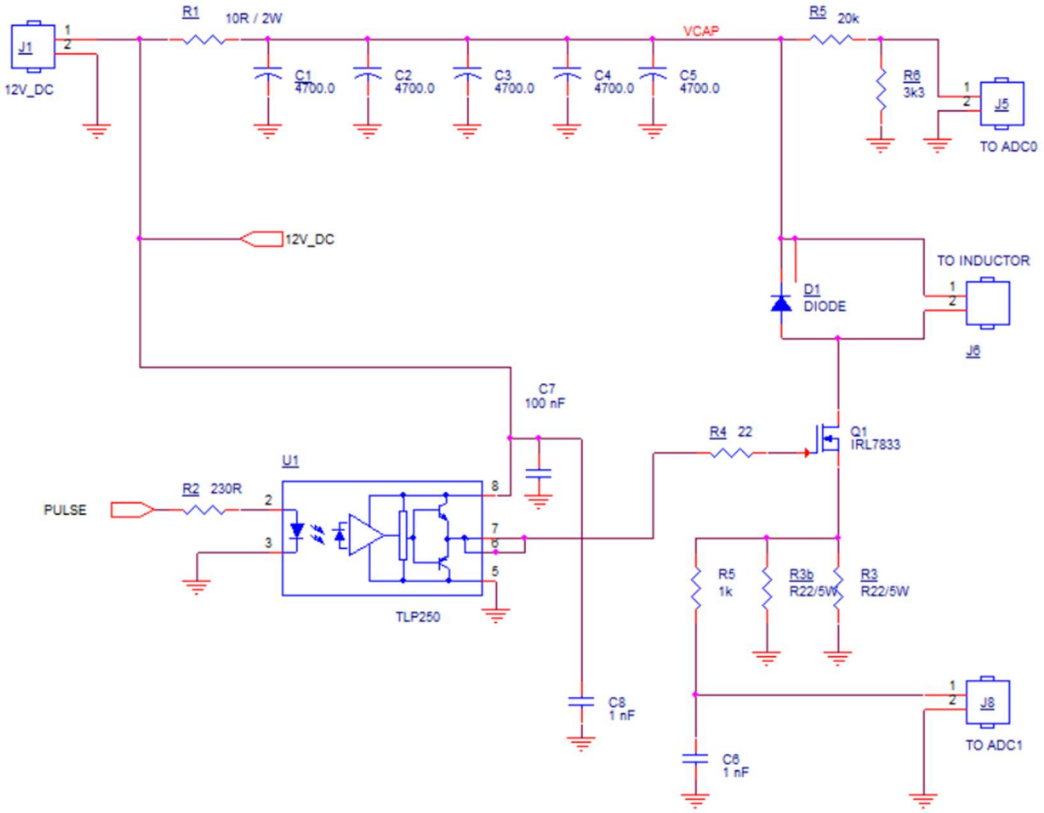


Fig.8. Inductor measurement circuit.

We use the energy stored in a bank of capacitors to apply a voltage pulse to the inductor for several microseconds. At the same time, we sample the current and voltage, which allows us to obtain the inductance and magnetization curve.

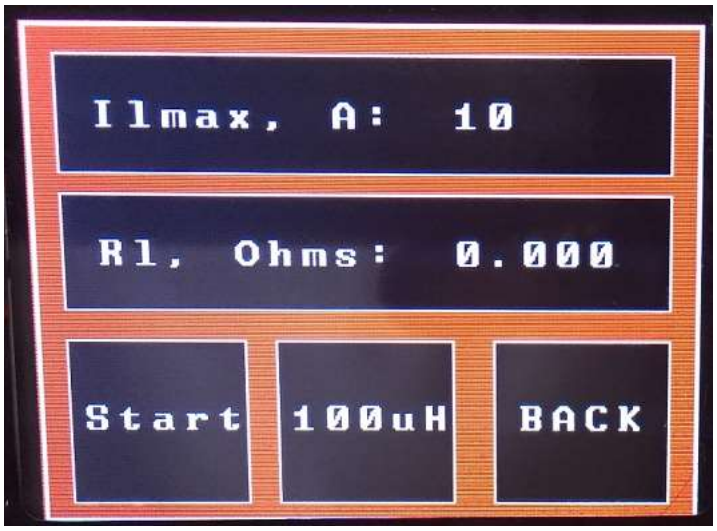


Fig.9. Inductor measurement setup screen.

The work screen allows you to enter the check current in amps, the coil resistance in Ohms and the measurement range, which can be: 150 uH, 1 mH or 10 mH, which covers most of the coils used in modern power conversion circuits. If we leave the resistance value at 0.0, the inductance values will be slightly above the actual value.

Measuring an inductor is very simple, just connect it to the two Lx terminals, access the measurement screen by pressing the **Lsat** button, enter the data and press the **Start** button or the rotary encoder.

If all went well, then the graph of the current over time and the value of the inductance for the selected maximum measurement current will appear.

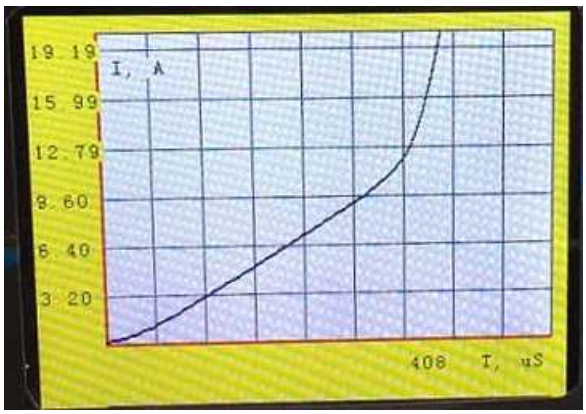
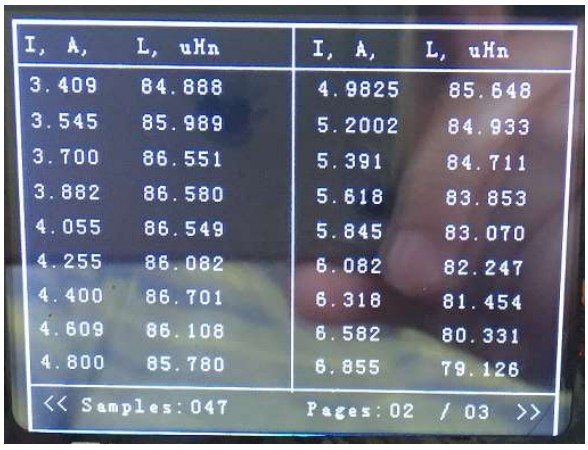


Fig.10. Inductor magnetization curve.

If we click on the graph we can access the results table, which can contain several pages, depending on the measurement parameters.



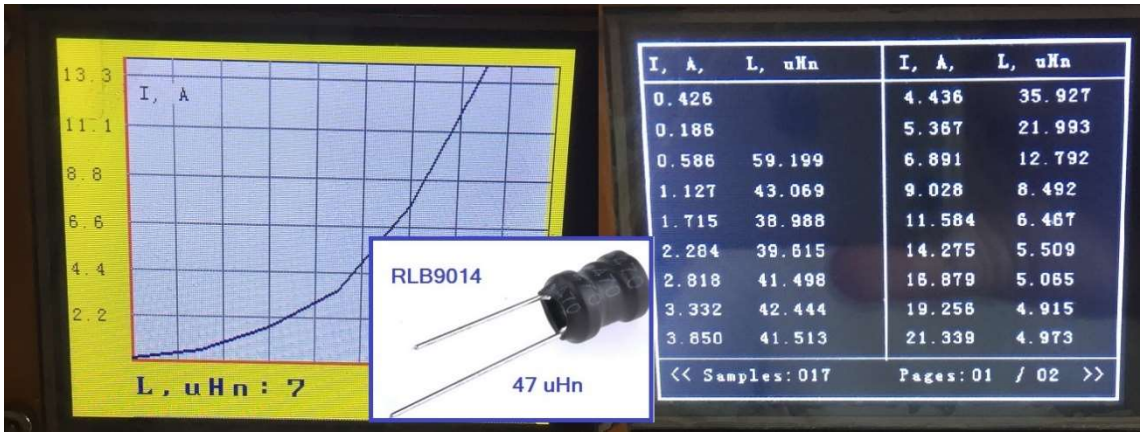
I, A,	L, uHn	I, A,	L, uHn
3.409	84.888	4.9825	85.648
3.545	85.989	5.2002	84.933
3.700	86.551	5.391	84.711
3.882	86.580	5.618	83.853
4.055	86.549	5.845	83.070
4.255	86.082	6.082	82.247
4.400	86.701	6.318	81.454
4.609	86.108	6.582	80.331
4.800	85.780	6.855	79.126

<< Samples: 047 Pages: 02 / 03 >>

Fig.11. Table of values obtained over time.

This table shows the evolution of the inductance of the coil as a function of the working current.

Next, we show frames of the results obtained during the measurement of some commercial coils, which were used during the adjustment and start-up of the equipment.



I, A,	L, uHn	I, A,	L, uHn
0.426		4.436	35.927
0.186		5.367	21.993
0.586	59.199	6.891	12.792
1.127	43.069	9.028	8.492
1.715	38.988	11.584	6.467
2.284	39.615	14.275	5.509
2.818	41.498	16.879	5.065
3.332	42.444	19.256	4.915
3.850	41.513	21.339	4.973

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Fig.12. Measurement of Bourns RLB9014 inductor at a maximum current of 10 A.

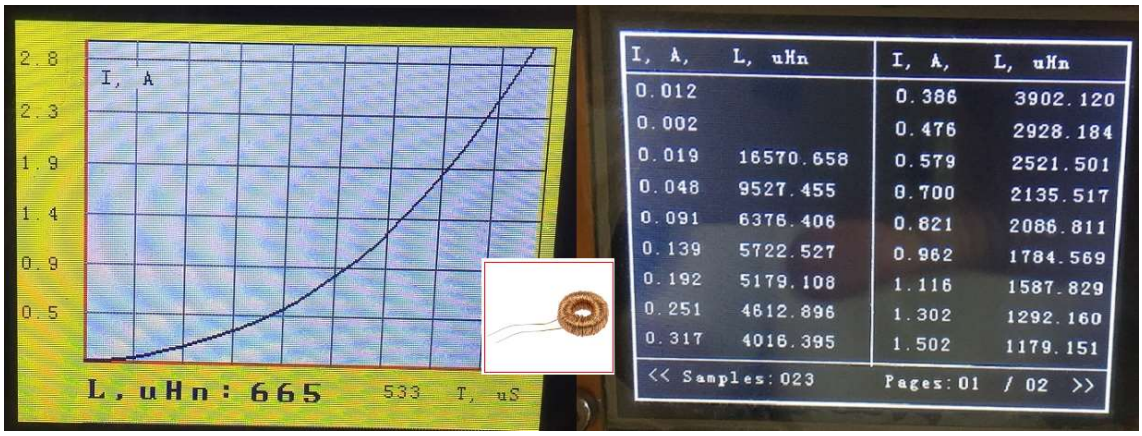


Fig.13. Roxburgh SF1121 inductor measurement. 4 mHn Powder Iron.

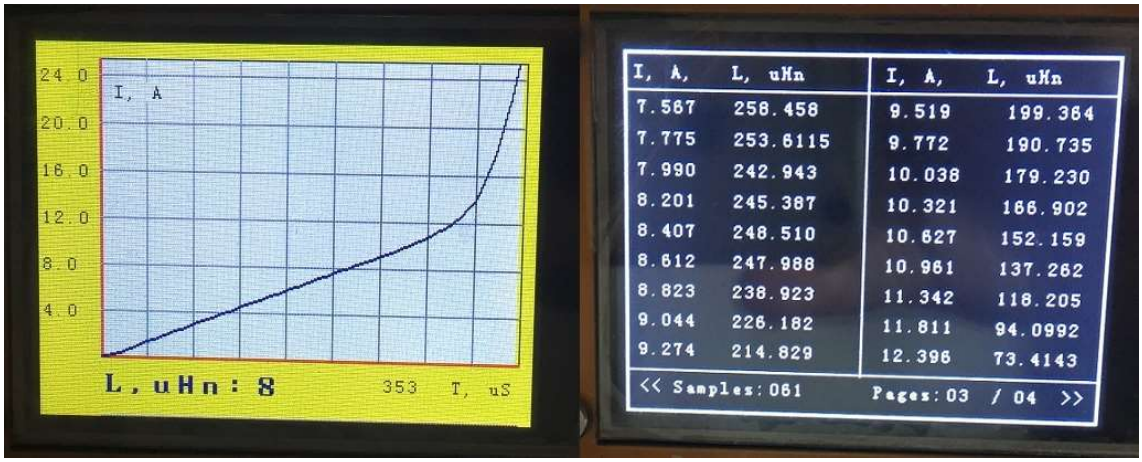


Fig.14. Measurement of a 180 uH 10 A inductor with EE42 N87 core at 25 A.

Inductance Meter Specifications

Measuring range	15 uH…10 mH
Test Current	1 A … 24 A
ADC resolution	12 bits
Maximum resistance of the coil to be measured	8 Ohms
Measurement accuracy 4%	4 %
Calibration adjustment	Yes

POWER SUPPLY

The equipment has a regulated voltage source that can be used to power low power electronic circuits. Given the small size of the entire equipment, its power is limited to about 15 Watts.

For the regulation and adjustment of the voltage, a DC-DC Buck type converter is used, fed from a rectifier with a maximum current of 1.25 A. This converter has the "transformer effect", so the current supplied at its output can be of up to 3 amps for output voltages less than 5 volts. The entire circuit is protected against current overloads and overheating.

It is important to take into account that this source also feeds the signal generation circuits and the inductor check circuit, so it shares the common (GND) with them.

The output voltage is adjusted between 1.2V and 12.5V DC with the potentiometer located on the left side of the front of the equipment. Its current value is automatically displayed on the screen each time its value changes.

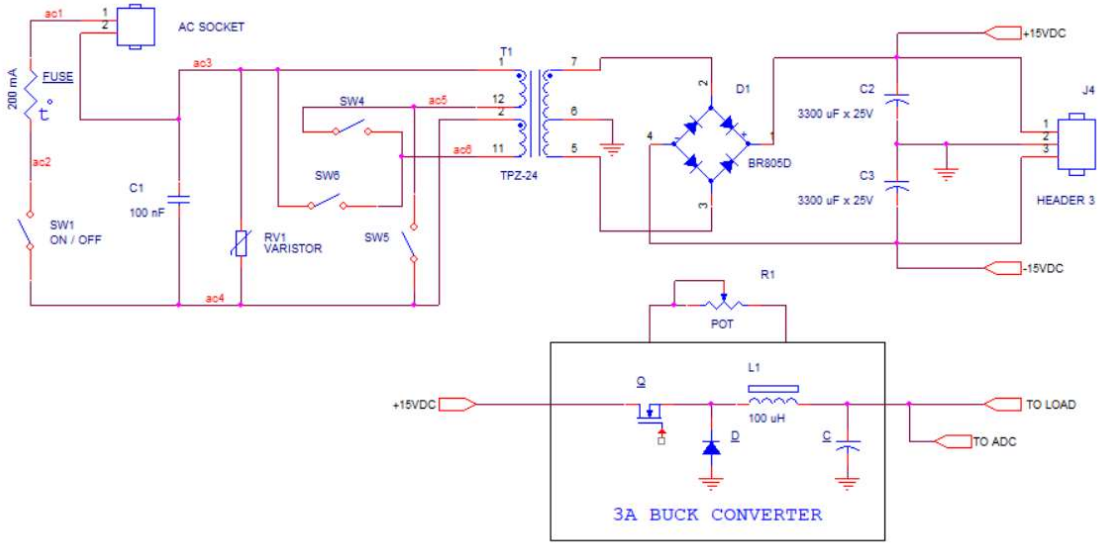


Fig.15. Regulated power supply present in the equipment.

Fig.16. Automatic representation on the screen of the power supply voltage.

Regulated Power Source Specifications

maximum power output	15 W
Output current V > 5V	1.25 A
Output current V = 5V	2 A
Output current V <= 3.3V	3 A
Minimum output voltage	1.2 V
Maximum output voltage	12.5 V
Output impedance	0.5 Ohms
Ripple coefficient	0.9 %

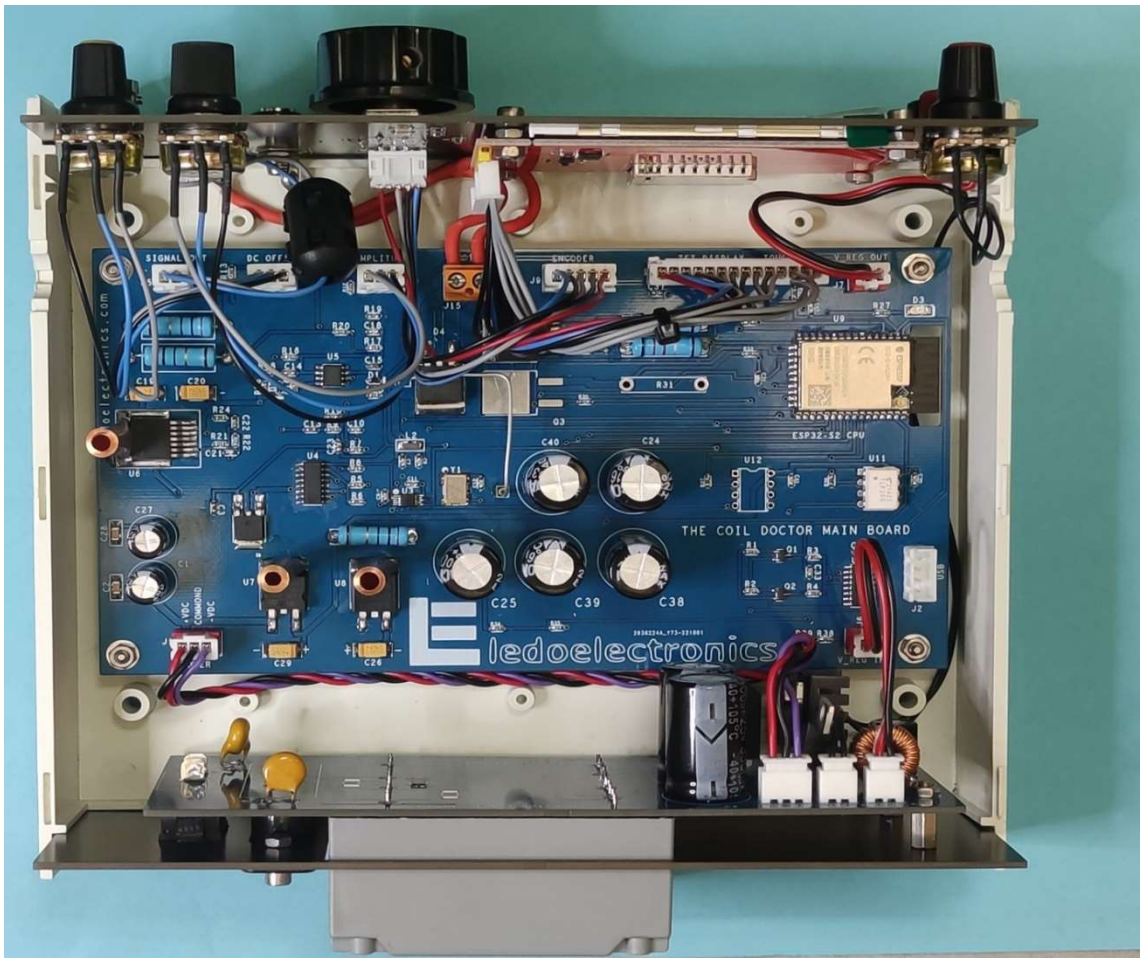


Fig.17. Photo of the inside of the equipment.

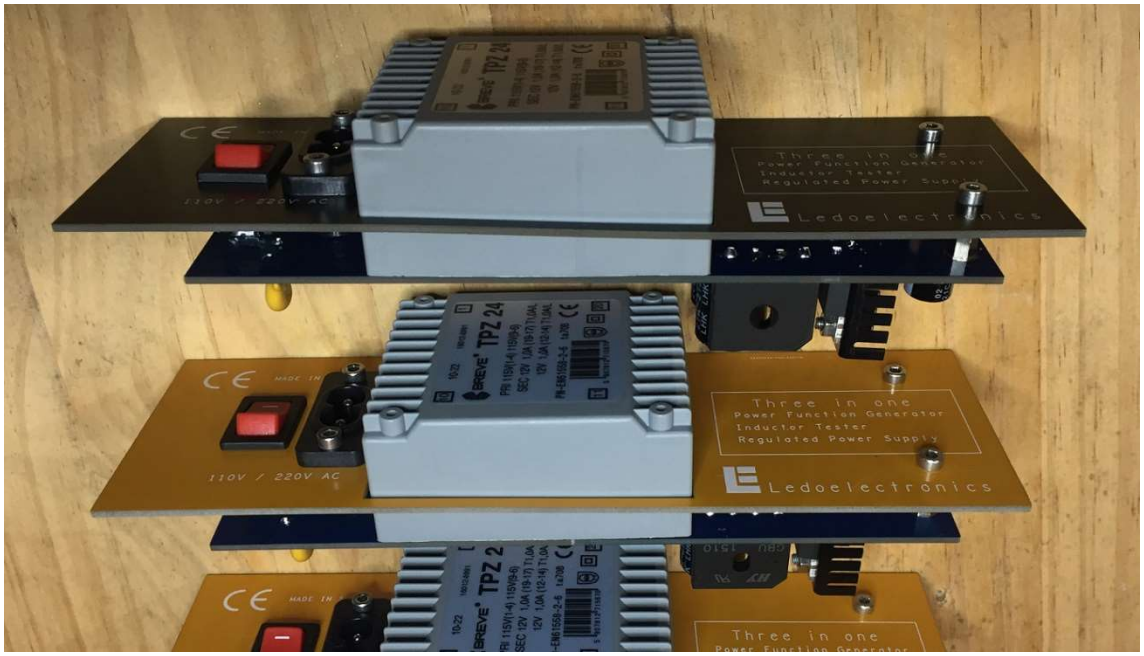


Fig.18. Equipment Power Supply.

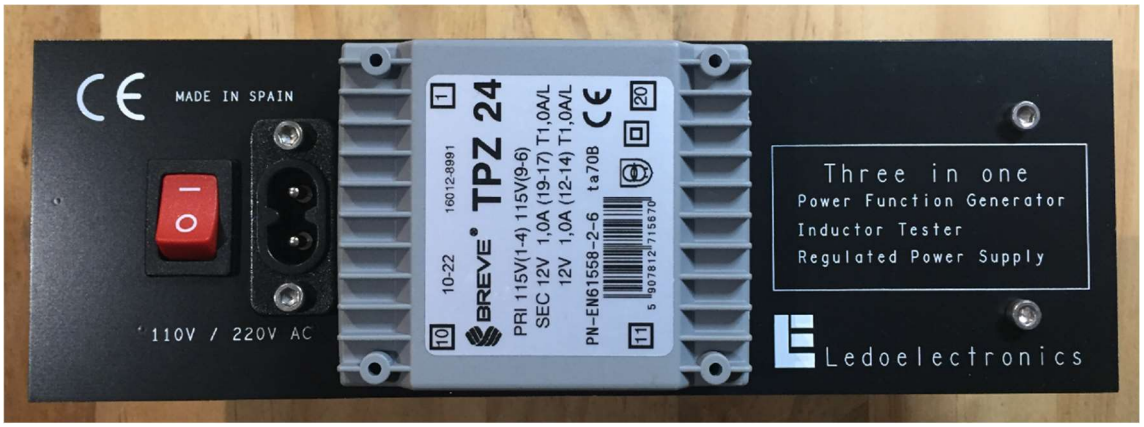


Fig. 19. Back side in black.

Fig. 20. Back side in yellow.

Fig.21. Main Board.

Fig.22. Front side view.

ACCESSORIES SUPPLIED WITH THE EQUIPMENT

1. 220V AC power cord

2. Output coaxial cable (50 Ohms) with alligator type terminals

3. Red and black leads with alligator tips, for power supply and inductor measurement

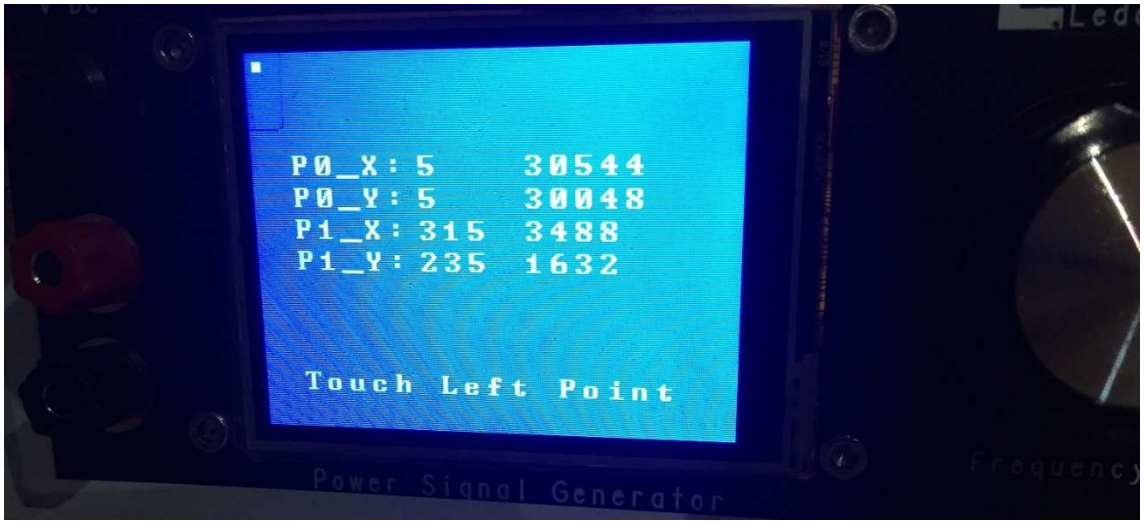
4. Touchpad pointer

CALIBRATION

The equipment has three parameters that can be calibrated if necessary

- Calibration of the digital voltmeter that represents the voltage of the power supply
- Calibration of inductance measurement
- Calibration of the coordinates of the touch panel.

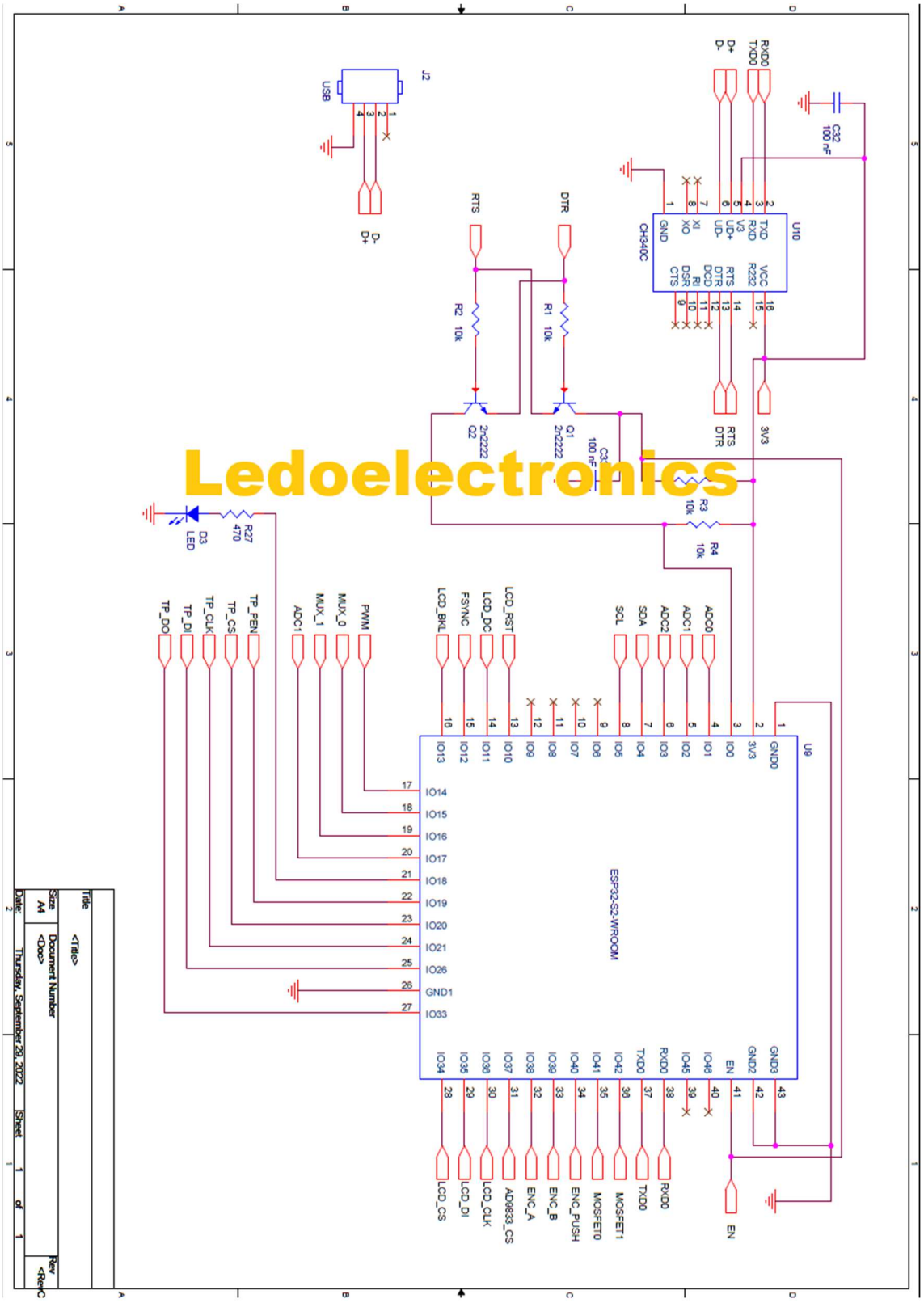
We can access the touch panel calibration by clicking on any area of the screen when turning on the equipment. In this case the screen below appears



Calibration is done by accurately clicking first on the point on the left, and then on the point that will appear on the right at the bottom.

To access the second calibration menu, it is necessary to click on the area of the screen that shows the source voltage, when it is active. In this case, the calibration window appears, and the parameters can be modified with the help of the tactile keyboard incorporated in the system.

Schematics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CH340C
J2
USB
D3
LED
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2n2222
Q2
2n2222
R1 10k
R2 10k
R3 10k
R4 10k
R27 470
C32 100 nF
C3 100 nF
3V3
GND
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DTR
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RXD0
D+
D-
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TP_DI
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TP_CS
TP_PEN
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MUX_0
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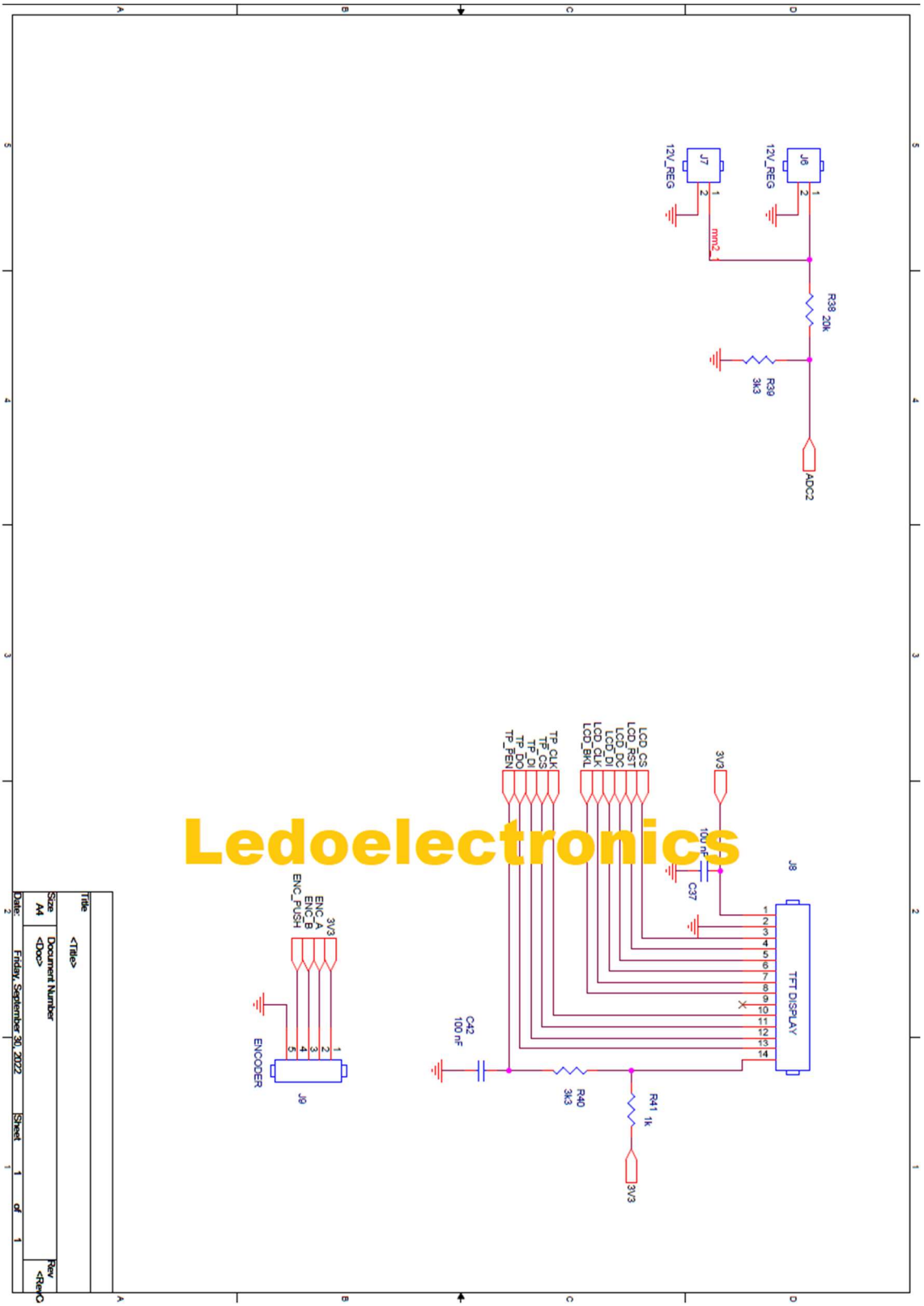

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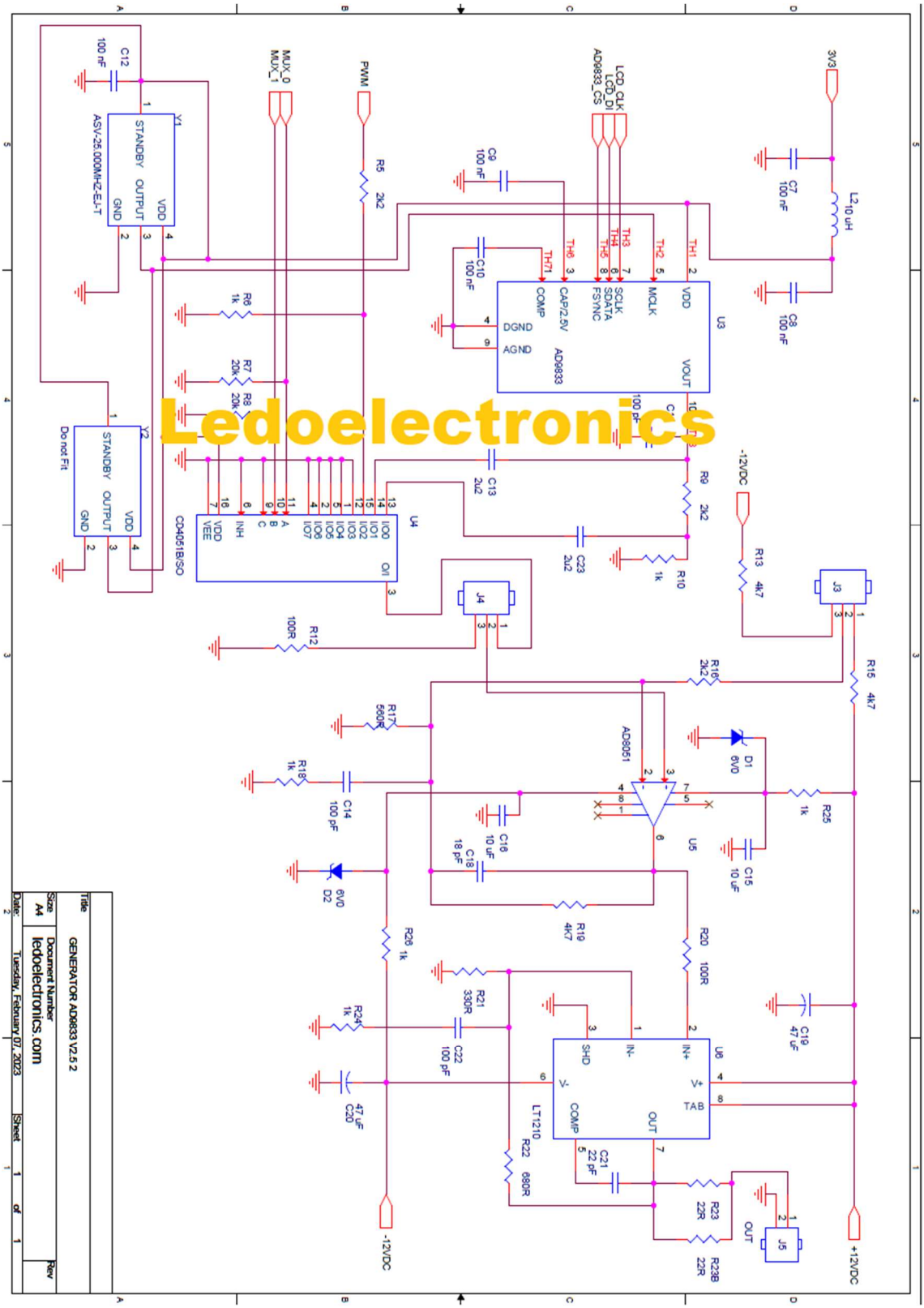
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CD4051B/SO
U5
AD8051
U6
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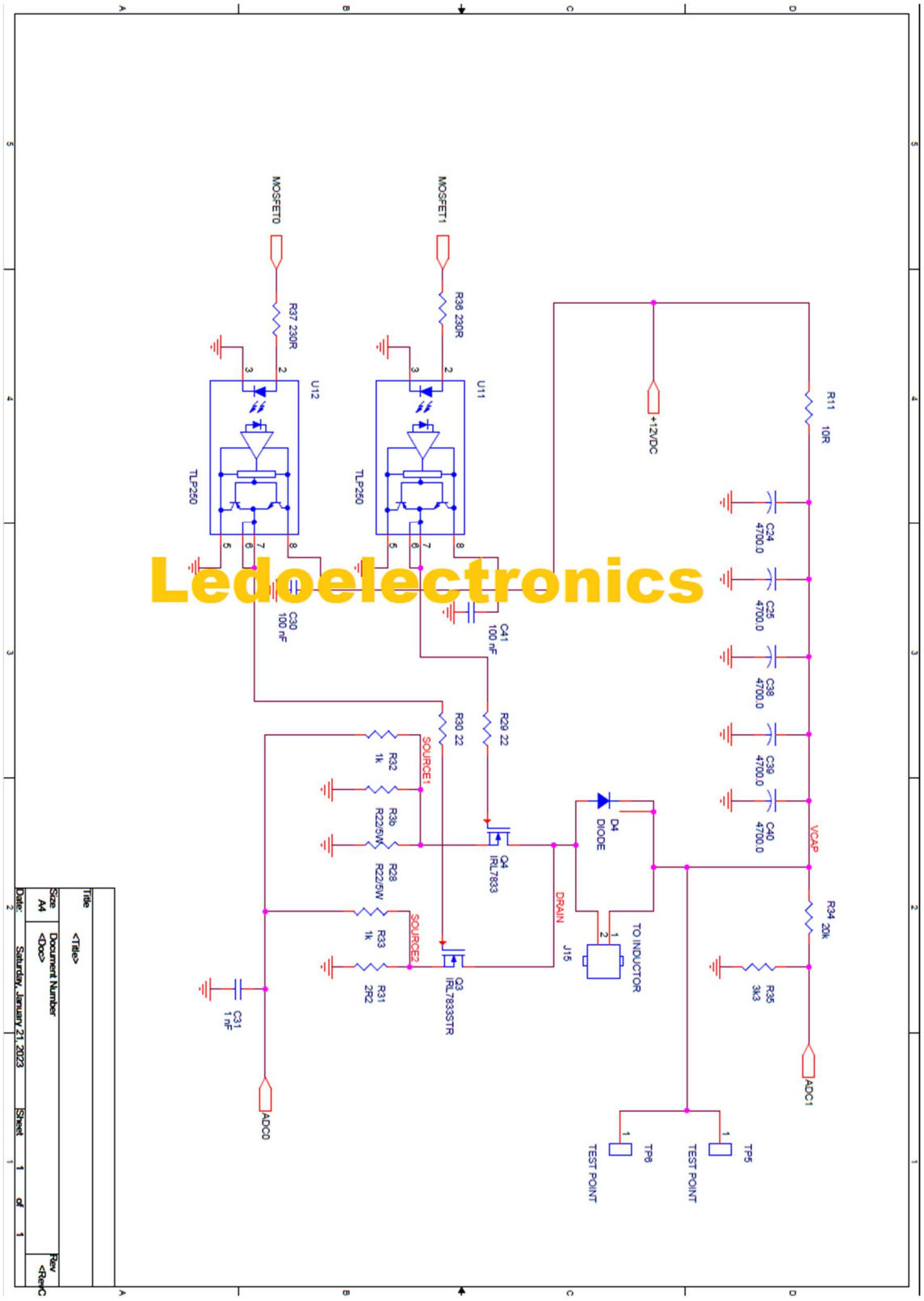

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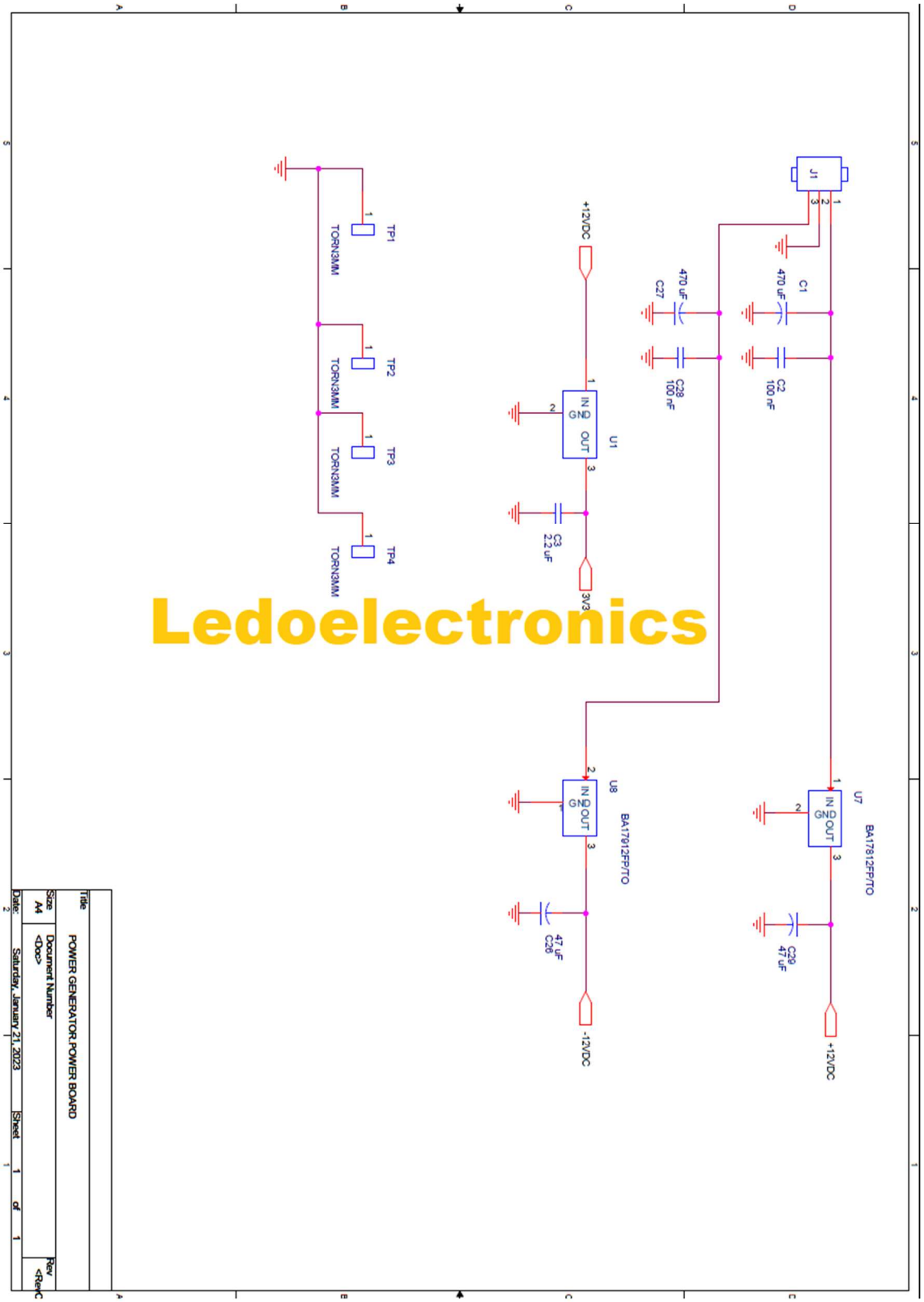
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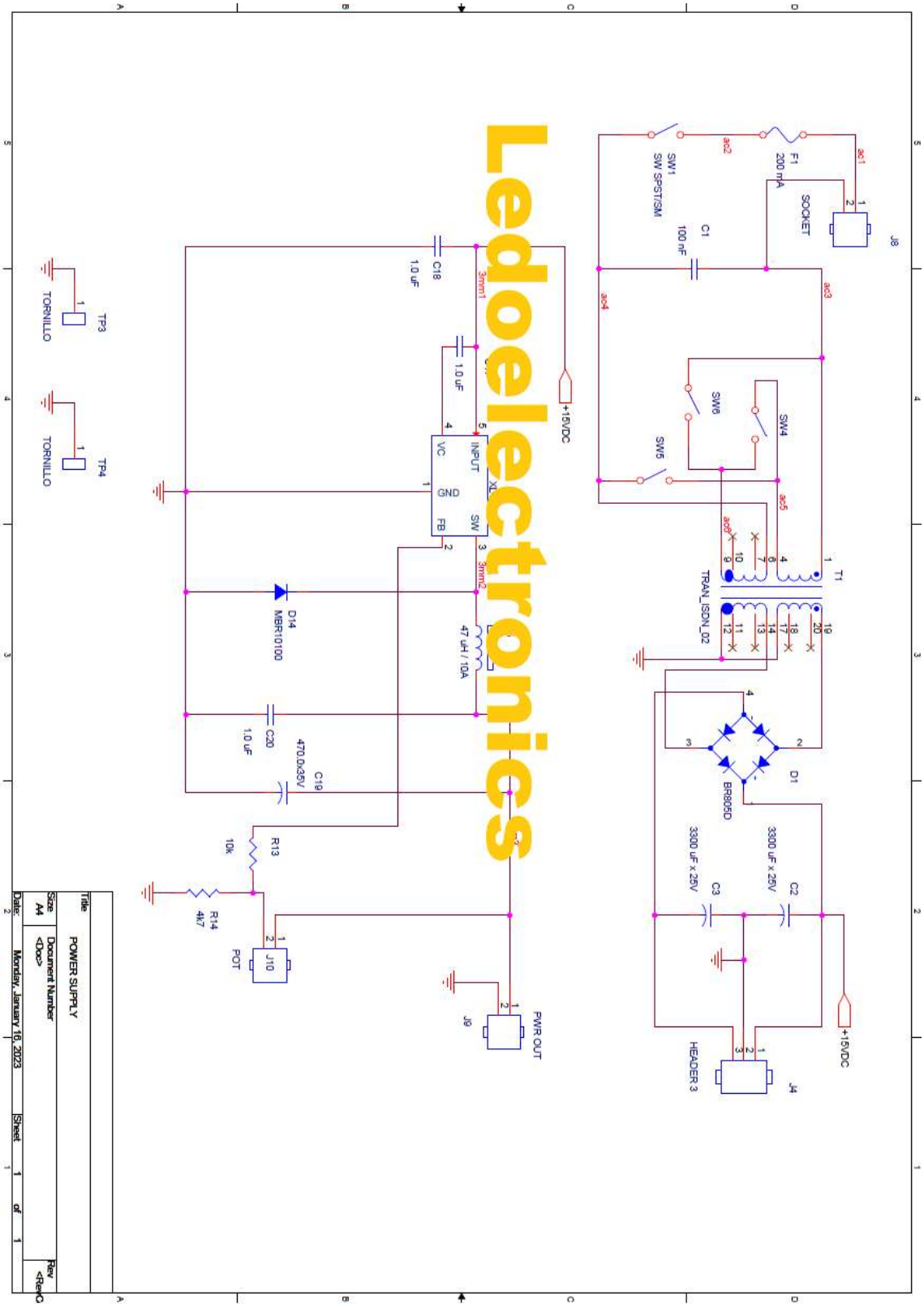
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FB
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VC
D14
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47 uH / 10A
C20
1.0 uF
C19
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Conclusions:

The Coil Doctor can be a great ally for all those who work in the world of electronics, whether they are professionals, hobbyists or students involved in the design and repair of electronic circuits. It is a compact, flexible, versatile and, above all, easy-to-use instrument, designed with the aim of facilitating design and diagnostic tasks. It has been manufactured without skimping on design time or cost of materials. It is a small and light equipment, easy to transport, that has an excellent wave generator, an innovative method to check Inductors and a simple regulated power supply. I hope that it is to your liking.

Typical Applications:

- Design and repair of amplifiers
- Design and adjustment of analog filters
- Design of frequency equalizers
- Manufacture of inductors
- Measurement of inductors (Inductance)
- Inductor check (saturation current)
- Manufacture and checking of pulse transformers for SCR, MOSFET, and IGBT.
- Design and check of gate drivers
- Measurement of capacitors by resonance frequency
- Supply of low power circuits
- Etc.