PREAMPLIFICATORI PER CONTEST IN 144 MHZ

Realizzazioni pratiche

Lucio Colautti

IV3HWT

51° Meeting Alpe Adria
Udine 20 ottobre 2024

caratteristiche di un preamplificatore per contest

- Cifra di rumore minore di 1,5 dB
- Guadagno regolabile
- Possibilità di essere telealimentato
- Buona selettività in ingresso in modo da ridurre drasticamente i segnali fuori banda (FM broadcasting, DAB plus ecc.)
- Elevata dinamica (IP 3 maggiore di + 10 dBm)
- Buon adattamento d'ingresso

Il dispositivo PSA4-5043+

LOW NOISE, HIGH IP3

Monolithic Amplifier PSA4-5043+

50Ω 0.05 to 4 GHz

THE BIG DEAL

- Ultra Low Noise Figure, 0.75 dB typ. at 1 GHz
- High IP3, up to 33.5 dBm typ. at 1 GHz
- Class 1B ESD rating (500V)
- Output Power at 1dB comp., up to +21 dBm typ.
- Gain, 18.4 dB typ. at 1GHz
- Supply Voltage, +3V, Id=33mA, +5V, Id=56mA
- Aqueous washable
- May be used as a replacement for SPF5043Z [a,b]

Generic photo used for illustration purposes only

CASE STYLE: MMM1362

+RoHS Compliant
The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

APPLICATIONS

- Cellular
- ISM
- GSM
- WCDMA
- LTE
- WiMax
- WLAN
- GPS

PRODUCT OVERVIEW

Mini-Circuits PSA4-5043+ is a E-PHEMT* based Ultra-Low Noise MMIC Amplifier operating from 50 MHz to 4 GHz with a unique combination of low noise and high IP3 making this amplifier ideal for sensitive high dynamic range receiver applications. This design operates on +3 to +5V supply at only 33 mA at 3V and 56mA at +5V, is internally matched to 50 ohms and is supplied in a super small SC-70 (SOT-343) MSL 1 package.

KEY FEATURES

Feature	Advantages
Ultra Low Noise: 0.75 dB at 1 GHz 0.98 dB at 2 GHz	Outstanding Noise Figure, measured in a 50 Ohm environment without any external matching
High IP3, 33.5 dBm	Combining Low Noise and High IP3 makes this MMIC amplifier ideal for Low Noise Receiver Front End (RFE) because it gives the user advantages at both ends of the dynamic range: sensitivity & two-tone spur-free dynamic range
High Output Power, +21 dBm	The PSA4-5043+ provides up to +21dBm output power at 1dB compression enabling this amplifier to support high linear dynamic range requirements.-
Broad Band, up to 4 GHz	Operating over a broadband from 50 MHz to 4 GHz, the PSA4-5043+ covers the primary wireless communications bands: Cellular, PCS, LTE, WiMAX
Internally Matched	No external matching elements required to achieve the advertised noise and output power over the full band
SOT-343 Package	Small size, industry standard package
High Reliability	Low, small signal operating current of 53mA nominal maintains junction temperatures typically below 125°C at 85°C ground lead temperature
Class 1B ESD (500V, HBM)	The PSA4-5043+ is a super low noise PHEMT based design. Unlike many other PHEMT designs. Mini-Circuits incorporates ESD protection on die to achieve industry leading ESD performance for a low noise amplifier.

* Enhancement mode pseudomorphic High Electron Mobility Transistor.

A. Suitability for model replacement within a particular system must be determined by and is solely the responsibility of the customer based on, among other things, electrical performance criteria, stimulus conditions, application, compatibility with other components and environmental conditions and stresses.

B. The RFMD SPF5043Z part number is used for identification and comparison purposes only.

REV. C
ECO-011279
PSA4-5043+
MCL NY
220105

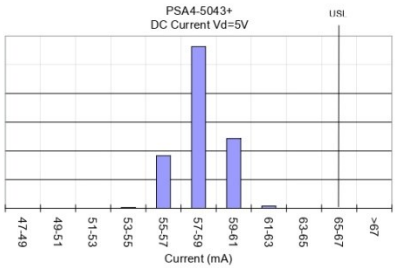
LOW NOISE, HIGH IP3

Monolithic Amplifier PSA4-5043+

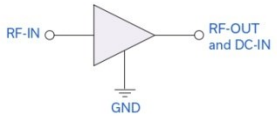
MAXIMUM RATINGS[4]

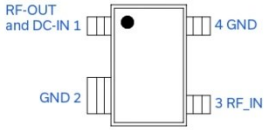
Parameter	Ratings
Operating Temperature[5]	-40°C to 85°C
Storage Temperature	-65°C to 150°C
Channel Temperature	150°C
DC Voltage	6V
Device Current	76 mA
Power Dissipation	380 mW
Input Power (CW)	23 dBm (5 minutes max), 17dBm (continous)

(1) Measured on Mini-Circuits Characterization test board TB-471+.
See Characterization Test Circuit (Fig. 1)
(2) Current increases at P1dB
(3) (Current at 85°C - Current at -45°C)/130
(4) Permanent damage may occur if any of these limits are exceeded. These maximum ratings are not intended for continuous normal operation.
(5) Defined with reference to ground pad temperature.



SIMPLIFIED SCHEMATIC AND PIN DESCRIPTION





Function	Pin Number	Description (See Application Circuit, Fig. 2)
RF-IN	3	RF input pin (connect to RF-IN via DC blocking cap)
RF-OUT & DC-IN	1	RF output pin (connected to RF-out via blocking cap C2 and supply voltage Vd via RF Choke L1)
GND	2,4	Connections to ground: use via holes as shown in "Suggested Layout for PCB Design" to reduce ground path inductance for best performance.

LOW NOISE, HIGH IP3

Monolithic Amplifier PSA4-5043+

CHARACTERIZATION TEST CIRCUIT

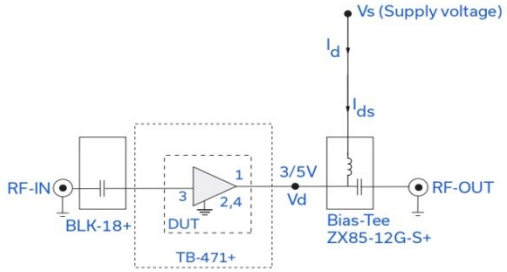


Fig 1. Block Diagram of Test Circuit used for characterization. (DUT soldered on Mini-Circuits Characterization Test Board TB-471+)
Gain, Return loss, Output power at 1dB compression (P1 dB), Output IP3 (OIP3) and Noise Figure measured using Agilent's N5242A PNA-X microwave network analyzer.

Conditions:
1. Gain: Pin= -25dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, 5 dBm/ tone at output.

RECOMMENDED APPLICATION CIRCUIT

(refer to evaluation board for PCB Layout and component values)

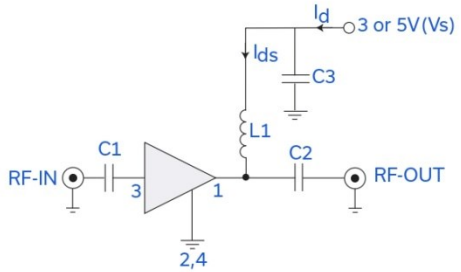
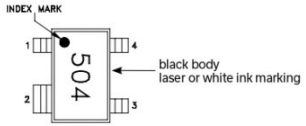


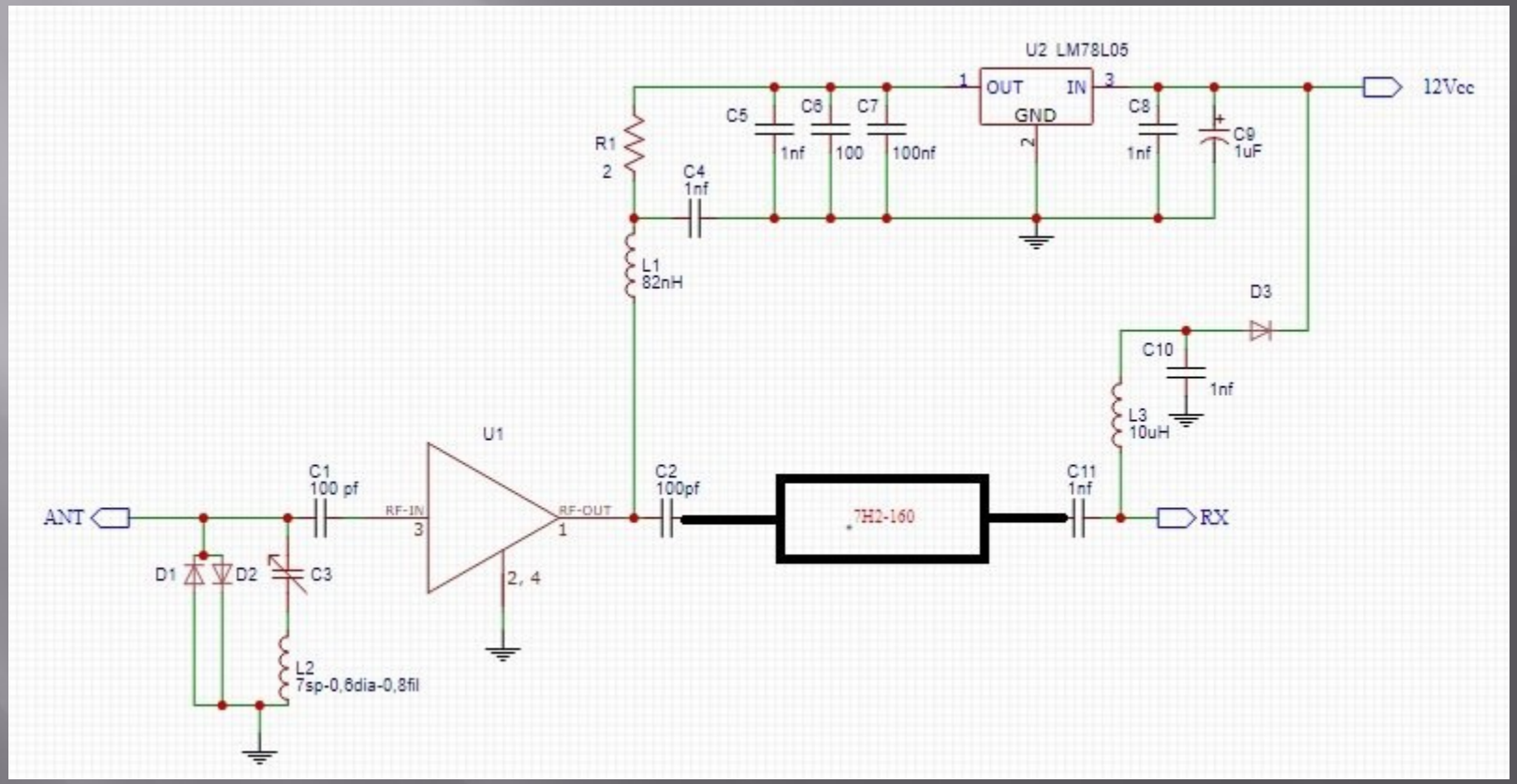
Fig 2. Recommended Application Circuit
Note: Resistance of L1, 0.1-0.2Ω typically

PRODUCT MARKING

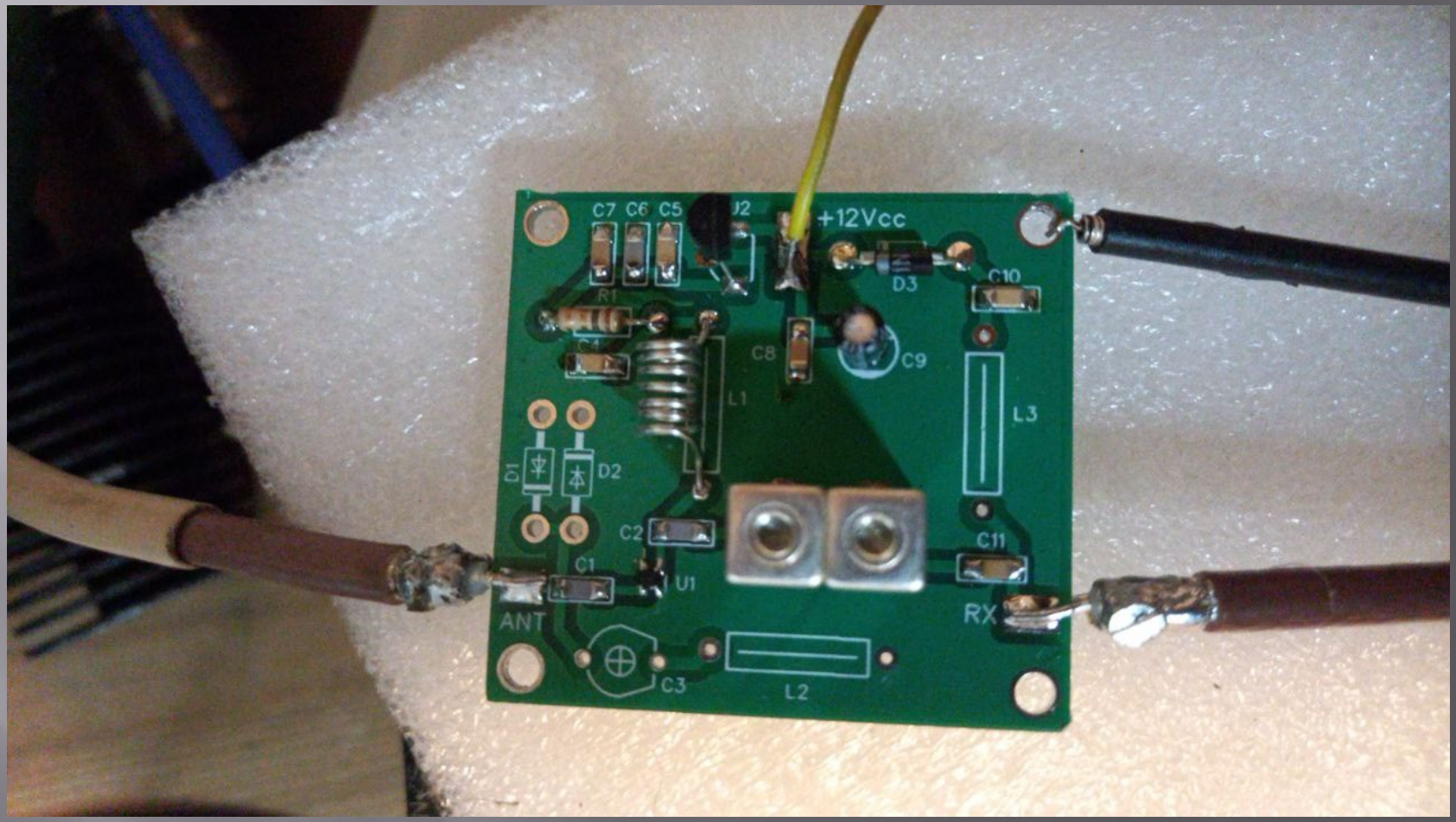


Marking may contain other features or characters for internal lot control

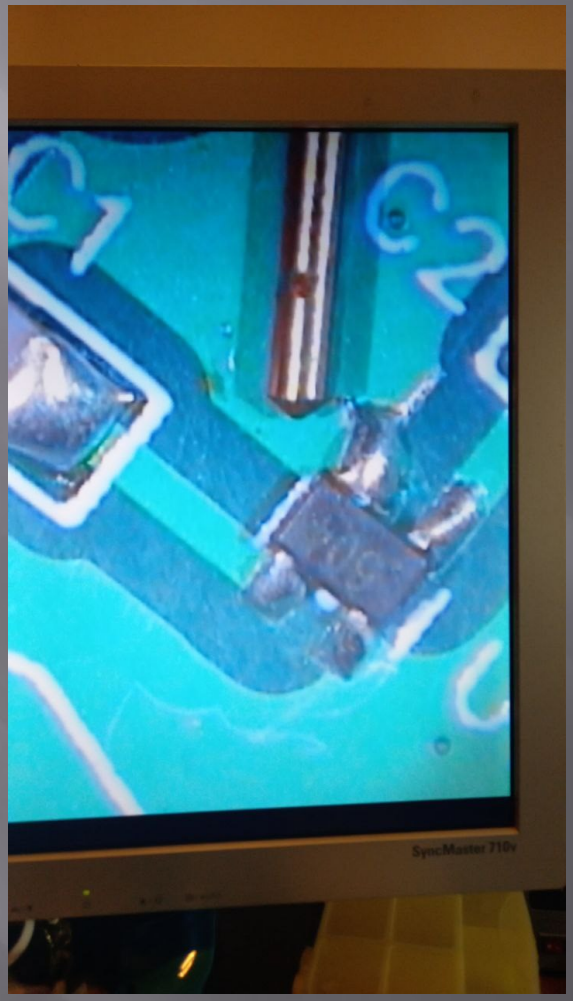
Schema elettrico



Il prototipo



Dimensioni del dispositivo



Risultati delle misure

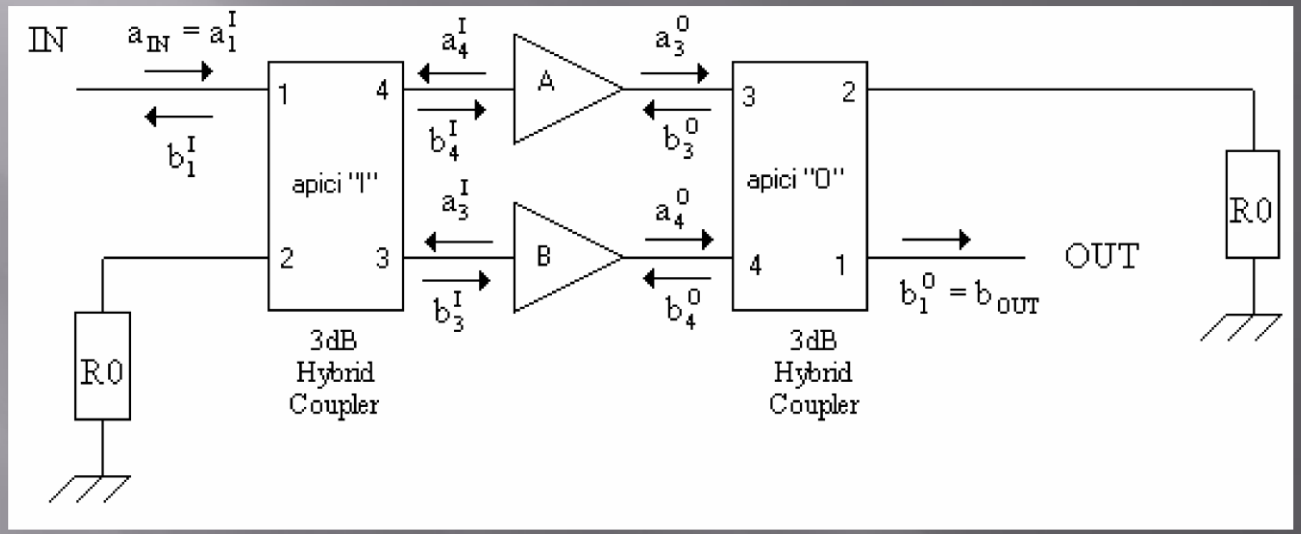
- NF 0,8 dB
- IP + 7,6 dBm

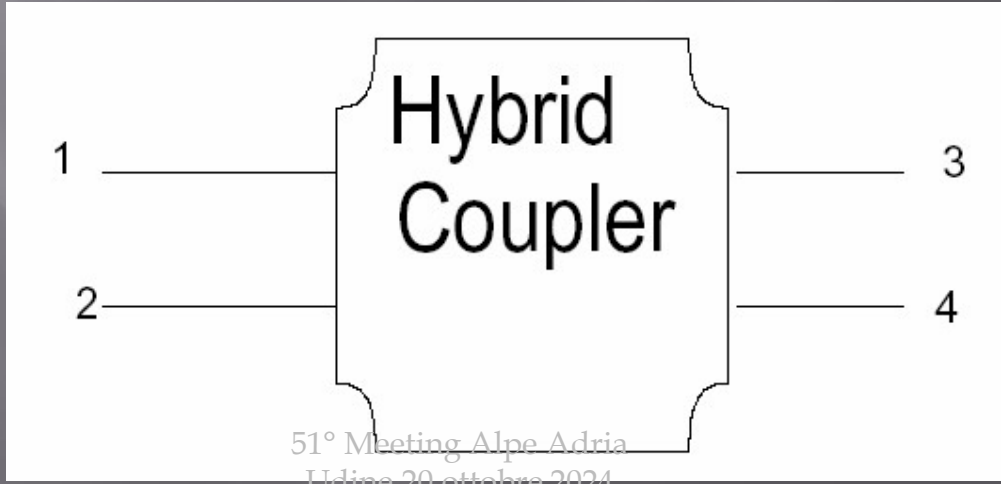
Come migliorare le prestazioni

Il front end di di OM6AA

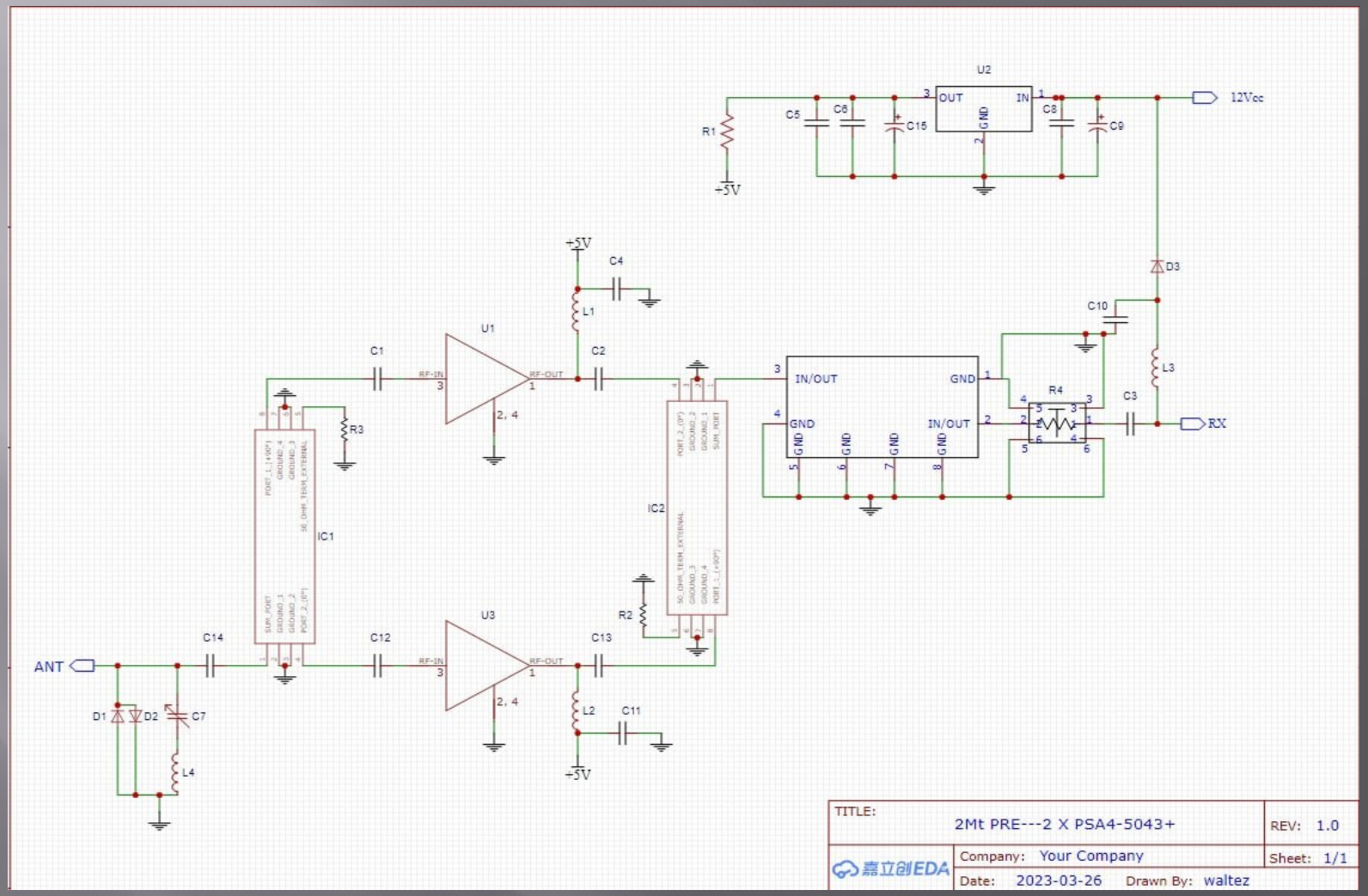
- **Rugged 2 m Preamplifier for Tough RF Conditions**

L'amplificatore bilanciato

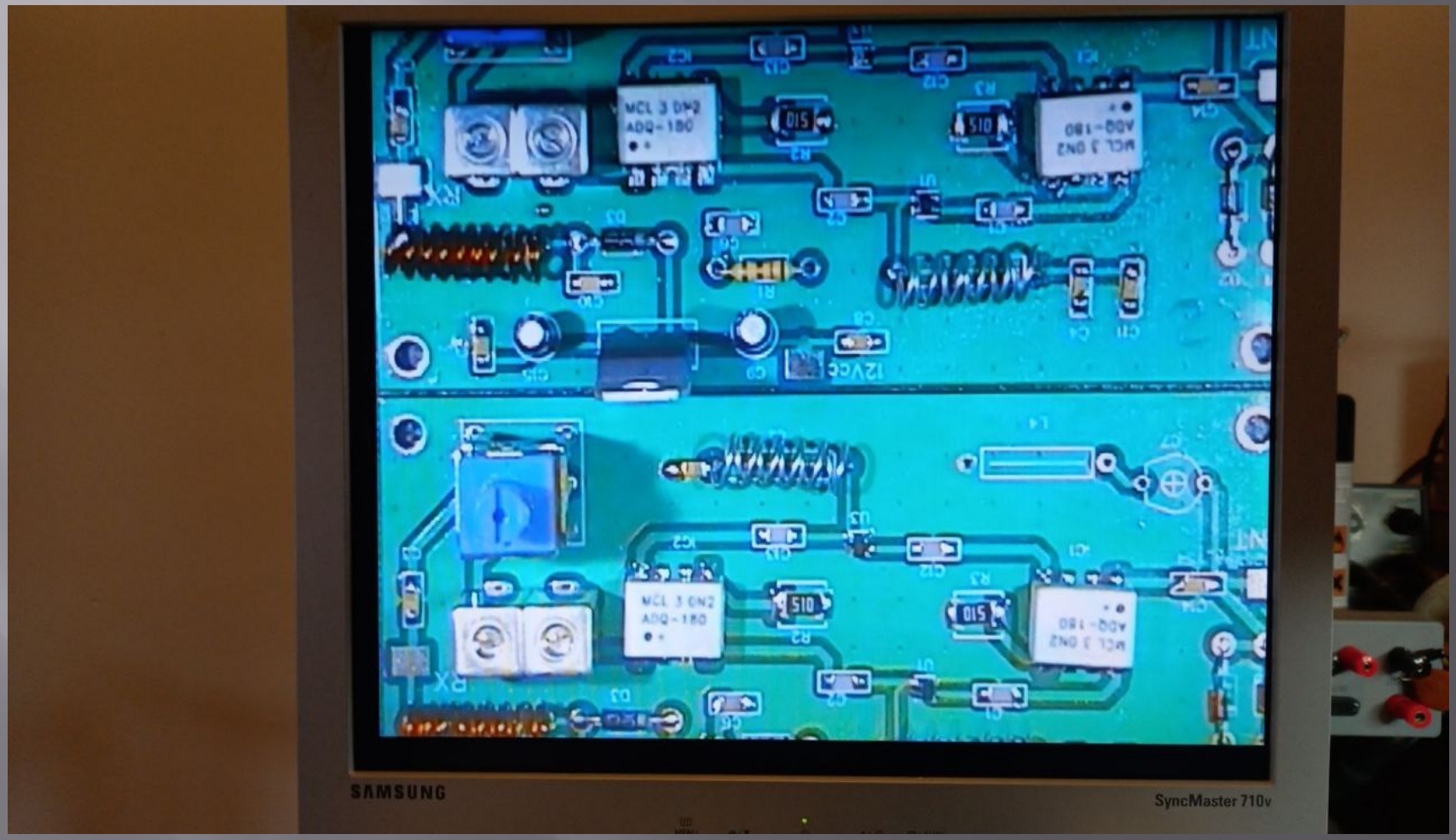




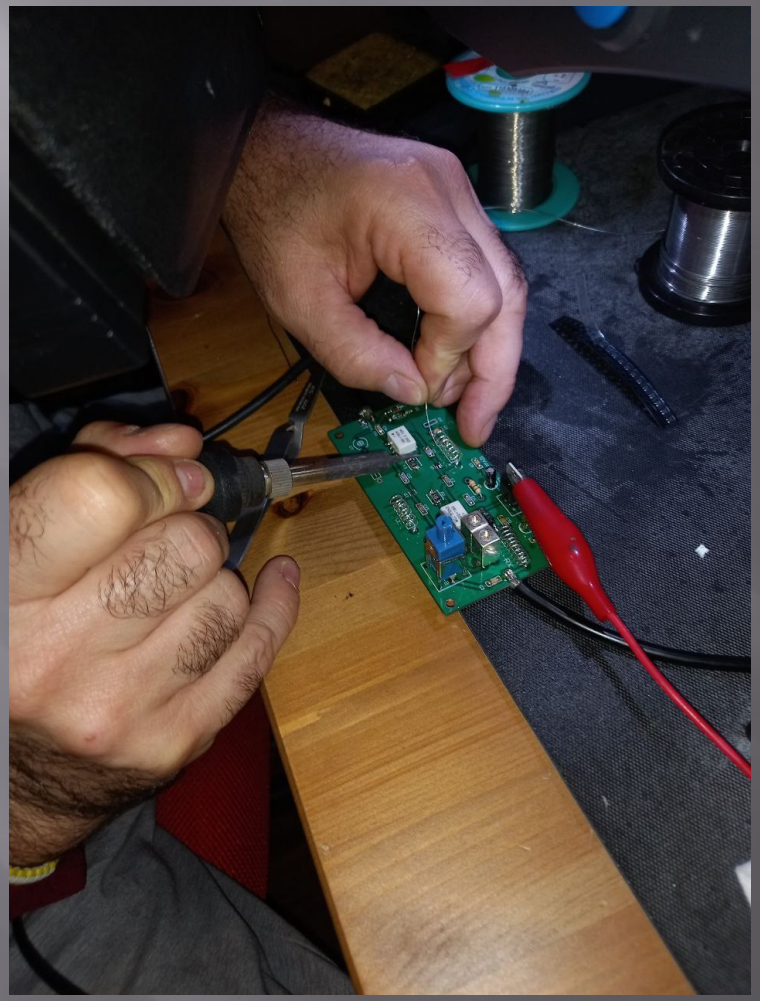
Il pre bilanciato con i PSA4 5043+



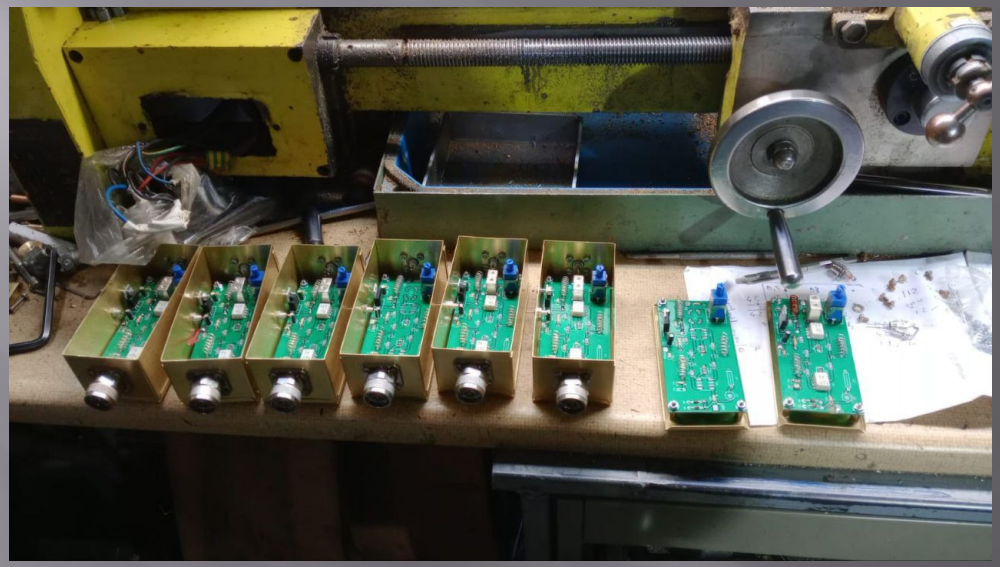
La realizzazione



Montaggio dei PSA4 5043+



Alcuni dispositivi



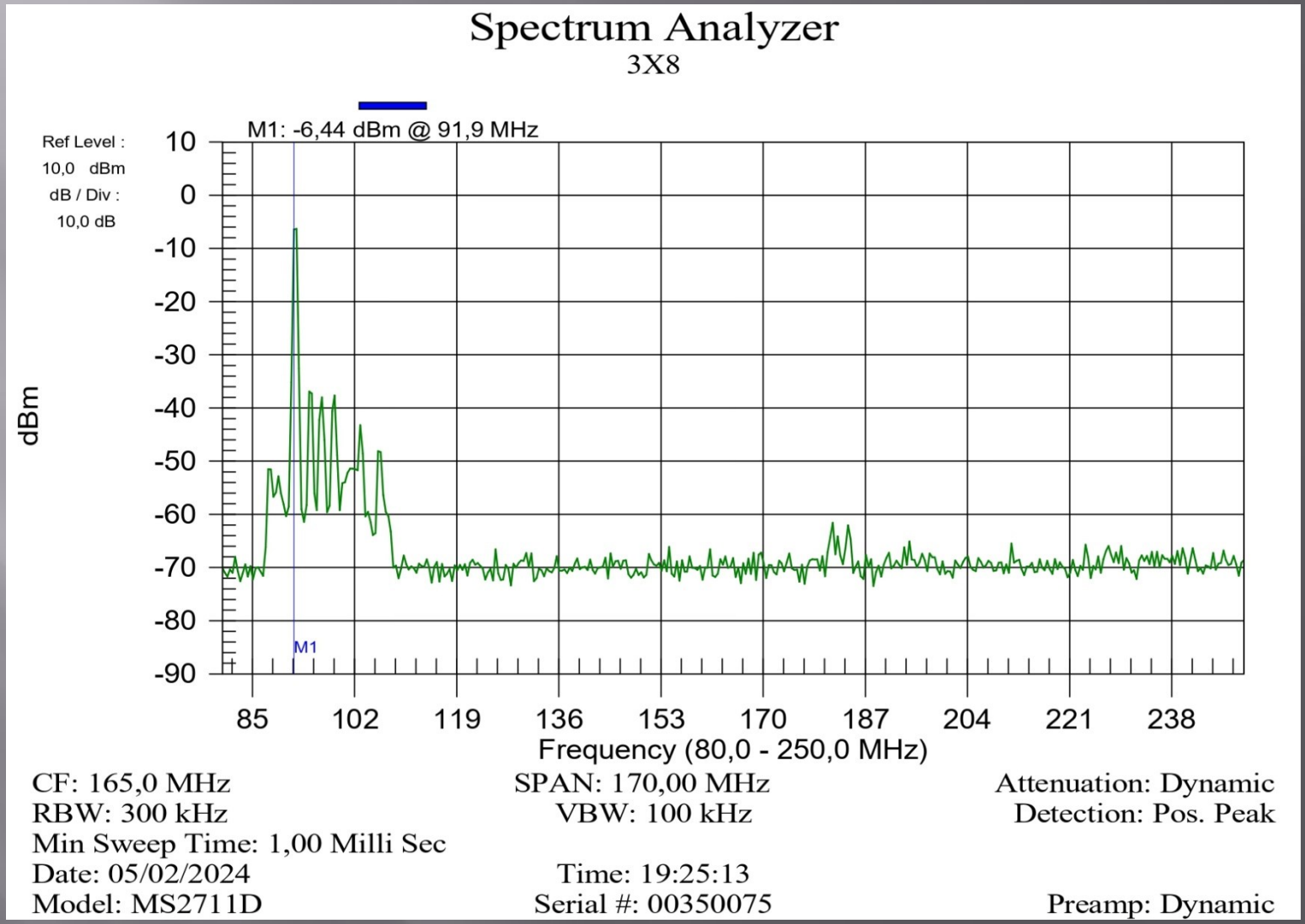
51° Meeting Alpe Adria
Udine 20 ottobre 2024

Le misure dei pre

preamplificatori monte Nerone

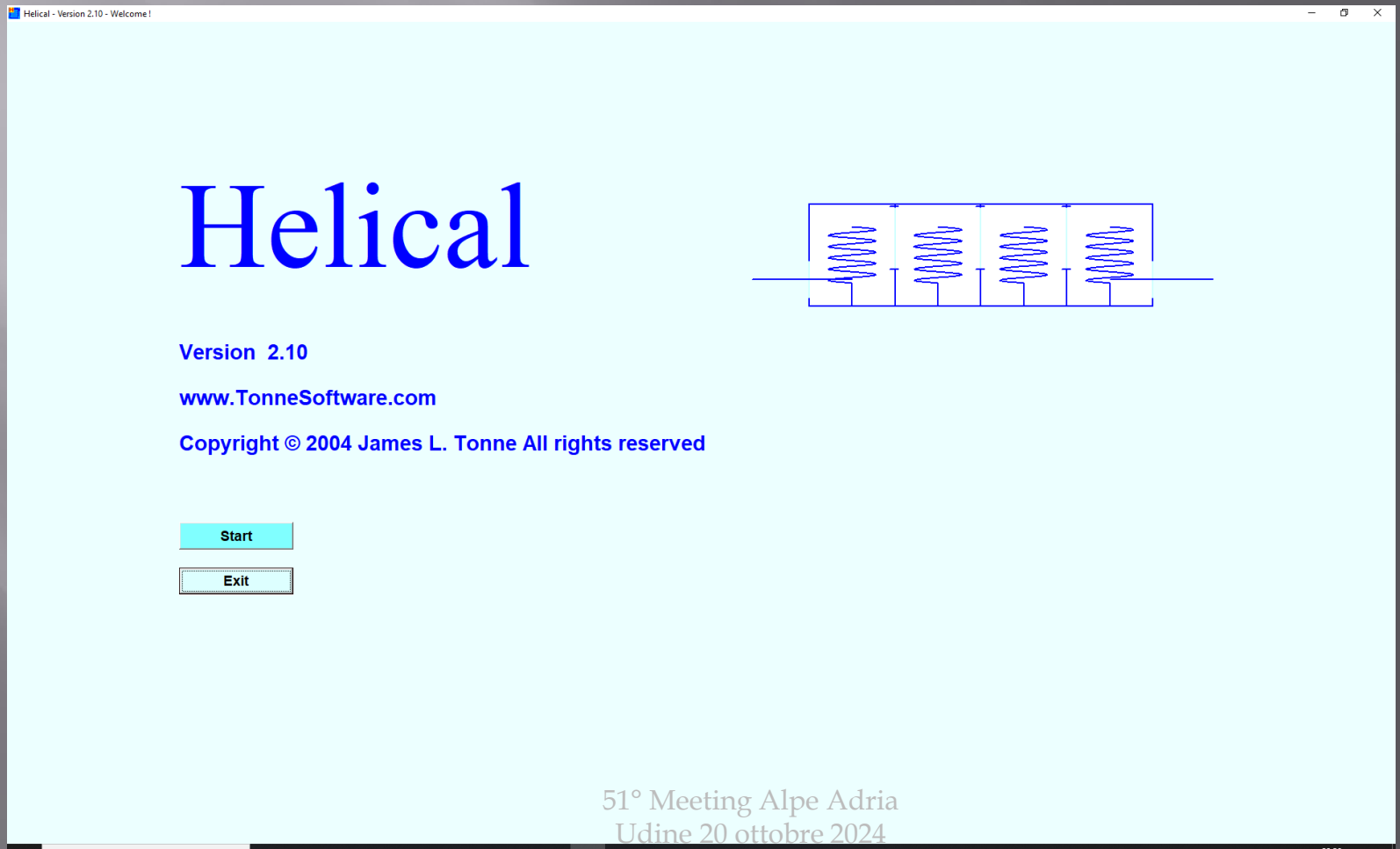
N. Pre	Gain	NF	Delta IMD	IP III input
1	14,62	0,87	61,50	10,75
2	14,01	0,85	58,50	9,25
3	14,08	0,87	60,37	10,19
4	14,09	0,88	58,68	9,34
5	14,20	0,98	57,30	8,65
6	14,12	0,90	58,20	9,10
7	14,10	0,91	58,87	9,44

I segnali FM sul Monte Nerone



Il filtro d'ingresso

- Il programma Helical



Progetto di un filtro a due eliche

Helical - Version 2.10 - Pictorial

Get file | Save file | Setup | Pictorial | Equivalent | Plot | Tabulate | Print | Exit

Pictorial

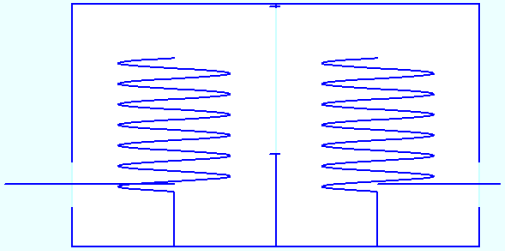
Shield:
- Height: 2,5631 in., 6,5103 cm
- Width: 1,7087 in., 4,3402 cm
- Resonator impedance: 397,73 ohms

Coil:
- Length: 1,4097 in., 3,5807 cm
- Diameter: 0,93981 in., 2,3871 cm
- Number of turns: 6,4935

Wire:
- Minimum diameter: 0,07322 in., 0,18599 cm
- Maximum diameter: 0,10983 in., 0,27898 cm

Tap: (for 50 ohms)
- Turns: 0,35028
- Degrees: 126,1

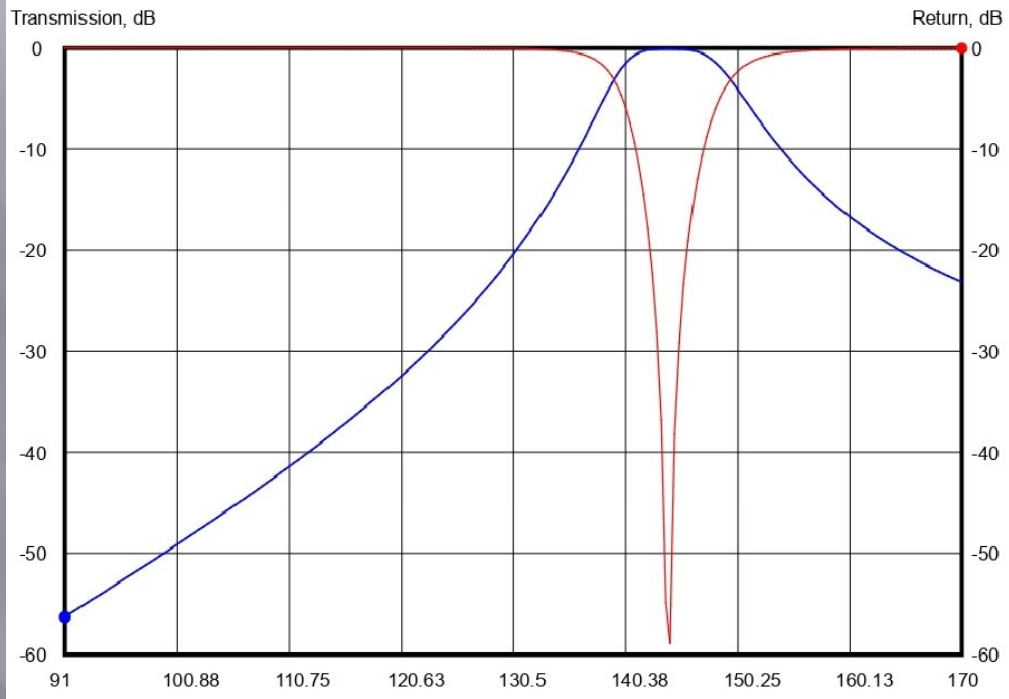
Unloaded resonator
- Square chamber Q: 1,229k
- Round chamber Q: 1,025k



This illustrates capacitive (top-side) coupling slots between resonators

Coupling
- K(1,2): 1,5341 in., 3,8965 cm

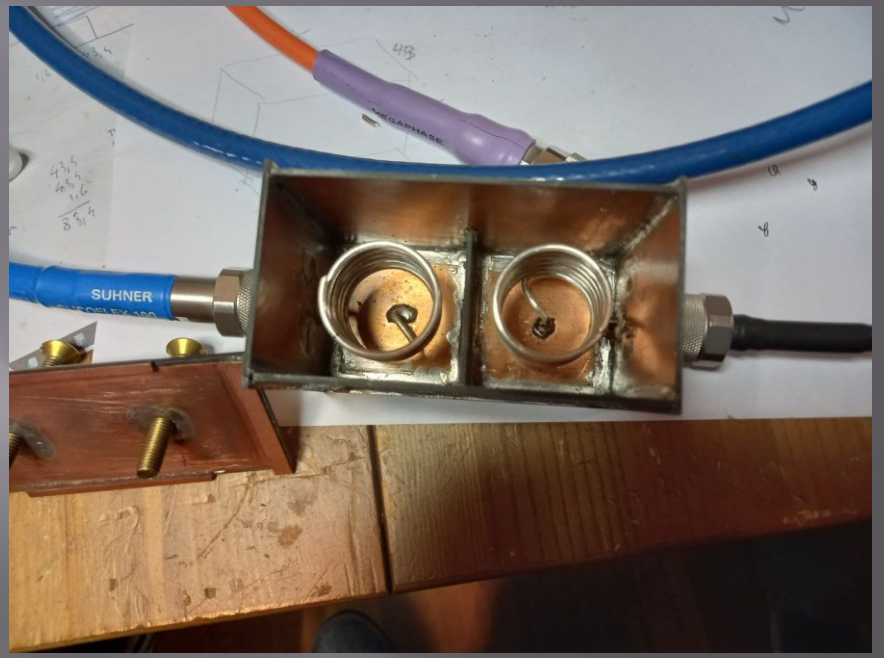
Risposta in frequenza



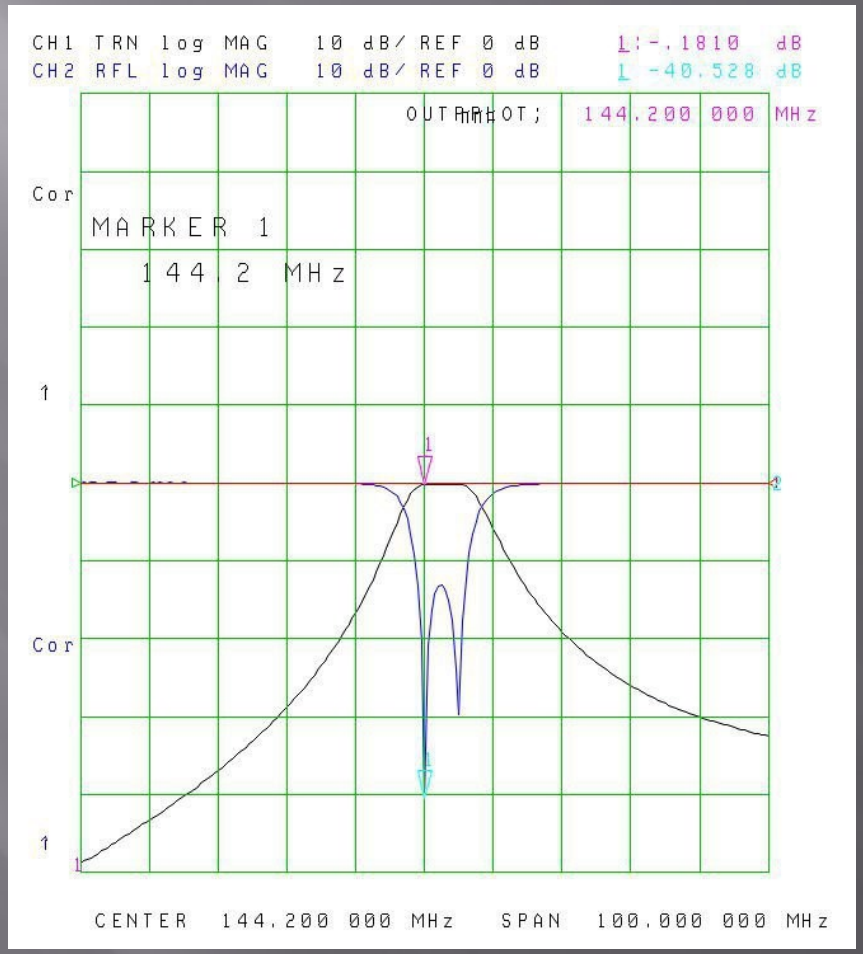
Center frequency: 144,2 MHz
Bandwidth: 10 MHz
Order: 2
Family: Butterworth
Passband ripple: 0 dB

05/10/2024 20:37:42
Helical Version 2.10 from www.TonneSoftware.com

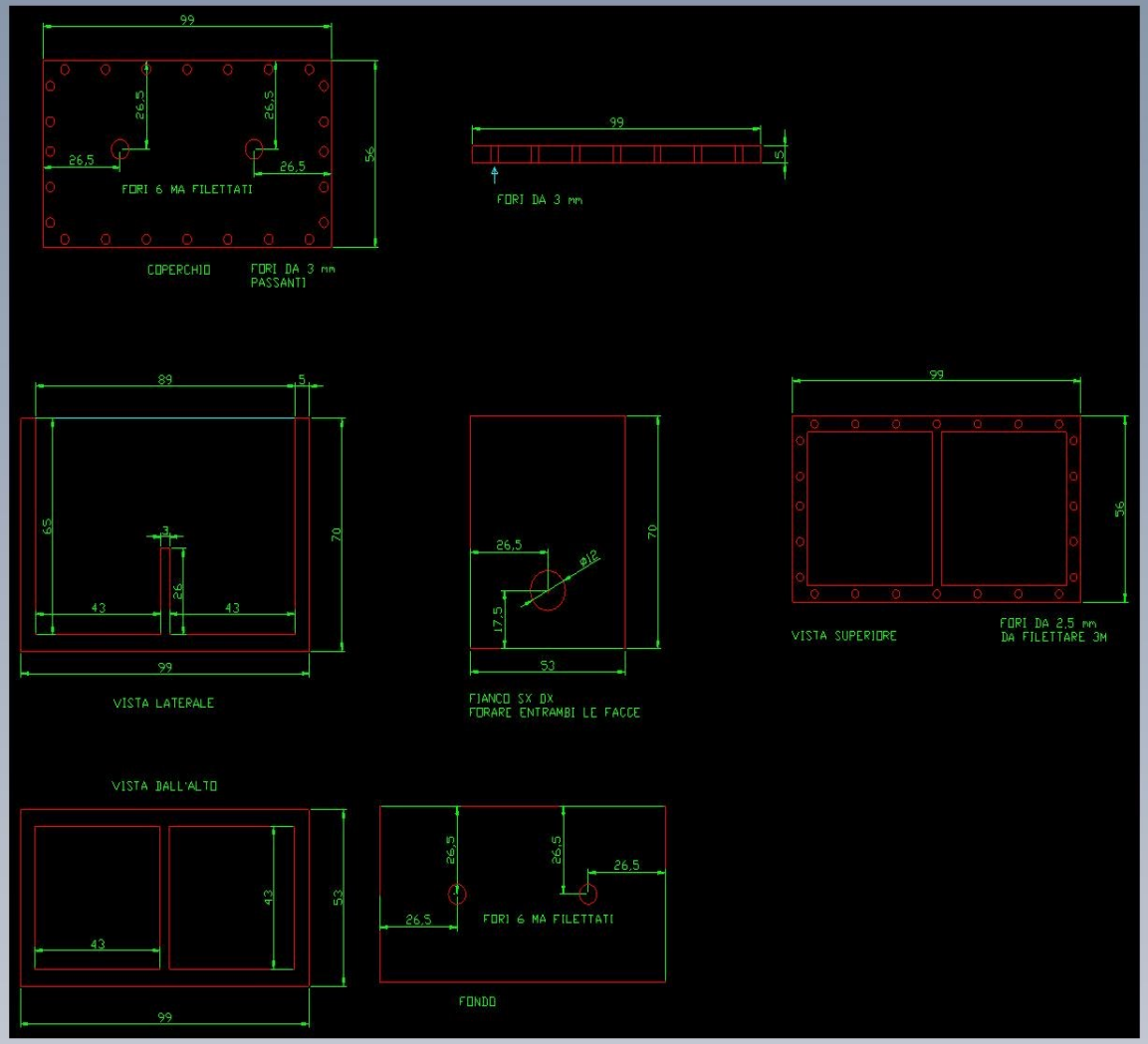
Il prototipo



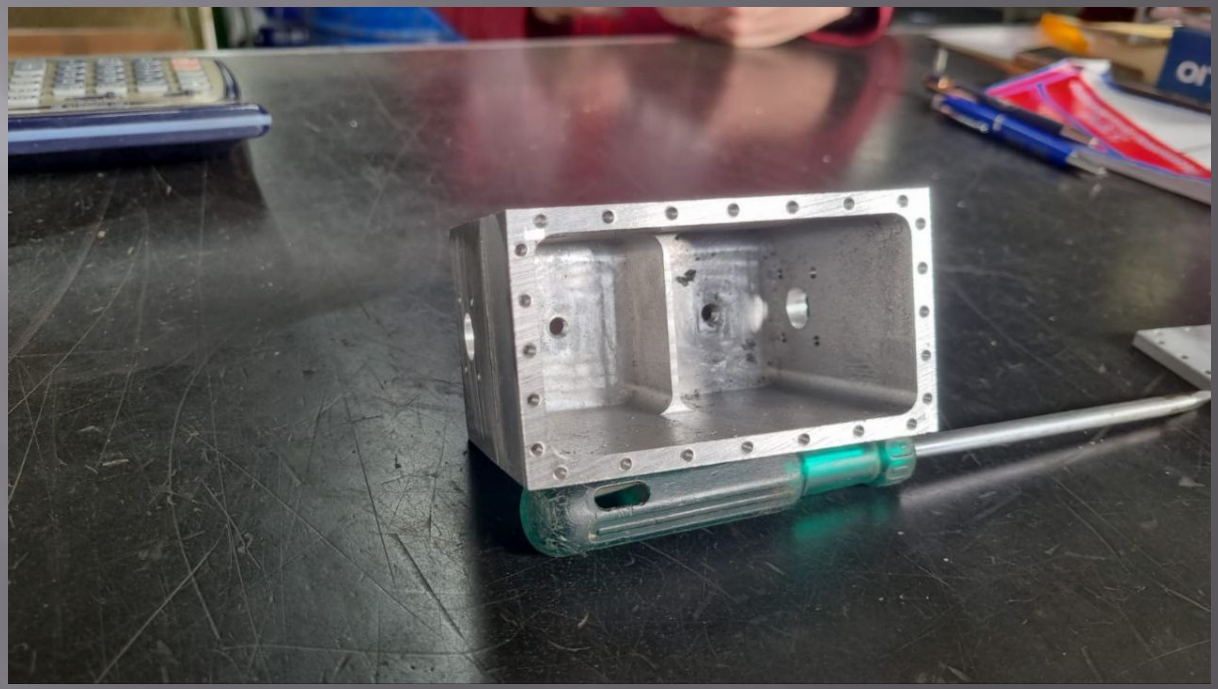
Misure del filtro



La versione definitiva

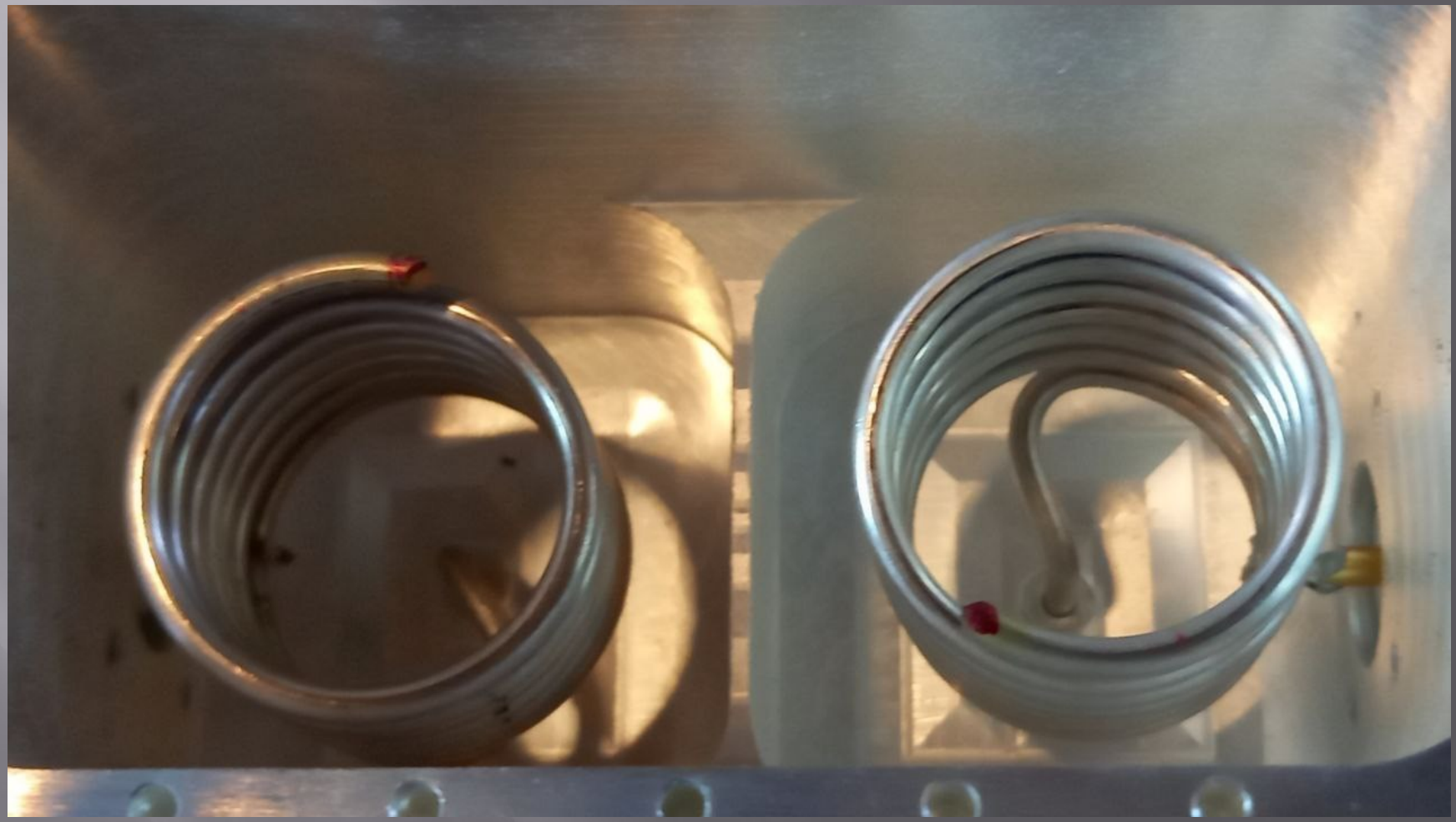


Le scatole fresate

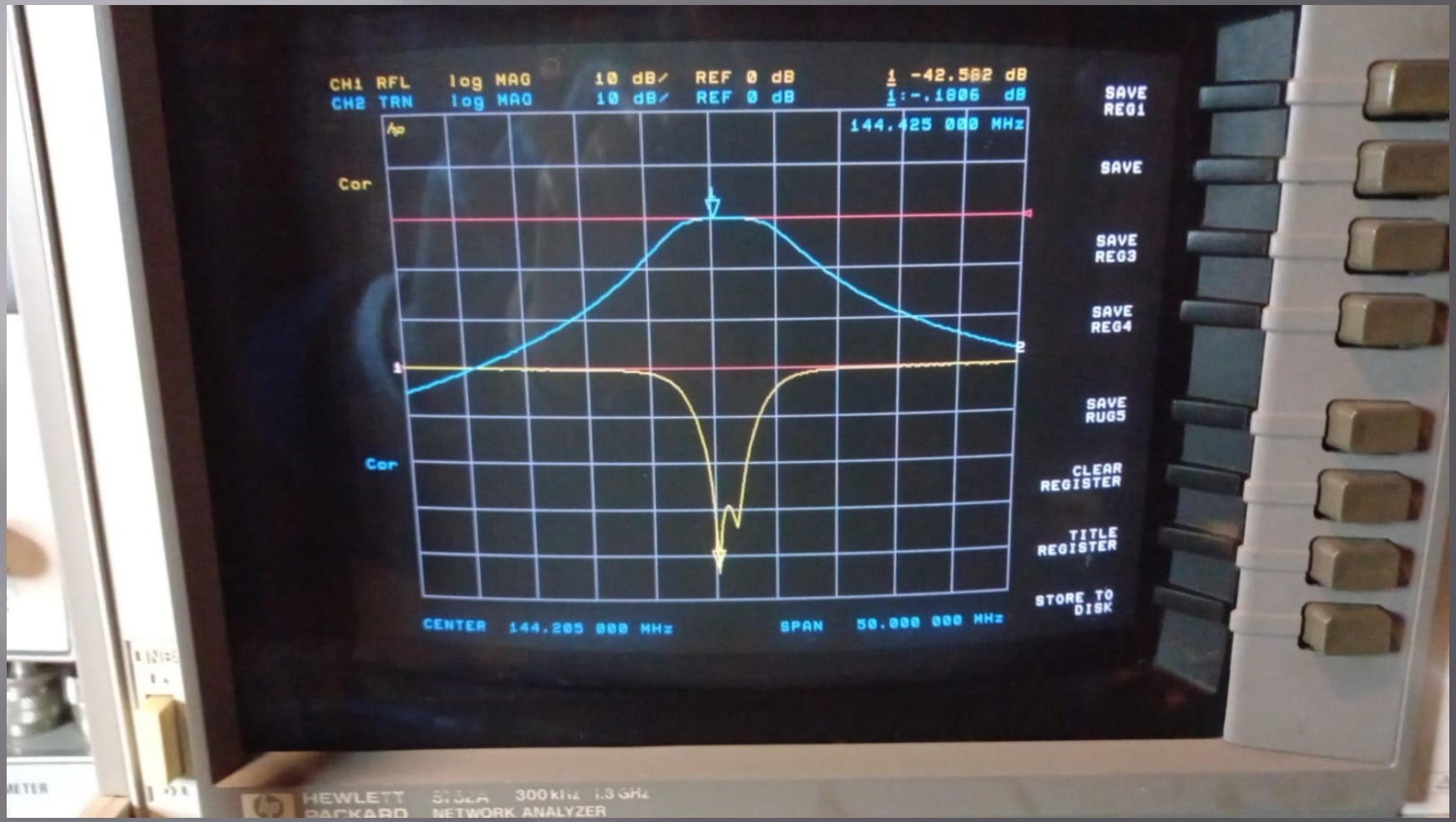


Le scatole fresate e argentate

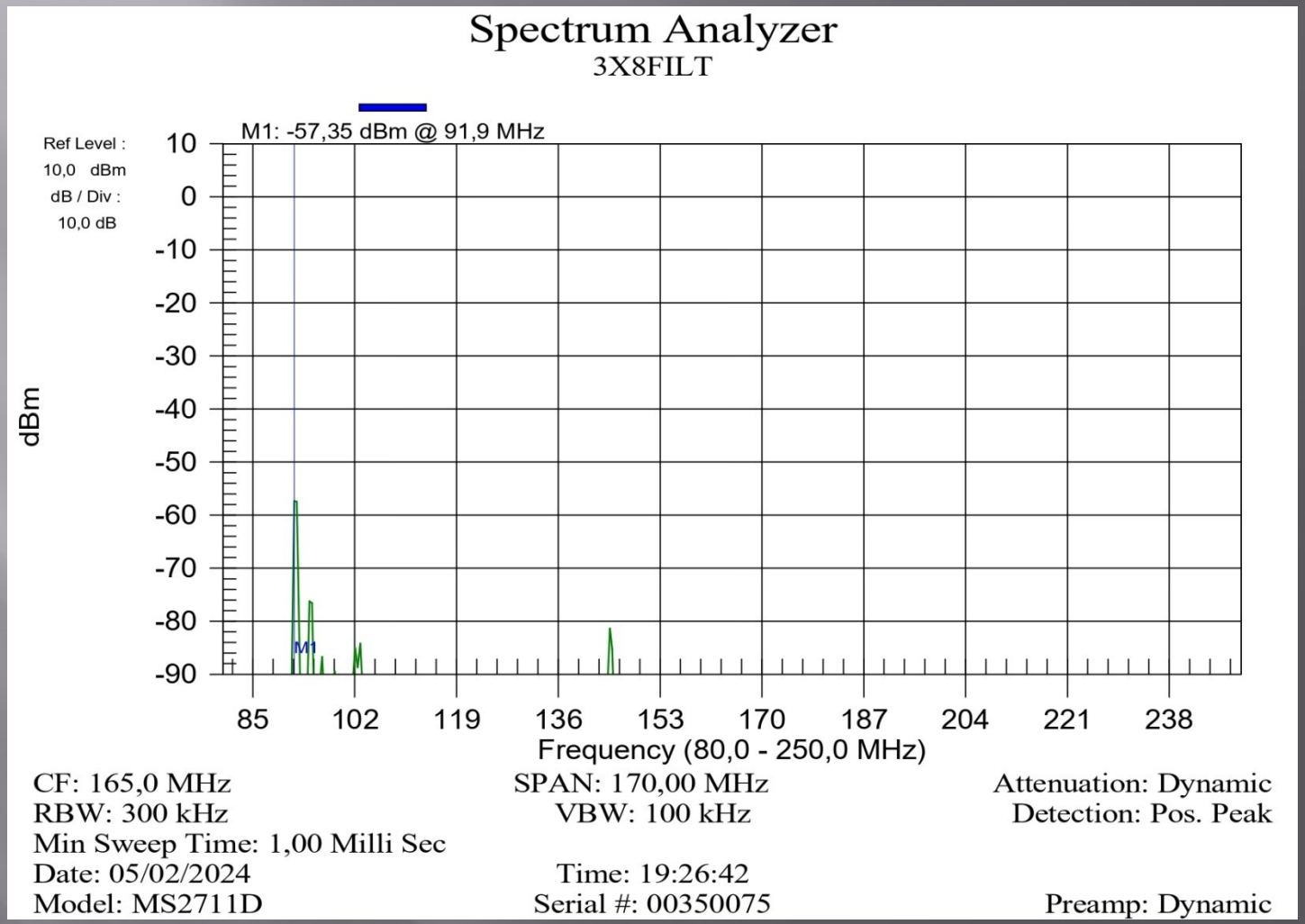
Costruzione del filtro



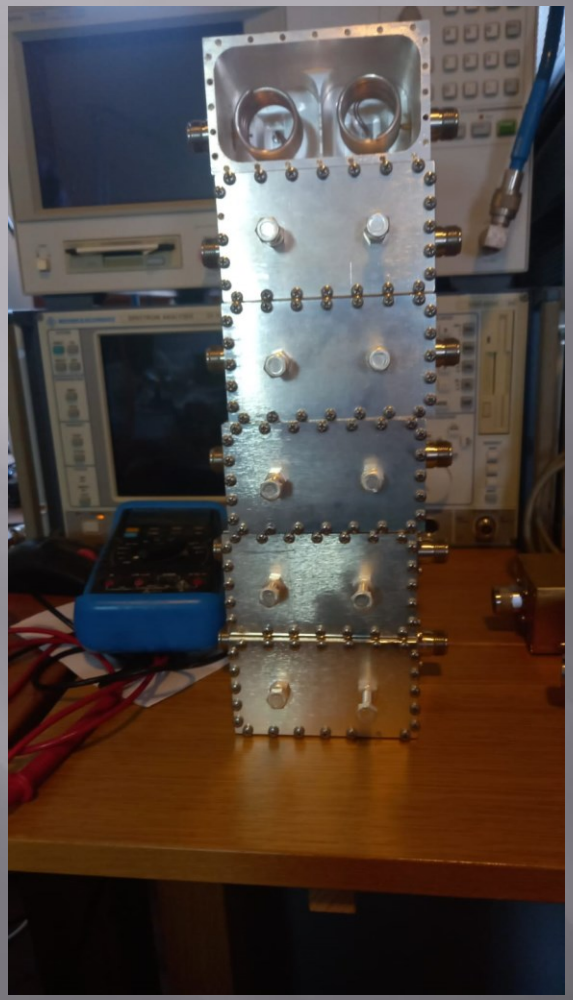
Misure

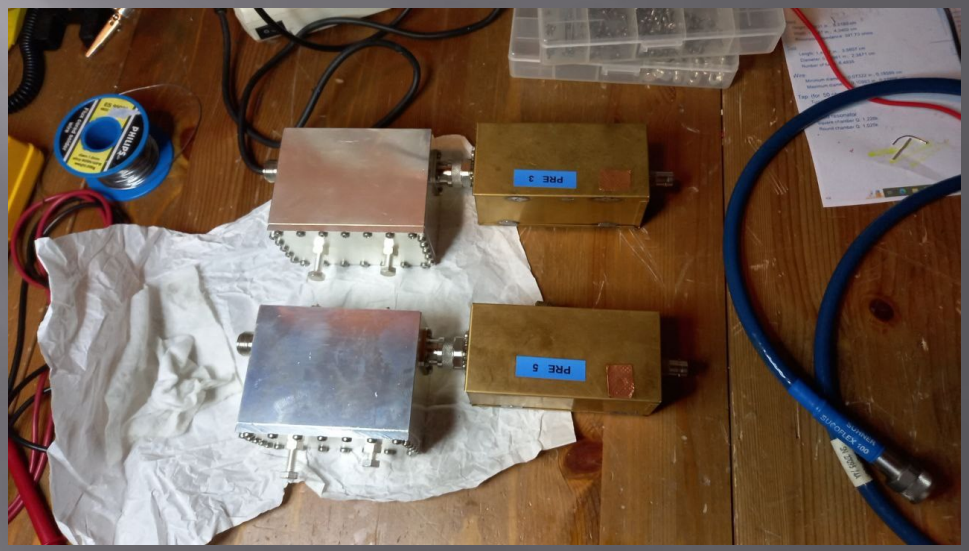

CH1 RFL log MAG 10 dB/ REF 0 dB 1 -42.582 dB
CH2 TRN log MAG 10 dB/ REF 0 dB 1:-.1806 dB
144.425 000 MHz
Cor
Cor
SAVE REG1
SAVE
SAVE REG3
SAVE REG4
SAVE RUG5
CLEAR REGISTER
TITLE REGISTER
STORE TO DISK
CENTER 144.205 000 MHz
SPAN 50.000 000 MHz
HEWLETT PACKARD
NETWORK ANALYZER

Le 3 x8 el. con il filtro RF

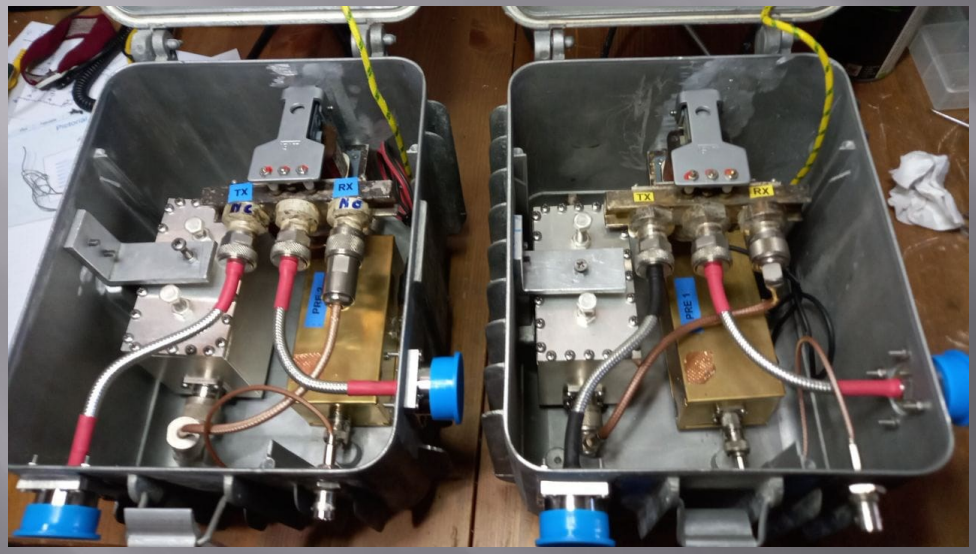


FILTRI E PREAMPLIFICATORI





Le unità d'esterno



Misure dei filtri

misure filtri "monte Nerone" filtri ad elica a due poli				
	analizatore di rete			gen. e Bolometro
unità	perdita (dB)	return loss dB	att. a 92,2 Mhz	perdita d'inserzione
1	0,17	48,00	53,40	0,20
2	0,16	50,00	52,00	0,15
3	0,18	42,00	52,00	0,22
4	0,17	33,00	51,00	0,17
5	0,13	31,00	49,00	0,14
6	0,12	43,00	49,00	0,14
7	0,19	50,00	54,00	0,19
8	0,10	44,00	49,00	0,17
9	0,14	30,00	50,00	0,11
10	0,12	49,00	50,00	0,16

NUOVI SVILUPPI

- Il dispositivo TQP3M9036 della Qorvo

qorvo

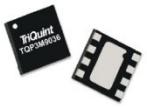
TQP3M9036
Ultra-Low Noise, High Linearity LNA

Product Overview

The TQP3M9036 is a high linearity, ultra-low noise gain block amplifier in a small 2x2 mm surface-mount package. At 900 MHz, the amplifier typically provides high 19.8 dB gain, +36 dBm OIP3, and 0.45 dB Noise Figure while drawing 68 mA current from a 5V supply. The amplifier does not require any negative supplies for operation and can be biased from positive supply rails from 3.3 to 5 V. The device is housed in a lead-free/green/RoHS-compliant industry-standard 2x2 mm package.

The TQP3M9036 is internally matched using a high-performance E-pHEMT process and only requires 4 external components for operation from a single positive supply: an external RF choke and blocking/bypass capacitors. The low noise amplifier contains an internal active bias to maintain high performance over temperature and integrates a shut-down biasing capability for TDD applications.

The TQP3M9036 covers the 50–2000 MHz frequency band and is targeted for wireless infrastructure. The LNA is pin compatible with the high-band, 1500–2700 MHz TQP3M9037.

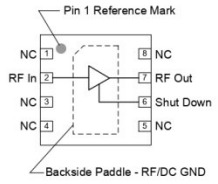


8-pin 2x2 mm DFN Package

Key Features

- 50–2000 MHz Operational Bandwidth
- Ultra-low noise figure, 0.45 dB NF at 900 MHz
- High gain, 19.8 dB Gain at 900 MHz
- High linearity, +36 dBm Output IP3
- High input power ruggedness, >22 dBm $P_{IN,MAX}$
- Unconditionally stable
- Integrated on-chip matching, 50 ohm in/out
- Integrated active bias
- Integrated shutdown control pin
- 3-5 V positive supply voltage: –Vgg not required
- Pin compatible with high-band TQP3M9037

Functional Block Diagram



Top View

Applications

- Repeaters
- Mobile Infrastructure
- LTE / WCDMA / CDMA / GSM
- General Purpose Wireless
- TDD or FDD systems

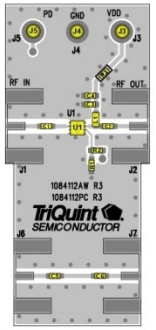
Ordering Information

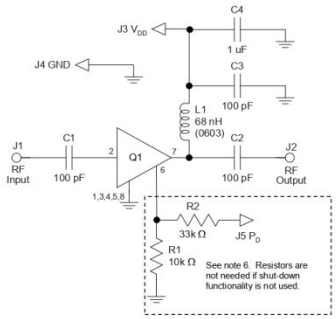
Part No.	Description
TQP3M9036	Ultra low noise, High IP3 LNA
TQP3M9036-PCB	100–2000 MHz Evaluation Board

Standard T/R size = 2500 pieces on a 7" reel

qorvo

Application Circuit – TQP3M9036-PCB





Notes:

1. See Evaluation Board PCB Information section for material and stack-up.
2. R3 (0 Ω jumper) is not shown on the schematic and may be replaced with copper trace in the target application layout.
3. All components are of 0402 size unless stated on the schematic.
4. C1, C2, and C3 are non-critical values. The reactive impedance should be as low as possible at the frequency of operation for optimal performance.
5. The L1 value is non-critical and needs to provide high reactive impedance at the frequency of operation.
6. R1 and R2 are optional and do not need to be loaded if the shut-down functionality is not needed; i.e. FDD applications. If R1 and R2 are not loaded, the LNA will operate in its standard "ON" state.
7. A through line is included on the evaluation board for board loss measurement and de-embedding.

Bill of Material – TQP3M9036-PCB

Reference Des.	Value	Description	Manuf.	Part Number
-	-	PCB, Printed Circuit Board	Qorvo	1084112
U1	-	AMP, Ultra-Low Noise, High Linearity	Qorvo	TQP3M9036
R1	10K Ω	RES, 0402, 5%, 1/16W	various	various
R2	33K Ω	RES, 0402, 5%, 1/16W	various	various
R3	0 Ω	RES, 0402, 5%, 1/16W	various	various
L1	68 nH	IND, 0603, 5%, Ceramic	various	various
C4	1.0 µF	CAP, 0402, 10%, 10V, X5R	various	various
C1, C2, C3, C5, C6	100 pF	CAP, 0402, 5%, 50V, NPO/COG	various	various
J3, J4, J5	-	Solder Turret	various	various

Dimensioni e schema di montaggio del dispositivo

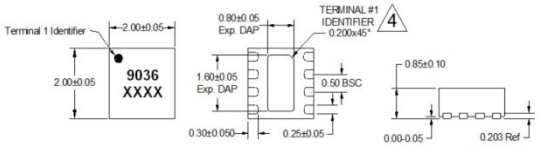
qorvo

TQP3M9036
Ultra-Low Noise, High Linearity LNA

Mechanical Information

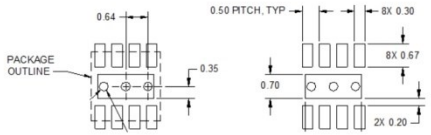
Package Marking and Dimensions

Marking: Part number – 9036
Lot Code – XXXX

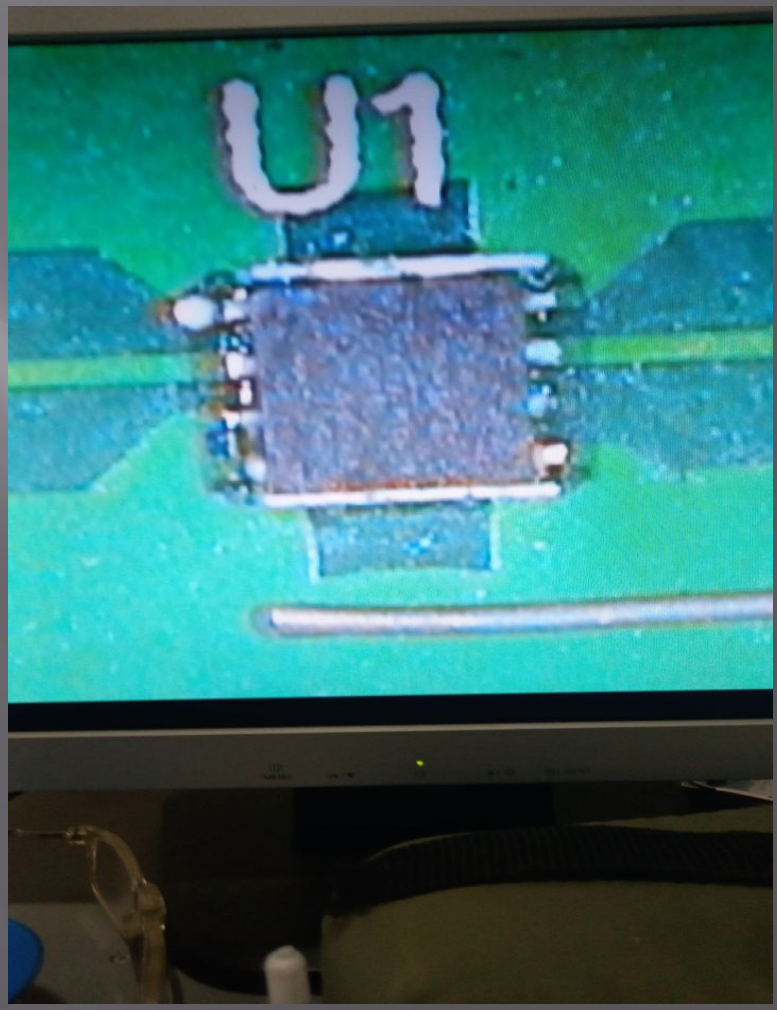


NOTES:
1. All dimensions are in millimeters. Angles are in degrees.
2. Except where noted, this part outline conforms to JEDEC standard MO-220, Issue E (Variation VGGC) for thermally enhanced plastic very thin fine pitch quad flat no lead package (QFN).
3. Dimension and tolerance formats conform to ASME Y14.4M-1994.
4. The terminal #1 identifier and terminal numbering conform to JESD 95-1 SPP-012.

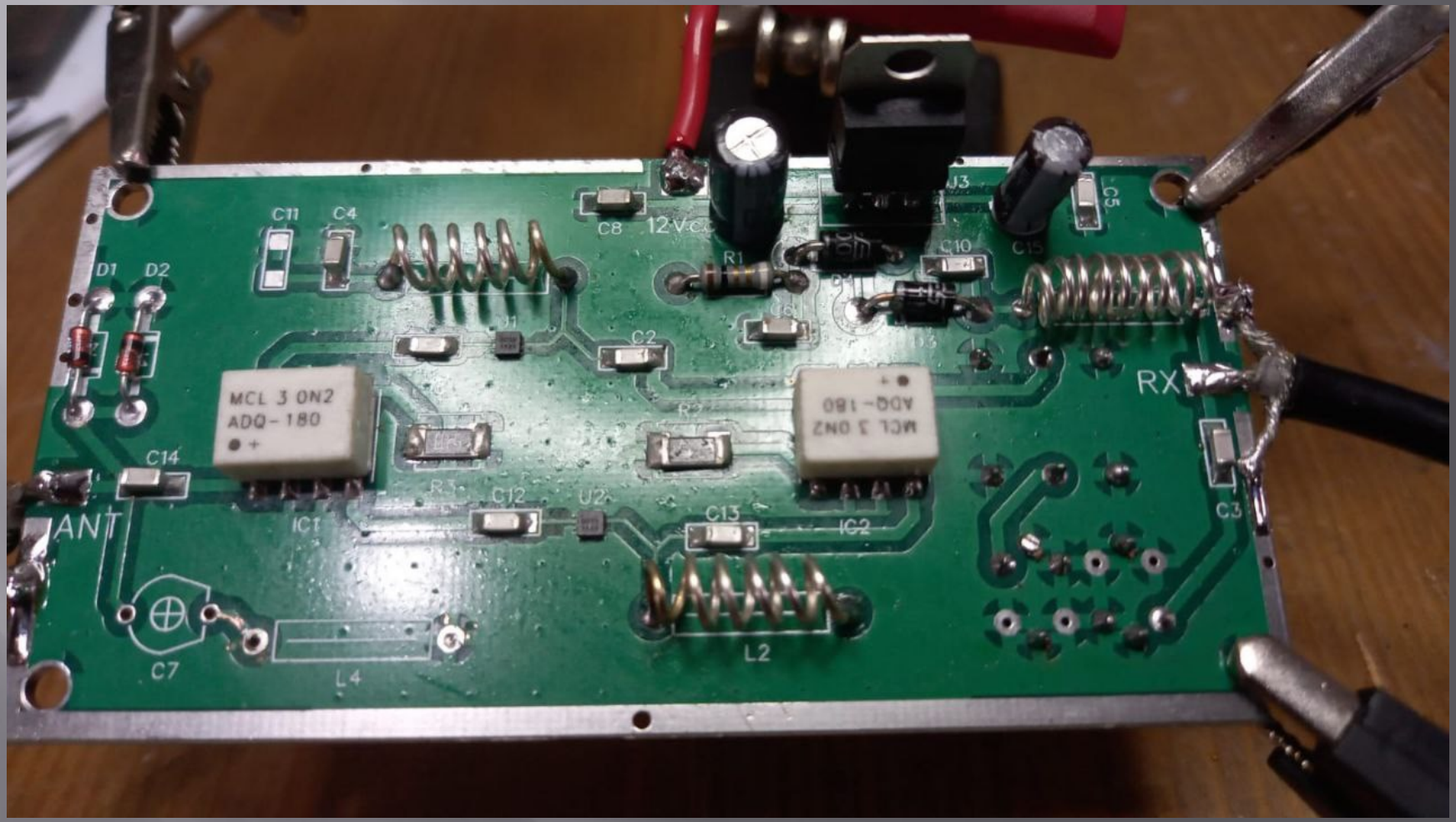
PCB Mounting Pattern



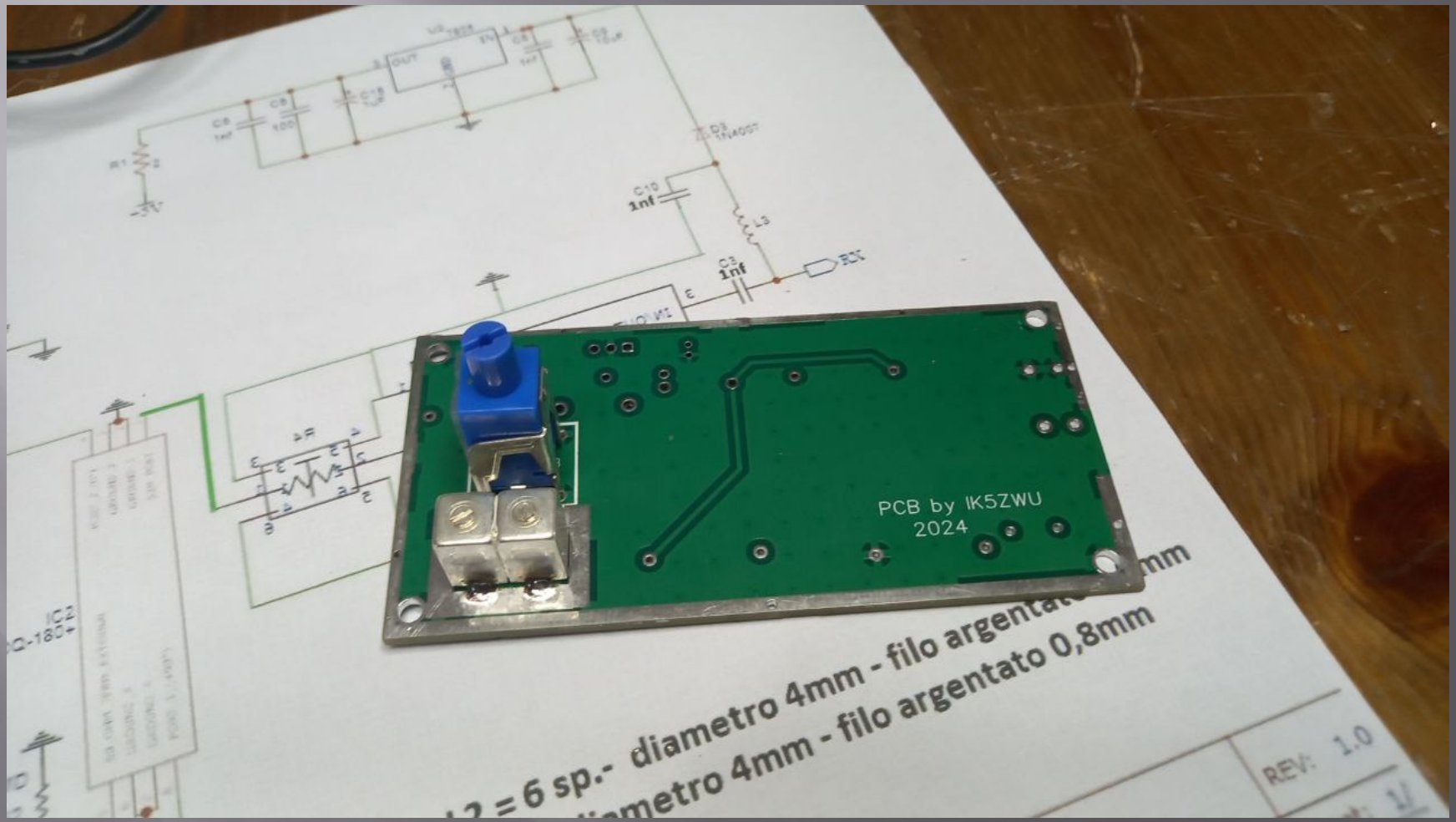
NOTES:
1. All dimensions are in millimeters. Angles are in degrees.
2. Use 1 oz. copper minimum for top and bottom layer metal.
3. Vias are required under the backside paddle of this device for proper RF/DC grounding and thermal dissipation. We recommend a 0.35mm (#80/.0135") diameter bit for drilling via holes and a final plated thru diameter of 0.25 mm (0.010").
4. Ensure good package backside paddle solder attach for reliable operation and best electrical performance.



Prototipo con due TQP3M9036

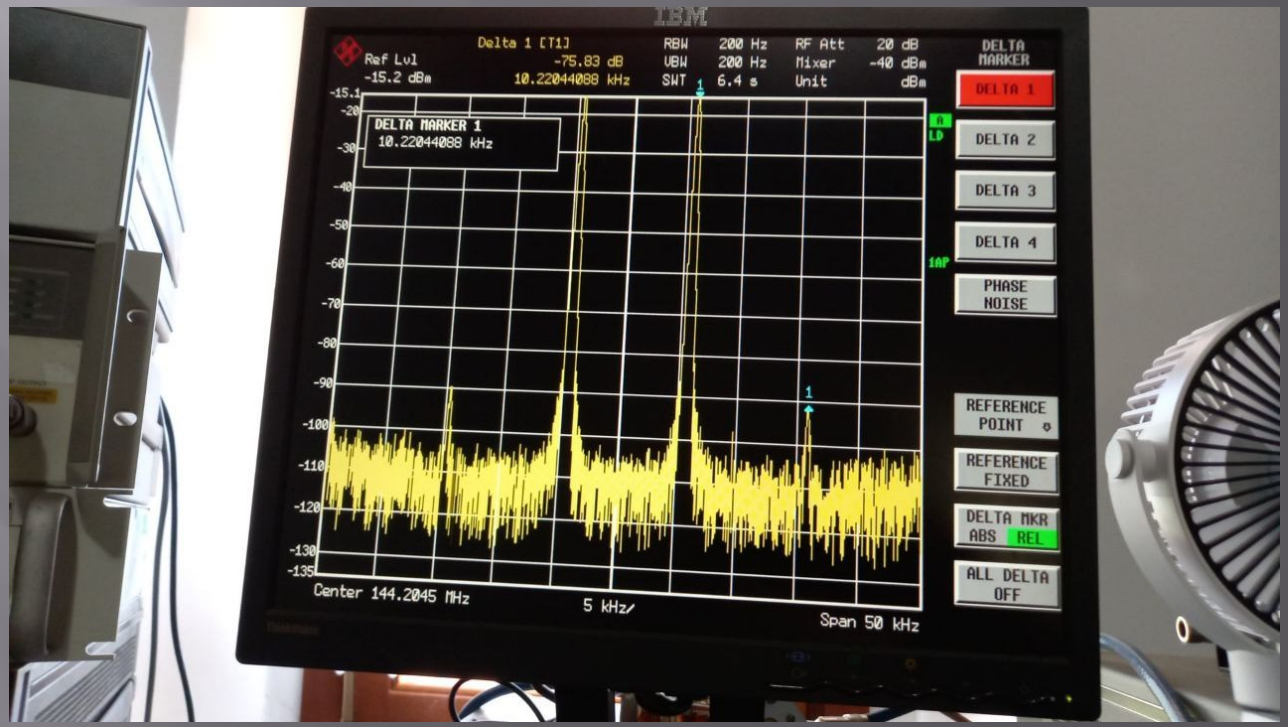


Lato posteriore del pcb

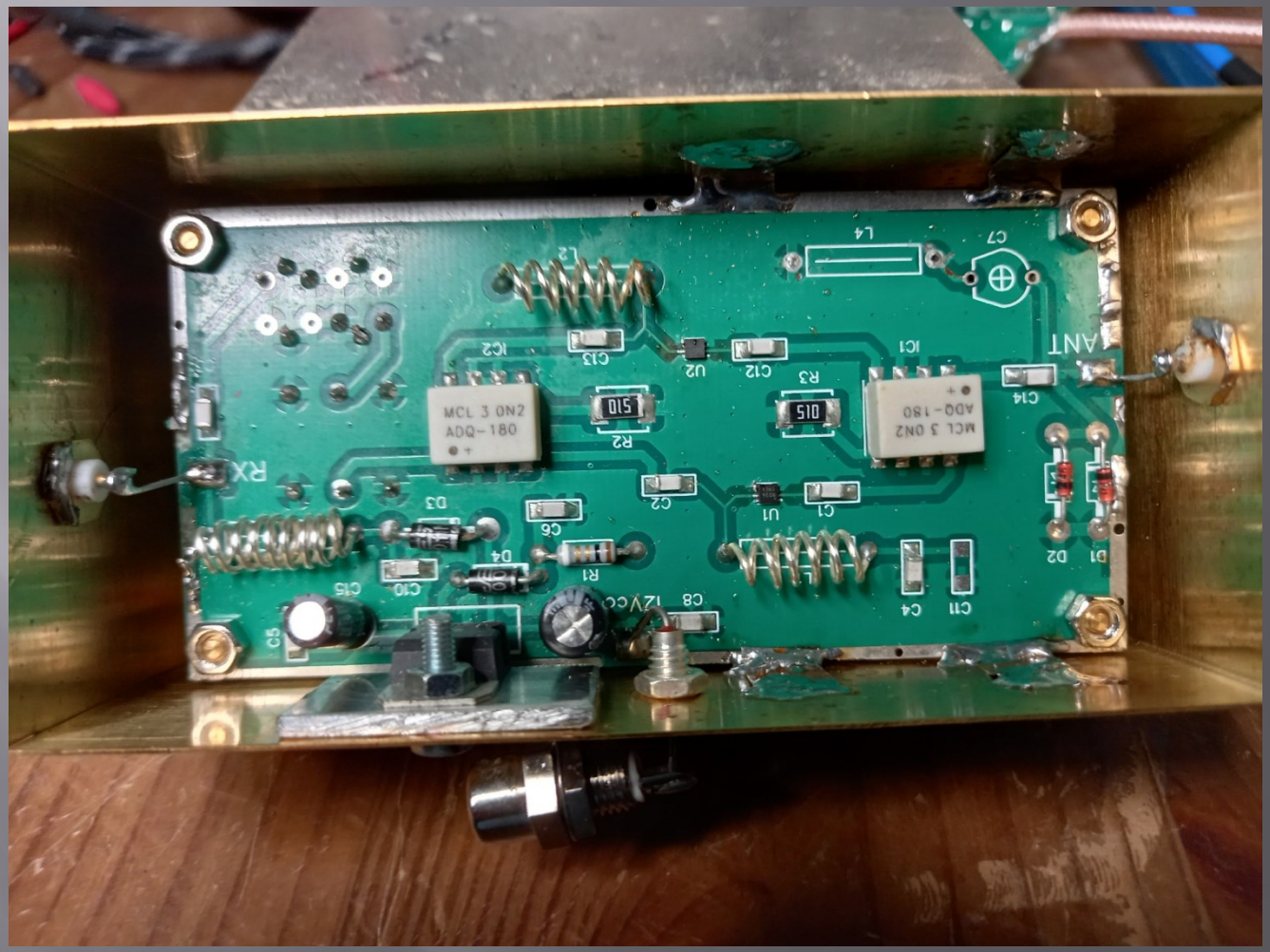


Misure

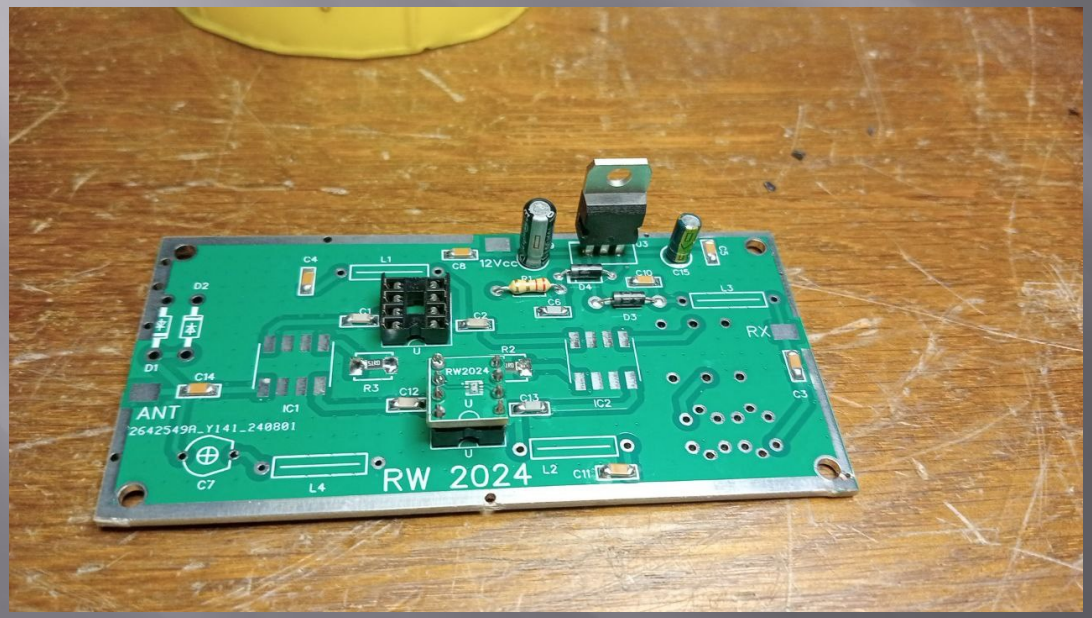
- NF 0,75 dB IP + 18dBm

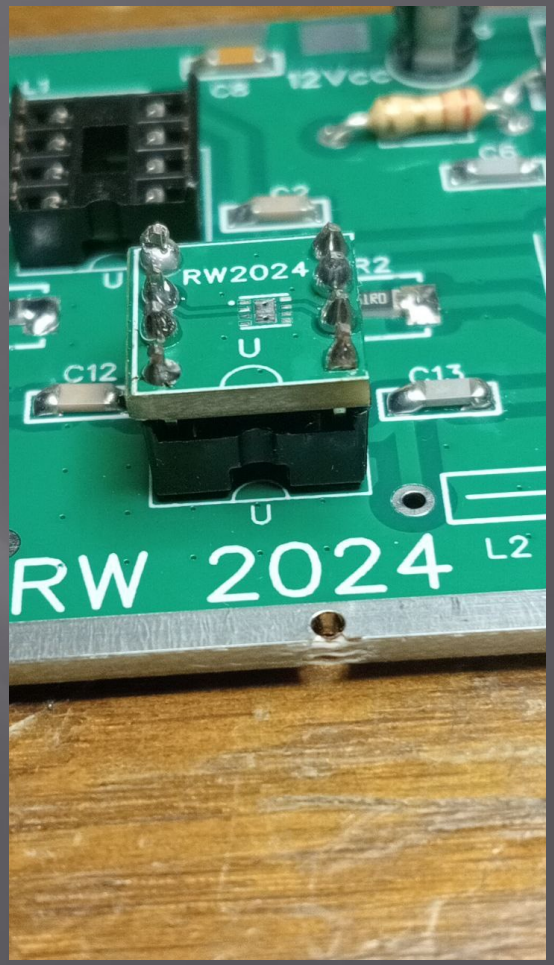


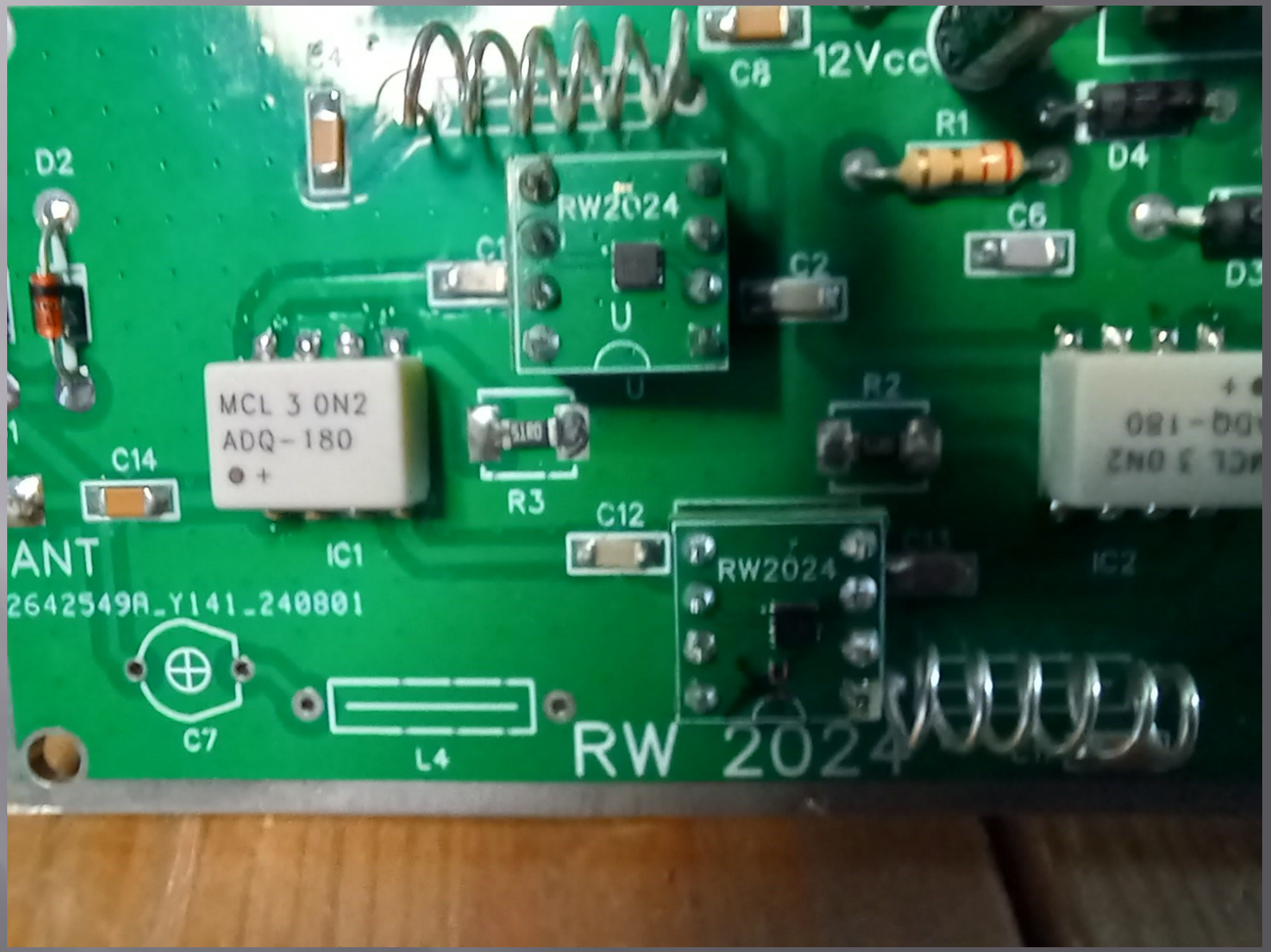
2 x TQP3M9036



Ultimi sviluppi






12Vcc
C8
R1
D4
D2
RW2024
C1
C2
C6
D3
MCL 3 0N2
ADQ-180
R2
C14
R3
C12
IC1
IC2
ANT
2642549A_Y141_240801
RW2024
C7
L4
RW 2024

RADIOAMATORI CHE HANNO COLLABORATO AL PROGETTO

- IK5ZWU Walter progettazione dei pcb e montaggio dei componenti smd
- S57C Branko contenitori dei pre in ottone
- IV3NCC Marco lavorazioni meccaniche dei contenitori, disegni in autocad, costruzione delle eliche dei filtri e delle boccole in ottone, realizzazione meccanica delle unità d'esterno
- IV3SXI Massimo montaggio e messa a punto dei pre e dei filtri
- I4KLY Walter realizzazione dei contenitori dei filtri in CNC
- I3OPW Armando argentatura boccole e viti di sintonia
- IV3GTH Gianluigi montaggio dei TQP3M9036

bibliografia

- **Rugged 2 m Preamplifier for Tough RF Conditions** *by Rastislav Galuscak - OM6AA, Peter Kasparek-OK2ULQ*
  http://www.om6aa.eu/Rugged_2%20m_Preamplifier_for_Tough_RF_Conditions.pdf
- **Progetto di un amplificatore bilanciato e di uno differenziale e confronto delle loro prestazioni per applicazioni radio nell'ambito del progetto SKA** – *tesi di laurea di Cinzia Carlotti, università di Bologna 2003*
- **Coaxial resonator with helical inner conductor** *W.W. Macalpine and R.O. Schldknecht ITT Laboratory Nutley N.J. IRE april 24 1959*
- **High dinamics low noise preamplifier SCP2 & SCP2P** *HA1YA's technical webpage*
- **Building a VHF/UHF Contest Station** *RSGB 2022 Convention Prof Alwyn Seeds, G8DOH* *https://www.youtube.com/watch?v=3p4Bk0Owd1s*

Grazie per l'attenzione