RADARC Sinad Meter v1.1 (May 2023)

Sinad definition

Signal + noise and distortion/noise and distortion

Welcome to the RADARC Sinad meter project

Description

Back in 1980 Helper instruments in the USA produced a standalone Sinad meter. This revolutionised the FM two way radio servicing industry. Until this time receivers were tuned by measuring the audio voltage level across the speaker terminals. However this includes the unwanted noise and distortion. The Sinad meter measures only the wanted signal. Helper instruments Inc. made the same instruments for Sinadder, IFR, Motorola, General Electric, Marconi and many others under their own names.

Gradually, through the 80's the 12dB Sinad value became the industry standard for receiver measurements.

In due course over the next 20 years the Sinad measurement instrument was incorporated into transmitter/receiver test sets across the industry.

Unfortunately Helper Instruments is no longer in existence and there are currently no other manufacturers producing this as a stand-alone instrument.

It is currently difficult to find a good working example of a Sinad meter for less than £200. Being 40 years old most examples will need the old capacitors changing and the unit recalibrating. Also being of USA manufacture most are 110V and will need the transformers changing to be used in the UK.

There are a lot of published circuits available on line of the various versions of Sinad meters that Helper Instruments produced. However most of these circuits have errors, commonly in the power supply regulation, AGC amplifier and the notch filter. It is not known if this was intentional by Helper Instruments or just poor drawing records.

A breadboard copy of the circuit was made, tested and the faults corrected. A working meter was produced and exhibited for the 2022 RADARC construction contest by G0JTN.

It was therefore decided to make this a RADARC project and make the PCB's available to club members as a club project.

The RADARC Sinad meter is a direct copy of the Sinadder SD101 from 1982. Reviewing the designs available this was decided to be the best version of the design.

It was decided that the RADARC design would stick with discrete components to make the building easier rather than using SMD design.

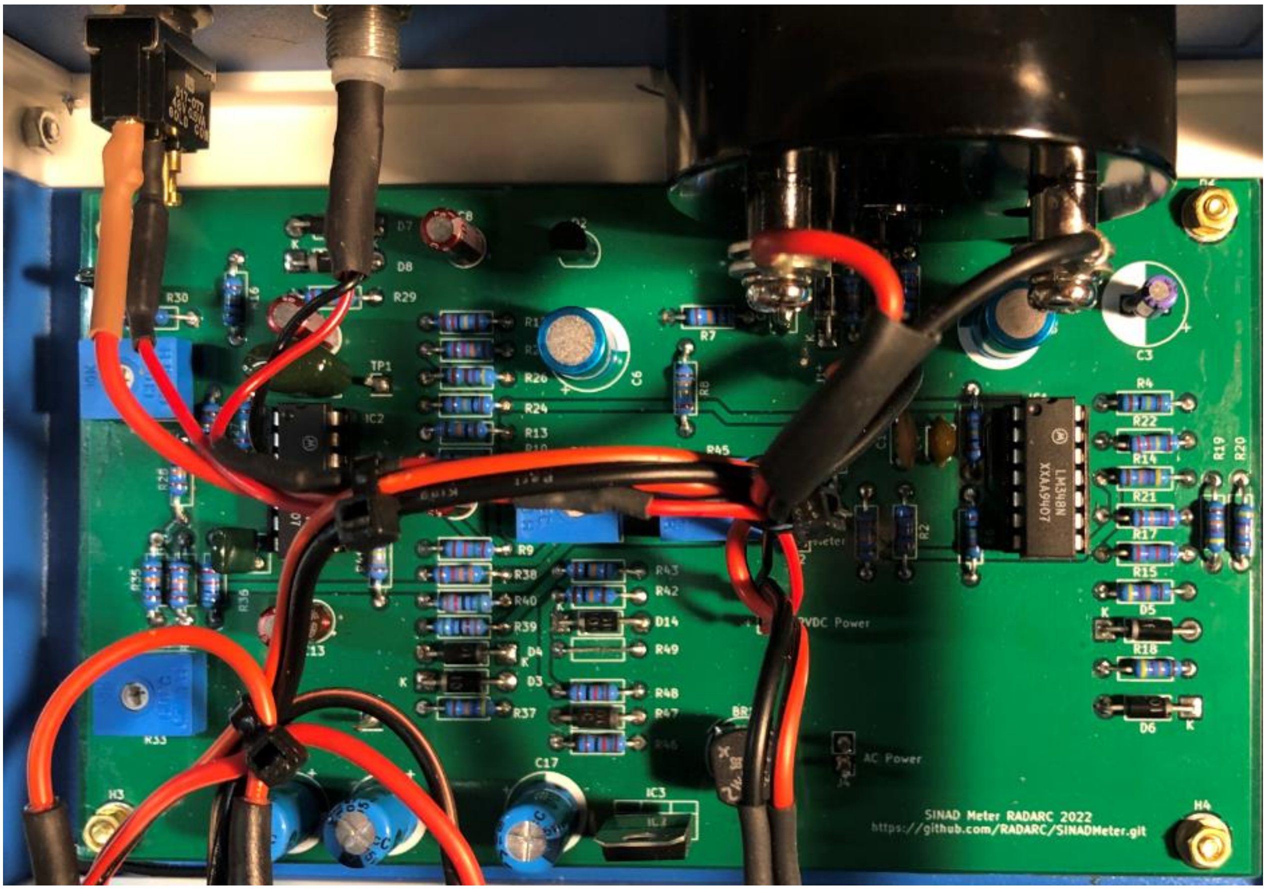
The RADARC printed circuit board has been designed using KICAD and makes use of four layer board technologies. The circuit diagram, Gerber files and component build list is available on GITHUB for downloading.

A small batch of PCB's has been produced to test the design and four successful meters have now been made by members and all have worked well.

A correct replacement Sinad scale for the meter has also been designed and can be downloaded and produced on a laser printer. This new scale can then be carefully spray glued to the existing meter scale.

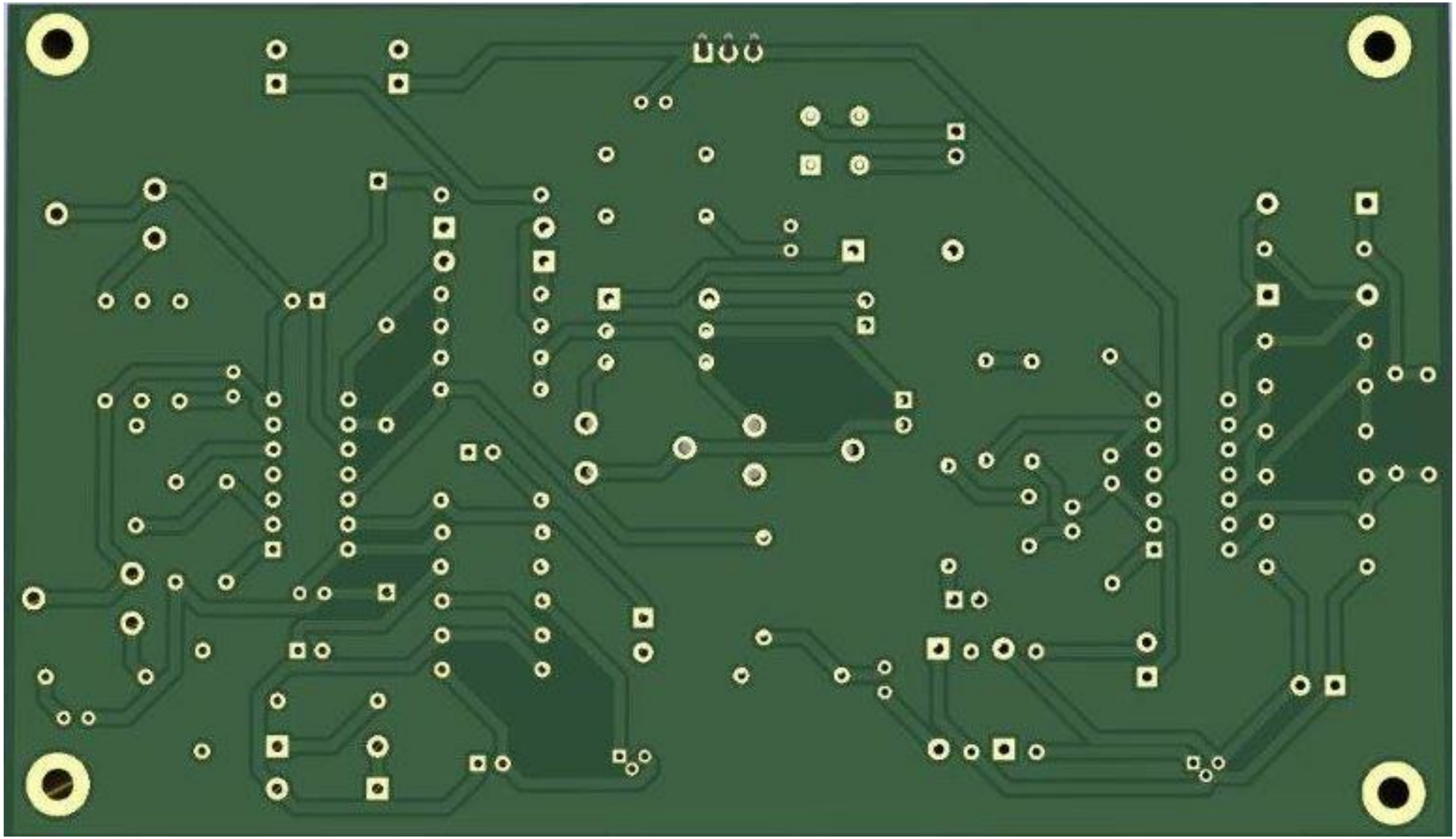
We hope you will have fun building this project and find the instrument useful for aligning and servicing your FM transceivers and radio receivers.

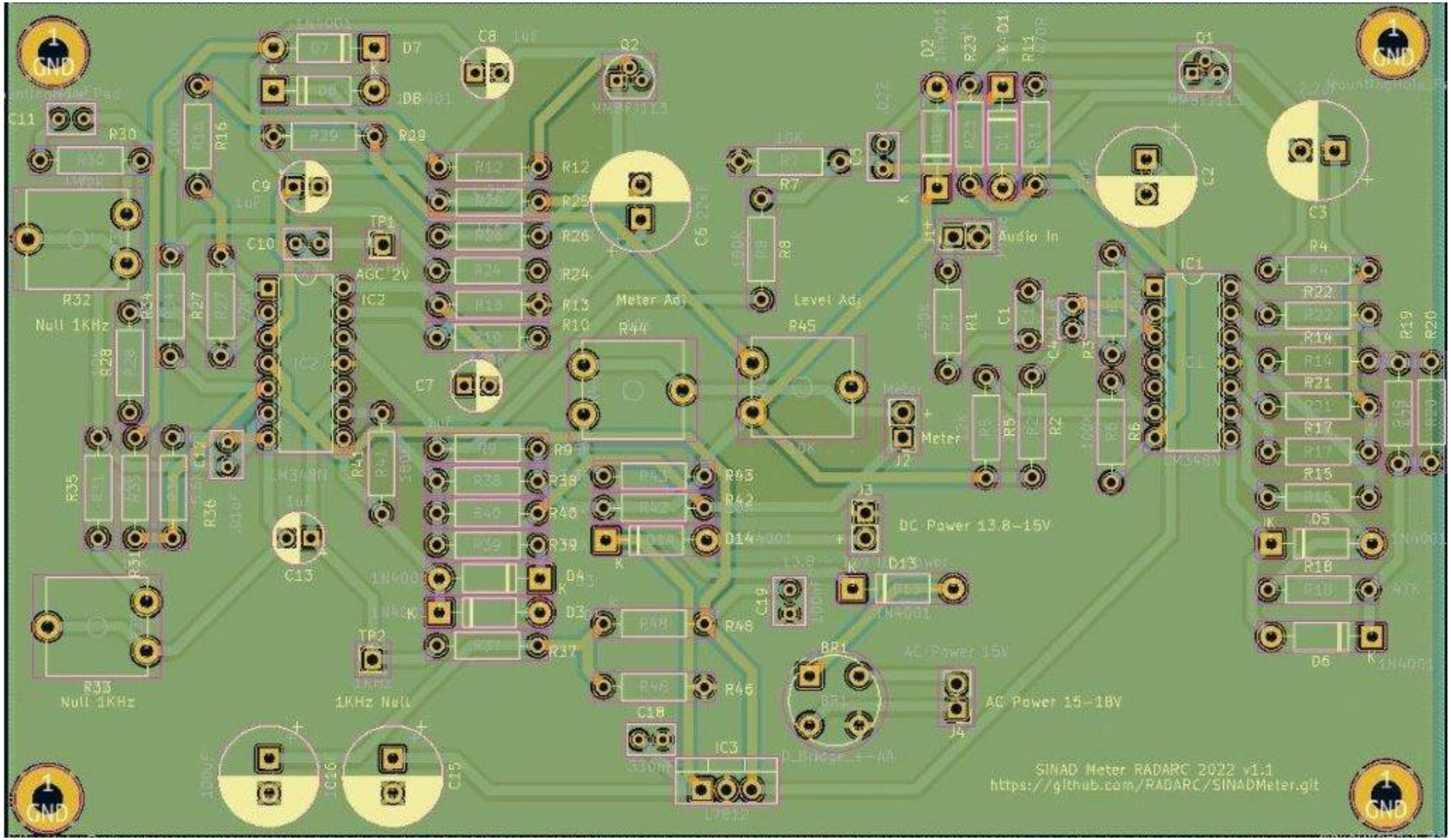
The RADARC meter can be made for around £50.



Thanks to Simon M0ZSU for his extensive help with this project (G0JTN)

Null 1KHz
AGC 2V
Meter Adj
Level Adj
Audio In
Meter
DC Power 13.8-15V
Null 1KHz
1KHz Null
AC Power 15-18V
SINAD Meter RADARC 2022 v1.1
https://github.com/RADARC/SINADMeter.git

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Audio In
Meter Adj
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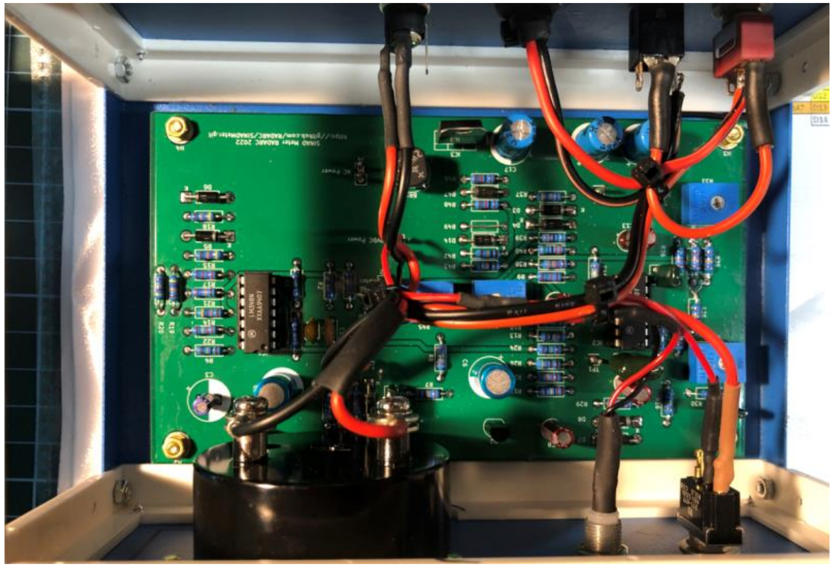
DC Power 13.8-15V
AC Power 15-18V
Null 1KHz
Null 1KHz
1KHz Null
AGC 2V
GND
GND
GND
GND
IC1
IC2
IC3
L7812
LM348N
MMBF3113
BR1
J2
J3
J4
TP1
TP2
R44
R45


20
12
6
3
DB SINAD
RADARC
PWR
OFF
SD-101
SINADDER


20
12
6
3
DB SINAD
RADARC


EXT
ON



RADARC Sinad Meter 2022 Project - May 2023 v1.1 PCB build sheet

Resistors		Value
R1	1/4 W	470K
R2	1/4 W	2.7K
R3	1/4 W	100K
R4	1/4 W	100K
R5	1/4 W	12K
R6	1/4 W	100K
R7	1/4 W	10K
R8	1/4 W	180K
R9	1/4 W	1.5K
R10	1/4 W	100K
R11	1/4 W	470R
R12	1/4 W	1.2M
R13	1/4 W	10K
R14	1/4 W	47K
R15	1/4 W	47K
R16	1/4 W	100K
R17	1/4 W	2.7K
R18	1/4 W	47K
R19	1/4 W	47K
R20	1/4 W	47K
R21	1/4 W	27K
R22	1/4 W	220K
R23	1/4 W	12K
R24	1/4 W	100K
R25	1/4 W	12K
R26	1/4 W	470R
R27	1/4 W	220K
R28	1/4 W	10K
R29	1/4 W	10K
R30	1/4 W	12K
R31	1/4 W	12K
R32	Preset	10K
R33	Preset	10K
R34	1/4 W	10K
R35	1/4 W	10K
R36	1/4 W	5.6K
R37	1/4 W	47K
R38	1/4 W	3.3K
R39	1/4 W	56K
R40	1/4 W	56K
R41	1/4 W	180K
R42	1/4 W	10K
R43	1/4 W	10K
R44	Preset	10K
R45	Preset	10K
R46	1/4 W	1K
R47		Not used
R48	1/4 W	1K
R49		Not used

Capacitors		Value nF	Value uF	RADARC
C1		100nF	0.1uF	Ceramic disk 100v
C2		Elect	22uF	Elect 25v
C3		Elect	2.2uF	Elect 50v
C4		10pF	10pF	Ceramic disk 50v
C5		22nF	0.022uF	Mylar 100v
C6		Elect	22uF	Elect 25v
C7		Elect	1uF	Elect 50v
C8		Elect	1uF	Elect 50v
C9		Elect	1uF	Elect 50v
C10		220nF	0.22uF	Mylar 100v
C11		10nF	0.01uF	Mylar 100v
C12		10nF	0.01uF	Mylar 100v
C13		Elect	1uF	Elect 50v
C14		Not used		
C15		Elect	100uF	Elect 35v
C16		Elect	100uF	Elect 35v
C17		Not used		
C18		330nF	0.33uF	Ceramic disk 100v
C19		100nF	0.1uF	Ceramic disk 100v

Regulator	Type
7812	12v 1A

Meter		Type
Sinad	Class 2.0	SD-670
RVFM	DC 50uA	Rapidonline (£18.00 Ebay)

LED		
		12v panel mounted
		Chrome Bezzel

Switches	2 off	Single pole on/off

Diodes	Value
D1	1N4001
D2	1N4001
D3	1N4001
D4	1N4001
D5	1N4001
D6	1N4001
D7	1N4001
D8	1N4001
D13	1N4001
D14	1N4001
D 9-12	Not used

BR1	1A / 50V	Bridge 9.5mm Dia

IC1		LM348N	Quad Op Am	LM348N
IC2		LM348N	Quad Op Am	LM348N
IC Sockets	2 off	14 pin	Turned pin	
Q1 & Q2		J113	FET	J113

Size	Case type
80x170x130	Project Case Junction Box Electronics Enclosure Box Instrument Housing (£17.99 Ebay China)
110x250x190	Project Case Junction Box Electronics Enclosure Box Instrument Housing Optional Larger case

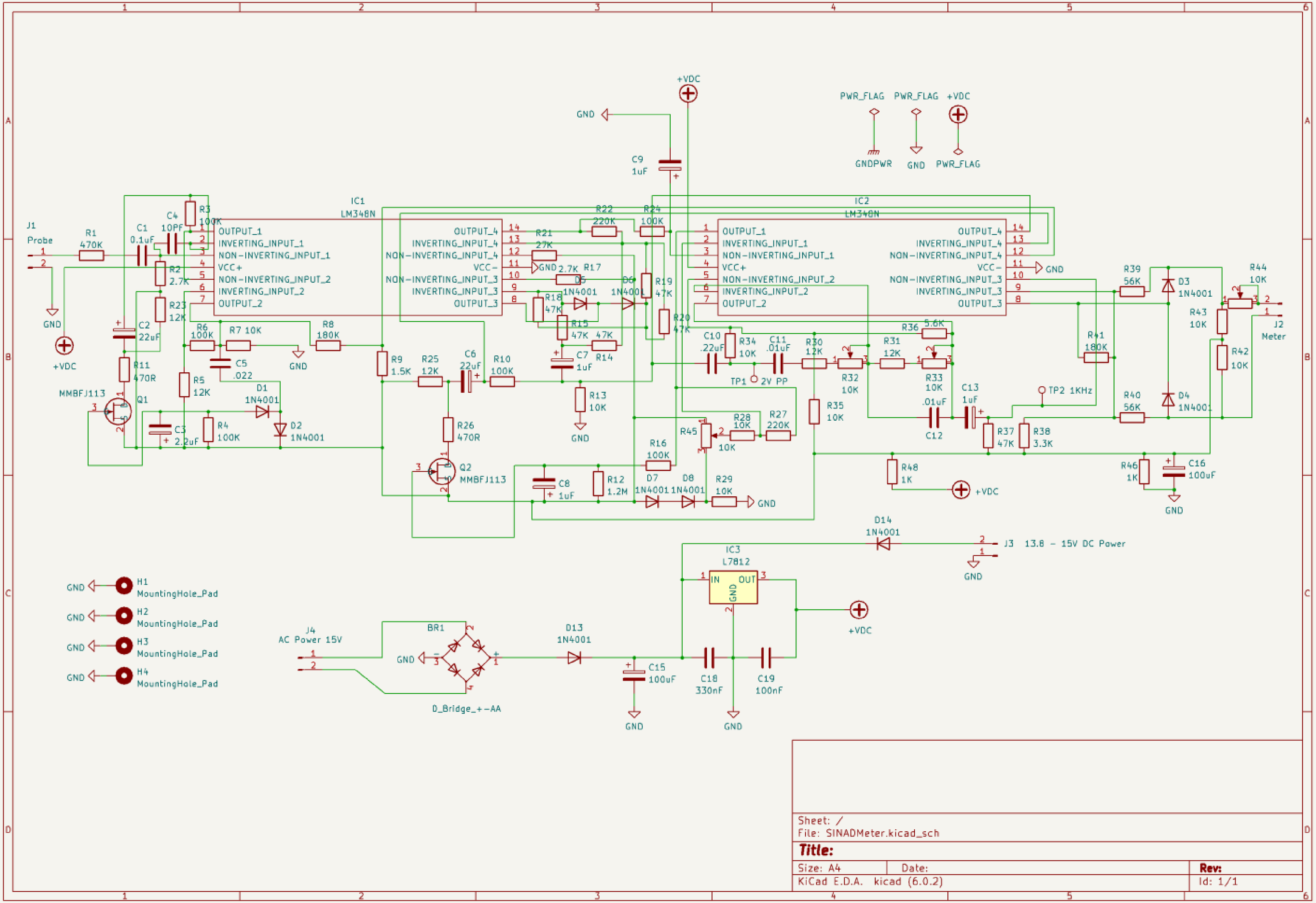
12V power plug and socket

3.5mm mono audio jack socket

0.5 mm Twinax red & Black cable

2 off Small Red & Black crocodile clips

PCB Versio	Date	Design
V1.1	05/05/2023	CAS/G0JTN/M0ZSU



+VDC
GND
C9
1uF
PWR_FLAG
GNDPWR
IC1
LM348N
IC2
LM348N
OUTPUT_1
INVERTING_INPUT_1
NON-INVERTING_INPUT_1
VCC+
NON-INVERTING_INPUT_2
INVERTING_INPUT_2
OUTPUT_2
OUTPUT_4
INVERTING_INPUT_4
NON-INVERTING_INPUT_4
VCC-
NON-INVERTING_INPUT_3
INVERTING_INPUT_3
OUTPUT_3
J1
Probe
R1 470K
C1 0.1uF
C4 10PF
R3 100K
R2 2.7K
R23 12K
C2 22uF
R11 470R
MMBFJ113
Q1
C3 2.2uF
R4 100K
R5 12K
R6 100K
R7 10K
C5 .022
D1 1N4001
D2 1N4001
R8 180K
R9 1.5K
R25 12K
C6 22uF
R10 100K
R26 470R
Q2 MMBFJ113
C8 1uF
R12 1.2M
R21 27K
R22 220K
R24 100K
R17 2.7K
R18 47K
R15 47K
R14 47K
D5 1N4001
D6 1N4001
C7 1uF
R13 10K
R19 47K
R20 47K
R16 100K
D7 1N4001
D8 1N4001
R29 10K
R45 10K
R28 10K
R27 220K
C10 .22uF
R34 10K
TP1 2V PP
C11 .01uF
R30 12K
R32 10K
R31 12K
R33 10K
R36 5.6K
R35 10K
C12 .01uF
C13 1uF
R37 47K
R38 3.3K
TP2 1KHz
R48 1K
R41 180K
R39 56K
R40 56K
D3 1N4001
D4 1N4001
R43 10K
R42 10K
R44 10K
J2
Meter
R46 1K
C16 100uF
D14 1N4001
J3 13.8 - 15V DC Power
IC3
L7812
IN
OUT
H1 MountingHole_Pad
H2 MountingHole_Pad
H3 MountingHole_Pad
H4 MountingHole_Pad
J4
AC Power 15V
BR1
D_Bridge_+-AA
D13 1N4001
C15 100uF
C18 330nF
C19 100nF
Sheet: /
File: SINADMeter.kicad_sch
Title:
Size: A4
Date:
Rev:
KiCad E.D.A. kicad (6.0.2)
Id: 1/1

<u>Assembly of the PCB</u>

Before you start, clean the work bench and check the PCB board for any damage.

Place the resistors first, carefully checking the values against the build sheet. Carefully solder the components in place. Clip the leads off on the underside of the board. Check for any shorts or bridged tracks.

Now place all the capacitors, carefully checking the values against the build sheet. Check the polarisation of the electrolytic capacitors. Carefully solder the components in place. Clip the leads off on the underside of the board. Check for any shorts or bridged tracks.

Next place all the diodes (D1- D8, D13 and D14), these are all the same (1N4001). Carefully solder the components in place. Check the polarity matches the screen printing. Clip the leads off on the underside of the board. Check for any shorts or bridged tracks.

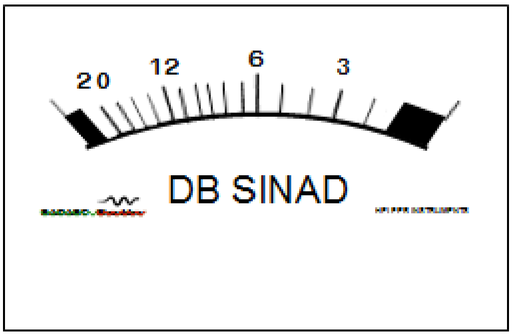
Now place all the resistor trimmers R32, R33, R44 and R45, these are all 10K. Carefully solder the components in place. Clip the leads off on the underside of the board. Check for any shorts or bridged tracks.

If installing sockets for the two LM348 IC's fit these now along with the test pins and main connection pins. Carefully solder these in place on the board and trim the legs off the underside of the board. Check for any shorts or bridged tracks.

Fit IC3 (12V regulator) and the two J113 FET transistors paying special attention to the polarity of these devices. Solder and trim the excess on the underside of the board. Check for any shorts or bridged tracks.

Temporarily fit the two LM348 IC's into the sockets.

Carry out a final check of the board and the values of each component. Check for any shorts or bridged tracks.



Testing the PCB

Set all resistor trimmers to mid position

Remove the two LM348 IC's

Power the board with a 13.8 -15V DC supply or 15-18V AC supply at the appropriate pins.

(The on board bridge rectifier allows a small mains transformer to be fitted inside the instrument. The instrument can then be powered from the mains. Make sure you fit a suitable in line fuse (100mA) to the output of the transformer and also a 1A fuse in the mains plug/lead).

Current should be around 50mA DC or less, if the current exceeds this switch off and check the board for shorts.

Check 12V rail is correct at pin 3 of IC3 (L7812) regulator and that pin 4 of the two LM 348 IC's are also correct.

Refit the two LM348 IC's into the sockets, check pin one is correct way round on the chip. Notched ends should be facing upwards on the board.

Apply 1 kHz audio signal at 2VPeak to peak to the input terminals.

Testing the AGC

Monitor TP1 with an oscilloscope or AC voltmeter. The level should be approx. 2V peak to peak. Adjust the input signal between 2 and 4V there should be no change in the value which should stay around 2V peak to peak.

Setting the 1 KHz null filter

Monitor TP2 with an oscilloscope and adjust R32 and R33 for best null. R33 should filter the top of the sinewave and R34 should filter the bottom of the sinewave. Adjust these two variables for the best filtering possible.

Turn off the signal generator and adjust R45 for full scale reading. If FSD reading cannot be achieved adjust R44 to increase the voltage setting to the meter. The purpose of R44 is to match the output to the 50uA meter. If a 100uA meter is used then R44 should be set fully clockwise position. (Note FSD may not be achieved with a 100uA meter) and the instrument will not be calibrated, however it can still be used for alignment but not for giving accurate 12dB Sinad readings.

Reconnect the signal generator and vary the frequency either side of the 1 kHz centre frequency. The meter should move over to the left -20dB reading at 1 KHz and to the right as you move away from the centre frequency.

The instrument calibration should now be close, and the meter can now be used to align receivers.

Final adjustment of R44 and R45 can be done if another calibrated meter is available for comparison.

Checking and comparing the common values of 20dB, 12dB and 10dB.

Using a Sinad Meter

Apply 13.8 - 15V DC supply to the meter

Turn on the meter

Connect the meter across the speaker terminals of the radio.

Set the volume on the radio to a meaningful level.

12dB measurement

Inject an RF signal of 100uV to the antenna socket of the radio modulated with a 1 KHz audio tone at about 1.5 to 2 KHz deviation level to give an S9 signal on the radio.

The meter should move over to the LHS.

Reduce this signal level and the meter should go over to the RHS.

Increase the signal generator until the 12dB position on the meter is achieved. Read off the level of the signal generator, this is the 12dB level of the receiver. Typical values for an FM transceiver would be -118dB for 12dB Sinad or .35uV for 12dB Sinad.

You can now take readings for 20dB and 10dB if you wish. (Note some receivers will not be able to achieve 20dB due to the noise level generated by the receiver and transistors in the circuit)

FM Receiver alignment

Increase the signal generator until the 12dB position on the meter is achieved. Read off the level of the signal generator, this is the 12dB level of the receiver. Note this value down for your records.

Set the signal generator to obtain a reading of around 6dB on the Sinad meter.

Working methodically through the RF stages using correct alignment tools, so as not to damage the delicate cores, adjust the front end stages and IF cores to obtain the highest deflection to the LHS of the meter scale.

As the gain of the stages increases back off the signal generator again towards the 6dB level for best sensitivity of the meter.

When adjusting the IF stages you may get a better result with the signal generator producing a slightly higher signal reading of around 8-10dB on the meter scale.

When no further improvement can be obtained, check the 12dB reading again to see the improvement you have made to the tuning. You will probably be pleasantly surprised at the improvement gained.

G0JTN 2023