RF power meter using HP33330B probe

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This digital power meter uses a diode detector probe from Hewlett Packard type HP33330B. This probe has a negative voltage output.

The advantage of this probe: the level measured is very precise and almost independent of the input frequency up to 22 GHz, which is not the case with commercial integrated circuits. The probe is accurate to +-0.3dB up to 12.5GHz and to +- 0.6dB beyond.

This probe is available from Marcel F1GE f1ge.mg@gmail.com

The circuit includes a very low offset operational amplifier mounted as a -2 gain amplifier. The output voltage of the amplifier is between 0 and 4 volts, which allows accurate measurement in the range between -30dBm and +20dBm, a range which can be extended by using an external input attenuator. Its value must be selected with the left button to compensate the display.

The voltage measurement is performed by an A/D converter from Texas Instruments ADS1115 which allows 32768 different measurement values in the range 0 to 4.095 Volt.
The value of the low weight is of the order of 0.150 mV.

Information processing and display are carried out by an M5Stack Core (see image). **Warning: do not buy the M5Stack Core2 which does not have buttons.**
Operation When

powered up, if the electronic assembly is not powered or present, the M5Stack displays "ADS1115 not connected".

Left button: it allows to compensate the reading when an attenuator is mounted upstream of the probe (from 0 to 40 dB) which allows a maximum of reading 100 mW full scale with 0 dB of attenuation and 1kW (60dBm) full scale with 40dB of attenuation.
Attenuation is displayed behind the needle

Central button: allows you to choose between three models of diodes. The selected diode is memorized and active on the next power-up. Diode parameters can be inserted from the calibrated generator 410 lines. Diode names can be changed on lines 412, 429 and 446. by entering the measured voltage values with a

Right button: It is used to read the voltage measured at the output of the OPA192 amplifier, ie twice the actual voltage at the terminals of the probe. The voltage is around 0mV with no input signal and around 4096 at full scale.
A second press on the key returns to dBm/mW.

If the signal level at the input exceeds +20dBm, the screen displays in red "Danger level"

Software: the program compiles with the Arduino IDE V1 or V2.03. Check during use that you have loaded the libraries, in particular M5stack and ADS1115_WE.

For Arduino novices, follow the procedure described here:

http://docs.m5stack.com/en/quick_start/m5core/arduino

Make sure everything is in place.
In tools, you must choose the M5Stack-Core-ESP32 card to
load the libraries if you have never loaded them - ADS1115_WE
- M5Stack - EEProm

Note: the program was calibrated with an HP 8648C generator and at a frequency of 100 MHz using a representative probe.
Between -30dBm and -10 dBm the calculation (quadratic zone) is carried out from a logarithmic interpolation, in the latest version of the software, which brings better precision and a range change without discontinuity.
Between -10dBm and +15dBm "linear" zone the calculation is performed by linear interpolation from point measurements every 5dB. The voltage is that measured at the output of the amplifier and available by pressing the button on the right.

70mA avec M5stack Core

J6
1
2
CONN-SIL2

D3 1N4001

U2
78D5

+5V
+5V   3 VO   VI 1
GND
2

C5
1DuF

R5   R1
1k   1k

J7
BMC

R2
1k
3
+   U1
2
6
–
R3
1k
OPA192

R4
1k

U4
2 CAP+   V+   8
CAP-
6 LV   VOUT 5
C1   7 OSC   GND 3
1DuF
ICL7660

C4
1DuF

U3
78LD5

+5VA 1 VO   VI 3
GND
2

C2
1DuF

C3
1DuF

ADS1115

J1
1
2
3
4
5
6
7
8
9
10
ADS1115

+5V

J2   J3   J4   J5
PIN   PIN   PIN   PIN

Connecteur PORTA M5stack Core (nol Core 2)

FILE NAME:	Schema_HP33330B_V2.DSN	DATE:
DESIGN TITLE:	Wattmetre HP33330B	14/03/2023
PATH:	Mon PC	PAGE: 1 of 1
BY: F1CJN	REV: 1.0	TIME: 17:67:27