JEY Labs Presents

HF Wattmeter Talk

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Purpose

- Highlight interesting meters and their design.
- What each offers that is special.
- What their limitations are.

Terms

- Accuracy factors-
- K is the coupler‘s accuracy and linearity

  M is the meter’s accuracy and linearity
- 5% of full scale vs 5% of reading.
- Three types of scales
  - Digital (linear)
  - Analogue- Linear and E2/r = W

Wattmeter Scale

- Watt meters read power as a voltage. Using $E^2/r = W$ produces a scale with ¼ power at mid range. This scaling helps compensate for the 5% ofs accuracy problem at low power. Some meters use a linear power scale.

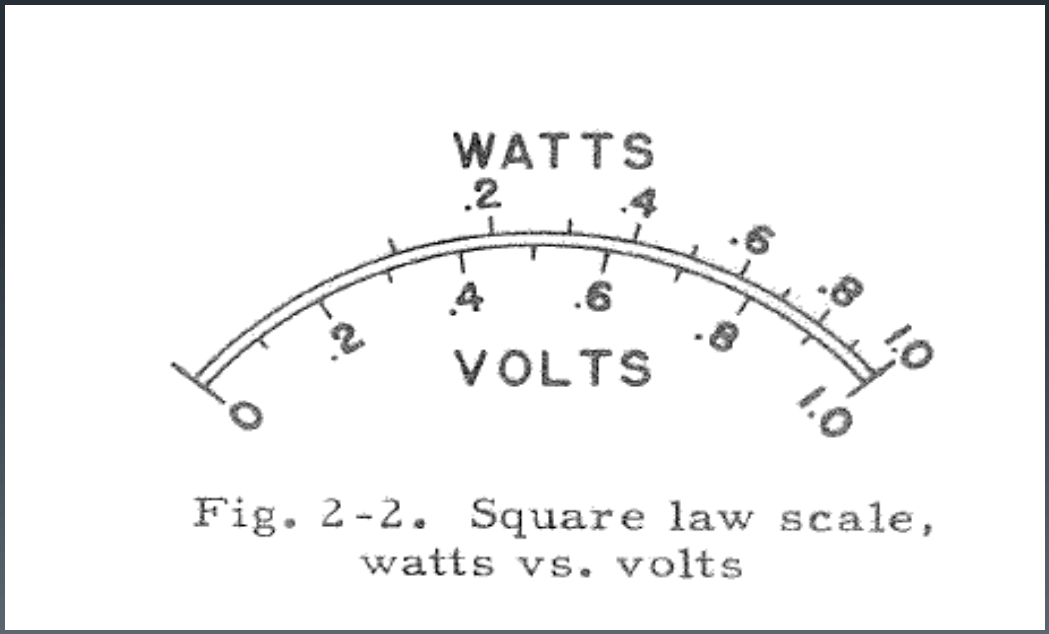


Fig. 2-2. Square law scale, watts vs. volts

General Comments

- Meter scale resolution indicates meter and coupler possible accuracy
- Most cross needle meters lack resolution
  - Few have excellent movements
- In high RF environments, use analog meters. SWR can get into a digital meter.
- Load to meter line length and condition can effect SWR and power measurement
- Use low loss cable.

Types of Meters

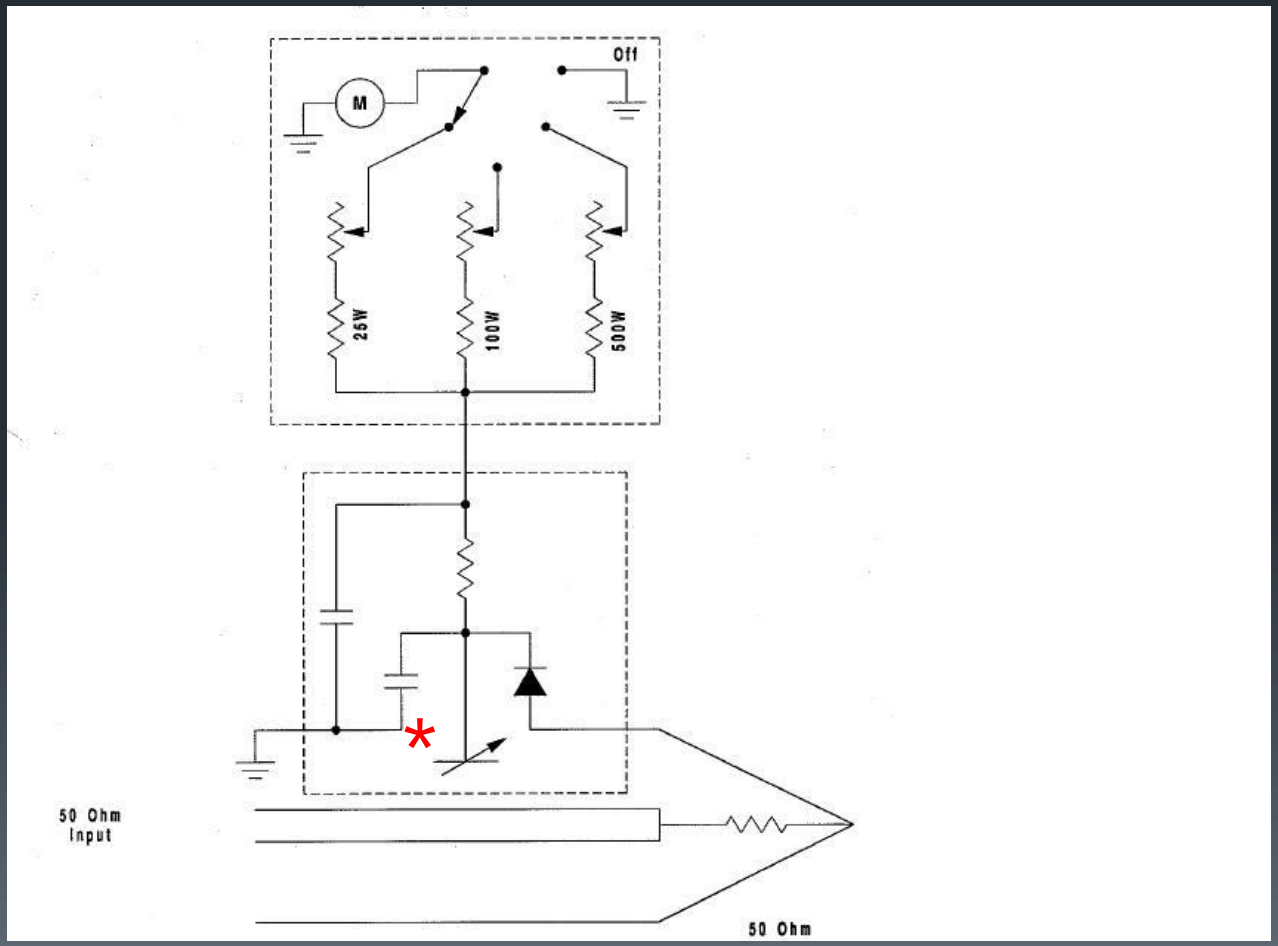
- Termaline Capacitive voltage divider
- Directional Couplers
- Inductive couplers
- Thermocouple meters
- Calorimeters

Termaline

- Sensors are a capacitive voltage divider and have a broader frequency response than the regular inductive elements. At higher power all the elements seem to have a flatter frequency response.

Termaline Schematic

The capacitive voltage divider * coupled to the line is much more broad banded than an inductive loop.



Bird 6154
25-1296MHZ

My go to meter

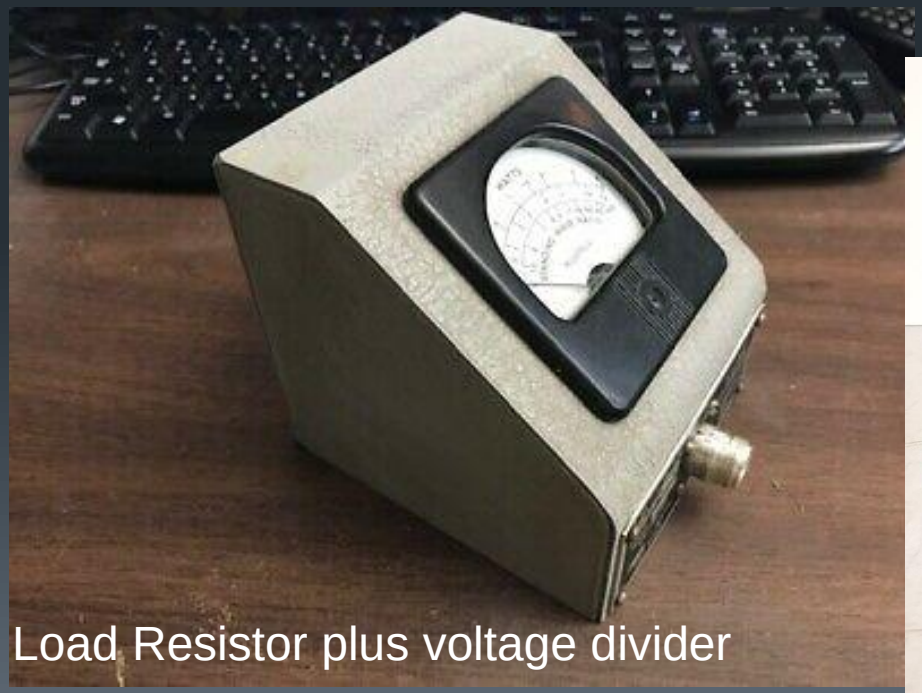
Fs. 5,15,50,150w

Terminating Watt Meters

Add attenuators for greater range

.0-1,000 MHz 10% OFS

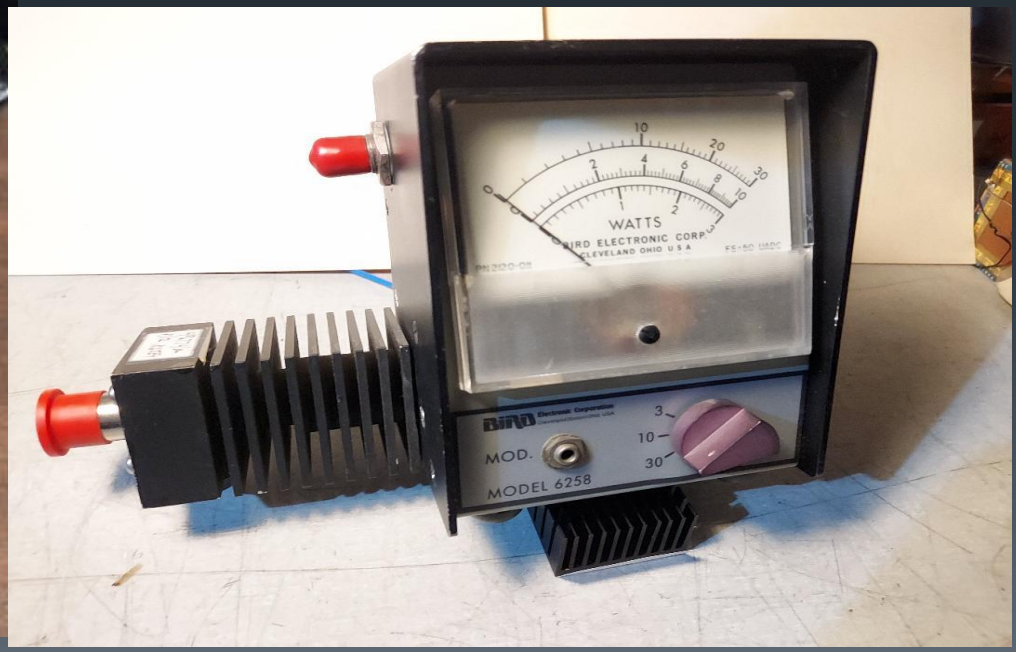
Micro Match 621u 4W



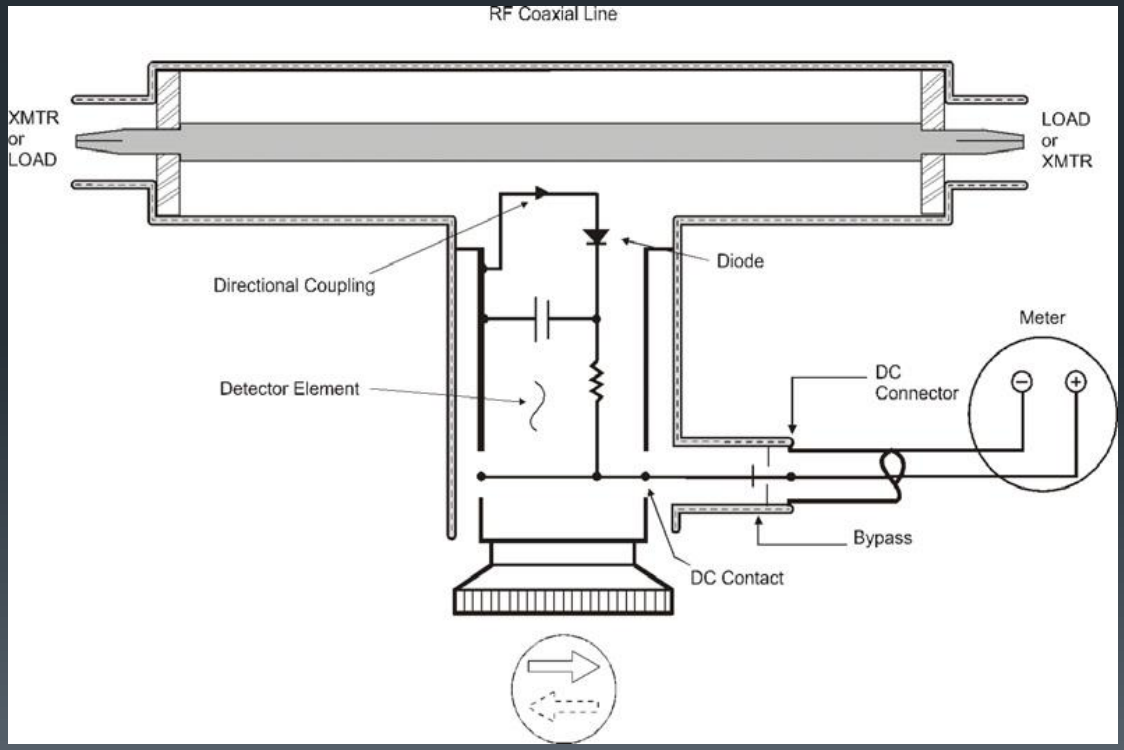
Load Resistor plus voltage divider

0-500MHz 5% OFS

Bird 6258 30W



Bird 43 and others use an Inductive loop and are directional (17-20db isolation)



Bird 4410a Meter

3 elements give you
21 ranges in power and
3 ranges in frequency
5% of READING accuracy.
Uses a battery.

All you will need.

Good and the Bad- loop coupler

- 17-20db directional isolation
- The lower the power the narrower the passband
- Higher power is more broadband.
- Wide power range in power ability
- Correcting for M and K factors difficult
- Bird 4410 uses temp compensated bridge.
  - Significantly broadens measurement range
  - Stability increased.

Inductive Coupler Type

- Most HF couplers are “inductive”
- Accuracy can be very good
  - Component quality is critical
  - Layout and isolation are also critical

MFJ 894

- Typical lower priced meter
- Better than average cross needle meter
- Good power ranges
- Accuracy just in spec
- Recalibrated to 5% ofs

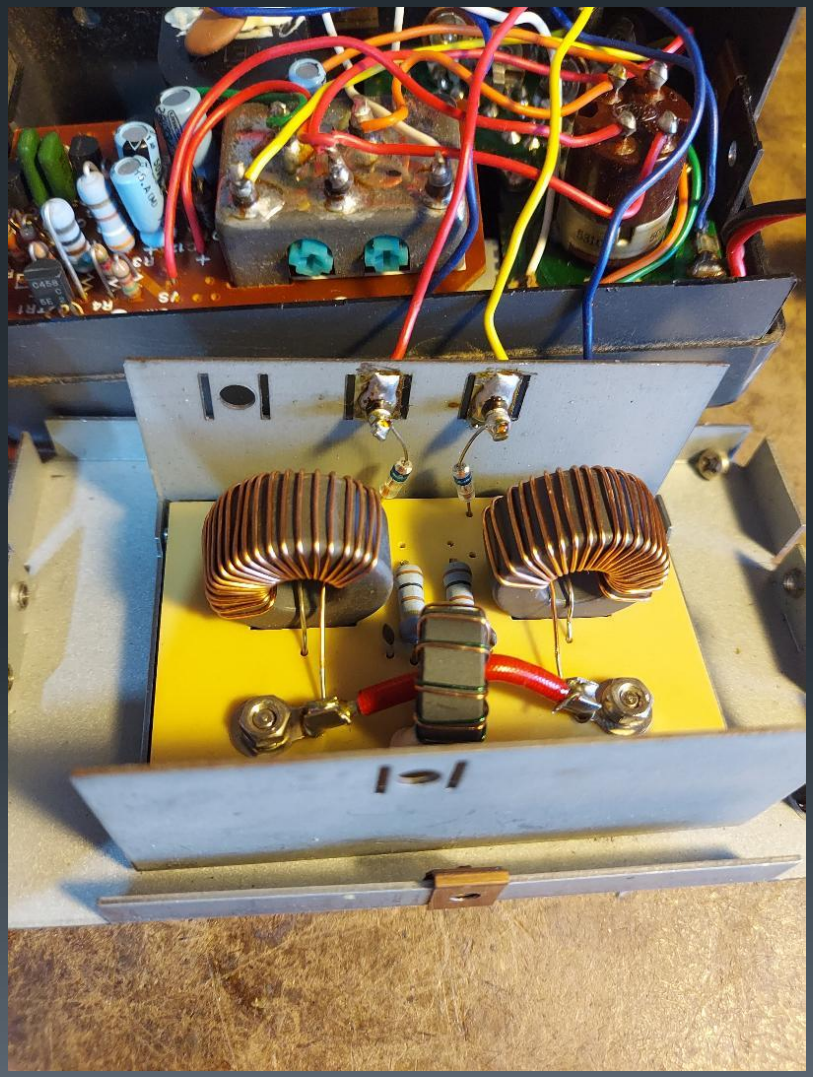
Kenwood SW 2000

SWC 3 HF

1500w CW

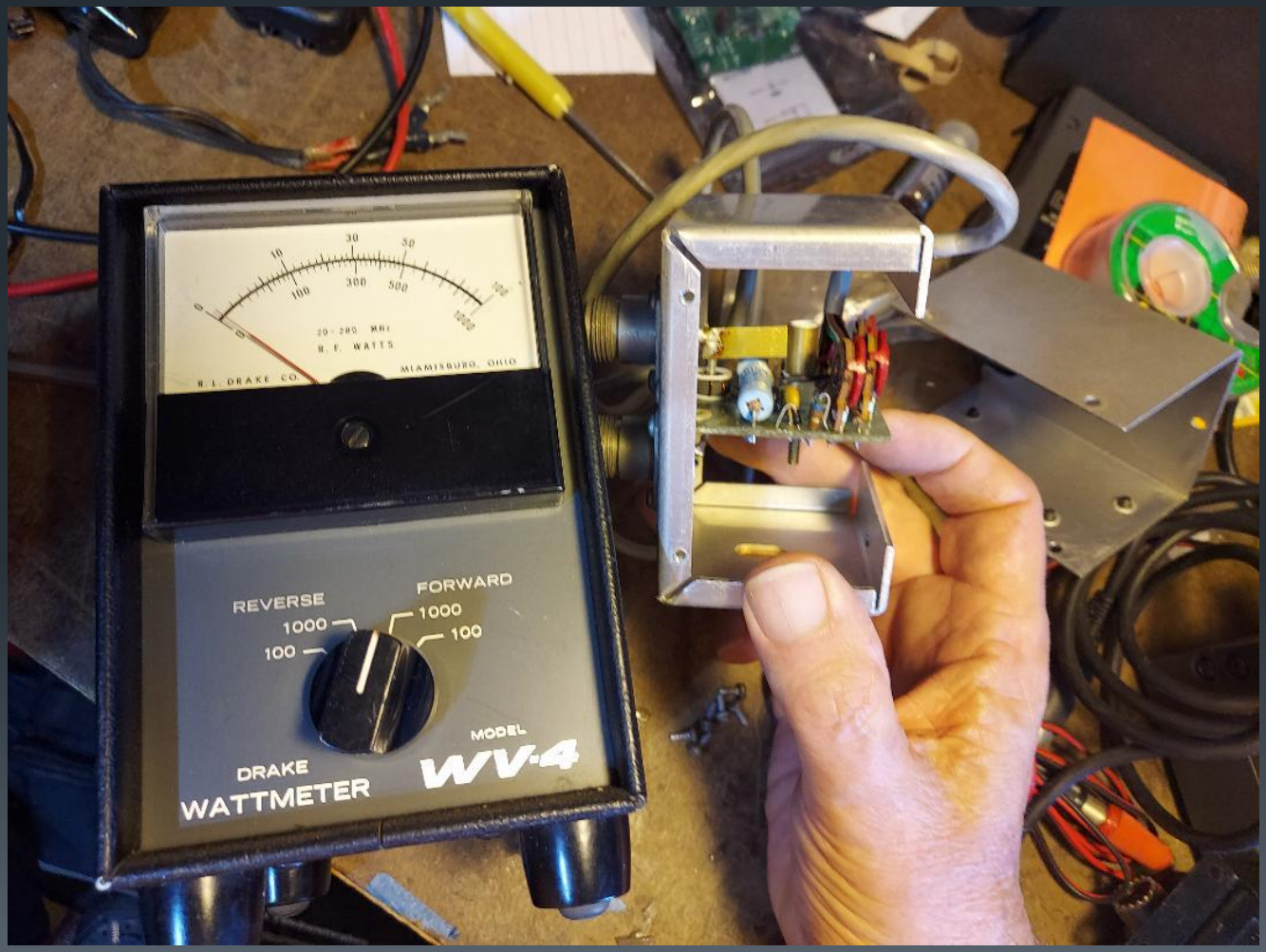
Yaesu YS 60

Internal coupler



Reflected power can effect readings

Drake W-4



The W-4 manual tells you How to calibrate it to 5% of Reading.

Remote coupler.

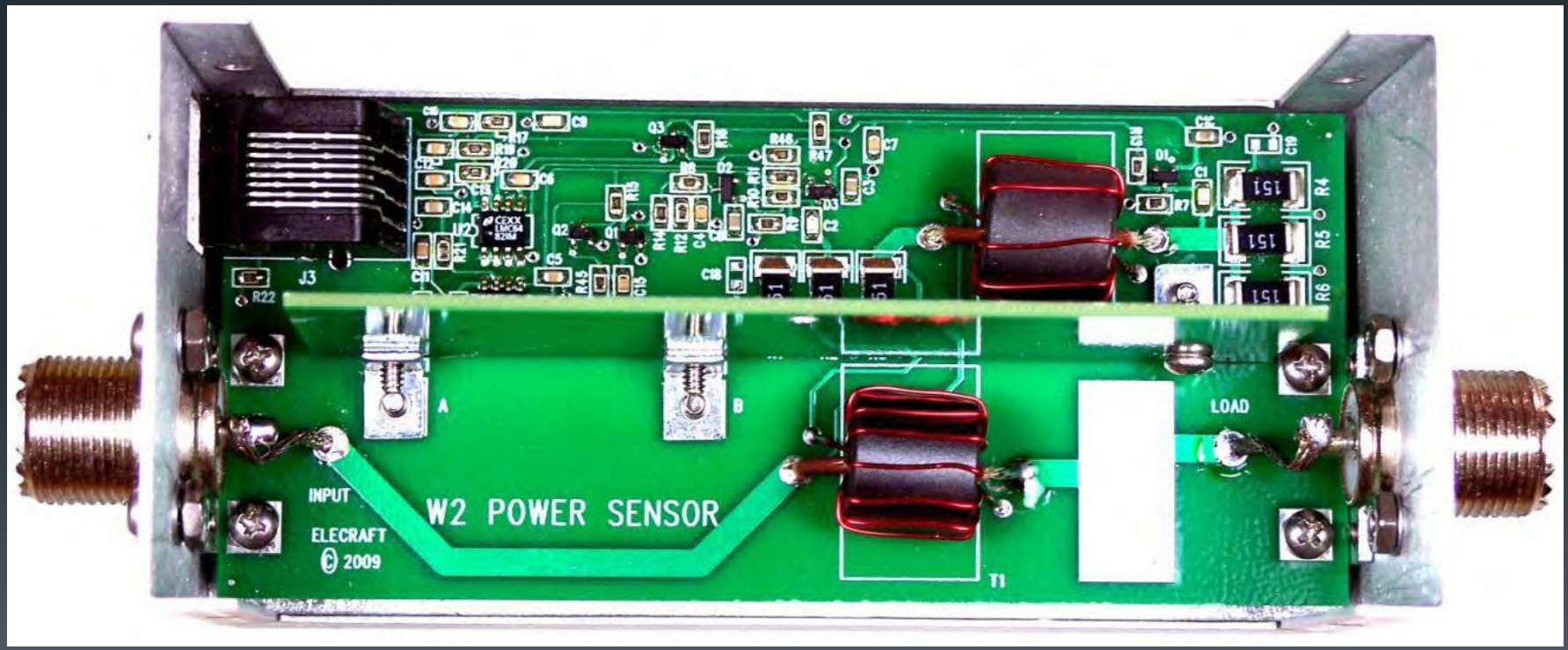
Unique among all The meters.

Mirage MP-1

5% accuracy
Excellent meter
Separate coupler
Requires 9v.
Easy to cal. <5%
All freq. ok.

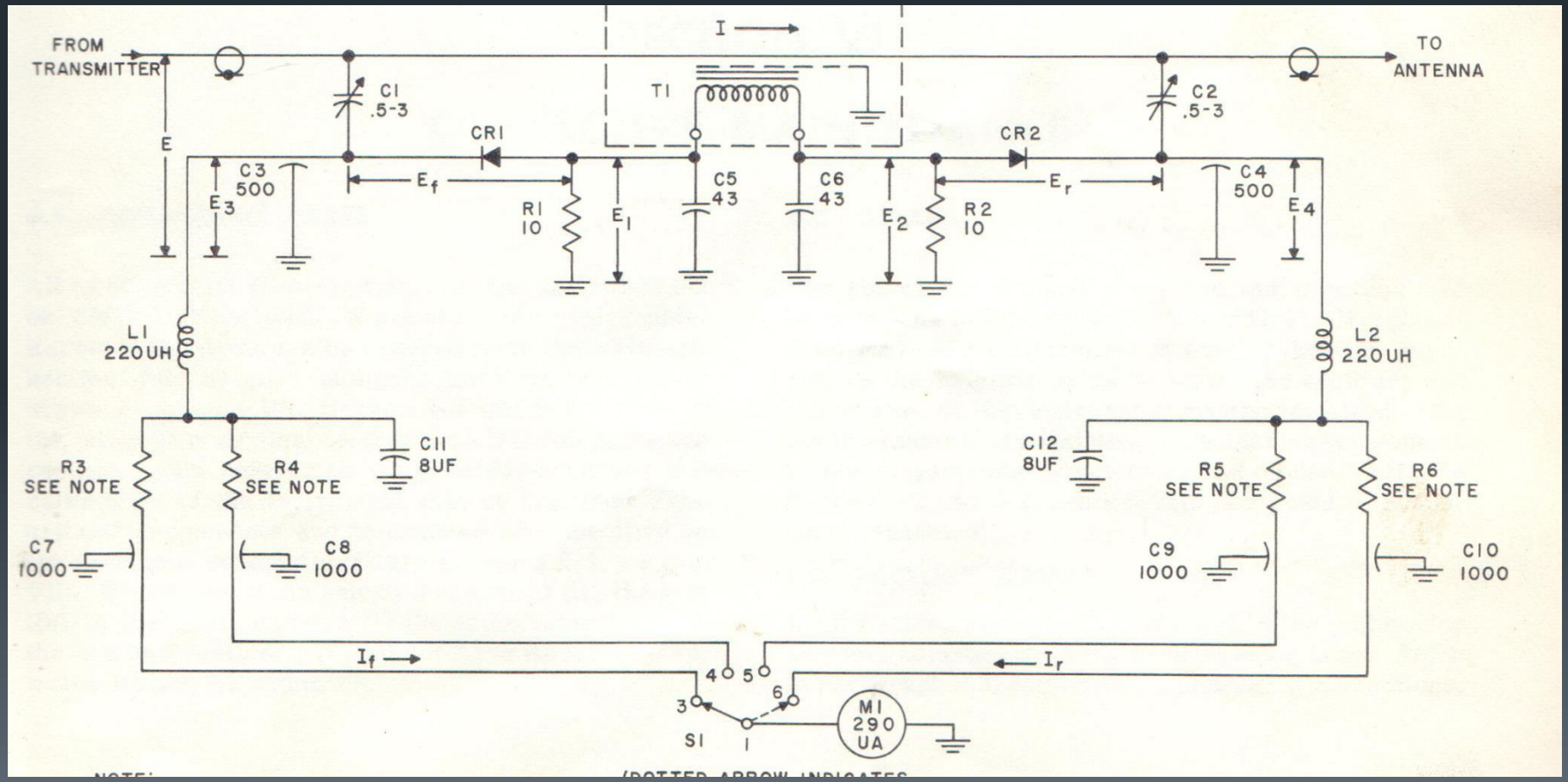
Elecraft HF Coupler

.5db accuracy (5%)
Goes with P3 or W2



Collins 302C-1 with Brune coupler

Collins Meter Schematic by Brune



Brune Inside

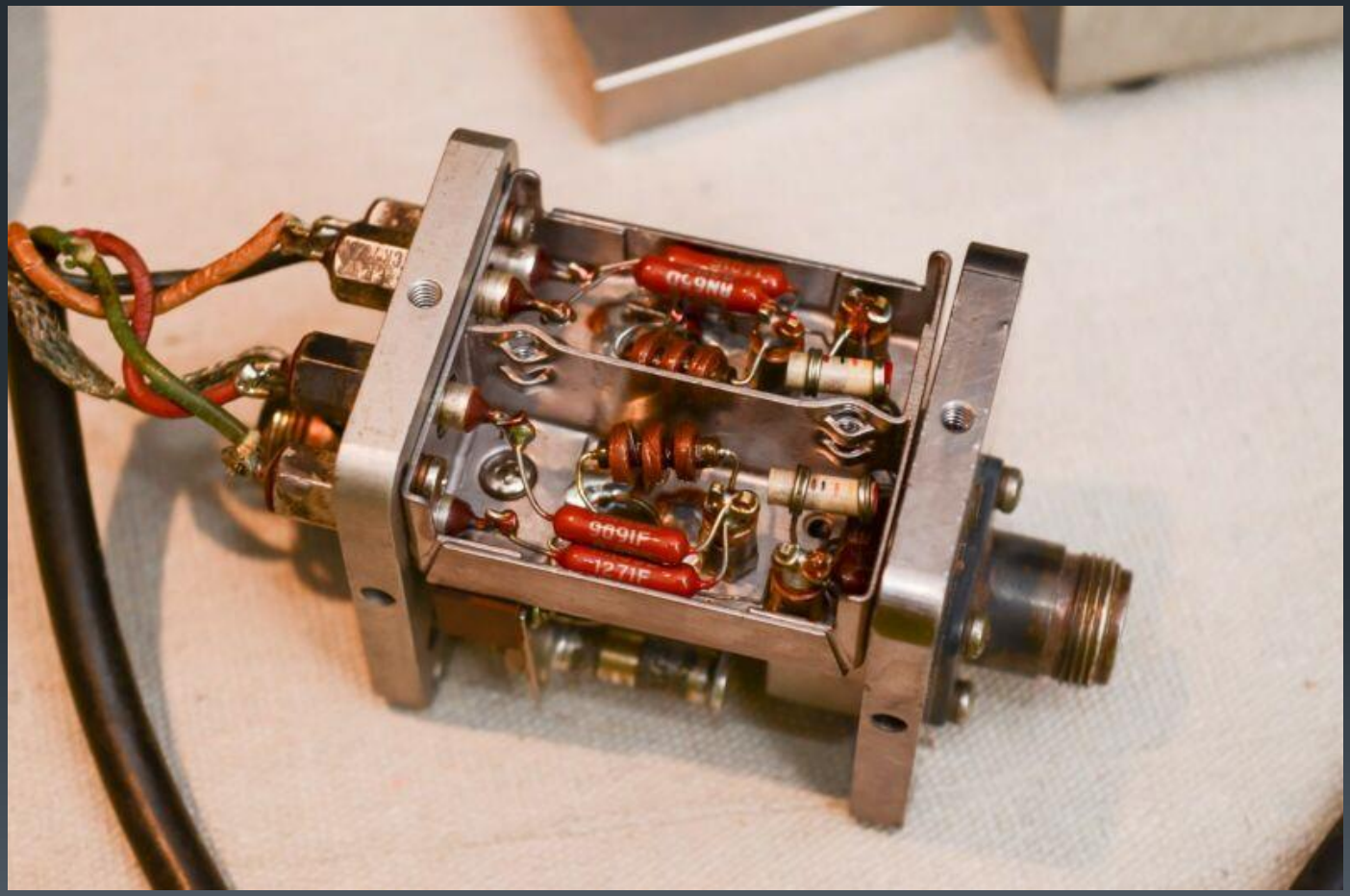
Rigid construction

Feed through caps

Excellent shielding

First rate
Piston Trimmers
(quartz)

Type N connectors
(No loose parts)

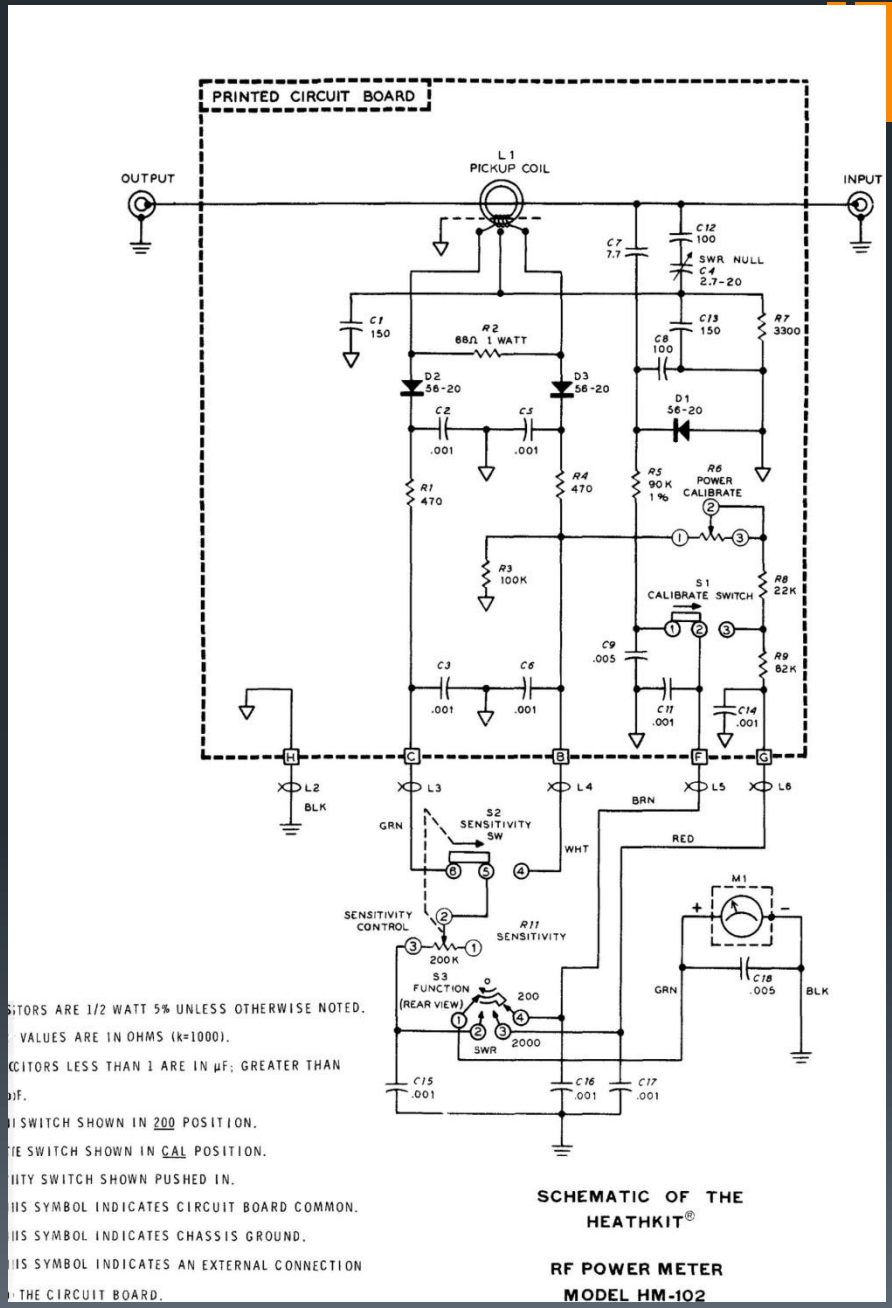


Autek WM-1

Auto SWR
5% ofs
Still made
Remote coupler

Heath HM 102

Clever and accurate
Remote coupler



Power measurement is not directional

Thermocouple Meter

- Very broad frequency range
- Wide power range and up to 1w without attenuators.
- AC/DC transfer ability for calibration.
- Relatively slow responding
- PRD, HP, and Anritsu

Anritsu ML4803a/ MA4601a Dc-5GHz, 200MW, cheap

30db=100w

Add attenuators to read higher power

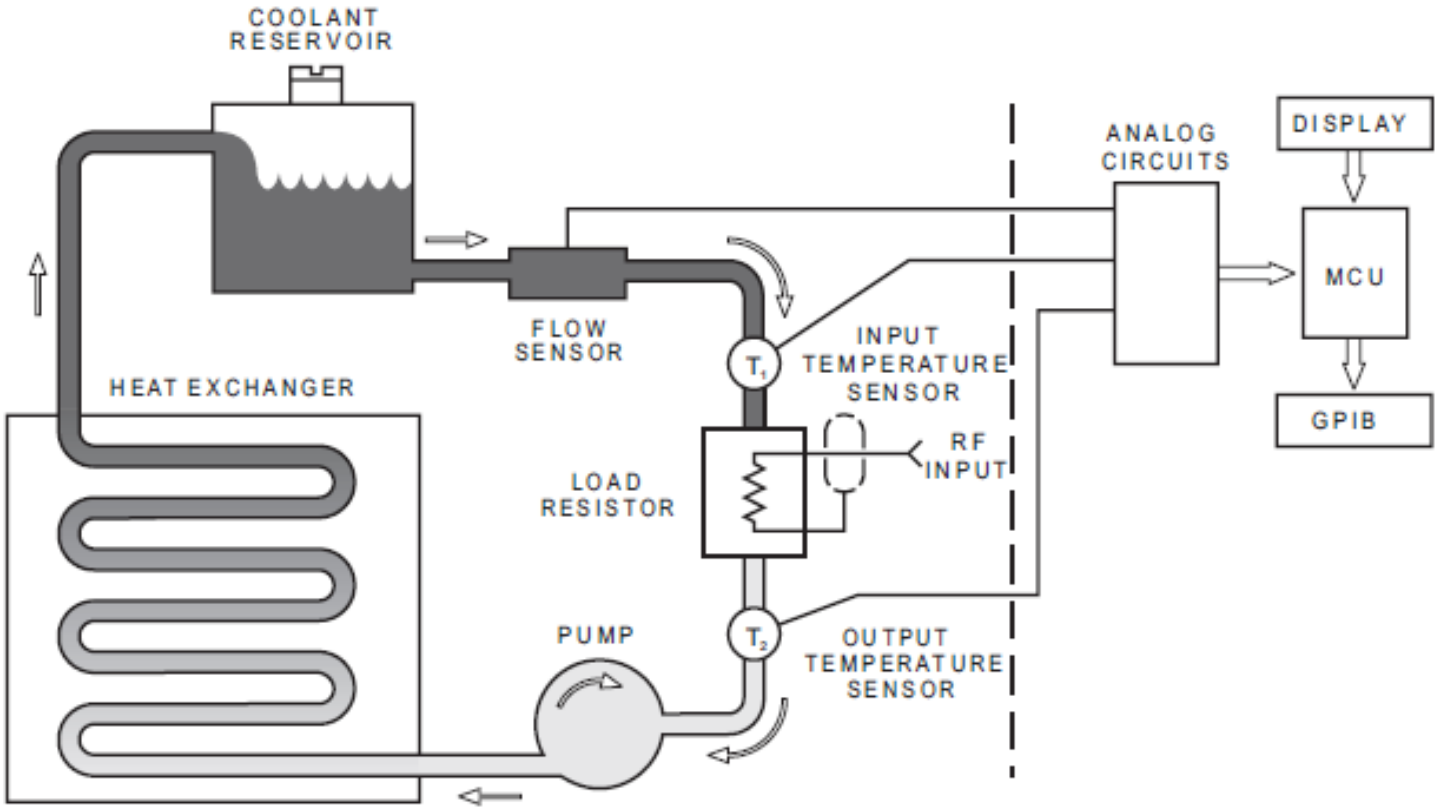
Make sure you get a cable!!

Calorimetric Meters

- HP 434 and Bird 6091
- Both use a fluid to absorb the input power and as a heat transfer medium.
- Very low SWR and excellent accuracy 2% or better.
- Can be very slow.
- From mill watts to Megawatts.

Figure 4

System Block Diagram



Bird 6091 Calorimeter

DC to 2.5GHz 2%

10 to 200W

Uses water for transfer

HP434A

One of the best. Make sure you get the oil with it.

PRD 680 Calorimeter

Thermocouple Type

.01mw to 1w

DC to 1GHz

Over the Top Meters

- Rhode and Schwartz NAP meter

Dual display
AC/Battery
Multiple ranges with available sensors.
5% of reading accuracy
Outstanding coupler
Expensive

LP100A

Highly accurate
Versatile
First rate coupler
And
Digital “back end”
5% of reading
Accuracy
$500

Recalibrating Notes

- If you are *sure* yours is off.
- Get a meter that is known to be better
- Check it at three levels of power
- Check it at three frequencies. 3.7, 14 and 28MHz
- Write down your data
- Check it in both directions
- Suggested calibration meter- Bird 4410, LP 100A

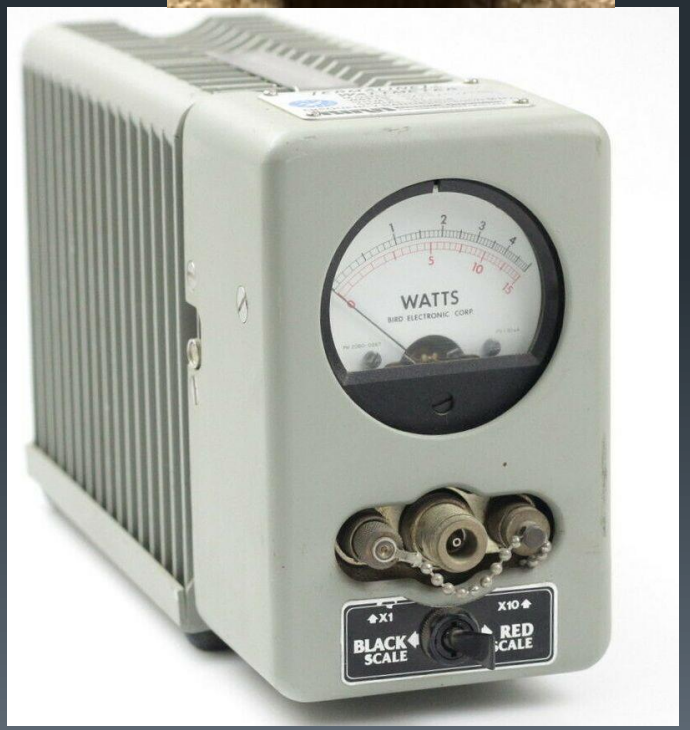
Conclusion-

Even with a new meter, check the calibration. Check the setup.

- Look at coupler design and quality of components.
- Look at meter scale resolution.
- Go for accuracy and convenience
- Connection RF cables between load and meter can drastically effect accuracy.

Best Bang for the Buck?

- Drake W-4
  - Accurate 5% of reading
  - Sturdy, no battery
  - Easy to read
  - Separate coupler
- Bird 6154
  - Accurate over full range
  - Made for rough usage
  - Versatile



That’s the Round-up

- I hope it has been informative and interesting
- Feel free to contact me.

Thank you

- Email
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- UHF wattmeter talk-
  - Google K6jey wattmeter talk.