The Cornet ED88TPlus:
Well played scam or naive application note design (or both) ….

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I recently came across the Cornet ED88TPlus EMF meter (S/N 1903002559). It is a handheld unit which measures low frequency magnetic and electric fields as well has high frequency electromagnetic fields.

On paper, it is quite highly spec'd, with an RF measuring range covering 100MHz to 8GHz and a lot of features, such as audio output, readout of the dominant frequency (<2.7GHz), USB interface for data logging, and a multi-function, bar-graph, display which features a ton of information.
It has become an extremely popular go-to instrument within the 'EMF-Aware' and EHS (Electromagnetic HyperSensitivity) community and given its price ($200) you would expect it to be of high quality and give accurate readings. It is not and it does not.

1. First impression

The instrument runs off a 9V battery. I measured 60mA vs. 45mA with/without display backlight, which by the way is white and clear. The backside has labels depicting the position of the measurement sensors, as well as a conversion table between the received signal power and the equivalent power density in W/m2. I won't dig in to the actual usage, but the conversion table also refers to the front panel LED bar-graph, which visually gives an impression of the measured power density and field strength. The conversion table puzzled me a bit – it seems they are using a fixed ratio between received power and corresponding power density, something I found a bit 'weird'… We will get back to it later.

Fig. 1 - ED88TPlus

I took a look inside and Fig. 2 below shows the PCB with its main functional areas and sensors / antennas.

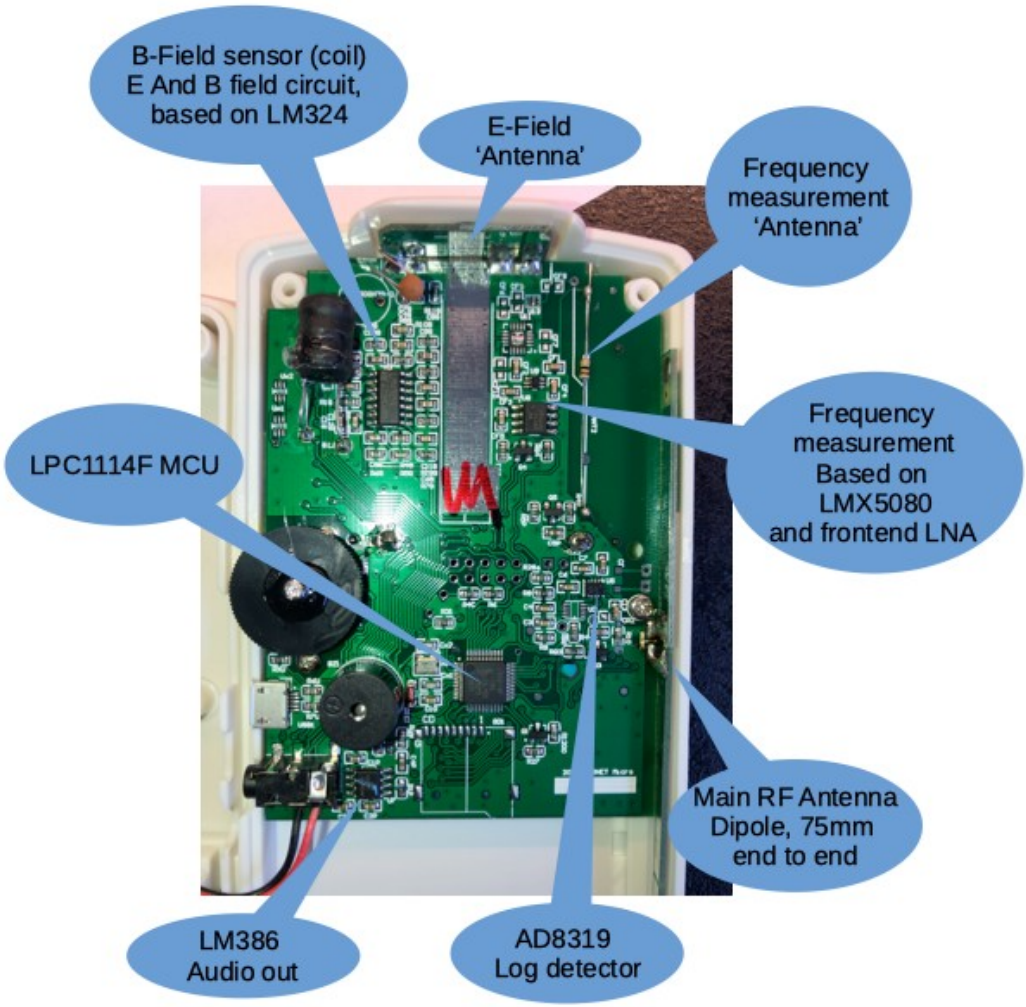

Fig. 2 – Inside view, bottom side of the PCB

The PCB is not fully populated – it may possibly be used across different models.

Generally the build quality is poor for an instrument at this price range. Surface mount component soldering is OK, but all man-made soldering is of extremely poor, brittle quality. Too much heat, low grade solder, no care for the craftsmanship in proper soldering. This essentially means that units may/will fail, where in reality it could have been avoided.

The electric/magnetic field circuit seems rudimentary, revolving around a single LM324 (four OP-AMPS) along with a coil and a perpendicular PCB as sensors. I focused primarily on the RF section, so I have not tested the accuracy of this circuit, only confirmed that it seems to work by holding the instrument near my induction cooktop and different 'live' wires.

Besides the measurement circuits, the PCB hosts an MCU, an amplifier for the audio output, and on the top side (not shown in this document): the display, buttons, the LED Bar and miscellaneous 'house keeping' components.

2. RF measurement section.
The RF section is divided in two independent circuits, each with their own antenna:
a frequency counter and the wideband signal strength meter (Fig. 2).

The frequency counter is based on the LMX5080 prescaler with a frontend amplifier to boost the signals. According to the specifications it will display the frequency of the dominant part of the signal, as long as it is below 2.7GHz and above -35dBm. I tested this, it is not overly accurate, but it does work.

The wideband signal strength meter is based on the AD8319 Log Amplifier, connected directly to the antenna, a simple dipole roughly 75mm end to end.

Deriving the power density from the measured power level at the antenna terminals, is frequency (actually $1/\lambda^2$) as well as antenna gain dependent. This is an absolutely fundamental relation, there is no way around it (λ is the wavelength).
There are instruments which measure frequency as well as the amplitude (We call this a spectrum analyzer….) and with a well defined antenna, the power density can easily be calculated.
Other instruments have a specially designed RF filter circuit, compensating antenna performance and the $1/\lambda^2$ relation across the desired frequency range before the wideband detector, thereby giving a more direct relation between the power density and the measured power level.

The ED88Tplus does neither.

In fact, the ED88TPlus does not (and is not designed to) use the measured frequency at all and from display readouts (and the before mentioned table on the back side), it seems that the designers employed a fixed conversion rate between the measured power and the corresponding power density, at around a factor of 580 ….

This basically means – assuming the antenna has a gain of exactly 1, that there is only one frequency where that conversion factor would be correct, in this case around 2GHz. It takes some antenna knowledge to work this out, but the formulas are well known (google ‘antenna aperture’)

Which brings us to the antenna. A PCB dipole with a total length of 75mm, ideally resulting in a center frequency of 2GHz.

Fig. 3,4 -Antenna poorly soldered to the PCB – Length of desoldered Antenna
It is a dipole, the reason for the green solder mask patches and the small disconnected square to the far right, is unknown..

However, because of the PCB dielectric constant, the resulting center frequency will be a bit lower, I measured it at around 1.65GHz. But that is NOT a broadband antenna, designed to operate from 100MHz to 8GHz. It is a narrowband antenna, and outside its center frequency, it has a massive loss factor. I found the antenna pretty much useless below 1.5GHz, with random resonant points up to 3.2GHz (which is the limit of my test setup), but even at the well known 2.4GHz band (WiFi, Bluetooth, Microwave ovens), the antenna performed extremely poorly.
In fact, I would argue that it is impossible to build an internal antenna, in a handheld instrument, which would be usable for accurate measurements in the stated frequency range. **The ED88TPlus fails irrecoverably right there.** There is a reason why precision instruments have the antenna externally, at a distance.

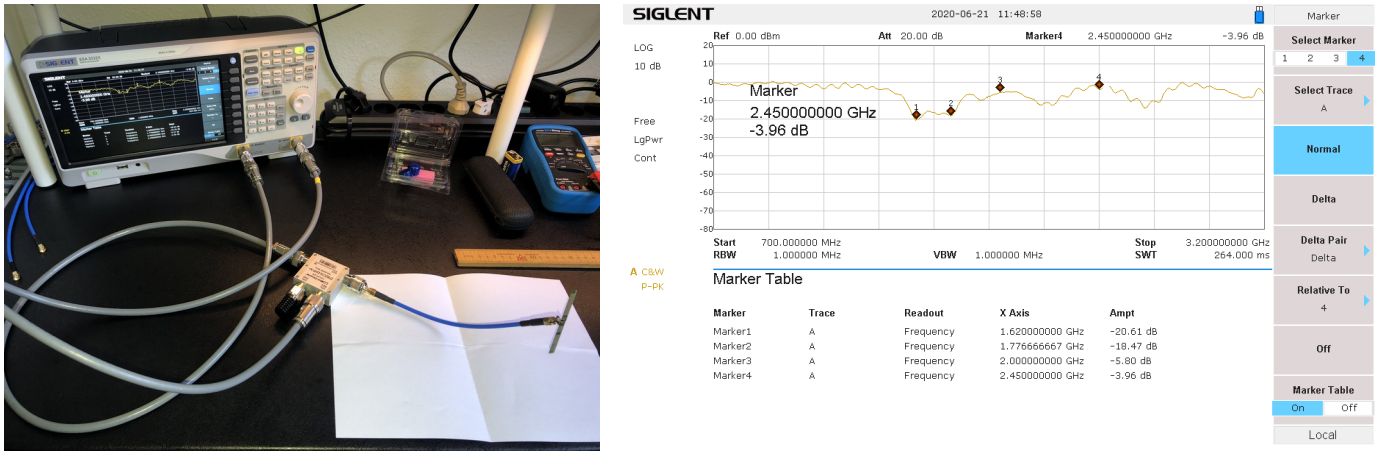

Fig. 5,6 - Antenna frequency response (return loss) measurement, 700MHz-3.2GHz

To verify all this, I did a couple of measurements, where I subjected the ED88TPlus to signals at 1GHz and 2GHz at a known distance, using a known transmit antenna and a known transmit power. Thereby being able to estimate the power density within reasonable margin.
At 1GHz, the received power and displayed power density were way off. Absolutely useless.
At 2GHz things looked a bit better, but now we are also closer to antenna resonance and the fixed conversion factor of 580, apparently ‘chosen’ for 2GHz.

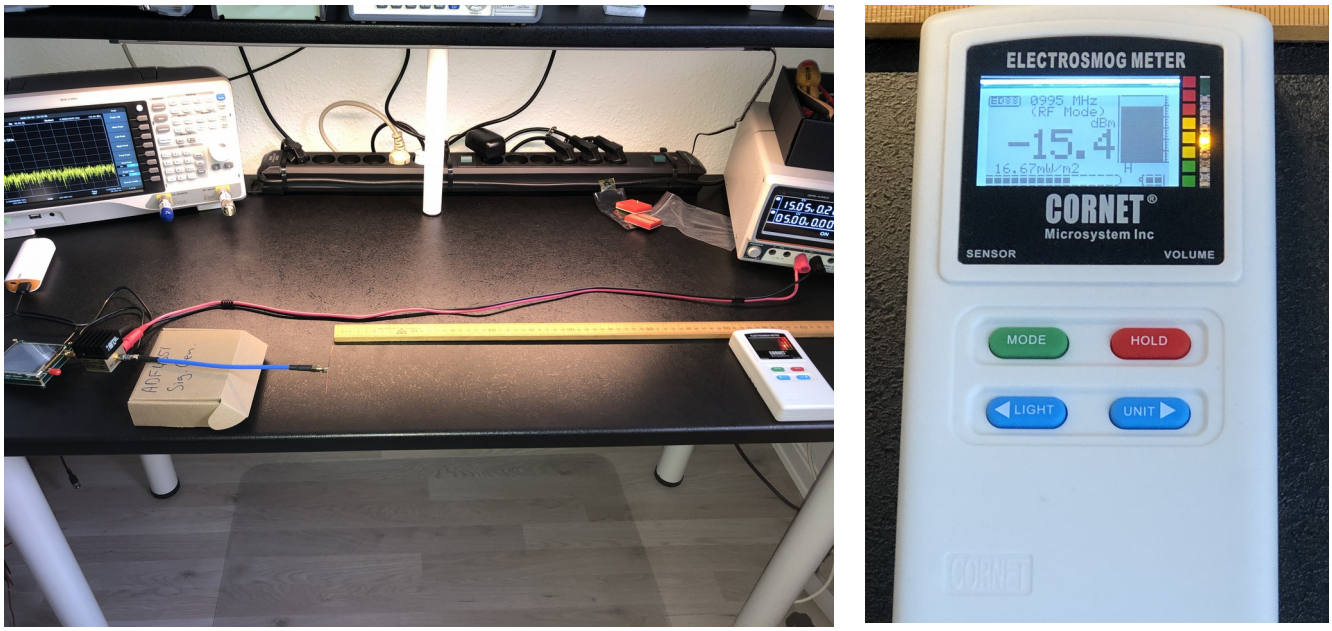

Fig. 7,8 - Power density experiments

Summing up, the RF measurement section is useless for any absolute, accurate, measurements. You **can not** use the readings to compare with any relevant standards or any recommended values from scientific bodies.
The displayed dBm values at the antenna terminals are most likely correct, but since the antenna clearly is faulty by design, and there is absolutely no correction implemented, they will have little or no relation to the real world other than the obvious increase when approaching a source.

3. Conclusion

So is this a well played scam or a naive application note design, or both?

It is hard to say. The instrument will tell you if there is something there, and you can use relative RF readings to hunt down sources, but the absolute RF readings are useless (the electric/magnetic field readings probably too, given our knowledge about the poor RF design.).

They did put a decent effort into designing UI functionality, even added a USB interface with logging capabilities and an offset adjustment of the LED bar, to emulate alternate exposure limits.
Some of the PCB layout strategies makes sense, other design choices does not.

All the circuits are there, they are functional, **but they did it wrong**. Deliberately? Did they know and simply didn't care? It boggles the mind.

It remains a fact, that people pay 200$, and trust the instrument in relation to their own beliefs around the EMF and EHS debate. Unknowingly being misled by useless measurements from this broken-by-design instrument and using them as (in)valid input in the ongoing EMF / EHS / 5G / etc. debate.

If you purchased this instrument to provide valid measurement inputs to the ongoing EMF debate, I suggest you return it immediately for a full refund.

4. Miscellaneous notes and fun facts

-Even though the instrument is priced at the high end for a private person, a calibrated instrument which conformed to the listed specifications, is likely to be much more expensive.

-If you're a spy, despite the poor antenna, due to its large bandwidth the instrument may be handy to hunt down bugs and scan hotel rooms for sensors. The audio output will definitely be a valuable feature here, at least that is what I learned from watching James Bond Movies.
Jokes aside – the instrument might actually work quite well for this purpose.

-There is a large community around the world dealing with paranormal phenomena (yes ghosts..)
Instruments like this are apparently essential when you hunt for ghosts – so there: if that is your thing, the ED88TPlus may prove handy with its many measurement modes (and audio! :-))

-Apparently Cornet Microsystem is based in California and has been on the market for quite a while. Their website seems outdated (http://www.electrosmog.org/) but I tried to mail them asking questions to their design and a schematic of the ED88TPlus.

I have yet to receive a reply, so my findings regarding individual components are my qualified guesses, as an RF engineer

-This entire document describes entirely my own findings and opinion. I am not affiliated with any of the mentioned communities or with the Telco industry in general.