Finding Field Strength The Sim

Gordon King G4VFV takes a breather from preparing his Looking At series to present a useful little instrument - the field strength meter, which we should all have in our shack.

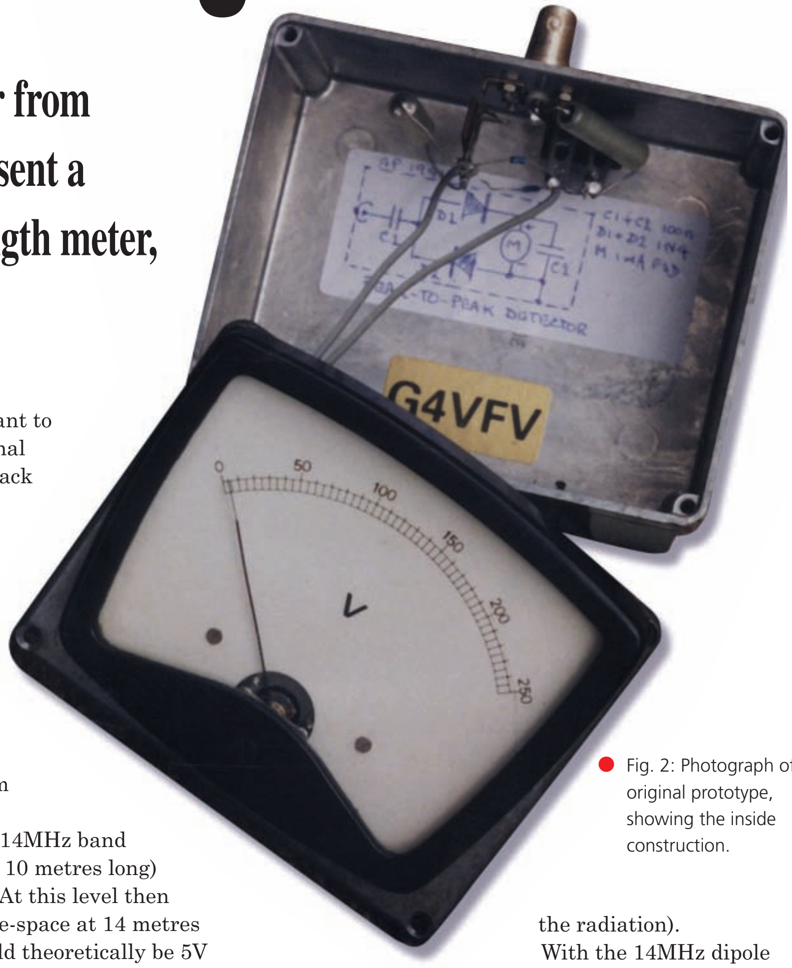

Fig. 2: Photograph of original prototype, showing the inside construction.

It's convenient and important to be able to monitor the signal field in and around the shack and QTH arising from radiated r.f. This can be done definitively, though expensively, by means of a sensitive and accurately calibrated commercial field strength meter (FSM), or less accurately and with minimal sensitivity - though far less costly - by the simple indicator (FSI) which I'm describing here.

Let's say we're working the 14MHz band using a half-wave dipole (about 10 metres long) to which the r.f. input is 100W. At this level then the electric field strength in free-space at 14 metres distance from the antenna would theoretically be 5V per metre (5V/m), e.g., $100^{0.5}$ x 7/14.

This simply means that the r.f. across a metre of space 14 metres from the antenna would have a strength of 5V. The trick is knowing how to measure the voltage!

Too Close

If measured too close to the transmitting antenna the result will be the near-field strength. A certain distance is required for the electric (E) and magnetic (M) components of the wave to link together and form what is known as a plane wave....EM radiation then commences. (This happens when the distance is not less than two times the square of he greatest dimension of the aerial, divided by the wavelength of the radiation).

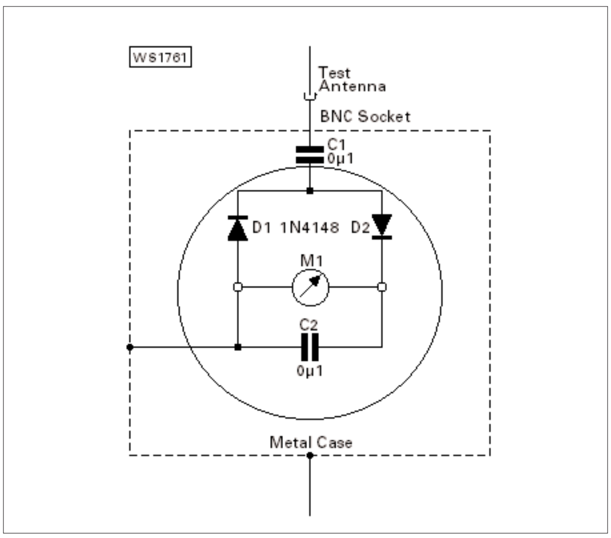

Fig. 1: Basic construction of a prototype. The meter resistor is not shown, but can be included inside the meter movement case or the enclosure. (The text reveals how the resistor value is calculated).

With the 14MHz dipole example, therefore, the distance works out to 10 metres (2x10^2/20). This is the start of the far-field distance. (The near field is regarded as distances closer to the radiating antenna than this).

With a compressed antenna **smaller than a half wavelength**, such as a helical, frame, small loop, etc., the far-field distance **cannot be less than the radiated wavelength divided by 2π**. At 14MHz, for instance, this means that the far-field distance can never be less than a little over three metres (20/6.28).

Simple Device

The circuit of the simple FSI device is given in **Fig. 1**. It's based on a simple peak-to-peak detector circuit (sometimes known as a voltage-doubler), which connects to a sensitive moving-coil meter movement.

The detector circuit proper merely consists of two diodes and two capacitors. These are housed, along with the meter movement, in a metal case with a BNC socket at the top and a terminal at the bottom.

Basically, a peak-to-peak detector operates as follows: During negative swings of the input signal diode D1 conducts and C1 charges to a value related to the signal's negative peak.

During positive swings D1 is back-biased while diode D2 conducts and C2 charges to a value related to the signal's positive peak.

With successive half cycles C1 charge is

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progressively transferred to C2, so that the voltage across C2 and hence across the meter relates to the sum of the signal's positive and negative peaks.

An early prototype employed a relatively insensitive meter of around 850µA full-scale. Although this provided reasonable indications of r.f., a more sensitive movement of around 50µA full-scale should be sought.

However, since the aim is to obtain an indication of the charge acquired by C2 it's desirable to change the function to a voltmeter of the highest possible sensitivity. This is easily achieved merely by including a resistor in series with the meter movement.

For instance, to read 0.25V full-scale (V=0.25) deflection on a 50µA ($I = 50 \times 10^{-6}$) movement, the series resistor (R) should have a value of approximately 5kΩ (R=V/I or $0.25/50 \times 10^{-6}$). For voltage reading accuracy the relatively low resistance of the moving coil would be deducted from the 5kΩ, but this hardly applies to the application in hand!

Possible Switch

It would, of course, be possible to include a switch to select any required series resistor - 20kΩ for 1V full-scale (20kΩ per volt sensitivity), 40kΩ for 2V full-scale, etc. Actually, the smallest loading across C2 the better, consistent with the requirement.

In practice I've experimented with an inexpensive high impedance digital voltmeter, reading down to a millivolt or so. Frankly, I was amazed by how sensitive the readout became with such a basic circuit - from very low mains frequency to v.h.f.!

Pick-Up Sensitivity

It will be appreciated, of course, that the effective sensitivity is also related to the nature of pickup antenna or wire used. For a good few applications a one metre wire connected to the BNC socket is likely to be adequate.

For enhanced pickup an additional wire can be connected to the bottom terminal, serving rather like a counterpoise! To locate items 'hot' to r.f. in the shack, only a short sensing wire to the BNC socket may be all that's necessary.

Basic Calibration

Some basic form of calibration could be explored using a metre long dipole established in a plane corresponding to that of a transmitting antenna. For example, a horizontal 29MHz half-wave transmitting dipole could be established in the garden with the FSI connected to its own horizontal one-metre wire.

Transmitter power and FSI positioning could then be arranged to provide full-scale deflection. Once established, the transmit power could be decreased in suitable steps while noting the meter deflection down from full-scale.

Of course, you'll realise that the indicator cannot be expected to compete with commercial models. It isn't meant to as it's neither particularly sensitive nor flat in frequency response.

However, this simple little device does lend itself to experimentation. This includes the addition of high input impedance front-end solid-state amplification and high impedance digital metering, as already mentioned.

So. altogether...it's worthwhile making one for your own workshop. As I've said...it's very useful!

PW

Gordon G4VFV demonstrating an early prototype in action in the shack (hanging on the door, left) responding to the r.f. being radiated from the short helical antenna of a 144MHz hand-held transceiver.

Errors & Updates

The PW International Beacon Project Electronic Timer part 2, by **Phil Cadman G4JCP** on pages 32-35 of the January 2002 issue of *PW*.

Santa's gremlins left us with rather red faces when the wrong version of the diagram of **Fig. 3** (p34) was printed instead of the updated diagram shown here. If you would like to update the drawing in your magazine then the following additions need to be made:

1) The wire connected to pin 3 of IC4A should be connected to pin 13 of IC4B. These should then both be connected to the positive supply line labelled V_{dd}.

2) The supply lines to IC4 do not have their pins numbers marked. Please add on to IC4B the pin number "8" to the line labelled V_{ss}. And on the line labelled V_{dd} please add the pin number "16".

My profound apologies for these mistakes and any inconvenience that they might have caused. **Editor**