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Problem solving

Two RF current meters from MFJ can help to solve many interference problems, writes Ian White.

Too many of us are staying off the air because of RF interference problems. The reason is that we lack the tools to tackle RFI problems and cure them. The problems have also become much more complex, typically taking us into a tangle of cables behind a 'home entertainment centre' comprising a TV, digibox, VCR, DVD player, hi-fi and more. The trickiest part is to find out which cables are actually involved in the RFI problem, and which cables can be left alone. Far too often we are reduced to trying filters and ferrites almost at random… which doesn't exactly impress the family or the neighbours. We need some better tools.

One of the best tools for RFI investigation is an RF current meter that simply clips over any wire or cable. When you turn on your transmitter, the meter will *show* you if any RF currents are flowing in places they shouldn't be. Then you can use filters or ferrite chokes to stop them. Because a clip-on meter lets you identify problem cables quickly and easily, without even needing to unplug them, it is much more likely to be acceptable in a neighbour's house. If everyone had a simple RF current meter – home-made or store-bought – then there would be far more cases of RFI successfully resolved, and more amateur stations on the air.

PHOTO 1. THE MFJ 805 (LEFT) AND MFJ 854

Several *RadCom* authors have described how to build an RF current meter, and this information is on the 'In Practice' website [1]. However, until recently there have been no ready-made alternatives available in the UK, so I welcomed the opportunity to review two recent offerings from MFJ, imported by Waters & Stanton.

The MFJ-805 and MFJ-845 are both clip-on RF current meters, battery powered, but the two models are intended for slightly different purposes. The MFJ-805 is a sensitive RFI detector for indicating unwanted signals emerging on cables from your own radio equipment, and also from computers, switch-mode power supplies and many other RF interference generators. The high sensitivity allows it to detect signals down to quite low levels, including currents induced by your own transmitter in a neighbour's house, but the sensitivity can also be reduced to indicate unwanted RF currents in your own shack.

The MFJ-845 is a dual-function instrument: it is primarily intended as an RF current meter for antenna measurements, but it also has enough sensitivity to diagnose most kinds of RFI problems within or near to your own station.

TABLE 1

Features of the two instruments, both specified and measured.

Features	MFJ-805 RFI Detector	MFJ-854 RF Current Meter
Claimed sensitivity	Detection range 20µA to 50mA	Six switched ranges: 0-3A, 0-1A, 0-300mA, 1-100mA, 0-30mA; and <30mA, adjustable
Measured sensitivity	At 10MHz, lowest usable reading 100µA; reverse meter indications above 4mA (see text). At 144MHz, lowest usable reading about 3mA.	On 0-30mA switched range: 0-40mA full scale. Higher ranges pro rata. On <30mA adjustable range: lowest usable reading about 10mA up to 50MHz, about 25mA at 145MHz.
Claimed bandwidth	Usable from 100kHz to VHF.	Accurate from 1MHz to 30MHz and beyond.
Measured bandwidth (at about 30mA)	Varies widely: max sensitivity at 7MHz; –6dB points 3MHz and 15MHz; –18dB at 50MHz; –29dB at 144MHz.	Very flat: –6dB points <500kHz and 125MHz.
Measured insertion impedance	Varies widely: 8Ω at 1MHz, peaking to 130Ω at 7MHz, falling to <1Ω at 31MHz, and 15Ω at 50MHz.	Low, rising steadily with frequency: <2Ω up to 10MHz, <5Ω up to 35MHz, 6Ω at 50MHz.
Max cable diameter	8.0mm	10.5mm
Fits RG213	No	Yes
Battery	9V PP3, <5mA	9V PP3, <5mA
Battery switch	On sensitivity pot	Push-button with 20s timeout
Price	£69.95	£89.95

MFJ-805. The MFJ-805 is a sensitive meter intended specifically for RFI investigations, so it is specified to cover the range of RF currents from about 50mA to 20 microamps. This is only a semi-calibrated instrument, because the sensitivity is set by a continuously adjustable potentiometer, which has to be turned fully anticlockwise to switch the instrument off. However, that is not a major problem for practical RFI investigations because you are mostly looking for broad indications rather than accurate measurements. In practice, it would not be difficult to make a measurement, switch the instrument off while installing a filter, and then return to near-enough the same sensitivity setting to see if the filter had made a worthwhile difference. The frequency range is claimed to be from 100kHz up to VHF, with declining sensitivity above 30MHz.

On test, the MFJ-805 proved very sensitive, although the lowest usable reading (measured with the sensitivity control fully clockwise) was higher than the claimed figure of 20 microamps. Even with no signal, the meter reading rises as the sensitivity control is turned clockwise, but this isn't a problem once the user is aware of it. However, there *were* some serious problems at low sensitivity settings, which you might have to use when investigating RF feedback in your own shack. As the RF current was increased above about 4mA, the meter began to read backwards. This was due to direct RF breakthrough into the sensitive op-amp that amplifies the very small DC signals from the detector diode; or more specifically, due to the absence of RF bypass capacitors on the PC board. Such poor RFI immunity is hardly a recommendation for an instrument that claims to be an 'RFI Detector'. A meter that can sometimes read backwards leaves the user unsure whether filters or ferrites are making things better or worse.

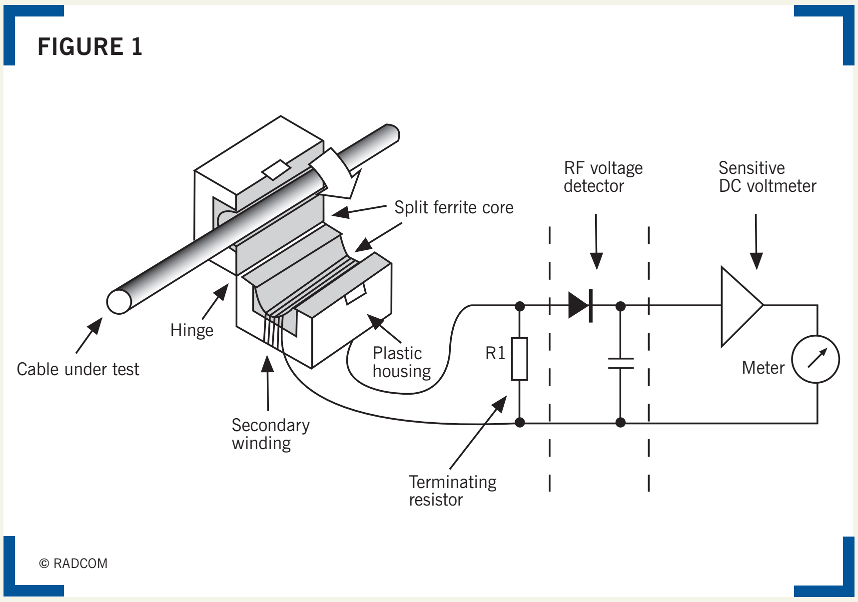
As the measurements show, the sensitivity and insertion impedance of the MFJ-805 are both affected by strong resonances at 7MHz and 22MHz. The sensitivity also declines sharply at VHF, but is still more than usable for most purposes. This frequency dependence appears to be mainly caused by the current sensing transformer and the lack of a terminating resistance (see sidebar). The usefulness of the MFJ-805 is also limited by the small-diameter opening in the split ferrite core, which will not close properly over RG213 coax, or over large mains/DC power cables.

MFJ-854. The MFJ-854 is a dual-function instrument. It is primarily intended to measure fairly high RF currents (up to 3A) on antenna wires and ground radials, but on its lower ranges the MFJ-854 is also sensitive enough for use in RFI investigations. Compared with the MFJ-805, another £20 buys you a lot more: five switched current ranges for full-scale readings from 3A down to 30mA; an additional <30mA range with adjustable sensitivity; a metal case; a power switch that is separate from the sensitivity control; and a current sensing transformer that has much better performance *and* can be used with larger cables.

The 10:1 current sampling transformer is terminated in 47Ω and gives very good broadband performance and a low insertion impedance. The impedance depends a little on the diameter of the wire or cable being checked, and on its location inside the hole through the core. This may affect the accuracy of some antenna current measurements, but would not be a problem for RFI investigation.

However, I did find a couple of quality control problems with the review model. The power-on button did not time out after about 20 seconds as claimed, so there was no way to switch the instrument off. Also the split ferrite core in the review model was installed upside-down, which meant that the instructions for unlatching the two halves of the core wouldn't work. Waters & Stanton and MFJ are investigating.

FIGURE 1. BASIC PRINCIPLES OF RF CURRENT METERS



HOW THEY WORK

These RF current meters consist of a transformer that clips onto the cable, and couples a small fraction of the current into a sensitive RF detector. **Figure 1** shows the principle. The transformer uses a split ferrite core, selected from one of the grades of ferrite usually sold for 'RFI suppression' purposes. Each pass of a wire through the centre of the core counts as one turn, so the cable under test is the one-turn primary of the transformer. Typically, the secondary (or 'pickup') winding will have about 10 turns, and should normally be terminated in a load resistor R1. Then a diode detector measures the RF voltage and a DC amplifier drives the meter [1].

A few points to note:

- When the secondary winding is terminated by a resistor, a larger number of turns on the secondary winding will give a *smaller* current sampling ratio. For example, a 10-turn secondary will sample one-tenth of the current in the cable.
- Clipping on the RF current meter will create an additional RF impedance in the line that is being sampled. This 'insertion impedance' is determined mostly by the value of R1 and the square of the turns ratio, so 47Ω and a 10-turn secondary will create an impedance of 47/102 = 0.47Ω in the transformer's one-turn primary. Losses in the ferrite core will have a small additional effect, but mostly at higher frequencies.
- If the terminating resistor R1 is omitted (as in the MFJ-805) the instrument becomes much more sensitive – which may be a good feature in an 'RFI sniffer' – but the insertion impedance becomes very much higher too. The effect will be similar to clipping on a *bare* ferrite core, which can insert a combined resistive and inductive impedance of 10-100Ω or more, depending on the frequency, the type of core and the layout. So a meter that has an un-terminated transformer can significantly affect the situation that you are attempting to test.
- The two halves of the split core must close firmly and reliably together, to avoid erratic performance due to gaps and leakage in the pathways for the magnetic flux. Both of the instruments reviewed use snap-on ferrite cores of the type supplied for RFI suppression. The hinges and catches of the plastic housings should be handled with care, for they were never intended for repeated use [2].
- With a simple diode detector, the sensitivity will be limited by the threshold voltage of the diode. Low-level RF signals close to or below this threshold will produce very little DC output indication.

All of these points are observable in the test results for the two instruments reviewed.

CONCLUSION. The MFJ-854 is a competent piece of amateur test equipment, with sufficient sensitivity to be used for RFI investigations and the facility for more accurate measurement of higher currents in antenna work. Peter Dodd's 'Antennas' column in the June issue shows the MFJ-854 in use, and Peter reports no problem with the battery switch/timer on his instrument.

I was unimpressed with the MFJ-805. Even if it had performed as claimed, it would not have been good value compared with the MFJ-854 at only £20 more. However, I regret to say that its lack of internal RFI immunity makes it barely adequate for its purpose.

NOTES AND REFERENCES

[1] *In Practice*, December 2003, and follow the links from the *In Practice* website.
[2] I did not test the long-term durability of the hinges and catches in the review models.