ELECTROMAGNETIC COMPATABILITY

Introduction.

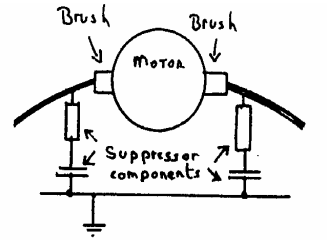
What is Electromagnetic Compatibility (EMC)? It is need the for various electromagnetic devices to function happily in each-others presence. For example, your electric drill or your vacuum cleaner should not cause a buzz on radios or lines on the TV. The thermostat in your central heating should not send spark transmissions to the whole neighborhood and the TV next door shouldn't make your radio whistle.

Unfortunately, we do not live in an ideal world. Many of the above forms of interference do, in fact, take place. They need not occur. With a little **more time and money at the design stage** the various types of interference could be quite **easily** avoided.

History

It is not all that long **ago** that all electric motors interfered with every wireless in the neighbourhood. The seat of the problem was the carbon brushes sparking on the commutator and radiating interference from the wiring.

What has happened - why doesn't it occur today?



It was soon recognized that such interference was antisocial. However, it was quite easily avoided - each motor was manufactured with a suppressor" fitted. This damped the spark and greatly reduced its annoying radiation. The circuit, although simple, was generally effective. Add-on suppressors then became available to fit to earlier un-suppressed motors.

This is EMC

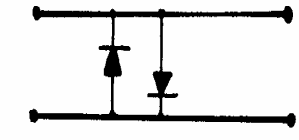
This is a simple case of EMC. The culprit is clearly the sparking motor.
IE The motor was interfering with the wireless so it was the design of the motor that **was** modified.

This is also EMC

All would be well if every motor was suppressed. However, this is not an ideal world. There will always be the odd sparking motor so the wireless makers had to take some precautions at the receiver end. They provided a noise limiter. These were usually very simple but could reduce the affect of spikey type of spark **noise.**

A noise limiter.

A simple **noise** limiter would comrise two back to **back diodes connected across** the headphone circuit.
Normally the diodes would be non-conducting and have little effect on the passing audio.
However, a spike resulting from a distant spark would have a much **greater amplitude** and 'switch on' the diodes. This would chop off the top of the spike making It **less** objectionable to the listener.



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Electromagnetic Compatability (EMC) is the ability of equipment to function satisfactorily in its electromagnetic environment without introducing intolerable disturbance to anything in that environment.

Unfortunately the onus of blame is not **so** clear when a radio transmitter is involved. Obviously, a radio transmitter intentionally radiates an electromagnetic wave. Ideally only radio receivers tuned to that frequency should react to that electromagnetic wave. Unfortunately, as mentioned before, this is not an ideal world. Modern domestic radios$_1$ TVs and Hi-Fi's are not always as efficient at 'ignoring' local electromagnetic transmissions as were their valve predecessors.

Everything could be OK - at a price!

It is, for example, quite possible to manufacture TV sets that are immune to strong electromagnetic fields. However, argue the makers, most TV's do not have to operate in the presence of a strong electromagnetic field. Therefore, to keep their production casts to a minimum they omit any components not absolutely necessary under normal operating conditions.

New Legislation

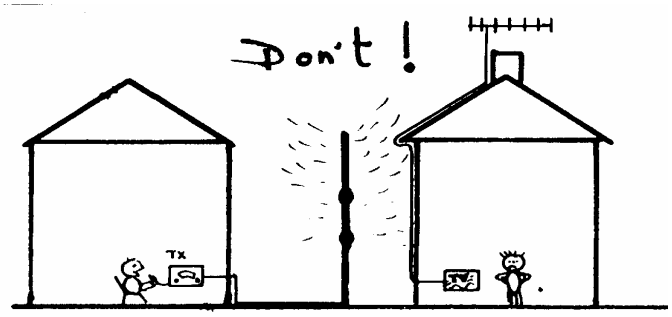
Some countries, like the USA,(and now the UK) have introduced stringent ENC regulations. These ensure that domestic entertainment equipment is built to EMC standards. Similar, (but watered down) regulations are being Introduced here In the United Kingdom. These should ensure that some degree of EMC protection Is built into new domestic entertainment equipment. Unfortunately the level of immunity is not as great as Radio Amateurs would like, but it is a step in the right direction.

Ideal to reality: bridging the gap!

For the Amateur Station to work well and, at the same time give rise to no interference, some 'common sense' precautions should be taken. The transmitting aerial should be in the clear and as far possible from anyone's TV (and aerial) or Hi-Fl equipment.

How can an Amateur transmission get into a TV or Hi-Fi?

a) via aerial coaxial feeder cable
b) via mains cable
c) directly into TV/Hi-Fl chassis
d) via loud speaker leads (Hi-Fl)



The transmitting aerial should be sited away from any TV's or .Hi-Fi's and their aerials or cables. Efforts should be made to minimize the coupling between the transmitting s>'stem and the TV coax by not having the two running parallel. For example, it would be unwise to Install a vertical amateur aerial anywhere near where the TV coax runs up the wall to the roof.

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End fed wire aerials - a problem?

Steps should be taken to avoid creating strong electromagnetic fields within the house in order to prevent it being picked up by the house electrical wiring. This means that it is often best not to use an 'end fed aerial' unless the aerial tuning unit can be fitted just inside the outside wall. At certain frequencies the internal portion of the end fed wire could create a very strong electromagnetic field within the house. If this field gets directly into the TV it is likely to cause problems.
Whereas the affect of pick-up via the TV coax or mains lead can be cured by suitable filters **(**see Lesson 11) it is very difficult to solve 'direct-pick up' problems.
Unfortunately, most TV's and Hi-Fl's have wooden or plastic cases and therefore have no inherent screening. It **is** possible for the manufacturer to 'treat' plastic to give it screening qualities. However, this costs money and so at present, this treatment **is** rarely carried out during manufacture. Fortunately, direct pick up **is** not a common problem and when it does occur it can usually be overcome by rearrangement of the transmitting aerial. As a last resort some dc-coupling components could be added to the TV component boards. But …….

Keep your fingers out of the neighbours TV or Hi-Fi

It is unwise for the Radio Amateur to make any internal modifications to neighbours equipment. Human nature Is such that any subsequent fault on **the** modified equipment would be blamed on the Amateur, If internal modification is the only remedy then it should only be carried out by a qualified TV engineer called in by the set owner.

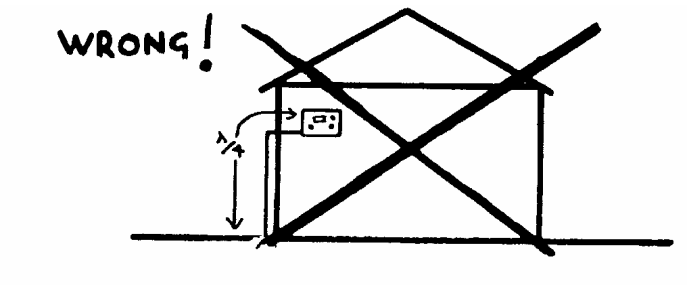
Earth in your home

Hopefully not mud brought in on your boots!
At first sight it may appear that most Amateur equipment is adequately earthed via the third pin in the mains plug. Alas this is not the case. The 'mains' earth should serve as a safety earth but it will be ineffective at radio frequencies. The length of the mains cable earth wire will be far too long -from 13 Amp socket to the real earth.

Radio Frequency Earth

A good RF earth must have a low impedance. Ideally the earth cable should be: short, straight and stout. (Please see appendix on Safety & PME)

Short - but care must be taken that it is not equal to a quarter wavelength, or **an odd** number of quarter waves at the **frequencies** to be used. At high frequencies this can be quite a problem.



Why?
Remember that low impedance at one end of a quarter wavelength of wire would result in a high impedance at the other. A transmitter that is 'earthed' via this length will be at a very high impedance point and as such is very likely to RF 'hot' to touch and will create a high RF field Indoors.

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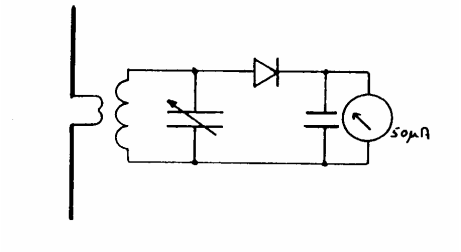
Field Strength

The strength of a field (E) reduces as you move away from transmitting aerial. Assuming an aerial that transmits equally in all directions it reduces by the distance squared. In other words, if the field is measured 3 Metres from the aerial and again at 6 Metres the field would have reduced to a quarter. IE Double the distance reduces the field to a quarter.

However, in the case of a directional aerial, the field strength can be calculated in terms of the Effective Radiated Power (ERP see Appendix) The distance (m) is measured in Metres

$$\text{Field strength (in } \textbf{Volts/Metre) is} \text{ approx} = \frac{7 \times (\text{square root of the ERP})}{m}$$

Field strength is measured in Volts (or uV) induced into each metre of receiving wire. A simple meter can be used to compare signal strengths in the vicinity of a transmitting aerial. The circuit is the same as a simple crystal set with the head phones replaced by a 5OuA meter.



Obvious, but……

One sure way to reduce the strength of a field in the vicinity of TV's is to reduce the transmitted power. In fact it is good practice *to use only enough power necessary for adequate communication*. This will benefit riot only neighbours but also other Amateurs on the band. It is quite easy for several fairly low power stations to operate around the same frequency. However, just one amateur using unnecessarily high power renders a whole block of frequencies unusable for everybody else!

The boot is also on the other foot!

So far this lesson has been concerned with TV's and HiFi's that have been disturbed by radio transmissions, This Is not the whole story

TV timebase radiation

In order to create a picture, TV sets have two time-base oscillators: The (horizontal) line timebase and the (vertical) frame timebase.
In a 625 line system the line oscillator runs atlS.625 kHz. The shape of the waveform is like a 'sawtooth'. Such a waveform is very rich in harmonics and they can heard throughout the Amateur Bands up to at least 30 MHz. An offending TV can be heard at 15.625 kHz as you tune up through the Amateur Bands. It sounds like a rough, buzzing noise.

Be a detective!

The pitch of the buzz will vary in sympathy with changes in the TV picture
This can be used to Identify the radiating TV. You can even tell which channel its owner is watching!
TV time-base radiation can often be reduced by fitting the usual filters in the TV aerial lead and the TV mains lead.

Computers

Computers, including home computers, do all their work by operating with noughts and ones. Their little circuits are either on or they are off. They switch continuously and rapidly resulting in many nasty squares. These 5 Volt square waves, being rich in harmonics, will create 'hash' throughout the Amateur Bands right up to at least 200 MHz. Nearly all small computers are, unfortunately, built in untreated plastic boxes. The addition of other bits and pieces such as printers or mouse/joysticks will make the matter very much worse.
The unscreened ribbon cable acts, unwittingly, as an aerial and ensures that the hash is spread over a wider neighbourhood.

Digits get everywhere....

Computer techniques are now finding their way into many domestic appliances:
Central heating control units, washing machines, clock radios, VCR's, CD players and calculators. They are all capable of creating interference.

Still with us

Older electronic equipment can still cause problems. Worn thermostat contacts and fluorescent strip lights continue to be a thorn in the side of the Radio Amateur and Short Wave Listener.

APPENDIX to Lesson 1OA

Safety and PME

It is normal practice nowadays for homes to have what is known as a Protective Multiple Earthing system.
This means the mains earth is connected (bonded) to both the gas and water pipes where they enter the house.
The main earth is either the lead sheath of the incoming cable or the mains neutral wire.
Great care must be taken on installations where earth leakage circuit breakers are used. The addition of an 'RF' earth could 'short-circuit" its operating coil and prevent its correct operation in an emergency!

ERP

For most purposes the 'standard' in aerials is the Half-wave Dipole.
In theory, a vertical half-wave dipole will transmit equally in all (horizontal) directions. The Effective Radiated Power from such an aerial will be the same as the transmitter output assuming no feeder losses.

However, in the case of a multi-element aerials, the transmitted power Is not radiated equally in all directions. Instead the power is concentrated in one direction.
This results in more power being transmitted in that direction.

EXAMPLE: If a 6dB gain aerial is fed with 100 Watts its ERP will be 400 Watts!

Think of this ….
A 20 Watt lamp does not seem at all bright by itself. The light spreads out in all direction.
But if this same bulb is fitted with a reflector, such as found in a car head light, it seems very bright . But it is only bright in one direction

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Power measurement and your log-book

The present license now requires the log entry to include the output 'power'. **(**Terms & Regulations BR68 6.(1)(c)**)**. The power should be quoted in the same terms as the limits quoted in col 4 or 5 of The Schedule.

See also Notes to Schedule (a) (b) Sc(c) for further guidance.

Most power meters are calibrated directly in Watts rather that dBW. The following table gives the approximate equivalents. The first and last values have been added to show how the decibel scale works - more on this in a later lesson so don't worry.

l0dB	9dB .	10dB	14dB	15dB	16dB	20dB	22dB	26dB	*30dB*
1W	6W	l0W	25W	32W	40W	100W	160W	400W	*1000W*

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QUESTIONS for LESSON 10A

Don't forget to read EMC chapter in your RAE Manual and the licence regulations in the latest copy of 'How To Become A Radio Amateur'. There is a publication called 'How to improve television and radio reception' available from your local main Post Office. I suggest that you pop around and get one. (If they still have some in stock)

Question 10A/1 What is EMC ?

Question IOA/2 Where should an Amateur Transmitting aerial be sited with your neighbours TV and EMC in mind ?

Question 10A/3 What could be the result of using and end fed aerial ?

Question IOA/4 What details need to be logged in respect of Mobile and Maritime Mobile operation ?

Question 10A/5 Draw the circuit of a high-pass filter (bread-breaker) that would be suitable for inclusion in a TV aerial cable. Or , if using email, tell me that page where one is shown in your RAE manual.

Question IOA/6 What is the advantage of using a ferrite ring instead of the filter in question IOAI/5 ?

Question 10A/7 What is the advantage of using a balun at the feed point of a dipole ?

Question 10A/8 What is maximum carrier power that is permitted in the 50-52 MHz Amateur Band ?

Question IOA/9 What suffix should an Amateur add to his/her callsign when operating from a hotel in Sussex ?

Question 10A.10 What is the most likely reason for an Amateur transmission on 21.2 MHz giving rise to problems on the neighbours steno Hi-Fi system ?

How could the problem be cured ?

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