EMC – Diagnosing and Reporting RFI

Radio Society of Great Britain

Advancing amateur radio since 1913

Dr John Rogers, M0JAV Chairman EMC Committee
What causes RFI?
Why is RFI a problem?

- All electrical devices produce electromagnetic emissions conducted &/or radiated
- Different electrical devices can be more or less immune to interference
- Problems arise when emission levels are high enough to effect operation of other equipment
- Emission and Immunity standards are designed to allow devices to operate together
- Radio amateurs and SWLs rely on low background noise for good radio reception
EM Radio Frequency Interference (RFI)
What Services does EMCC provide

• **Advice and Support**
  – Help and advise members with RFI problems
    • EMC Matters Forum and problem reporting
    • RSGB website self-diagnosis using EMC leaflets
  – Provide updates through web pages and publications
    • Regular EMC column in Radcom – “EMC Matters”

• **Protect the Spectrum from RFI**
  – Representation on Standards Committees
  – Lobbying regulators, suppliers and service providers
  – Investigations of New Technology Interference
  – Recommendations for new threats
RSGB EMCC Service Changes

• Help Desk and **EMC Matters Forum**
  – EMC Matters Forum visited 93000 times since April 2015
  – Leaflets and publications updated aimed at self help
  – Help Desk - Over 100 reports per annum - via email and telephone
  – Online problem reporting helps us lobbying suppliers and regulators

• **New process for Investigating RFI problems** using
  – Assisted diagnosis using signature examples – spectra, waterfalls, recordings
  – Helps you find **where** it is, **when** it is operating and **what** it is

• Ofcom advice and assistance
  – Reluctant to enforce against non WTA apparatus
  – New Statutory Instrument to cover in service equipment
  – RSGB preparing reports on results of investigations
### Help Desk, Forum and Reporting

<table>
<thead>
<tr>
<th>Type of RFI</th>
<th>Number of cases</th>
<th>Number resolved</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDSL</td>
<td>105</td>
<td>5</td>
<td>Line balance and extension fix</td>
</tr>
<tr>
<td>Plasma TV</td>
<td>30</td>
<td>26</td>
<td>Panasonic and Samsung sets replaced</td>
</tr>
<tr>
<td>Solar PV</td>
<td>18</td>
<td>4</td>
<td>Problem usually Optimisers or Invertors can be affected by wiring layout</td>
</tr>
<tr>
<td>SMPSU</td>
<td>11</td>
<td>9</td>
<td>Probably most common source most people identify problem and don’t report it</td>
</tr>
<tr>
<td>Home appliances</td>
<td>8</td>
<td>4</td>
<td>Fridges, Boilers, Alarms</td>
</tr>
<tr>
<td>LED Lighting</td>
<td>5</td>
<td>3</td>
<td>Most OK some bad floodlights and 12V ones often a problem</td>
</tr>
<tr>
<td>Pylons, Industrial etc</td>
<td>9</td>
<td>5</td>
<td>Outstanding windfarm problems</td>
</tr>
<tr>
<td>Breakthrough</td>
<td>9</td>
<td>3</td>
<td>Telephones, POS, HiFi, TV distribution amps</td>
</tr>
</tbody>
</table>
New Investigations Process

Problem recorded on standard form
Advisor assigned to assist

Likely source  Diagnosed
Located  Recorded

If cannot be resolved locally then collate cases to approach Ofcom or Supplier

Investigate further and record Harmful Interference
Log to show Degradation, Obstruction or Repeated Interruption
Steps to reduce Interference
RFI Signatures see EMC04

- **Narrowband** a few spot frequencies, on an SSB receiver, a true narrow band source would be heard as a tone, but in some cases it will be a rough burbling signal covering a few kHz.

- **Broadband with no peaks** appears right across a band at about the same level with no peaks.

- **Broadband with broad peaks from** switch-mode power supplies / digital electronics produce broadband emissions with regularly spaced broad peaks at fundamental frequency.

- **Broadband with narrow peaks** digital electronic circuitry.

- **Drift** measure the time period it gives a clue.

- **Modulation** 50 or 100Hz buzz mains synchronous – SMPSU.

- **White noise** often xDSL.

- **Sigidwiki.com** contains signatures of known systems and some unknowns and interference; we could add to this or develop similar.
Comparison with Signature sheets to identify likely source

Guidance notes on what to look for

Linked to advice leaflets for minimising impact

Record actual Signature to add to database
RFI Signature Sheets - VDSL Upstream 2

- Frequencies to check
- What to look for and record; best receiver set ups to use
- Time profile of interference
VDSDL during Training

Carriers across upstream and downstream bands

Carriers 4kHz apart
Computer SMPSU 10 to 18MHz
Computer SMPSU 19 to 27MHz
Lead Acid Battery Charger
LED lighting

Conducted Emission (dB(μV))

Frequency (MHz)

- LED floodlight conducted emission (QP)
- EN 55015 limit (QP)
Solar PV Spectra

- Mitigation
  - DC cables should be run as closely spaced pairs
  - Clip-on ferrites may be required on DC cables
  - May be necessary to change inverter or optimisers

Broad band emissions up to 40dB above typical back-ground noise level on 10.1 – 10.15 MHz band
Plasma TV

- Problems may increase as the plasma ages
- Cooperation of the set owner is key as suppliers will only deal with them
- Problem will go away as sets go out of production

- “your equipment shall not cause interference…” not enforced by Ofcom or BBC
- Contact Ken Underwood G3SDW directly or via the EMC Matters forum he has good record with manufacturers getting problems resolved particularly with Panasonic and Samsung
Fluorescent Lighting

Starter and electronic ballast cause the problem
Good Earth at RF, screening and ferrites on leads to ballast help
Filter the shack supply to reduce conducted emissions
Faulty CH Pump

Carriers every 15kHz modulated with water flow
This is where you can help us!!!

• How many of you have or can borrow an SDR?
• How many have a known source of interference?
• Please make some spectra/waterfall pictures or sound recordings we can add to the database
• Confirm source with on-off-on test
• Use of Spectra and Waterfall displays
  – Avoid overloading the receiver – gain settings
  – Select frequency range (filtering), resolution and averaging suitable for interference type
  – Beware of cheap dongles with poor filtering which give aliases of actual signal
Standards

• International and European Standards designed to protect against RFI
• Regulations can prevent equipment being put on the market if not compliant
• WTA Section 54 allows Ofcom to make Regulations to stop the use of apparatus that is causing undue interference
Ofcom: WTA Interference

- WTA Section 4 requires Ofcom to provide advice and assistance to complainants of Interference
- WTA Section 54 Ofcom can regulate for maximum EM energy that can be radiated and conducted to mains
- Ofcom should regulate to ensure that apparatus does not cause undue interference with wireless telegraphy
- Recent S54 regs extend to apparatus that is improperly— (i) installed; (ii) assembled; (iii) maintained; (iv) functioning due to degradation, deterioration, modification, or damage; or (v) used for a purpose other than its intended purpose
- Ofcom can then enforce under Section 55 of WTA
Enforcement Ofcom requirements

• Must be evidence of Actual Harmful Interference
  – degrades, obstructs or repeatedly interrupts anything which is being broadcast or otherwise transmitted ...by wireless telegraphy and in accordance with a licence
  – Tighter when emergency/safety services impacted
• Apparatus responsible is Identified
• All reasonable steps to minimise impact have been taken by person suffering RFI
• On balance Public Interest is served
  – In a Balanced, transparent, proportional, accountable way
Harmful Interference Evidence to collect

• **Here and There** – use two locations one with Interference and one close by without, use two equivalent set ups and log at both – automate if possible

• **Now and Then** – keep logs of contacts which were and were not made before the interference and contrast with situation now

• **With and without** – locate and either turn off or null the interference to show stations workable when Interference is absent

• Remember need to demonstrate actual not potential Harmful Interference - no good just quoting RFI level
Update on Investigations

- xDSL – Investigations report (172 pages) prepared for RSGB, BT, Ofcom meeting
- Solar PV still collecting data on noisy units
- LED Lighting – reports to Trading Standards on defective units
- Windfarms – All avenues explored by Tom: Ofcom, MP’s, MEP’s, Suppliers, Ombudsman
EMCC Interference Measurements

'E' field dB(μV/m)

- Median man-made noise (residential) ITU-R P.372-11 r.m.s. lossless vert. monopole in 9kHz
- Median man-made noise (rural) ITU-R P.372-11 r.m.s. lossless vert. monopole in 9kHz
- Median man-made noise (quiet rural) ITU-R P.372-11 r.m.s. lossless vert. monopole in 9kHz
- Measured background noise at fairly quiet site, loop, H-field horiz. pol. RMS in 9kHz
- VDSL emissions, loop, H-field horiz. pol in 9kHz
- Wind farm emissions, PEV in 9kHz
- Solar PV emissions at 10m in 9kHz

Frequency (MHz)
Thank You for your attention

Any Questions...
Just Ask!
Minimum Signals detectable by Antenna

- (A) Minimum signal (RMS) HLA
  6120 0.6 m shielded non-resonant active loop
- (B) Minimum signal (RMS) 0.9 m unshielded non-resonant active loop
- (C) Minimum Signal (avg)
  AY3920 unshielded resonant loops A, B, C in 9kHz
- (D) Minimum signal (RMS) 1.6 m unshielded resonant loop

residential ITU-R P.372-11 r.m.s in 9kHz
rural ITU-R P.372-11 r.m.s
quiet rural ITU-R P.372-11 r.m.s