EMC REQUIREMENTS

Electromagnetic Compatibility

E m i s s i o n s

Conducted Emissions

Power Line and Telecomms Lines - 150kHz to 30MHz
Measurement bandwidth 9kHz
Quasi-Peak and Average Detector Limits

Noise frequency components with spacing <9kHz will appear as broadband (BB) noise. Frequencies separated by more than 9kHz will be resolved as narrow band (NB)

Harmonics - 100Hz to 2kHz on power input connector only
Flicker - low frequency fluctuations causing lights to flicker

Noise Power

Cable conducted common-mode noise - 30MHz to 300MHz
Quasi-Peak and Average Detector limits. Bandwidth as radiated.

Radiated Emissions

Enclosure and Cables - 30MHz to >=1GHz
Measurement bandwidth 120kHz
Quasi-Peak Limit below 1GHz. Peak above 1GHz

Noise frequency components with spacing <120kHz will appear as broadband (BB) noise. Frequencies separated by more than 120kHz will be resolved as narrow band (NB)

I m m u n i t y

Electrostatic Discharge (ESD) - 4kV / 8kV
Enclosure - very fast risetime (0.7ns) - particularly affects logic

Radio Frequency Fields (RFF) - 3V/m or 10V/m
Enclosure - continuous - particularly affects sensitive analog circuits

Electrical Fast Transients (EFT) - 1kV or 2kV
Power & I/O cables - fairly fast risetime (5ns) - affect logic & analog

Surges - 1kV differential / 2kV common-mode
Power & long / extnl telecomms cables - risk damage to electronics

Conducted Radio Frequencies - 3V or 10V rms
Power, signal and control cables - affects mainly analog circuits

Power Dips and Interruptions
Power lines - affects power down, reset, backup & restart circuitry

Power Frequency Magnetic Fields - 3A/m or 30A/m
Enclosure - affects hall effect, photomultiplier & induction circuits

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CAUSES OF EMISSIONS

Conducted

Broadband (BB) noise generally produced by devices switching at frequencies below 9kHz - typically rectifier diodes, triacs or gas discharge lamps which conduct for part of the power cycle, producing emissions at harmonics of power frequency.

Broadband noise produced by impulsive sources such as motor brushes or arcing contacts (e.g. thermostat). Such sources often splatter across not only the conducted frequency band but also the radiated band.

Narrow band (NB) noise produced by devices running repetitively at fixed frequencies above 9kHz. Typically Switch-Mode Power Supplies produce this type of noise in the conducted frequency band (operating in the range of 10kHz to 100kHz).

Microprocessors and similar clocked logic circuits will also produce narrow band emissions.
Note that emissions will often also occur at multiples of the basic operating frequency (harmonics) when the waveform is not sinusoidal.

NOTE:

It is only active switching operations (including rectification) either by mechanical means (commutators, thermostats) or electronic means (diodes, thyristors, SMPS) or oscillators that cause such emissions. An incandescent light or heater running continuously from the power main without any active control will not produce such emissions and can be considered benign.

Battery operated equipment will generally not be subject to conducted emissions unless connected to telecomms lines.

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CAUSES OF EMISSIONS

Harmonics

These are produced by the effects of pulling current from the power main for only part of the cycle. Typically this would be due to rectifiers dumping current into a reservoir capacitor at the peak of the voltage waveform (typical of most power supply input circuits) or triacs / thyristors conducting for only a part of the cycle.

This results in severe distortion of the power waveform (which tends to become trapezoidal rather than the intended sinusoid). The implications of this are that power transformers and wiring become over stressed due to the poor form factor and power factor of the resulting waveform. This means that power distribution systems need to be over designed in order to cope.

Of particular importance is the neutral conductor rating of the power supply system. In a true, balanced three phase system the current components due to each phase cancel out and therefore the neutral conductor carries little current and is almost redundant. When there is severe harmonic distortion the current components do not cancel out and may even be additive. This can result in burn-out of the neutral circuit of the power distribution system. The utility companies do not like this!

This problem can be remedied by implementing "power factor correction" on the front end of power supply units.

Flicker

Flicker is produced when a product pulls varying amounts of current from the power main. This causes the power voltage to vary and causes lights to flicker. There are specified levels of fluctuation allowed, depending on the subjective effects of different frequencies.

This is best remedied by controlling the rate at which high power devices are turned on and off, possibly phasing individual operations so that they "dovetail" and even out the overall current variation.

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CAUSES OF EMISSIONS

Radiated (and Noise Power - Absorbing Clamp)

Broadband (BB) noise generally produced by devices switching at frequencies below 120kHz - typically SMPS, video scan generators (e.g. in VDUs & TVs) and random data on EtherNet and similar interfaces.

Broadband noise produced by impulsive sources such as motor brushes or arcing contacts (e.g. thermostat) often extends into the radiated band. These types of device are often tested in Europe using the Noise Power (or Absorbing Clamp) method. In Europe the Noise Power method is also applied to audio and video equipment (power lead and all signal leads).

Narrow band (NB) noise produced by devices running repetitively at fixed frequencies above 120kHz. Typically microprocessors and similar clocked logic (gate arrays etc.) produce narrow band emissions. There will also be deliberate transmitters which radiate within this band of frequencies and also devices which use RF for a process whilst not deliberately radiating (ISM eqpt). There are allowable frequencies for certain transmitting devices and recognised frequencies for ISM use.

Note that emissions will often also occur at multiples of the basic operating frequency (harmonics) when the waveform is not sinusoidal. ISM and transmitter waveforms will be relatively free of harmonics.

NOTE:

It is only devices which operate at frequencies above 9kHz that are generally considered for radiated emissions. At lower fundamental frequencies the energy in the harmonics above 30MHz is so low as to be insignificant. Equipment with no high frequency devices can often be considered benign in terms of radiated emissions - but beware that brush noise from poorly suppressed motors can extend up to frequencies of hundreds of MHz.

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IMMUNITY ISSUES

General

In general the various immunity phenomena contained within the EMC Directive cannot affect devices that do not contain electronic circuits.

It is impossible, for instance for ESD, EFT, RF Fields etc. to operate a relay, thermostat or mechanical switch. It is also not possible for lamps, heaters or motors to be affected by these phenomena - excepting that if a fluorescent tube is held up in a field of hundreds of volts per metre it will glow. These are not the levels which we are considering here!

Surges on the power line are also generally not an issue as the duration of the surge is only a few tens of microseconds. Such a short duration surge causes little current change in a fluorescent tube as the inductance of the balast will not allow the current to change significantly in such a short time period. Any product which meets the standard safety isolation requirements will not usually suffer problems with the 1kV differential and 2kV common-mode voltage levels.

ESD Effects

ESD will generally affect logic circuitry, due to induction into fast circuitry by the fast (0.7ns) risetimes involved. It is, however, possible for glitches to be caused in analog signals and also for unprotected semiconductor devices to be damaged by direct discharge.

EFT Effects

EFT will generally affect both logic and analog circuitry. Logic circuitry is affected by the fast (5ns) risetimes involved. Analog circuitry is also affected by the burst nature of the waveform. This can cause offset voltages produced by rectification effects when the charge on capacitors is "pumped up" on successive transients. Triacs (and, to a lesser extent thyristors) can also be turned on by transients on the power line.

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IMMUNITY ISSUES

Radio Frequency Effects (Fields and Conducted)

It is unusual for digital circuitry to be affected by these radio frequency phenomena - although poorly protected network systems may suffer corruption at the higher (10V/m) levels.

Analog circuits are often badly affected by RF. Strain gauge amplifiers and the like, working at mV or uV levels, are often the worst affected. This is caused by the input devices of amplifiers being driven out of their linear range of operation and as a result, acting as demodulators. Once the RF (which is modulated at 1kHz) has been demodulated it generates a 1kHz demodulated signal in addition to a DC offset. These components are often within the wanted signal band and once they have been demodulated into the wanted signal band they cannot be filtered out.

Any control circuit incorporating active electronics can be affected in this way. Clearly instrumentation for measurement and control, audio systems etc. are likely to be affected but devices such as switch-mode power supplies will also incorporate feedback and control amplifiers which can be affected by such interference.

Surge Effects

Surges may cause flashover if adequate distances are not maintained in the primary mains circuit. Equipment which meets the usual electrical safety requirements will not generally have a problem with this.

Differential surges can cause overload of rectifier diodes (generally exceeding their forward surge current rating) in power supplies. Triacs and, to a lesser extent, thyristors can also be turned on by avalanche breakdown at these voltages.

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IMMUNITY ISSUES

Power Dip Effects

Power dips can affect power down, power up and battery changeover circuits (battery backed up memory etc.). It is essential to ensure that equipment (especially any equipment which may fail in a hazardous way) does not fail unacceptably for various durations and depths of dip. A 100% dip is referred to as an interruption.

The test involves multiple power dips (usually three at 10 second intervals). The test also has implications regarding the inrush current at power up. It is necessary for equipment to tolerate this without undue damage.

Magnetic Field Effects

High levels of magnetic fields can affect such devices as hall effect sensors, induction systems and photomultiplier tubes. This test is only applied to equipment which incorporates these and similar devices that are likely to be susceptible.

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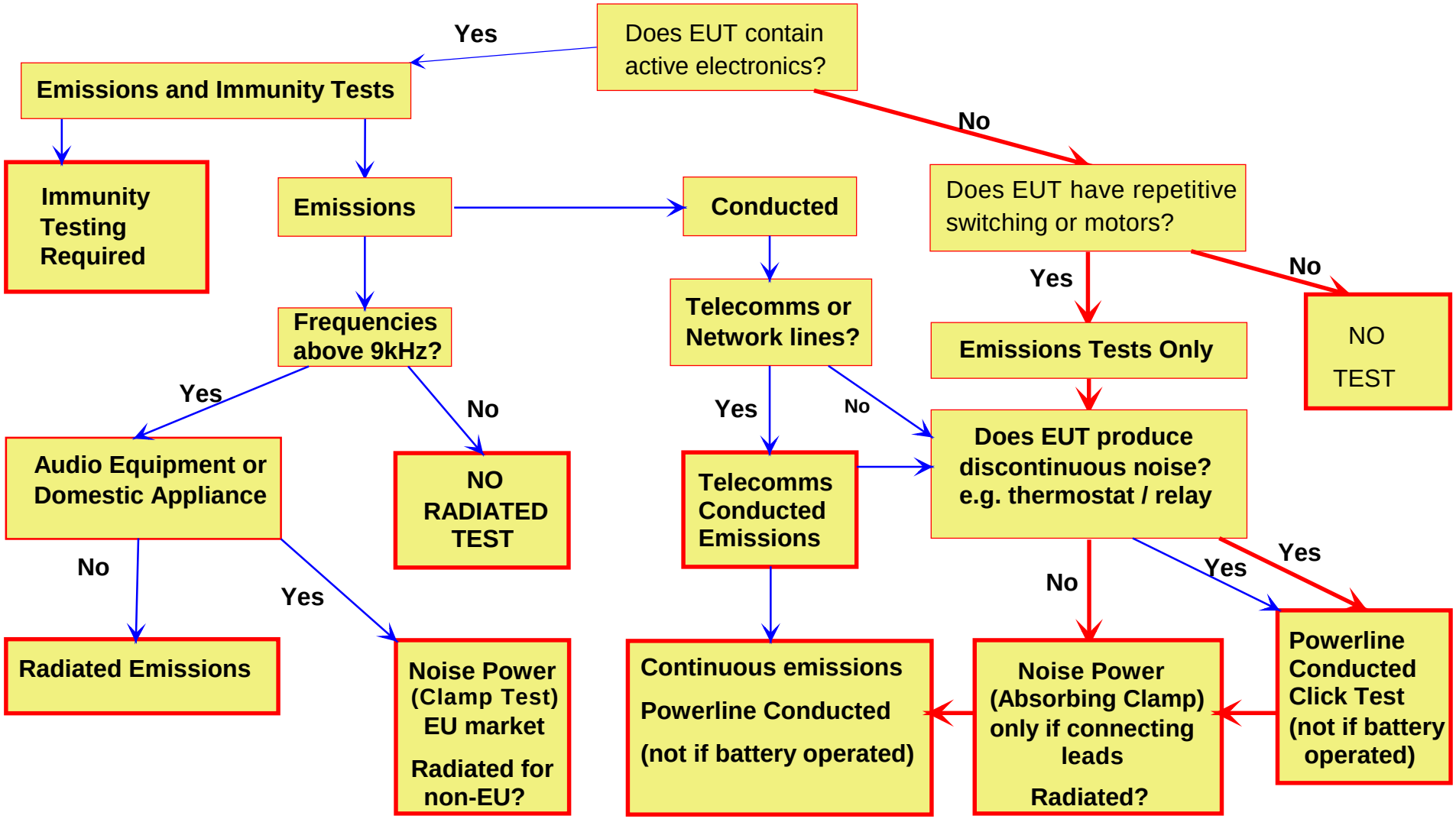
DECISION TREE



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