Electromagnetic compatibility

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For all electrotechnical equipment, EMC must be considered right from the initial design phase and the various principles and rules carried on through to manufacture and installation.

This means that all those involved, from the engineers and architects that design a building to the technicians that wire the electrical cabinets, including the specialists that design the various building networks and the crews that install them, must be concerned with EMC - a discipline aimed at achieving the "peaceful" coexistence of equipment sensitive to electromagnetic disturbances (which may therefore be considered as the "victim") alongside equipment emitting such disturbances (in other words, the "source" of the disturbances).

EMC is a characteristic of equipment or systems that mutually withstand their respective electromagnetic emissions. According to the International Electrotechnical Vocabulary IEV 161-01-07, EMC is the ability of a device or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment. EMC is now also a discipline aimed at improving the coexistence of equipment or systems which may emit electromagnetic disturbance and/or be sensitive to them.

The importance of identifying the source

The identification and measurement of the source is essential since the type of source will determine which of the following measures must be taken:

- Limiting the disturbances generated (e.g. on a contactor, by installing an interference suppressing RC unit in parallel with the A.C. coil, or a diode on the D.C. coil)
- Avoiding cross-coupling (i.e. physically separate two highly incompatible elements)
- Desensitizing potential victims (e.g. using shielding)

Main causes

Any device or physical/electrical phenomenon that emits an electromagnetic disturbance, either conducted or radiated, qualifies as a source. The main causes of electromagnetic disturbance are electric power distribution, radio waves, electrostatic discharge and lightning.

- In electric power distribution, a large number of disturbances are created by circuit switching operations:

1. In the low voltage field, the opening of inductive circuits such as contactor coils, motors, solenoid valves etc. generates very high surge voltages (up to several kV across the coil terminals) that contain high-frequency harmonics (ten to hundreds of MHz).
2. In the medium and high voltage fields, the opening and closing of disconnections produces waves with a very fast rate of rise (a few nanoseconds). These waves are particularly harmful to microprocessor-based systems.

- Radio waves emitted by remote monitoring systems, remote controls, radio communications, television sets, walkie-talkies etc. are, for some equipment, sources of disturbance in the order of several volts per meter. All of these disturbance emitters are nowadays increasingly common and susceptible equipment must therefore be provided with increasingly effective protection.
- An electrically-charged human body: for example, a person walking on certain types of carpet in a cold and dry climate can be charged up to more than 25 kV! Any contact with electronic equipment produces a discharge with a very fast rise time (several nanoseconds) which enters the device by conduction and radiation, generating a major disturbance.

Disturbance characteristics

Sources may be intentional (e.g. radio transmitters) or not (e.g. arc welding units). However in general they can be distinguished by the characteristics of the disturbances they produce:

1. Spectrum
2. Waveform, rise time or envelope of the spectrum
3. Amplitude
4. Energy

- The spectrum, i.e. the frequency band covered by the disturbance can be very narrow, as in the case of mobile telephones, or very wide, as for electric arc furnaces. Pulse type disturbances cover a particularly wide spectrum extending up to 100 MHz or more. To this last category belong almost exclusively sources such as:
    1. Electrostatic discharge
    2. Switching of relays, disconnectors, contactors, switches and circuit breakers in the LV, MV and HV range
    3. Lightning
    4. Nuclear electromagnetic pulses (a special domain)

Since the degree of coupling is directly proportional to frequency, EMC uses the frequency domain to characterize disturbances. This type of representation, for a periodic signal, is similar to a Fourier series decomposition (as a sum of harmonics).

- The waveform describes the characteristics of the disturbance over time and can, for example, be a damped sine wave or double exponential function. It is expressed as a rise time tr, an equivalent frequency 0.35/tr or simply the

disturbance frequency for a narrow band signal or as a wavelength λ related to frequency by $\lambda = c/f$, where c is the speed of light ($3 \cdot 10^8$ ms^{-1}).

- The amplitude is the maximum value the signal reaches in terms of voltage (Volts), electric field (Volts/meter), etc.
- The energy is the integral of the instantaneous energy over the time the disturbance lasts (Joules).