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Lightning and Overvoltage Protection for Radio Equipment

Overvoltages caused by switching processes, atmospheric discharges and electrostatic discharges are amongst the most frequent causes of failures of highly sensitive electrical installations (which also include professional and amateur radio installations).

This danger can be forestalled by means of special protective measures and the purposeful use of overvoltage protection equipment.

1. MAIN STRUCTURE OF A RADIO INSTALLATION

Every radio installation consists of the radio equipment, perhaps connected up to a control unit (CPU) for rotator control, power amplifiers and/or reception amplifiers, and the actual aerial installation. We make a distinction here between the aerial tower on the roof of a building (Fig.1) and a free-standing aerial tower (Fig.2). It is unimportant what kind of aerials are mounted on the aerial tower and how many there are.

2. EARTHING OF AN AERIAL INSTALLATION

DIN VDE 0855, Part 1 /1, 2/ requires the aerial support structure to be connected to the earthing installation through an earthing line made of copper, with a 16mm² cross-section (Fig.3). This measure is exclusively an earthing measure and offers no protection to people or property against the effects of lightning.

2.1. Earthing an aerial installation on a building

Should the aerial installation be on a building with no external lightning protection, it is advantageous to lead the earth connection away from the

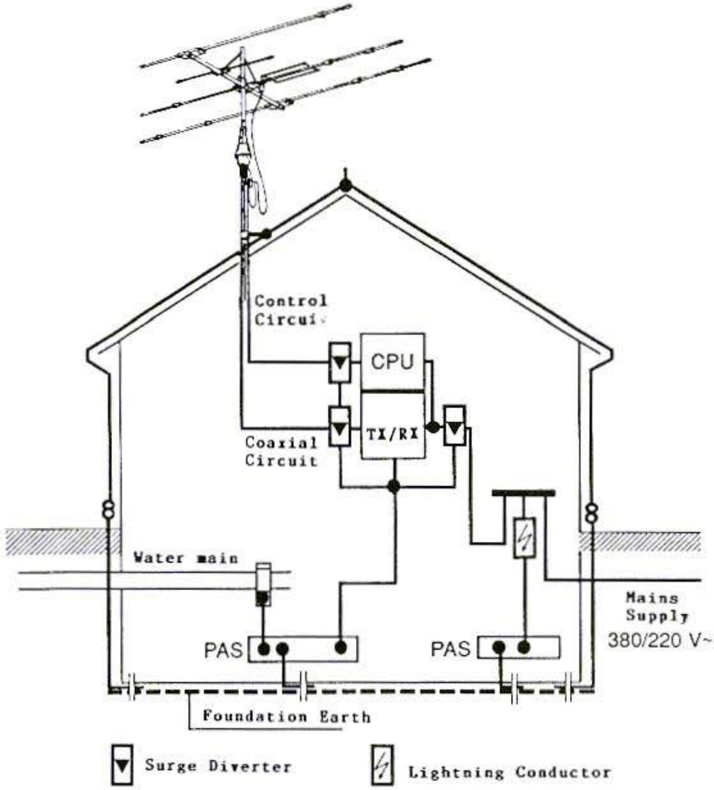

Fig.1: Lightning Protection for a Transmitter/ Receiver Installation and Ground-Mounted Aerial Tower

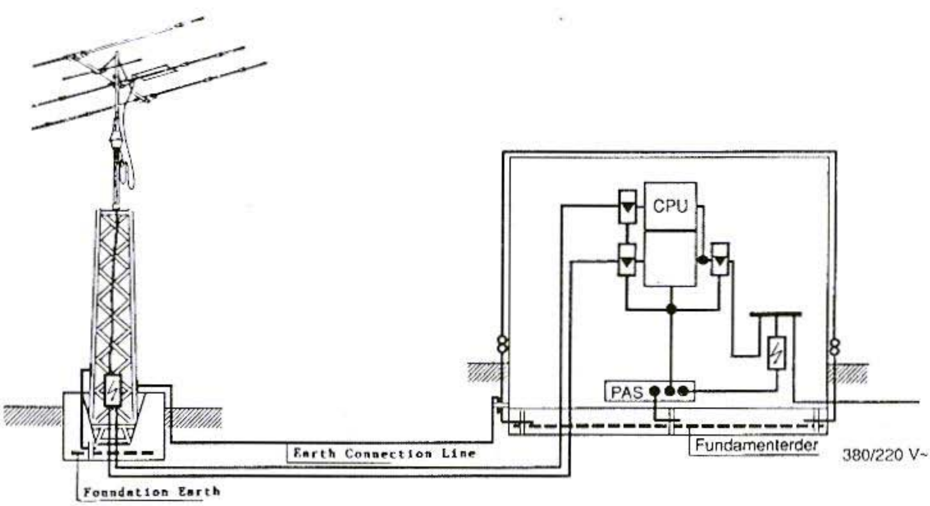

Fig.2: Lightning Protection for a Transmitter/Receiver Installation and Ground-Mounted Aerial Tower

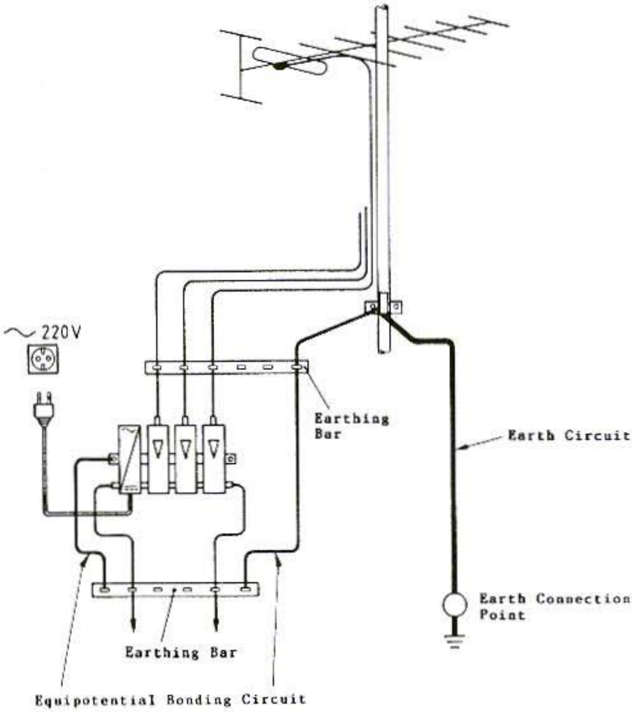

Fig.3: Earth Balancing and Equipotential Bonding of Aerials with Amplifier Installations

aerial support structure over the roof and the external wall, and to connect it at ground level to an earthing rod (minimum length, 1.5m), a strip earth connection (minimum length 3m) or, if available, the lead-through terminal lug of the foundation earth connection.

Should external lightning protection be present on the building, in accordance with DIN VDE 0185 (3), then the aerial support structure should be connected to the existing interceptor equipment / lightning conductor by the shortest path. The normal 8mm diameter lightning conductor wires, made of steel, copper or aluminium, are to be used as a cross-section.

2.2. Earthing the aerial with a free-standing aerial tower

There are aerial tower masts made of wood, steel (tubular or latticework) and reinforced steel. As a rule, it can be assumed that the tip of the mast is fitted with a metal aerial tower unit construction. This Cartowerit construction simultaneously acts as an interceptor device for lightning, and must be connected to the earthing installation through a lightning conductor. In the case of a steel mast, the conductor is superfluous, but a connection with the earthing installation should be provided at the base of the mast. If aerial towers made of fibreglass-reinforced plastic (FRP) are used, a lightning conductor should be laid parallel to the FRP mast from the aerial tower to the earthing installation, in order to discharge the lightning component current from the coaxial screen.

For aerial installations mounted so that they can rotate, the aerial rotator should be flexibly bridged. Make sure that the rotary movement is not impaired mechanically.

3. PROTECTION CONCEPT

Even if the aerial installation is earthed according to the guidelines, there is no protection against overvoltages in the case of a direct lightning strike or a near miss. The rapidly changing magnetic field of the lightning current induces overvoltages in all conductor loops. Such loops arise, for example, from the interaction of the aerial earthing circuit, the aerial feed, the rotator control and the mains circuit.

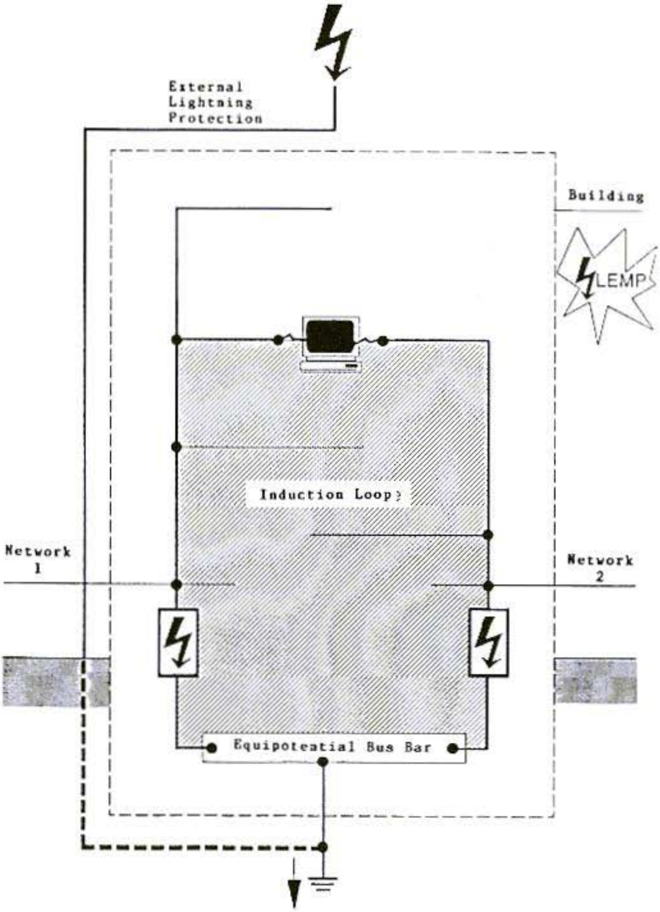

Fig.4: Loop Formation using Separated Networks

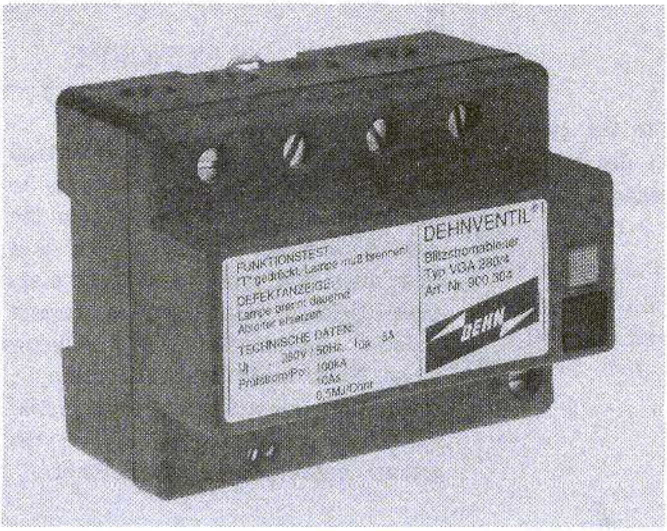

Fig.5: Dehnventil type VGA 280/4 4-pole Lightning Conductor

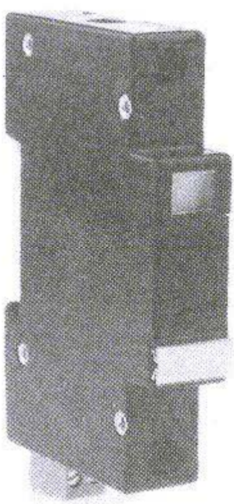

Fig.6: Type VM280FM Module Width Surge Diverter, with Telecomms Contact

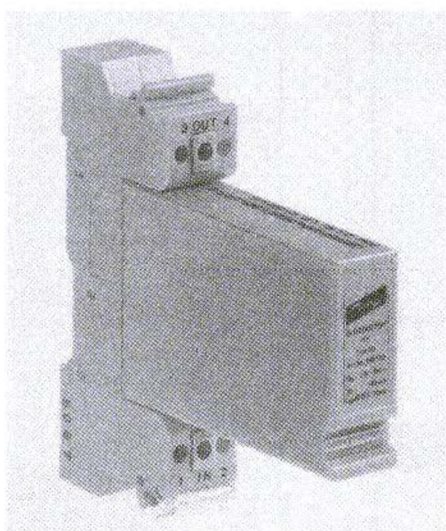

Fig.7: Type LD KT Blitzductor, for Rotator Control Circuit

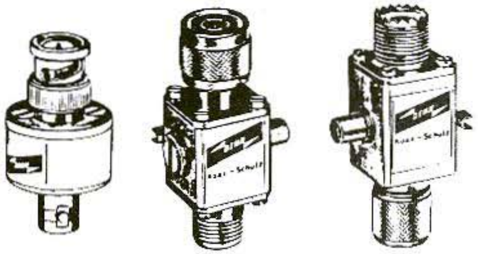

Fig.8: Overvoltage Units for 50Ω Coaxial Cable

Formats and Technical Data Daten :

Connectors	BNC	N	UHF
Protection Level	ca. 2 kV	ca. 600 V	
Rated Surge Current	15 kA	5 kA	
Max. Frequency	800 MHz	1,5 GHz	800 MHz
Max. Power	5000 W	2000 W	
Return Loss	≥ 20 dB		
Additional Damping	< 0,5 dB		

As we look outwards from a radio set, the aerial and network connections lie at the end of an open induction loop, which can occupy an area of many square metres (Fig.4). Should there be a direct strike, or even a lightning strike close by, overvoltages of several tens of thousands of volts, or some hundreds of thousands of volts, are induced in these loops, leading to the destruction of the radio equipment and/or the ancillary equipment.

The protection concept which protects radio equipment even if the aerial is directly hit by lightning provides the following measures (Figs. 1 and 2).

* The support structure of the roof aerial or, on a free-standing aerial tower, the metallic latticework construction, must be connected to the equipotential bus bar or the earthing installation by a connection which can carry a lightning current. A 16mm² copper cross-section is to be used.

* The protective conductor of the network (PE) must be connected to the equipotential bus bar or the earthing installation in accordance with DIN VDE 0100 and DIN VDE 0800, Part 2 /4, 5/.

* Overvoltage protection devices are used (6) which connect the weak current and mains networks transiently in the event of a parasitic coupling (protection bypass), and also provide a brief connection to the earthing installation.

The rise in the radio installation voltage as a consequence of a coupled-in lightning current can basically not be prevented, but excessively high potential differences can be avoided by the purposeful use of protective devices.

The following protective devices can be used here:

- Use a lightning conductor at the point where the mains circuit enters the building, or in the distribution of the power engineering network (e.g. Dehnventil, VGA 280) - Fig.5 (7)
- Surge diverter inserted directly into the network feed before the radio installation to be protected (e.g. VM 280 protector NSM or even S protector) - Fig.6 (7)
- Overvoltage protective device, inserted directly into the rotator control circuit before the control unit (CPU) (e.g. Blitzductor KT) - Fig.7 (7)
- Overvoltage protective device inserted directly into the coaxial circuit on radio equipment (e.g. LPN, LPU, LPB or ÜGK) (7)
- The choice here depends on the corresponding connection standard, type BNC, N or UHF (Fig.8). The protective devices can be remote-powered to some extent.
- Should the distance between the radio equipment and the free-standing aerial installation be rather large, additional protective devices should also be inserted into the circuits on the free-standing aerial carrier.

4. SUMMARY

The lightning and overvoltage protection concept presented here makes it possible to protect radio installations effectively, even from direct lightning strikes, distant lightning strikes and electromagnetically coupled-in overvoltages.

5. LITERATURE

(1) DIN VDE 0855, Part 1: Earthing Aerial Installations VDE-Verlag GmbH, Berlin

(2) Booklet no. 307: Earthing Aerial Installations as per DIN VDE 0855 / Part 1; Dehn + Söhne, Neumarkt

(3) DIN VDE 0185, Part 1: Lightning Protection Installations DIN VDE 0185, Part 100 / Draft 10.87: Guidelines for Protecting Buildings against Lightning General Principles VDE-Verlag GmbH, Berlin

(4) DIN VDE 0100, Parts 540 and 410: Earth Connections, Protective Conductors, Equipotential Bonding and General Protective Measures VDE-Verlag GmbH, Berlin

(5) DIN VDE 0800, Part 2: Earthing and Equipotential Bonding VDE-Verlag GmbH, Berlin

(6) DIN VDE 0845, Part 1: Measures against Overvoltages VDE-Verlag GmbH, Berlin