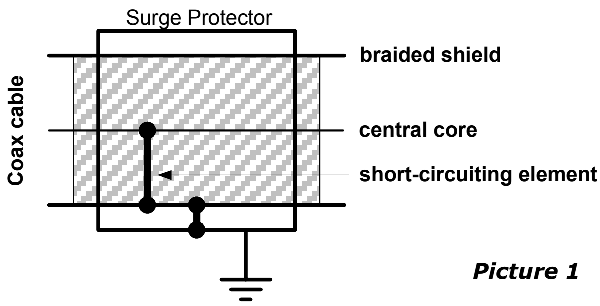
"LIGHTNING BARRIER" SYSTEM *LB-1*

Description and comparison with existing lightning arrestors / surge protectors.

How a common lightning arrestor / surge protector works

There are two traditional schematics for lightning arrestors (LA) and surge protectors (SP) – first based on Plasma Technology and the second based on Quarter Wave Technology (QWT)[1]. Their schematics are similar and shown on the Picture 1.



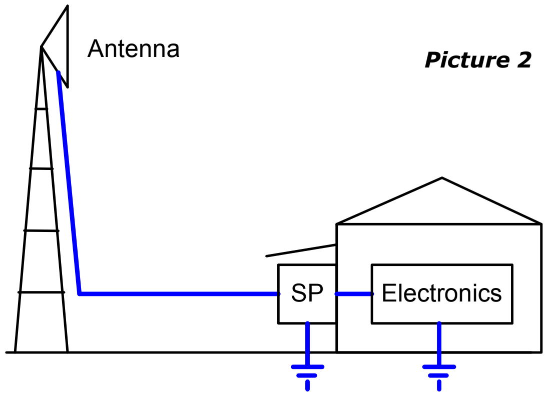
Picture 1

On the Picture 1, the "short-circuiting element" for QWT is the quarter-wave length strong wire that permanently breaks down a charge from central core to the shield and then to the earth. This short-circuit is not "visible" for the HF signal of the specified length.

For Plasma Technology, the "short-circuiting element" is a bulb with a gas, that after a critical (breakdown) potential appearance on its clamps, turns to plasma state and thus become a conductor that breaks down the charge from the central core.

Note that in both cases neither central core, nor shield is broken.

Picture 2 presents a general scheme of surge protector or similar device inclusion in the feeder cabling system.



Picture 2

Possible hazards

To provide indoor part of the feeder system with a suitable protection, we must take in account all kinds of potential threats:

- Atmospheric electricity
- Lightning discharge
- Penetration energy from domestic and industrial electric systems due to accidents.

Traditional surge protectors and so-called "lightning arrestors" provide protection only from the first hazard, providing nothing against last two.

Picture 4 presents a general electrical scheme of down part of the feeder system with SP or similar device, excluding ignorable resistance such as connectors' resistance, QWT impedance, etc.

Atmospheric Electricity.

Charge accumulates on the outer antenna as well as on bearing bars and thus on the cable's central core and its braided shield. As soon as SP has short-circuiting element that makes galvanic zero-resistance connection between central core and the braided shield, the charge flows down to the shield and then to the earth. Traditional SP, better or worse but protects input stages of electronics from this.

Lightning discharge

When lightning occurs, a very strong impulse of alternating current appears along the braided shield of the feeder cable. Though this impulse lasts for milliseconds, the current strength may reach tens or hundreds of thousands of amperes.

Looking at the Picture 4: as soon as grounding methods at SP installation point and at the electronics location are similar, we can assume their equivalence by the order of magnitude. So it occurs that approx a half of the current flows along the shield of the indoor part of the feeder cable, that fall onto the case (frame) of the electronics. This results in a very strong electromagnetic filed around elements on the circuit boards, and they burn out. Besides of this, a threat of electric shock appears to humans, as well as the threat of the fire, and other threats.

Moreover, when lightning occurs, an alternating current appears in the central core as well (due to induction from the shield), and the front edge of the impulse of the current is very steep, so it easily runs into input stages of the electronics, and burn it out immediately.

Accidental external electricity penetration in the feeder

If an external electricity (domestic or industrial) fall into the feeder system due to accidents, similar unwanted effects may take place.

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[1] It makes sense to note, that term "lightning arrestor" is not absolutely correct, since these devices doesn't provide protection from lightning. More correct is the second term, "surge protector", because main their function is to protect input chains of electronics from the static electricity.

How Lightning Barrier System works

Picture 3 presents mechanical schematics of the “Lightning Barrier” system that we propose. The backbone idea is to break galvanic connection along the both central core and the shield, still keeping working parameters of the feeder system without changes.

We break galvanic connection by including two resonance systems built on technology “bound line” (see Picture 5 – condensances C_C and C_S).

In case of static electricity, these bound lines work like dielectric screens, so the resulting current in the core and the shield is near to zero.

In case of lightning discharge (and/or external domestic/industry electricity penetration), these bound lines work as conductors with extremely high impedance.

Electrically equivalent scheme is presented on the Picture 6. It demonstrates the general idea very clearly: we add an extra impedance in the indoor branch of the feeder system. The condensance C is specially selected and lies within tens of picofarad. The condensance also works as a frequency filter when high energy discharge occurs. As soon as the main energy of the discharge is accumulated in the bandwidth up to 10KHz, we obtain the additional impedance is about 0.8-1.6 MOhm. It means that current along the indoor part of the feeder is as million times less rather than for traditional SP systems.

Signal Losses

Special design of the bound line for the core line assures that losses of the signal will not exceed 1dB, that actually is equivalent of the signal attenuation on the feeder connector.

Conclusions

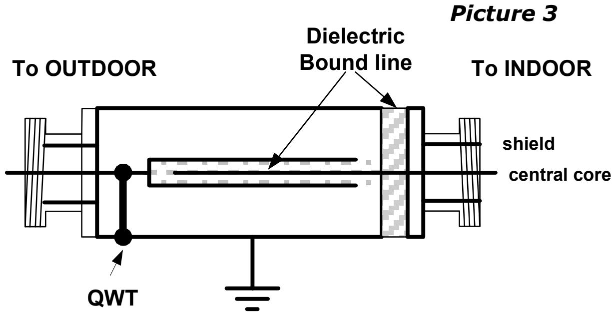
Therefore, the LB system increases safety of the grounding system as million times more than traditional SPsystems. Moreover, it protects not only electronics, but whole indoor environment from the external high power electricity. Even if a lightning occurs very closely, the worst case for LB is that outdoor cable system will be burned or even evaporated, but indoor environment, electronics and humans stay relatively safe.

Puncture potential

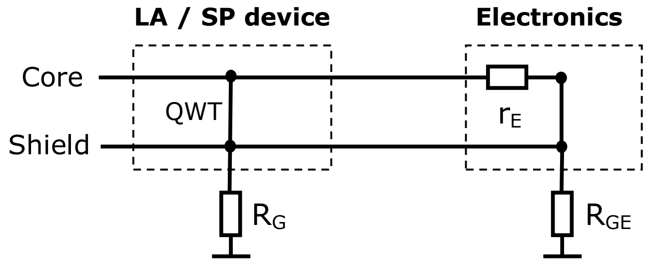
Discussion about breakedown capacity of the dielectric screen makes sense only for static cases, when high potential accumulates statically on the opposite sides of the screen. In the system we discuss we have grounding chain on the one hand and condensance on the other hand. Static electricity doesn’t accumulates at the dielectric since it flows the grounding chain of the LB. When lightning occurs and high power current flows down over the braided shield, and condensance of the bound line works like a conductor with a extremely high impedance.

However, if accidentally LB grounding is corrupted, 40 KV needed to break down the bound line dielectric screens.

Picture 3



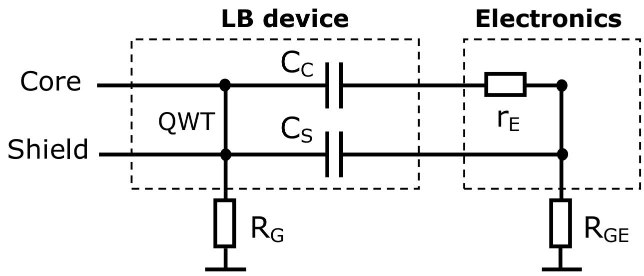
Picture 4



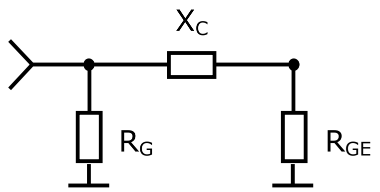
Notations for Pic.4 and 5:

QWT	Quarter-Wave short-circuit
R_G	Grounding resistance at the SP point
r_E	Electronics input resistance
R_{GE}	Grounding resistance at the electronics side
C_C	Central core bound line, and its impedance
C_S	Shield bound line, and its impedance

Picture 5



Picture 6



Notations for Pic.6:

R_G	Grounding resistance at the SP point
R_{GE}	Grounding resistance at the electronics side
X_C	Total impedance of the joined bound line