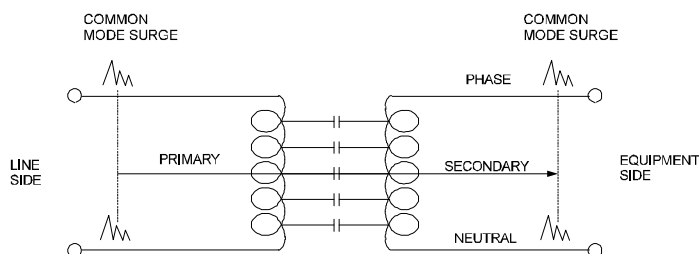


## Medium Voltage Arresters and Protection of LV Equipment

The medium voltage (MV) distribution class arrester is commonly used at the ends of distribution lines at substations and at distribution transformers that supply larger facilities. These devices are primarily installed to provide protection to the MV switchgear and transformers, which has much higher insulation ratings than Low Voltage (LV) or common mains powered equipment. A typical MV transformer may be able to withstand voltages 5 times the peak operating voltage, while LV equipment can be damaged with as little as 2.5 times the peak LV voltage. The clamping voltage for most MV Metal Oxide Varistor (MOV) based surge arresters at or near the maximum surge current rating is generally around double the peak of the operating voltage. For example, a 10kA arrester on a 6kV line will typically clamp an 8kA surge to  $6kV \times 1.41 \times 2 = 17kV$ , that is the transient is limited to only 17kV.

Common mode transients on the MV side of a transformer unfortunately are not attenuated by the turns ratio of the transformer but in fact are capacitively coupled to LV secondary via interwinding capacitance. Hence voltage transients impressed on the primary side of a transformer can be coupled through to the secondary side and to the low voltage equipment connected, with little attenuation. Even with the presence of arresters on the MV side of the transformer this high let-through of the MV arresters (e.g. 17kV) will be coupled with little attenuation through to the LV side. For LV equipment (mains powered equipment) the damage threshold is often in the order of double the peak operating voltage, for example 120Vac equipment damage might occur for any voltage in excess of  $120 \times 1.41 \times 2 = 338V$ .



As shown above a transformer provides a path for high frequency common mode transients to flow via capacitive coupling to the secondary with little attenuation.

Unlike common mode transients, differential mode transients are attenuated roughly proportional to the turns ratio of the transformer (However, capacitive coupling again allows a proportionately higher amount of the transient to pass through). The frequency make up of a lightning induced transients energy content is mostly in the region of 5-25 kilohertz, which is largely inside the pass band of most power transformers. Additionally the rate-of-rise-of-voltage and current transients are not significantly attenuated for the same reason. Given the MV arresters high residual voltage, even a clamped differential pulse attenuated through the transformer action may be above the LV equipment withstand level. Adding to this, MV arresters are generally installed to provide protection to common mode transients and not specifically differential mode protection. The electronic equipment connected to the LV side is generally most susceptible to damage from differential mode transients which produce a high voltage between the active and neutral conductor inputs.

In many applications arresters installed on the MV side of a system will be a considerable distance away from the LV equipment. The presence of these remote MV arresters offers little protection to the LV sensitive equipment. Circuit capacitance and inductance in the interconnecting circuit can cause a voltage doubling effect so the transient on the LV side can double in magnitude by the time it reaches the sensitive equipment. The sensitive equipment is also exposed to other sources of induced transients on this interconnection and those generated by nearby equipment.

Thus it can be seen that to provide effective lightning transient protection to sensitive LV equipment for all conditions, dedicated low voltage surge protection devices (also referred to as Transient Voltage Surge Suppressors - TVSS devices) must be placed near the equipment to be protected. MV surge arresters should be used to provide course protection to the MV equipment, but this does not eliminate the need for LV surge protection devices to be placed close to the load, for example at the main service entrance panel.

