

# Multilayer Varistors

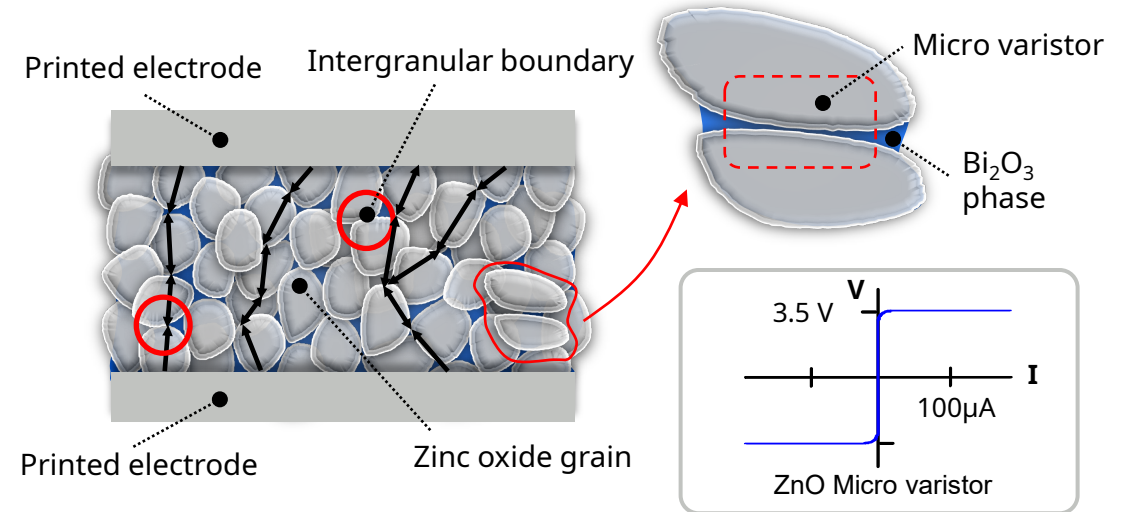
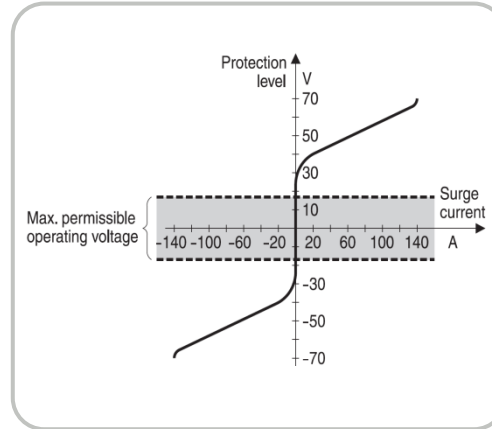
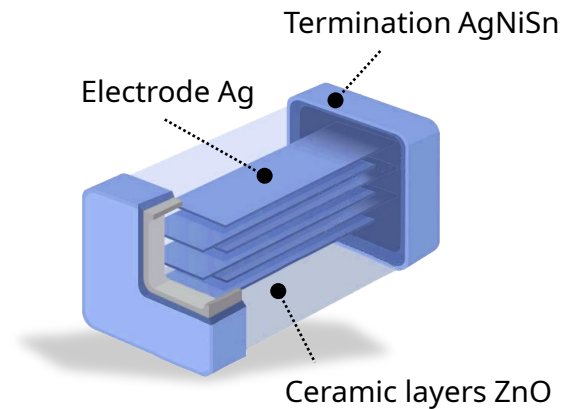
 **TDK** In Everything,  
Better

Reliable protection against ESD and high energy transients



TDK Electronics AG  
December 05, 2025

# Multilayer varistors: Technology



- ▶ The chip of a ceramic multilayer varistor (**MLV**) consists of a **stack of alternating ceramic/electrode** layers. The thickness of the ceramic layers affects the protection level.
- ▶ In the **active volume** of the ceramic chip there are a number of **internal electrode layers** with an overlapping area affecting the **pulse absorption** capability. The **internal electrodes are connected to the terminals** or external electrodes.
- ▶ Connected in **parallel** with the electronic device to be guarded, **MLV** form a **low resistance shunt** when **voltage increases above** a MLV type-specific **threshold value** and thus **prevent** any further rise in the **transient overvoltage**.

- ▶ Sintering zinc oxide (ZnO) together with other metal oxide additives under specific conditions produces a polycrystalline ceramic whose grain boundary resistance exhibits a non-linear dependence on voltage. This phenomenon is called the **varistor effect**.
- ▶ At those points where zinc oxide grains are connected by an intergranular layer, sintering produces a microscopic structure of 'micro varistors'. The electrical behavior of the MLV results from the number of micro varistors connected in series and in parallel.
- ▶ MLV naturally offer **millions of "PN" junctions** within the entire volume of a single component instead of a single PN junction in case of a silicon based transient voltage suppression diode (TVS).

# Multilayer varistors: Basic functionality

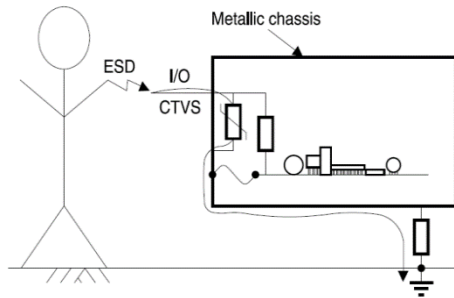


Fig. 1: ESD event

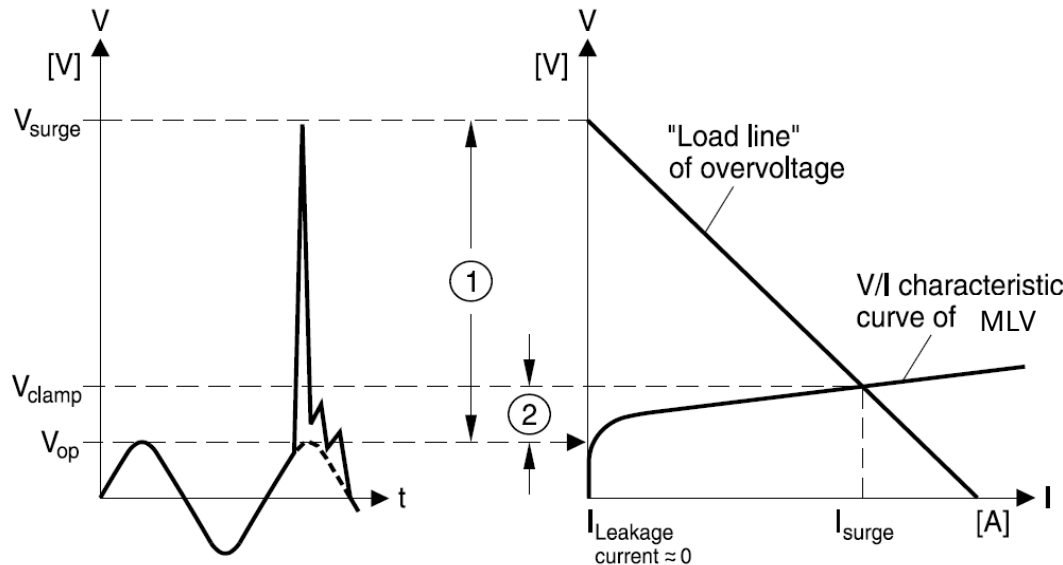


Fig. 3: Typical protection scenario

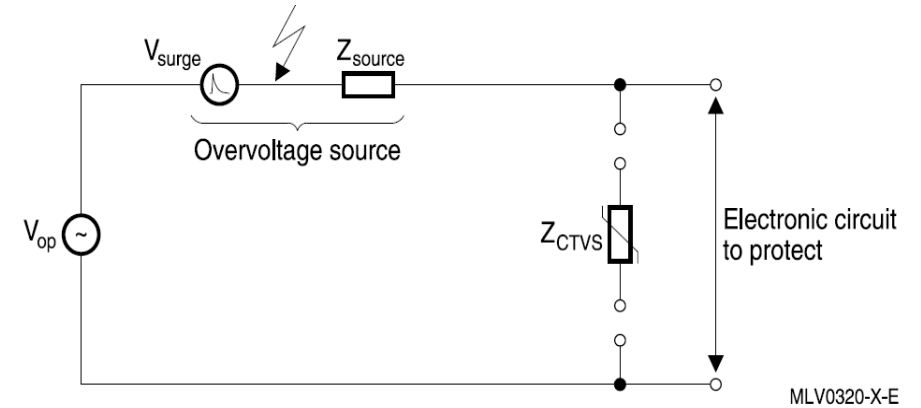


Fig. 2: Equivalent protection circuit with MLV

$$V_{CTVS} = (Z_{CTVS} / (Z_{source} + Z_{CTVS})) * V_{source}$$

An overvoltage event (e.g. ESD-pulse) above  $V_{op}$  causes a shift in the MLV operation point to the intersection of V/I characteristic and the overvoltage load line. Thus, the overvoltage is effectively clamped at  $V_{clamp}$ .

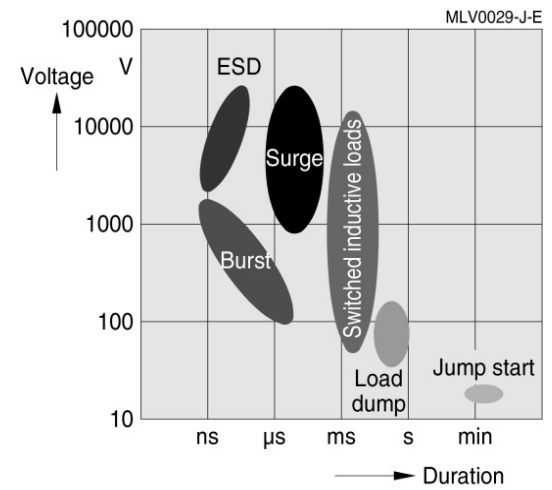
# Multilayer varistors: Portfolio



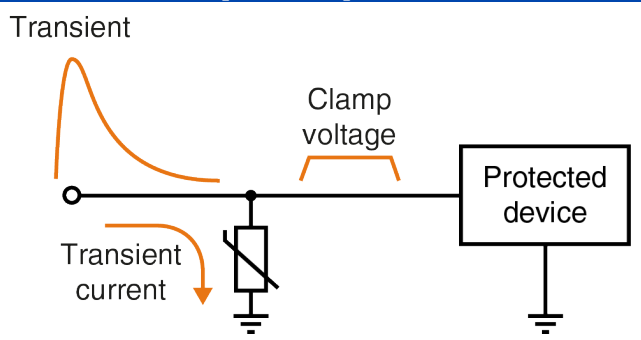
		4V <sub>RMS</sub>	6V <sub>RMS</sub>	8V <sub>RMS</sub>	11V <sub>RMS</sub>	14V <sub>RMS</sub>	17V <sub>RMS</sub>	20V <sub>RMS</sub>	25V <sub>RMS</sub>	30V <sub>RMS</sub>	35V <sub>RMS</sub>	40V <sub>RMS</sub>	50V <sub>RMS</sub>	60V <sub>RMS</sub>	90V <sub>RMS</sub>
Single type	01005														
	0201														
	0402														
	0603														
	0805														
	1003														
	1206														
	1812														
Array type	0405														
	0508														
	0612														
	1012														
	2220														
SHCV	SR6														
	SR1														
	SR2														

Standard Series – Operating temperature 125°C  
 Automotive Series acc. to AEC-Q200 – Operating temperature 150°C

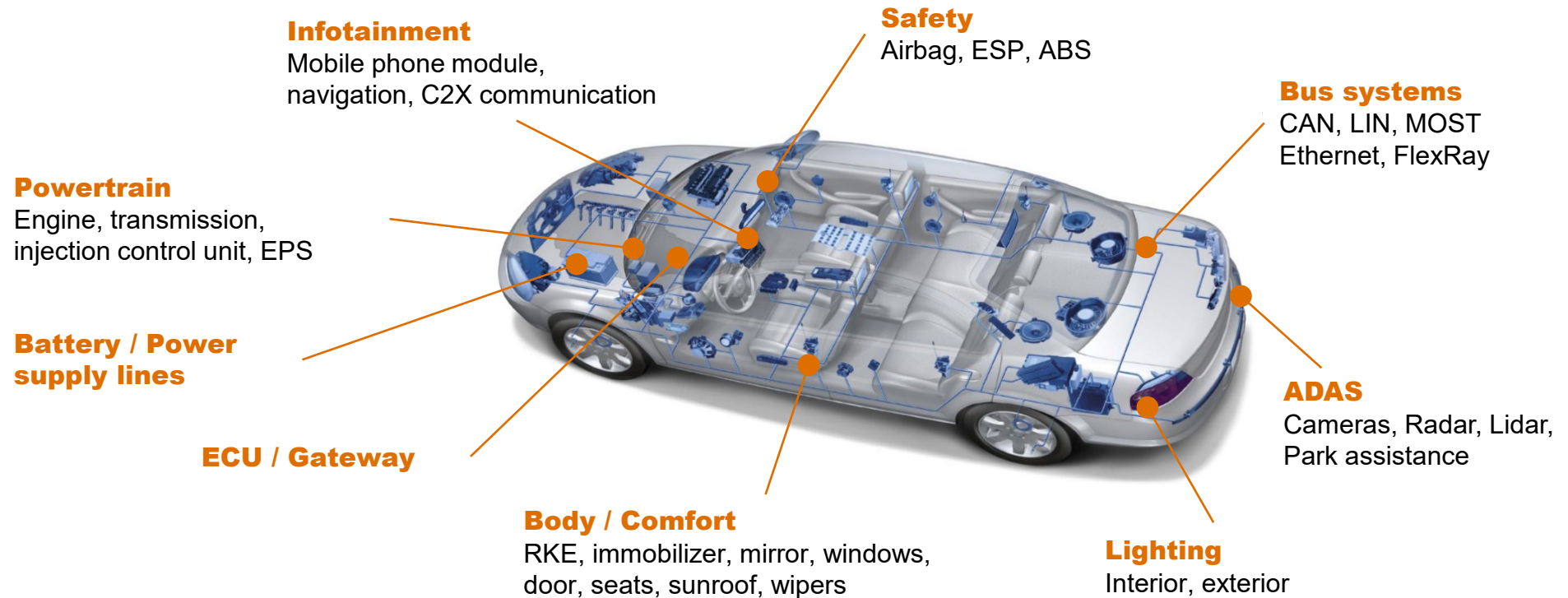
## Transient environment



## Protection principle



# Multilayer varistors: Protection against voltage transients in automotive applications

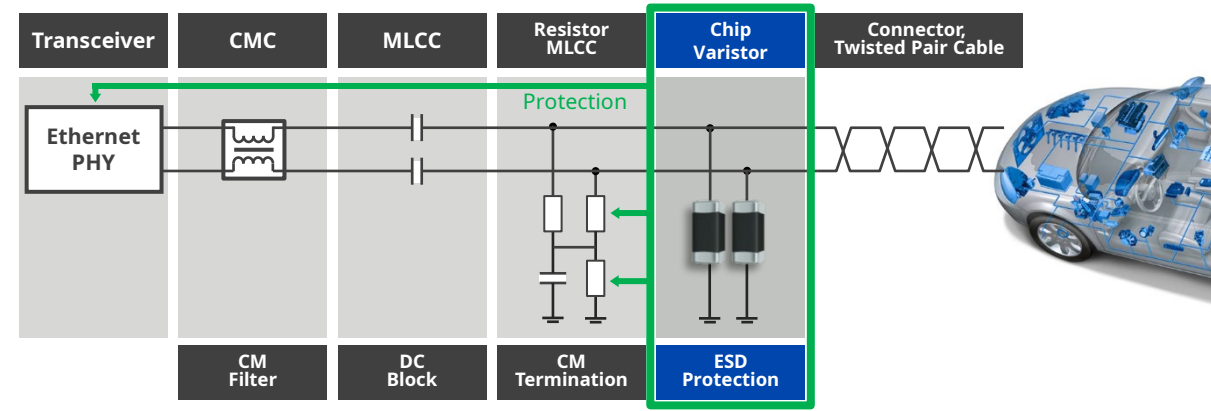


Application focus:

- ▶ ESD protection for Bus Systems

# Multilayer varistors: ESD protection for automotive Ethernet data ports

- ▶ Electronic subsystems used in cars are getting more complicated – and more **connected**. The growing number of advanced applications, such as autonomous driving, internet connectivity and advanced car entertainment, are driving up the **bandwidth requirements**.
- ▶ The growth of high-speed data ports introduces new and unique **ESD immunity challenges**, that need to be overcome in order to manage costs, increase efficiency and reduce the time to market.
- ▶ TDK, as leading company for **overvoltage protection**, created a state-of-the-art MLV portfolio to protect **automotive Ethernet** data lines from ESD. Ultra-low capacitance and optimized clamping voltage make this devices an ideal solution for protecting voltage **sensitive Ethernet PHYs** and preventing the degradation of **termination resistors**.



- ✔ Based on **Open Alliance 100BASE-T1** EMC test specification
- ✔ High ESD durability based on **IEC61000-4-2**
- ✔ Automotive qualified according to **AEC-Q200**
- ✔ **EIA 0402** and **EIA 0603** single chip size

## ■ Ethernet – 100Base-T1

Recommended type	Size (EIA)	V <sub>DC</sub> (V)	Capacitance (pF)
CT0402S20AHSG_P	0402	24 max	4.7 (5.7 max)
CT0603S20AHSG_P	0603	24 max	4.7 (5.7 max)

## ■ Ethernet – 1,000Base-T1

Recommended type	Size (EIA)	V <sub>DC</sub> (V)	Capacitance (pF)
AVRH10C101KT1R1NE8	0402	70 max	1.1 (1.4 max)



# Multilayer varistors: Open Mode Failsafe protection for automotive battery lines

## Features



TDK's new **Open Mode series fulfill all Volkswagen specific requirements** for protection against transients along battery lines varistors in terms of:

- ✓ **Open Mode design**
- ✓ **Failsafe acc. VW 80808-1, issue 2020-03**
- ✓ **Qualified based on AEC-Q200 and VW 80808-2**
- ✓ **Protection against pulses of ISO 7637-2**
- ✓ **Available in EIA 0805, 1206, 1210**

## Ordering codes

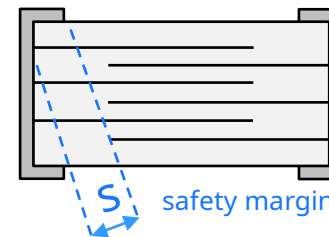
<b>EIA 0805:</b>	<b>B72510G1140S862</b>	CT0805S14BAUTOGOM_G
<b>EIA 1206:</b>	<b>B72520G1140S862</b>	CT1206S14BAUTOGOM_G
<b>EIA 1210:</b>	<b>B72530G1140S862</b>	CT1210S14BAUTOGOM_G

## Reliability pulse robustness

- ▶ Robustness acc. to VW 80808-2, issue 2020-03
- ▶ 60.000 pulses acc. VW TL 81.000 pulse 1
- ▶  $\geq 5.000$  pulses acc. ISO 7637-2
- ▶ Pulse robustness from  $-55^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$
- ▶ Failsafe up to 5 mm bending



## Design

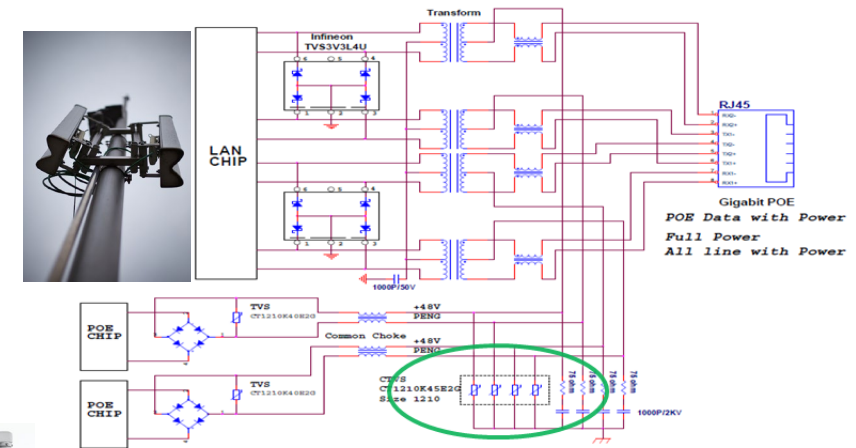


→ Opposing electrodes will not be linked in case of a bending crack.





# Multilayer varistors: Surge protection for Telecom and PoE devices

Ethernet is a widely used standard for high-speed communication. The addition of **Power over Ethernet (PoE)** provides **many advantages** in the field of application. Since the same cable used for communication is also used to power the device, it eliminates the need to provide an AC power source for devices such as Internet Protocol (IP) phones, IP cameras and wireless access points.

MLV's of the high surge series enables an **efficient protection** against severe **transient overvoltage** and **high surge currents**, such as 8/20µs pulses with peak currents up to 5kA and 10/700µs pulses up to 150A.



	Indoor Basic	Indoor Enhance	Outdoor
<b>Application</b>	VoIP Phones, Wireless Access Point, Networked Audio	Door Access Systems, Video Phones, IP cameras, Point-of-Sale Systems	Base stations
<b>Pulse requirement</b>	500A (10 x 8/20µs) 100A (10 x 5/320µs)	Up to 1000A (10 x 8/20µs) Up to 150A (10 x 5/320µs) 6kV (10/700µs)	3000A...5000A (10 x 8/20µs)
<b>Recommended types</b>	B72530T6170K062 B72530T6250K062 B72530U1450K062 B72530U1500K062	B72530U1450K062 B72530U1500K062 B72530U1600K062	B72540T6500S162 B72540T0600K162

-  Fulfil all common **PoE pulse requirements** for **indoor** and **outdoor** applications
-  High **energy capability** in a **compact package**
-  **No temperature derating** up to 85 °C
-  **UL approval** according to UL 1449 standard

[product.tdk.com/Surge\\_protection\\_series.pdf](http://product.tdk.com/Surge_protection_series.pdf)  
[product.tdk.com/Surge\\_protection\\_B72530U1450](http://product.tdk.com/Surge_protection_B72530U1450)  
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