

STACKED GAS DISCHARGE TUBE (GDT) AS A NEW OVERVOLTAGE PROTECTION DEVICE FOR RADIO BASE STATIONS (RBS)

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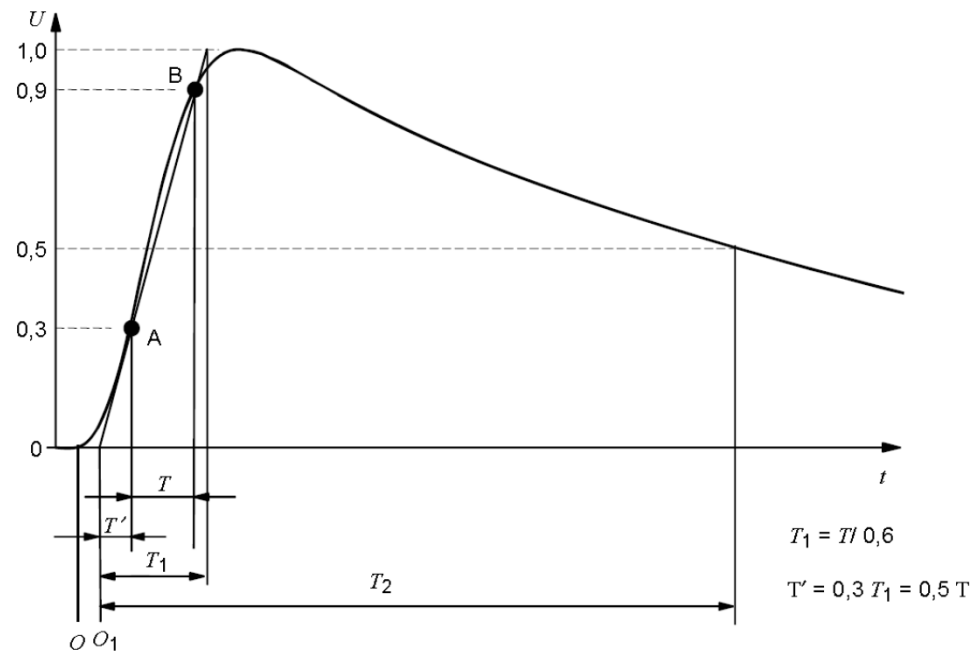
STACKED GAS DISCHARGE TUBE (GDT) AS A NEW OVERVOLTAGE PROTECTION DEVICE FOR RADIO BASE STATIONS (RBS)

*Antenna equipment with
RBS radio base station
or
BTS base transceiver
station*



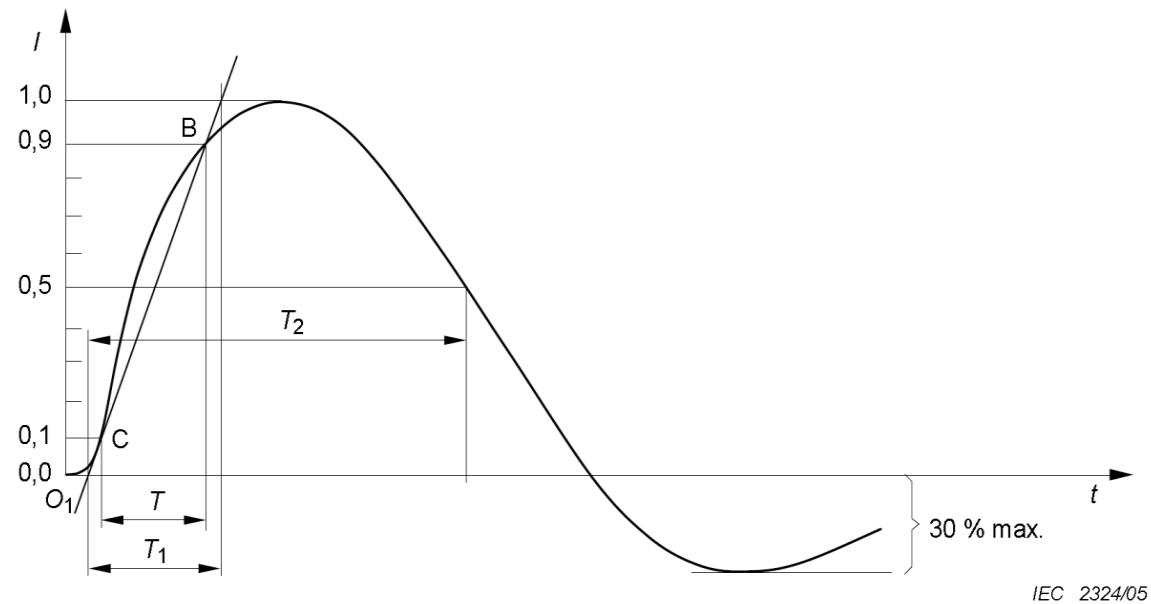
STACKED GAS DISCHARGE TUBE (GDT) AS A NEW OVERVOLTAGE PROTECTION DEVICE FOR RADIO BASE STATIONS (RBS)

➤ *Lightning impulse current wave form 10/350 μ s*



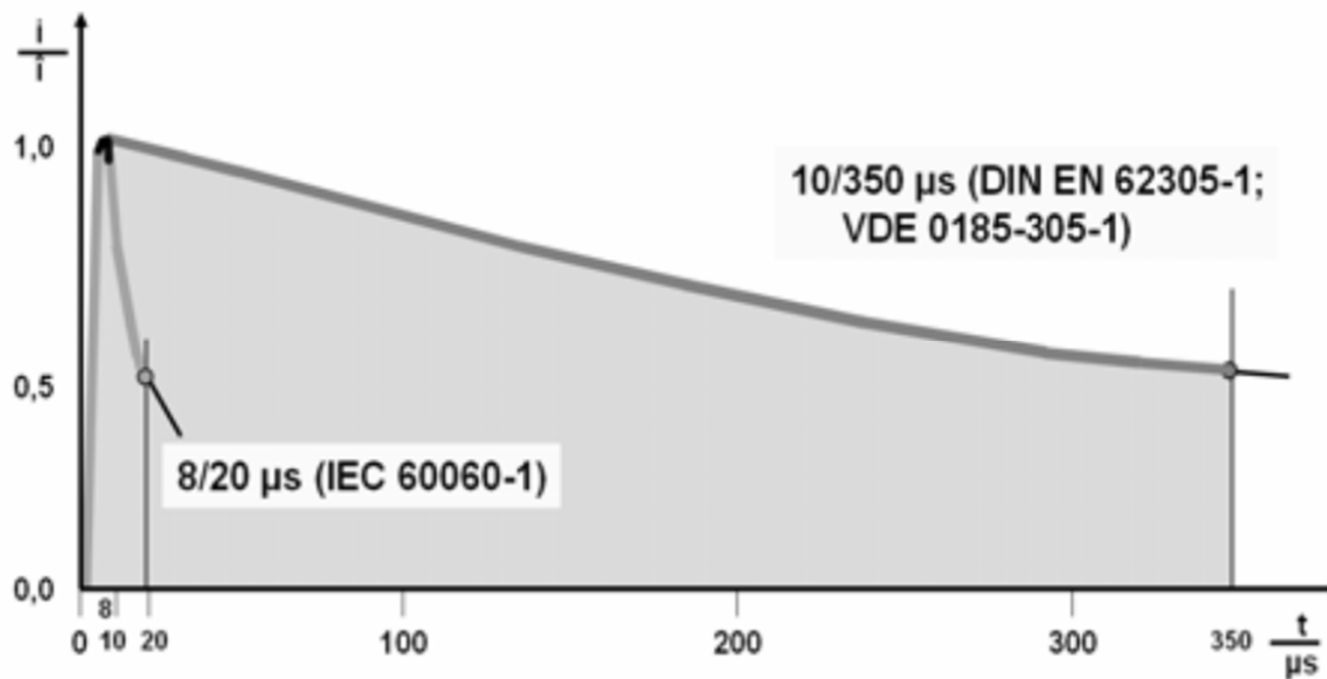
STACKED GAS DISCHARGE TUBE (GDT) AS A NEW OVERVOLTAGE PROTECTION DEVICE FOR RADIO BASE STATIONS (RBS)

➤ *Lightning impulse current wave form 8/20 μ s*



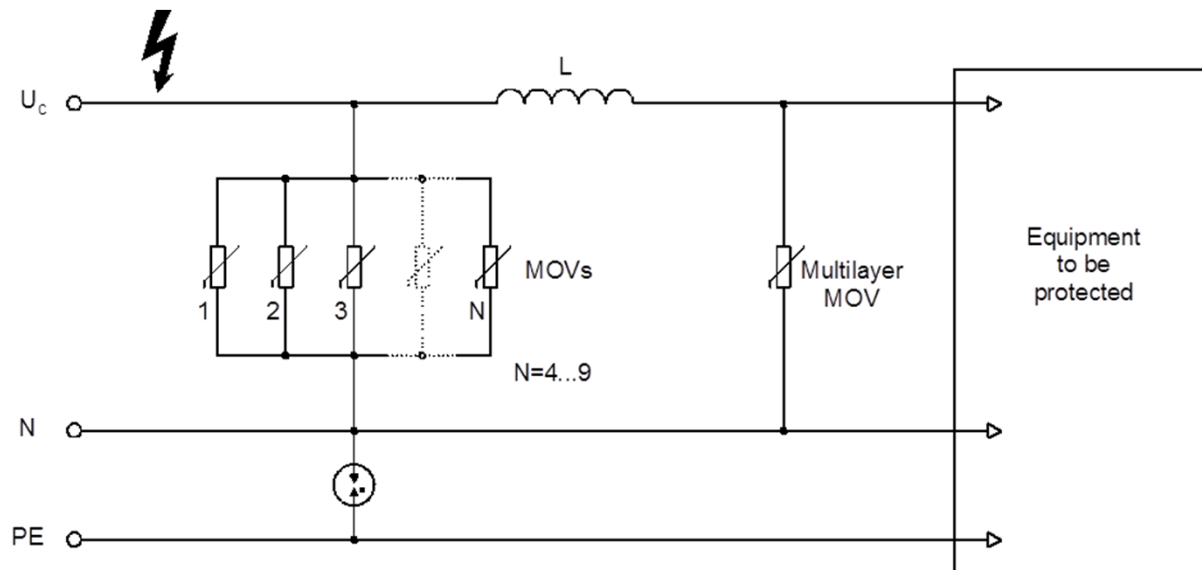
STACKED GAS DISCHARGE TUBE (GDT) AS A NEW OVERVOLTAGE PROTECTION DEVICE FOR RADIO BASE STATIONS (RBS)

➤ *Lightning impulse wave forms*



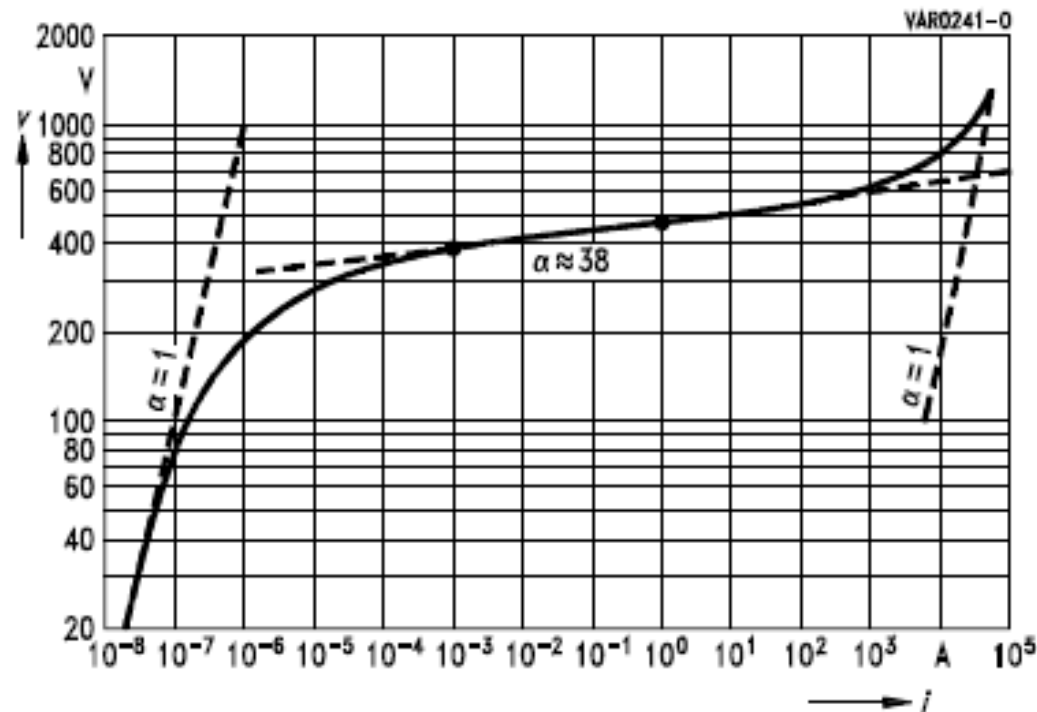
STACKED GAS DISCHARGE TUBE (GDT) AS A NEW OVERVOLTAGE PROTECTION DEVICE FOR RADIO BASE STATIONS (RBS)

➤ *Currently used overvoltage protection with Metal Oxide Varistors MOV's:*



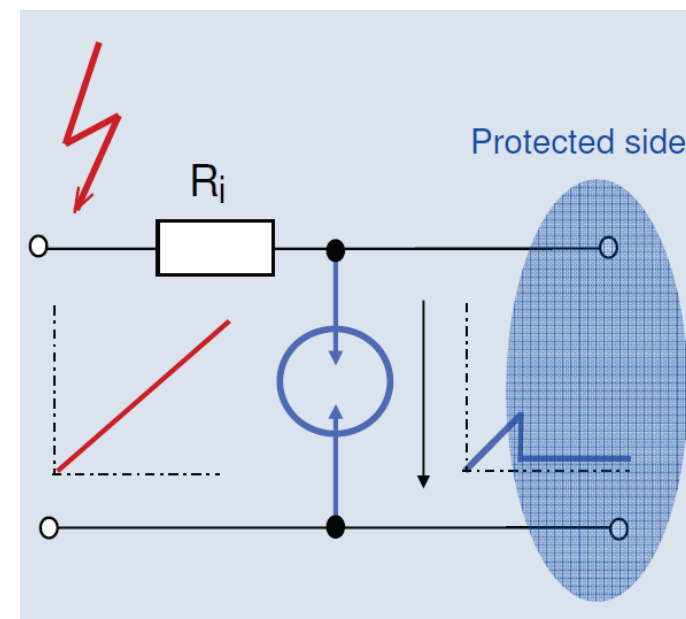
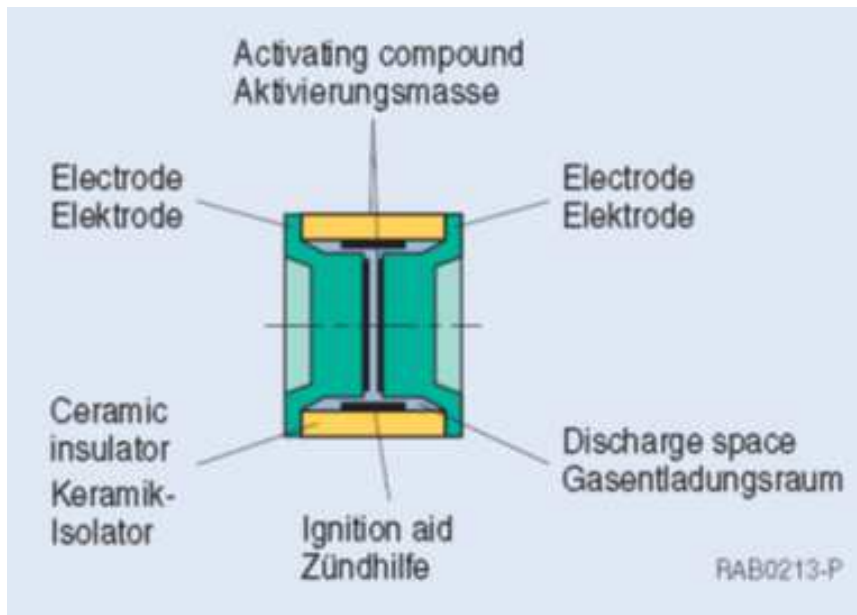
STACKED GAS DISCHARGE TUBE (GDT) AS A NEW OVERVOLTAGE PROTECTION DEVICE FOR RADIO BASE STATIONS (RBS)

- ***U-I characteristics MOV . „Clamping of voltage“.***
- ***Advantage:*** Fast acting component with stable clamping in the low kA range.
- ***Disadvantages:*** Voltage increase at higher currents, high energy dissipation, voltage derating during life time.



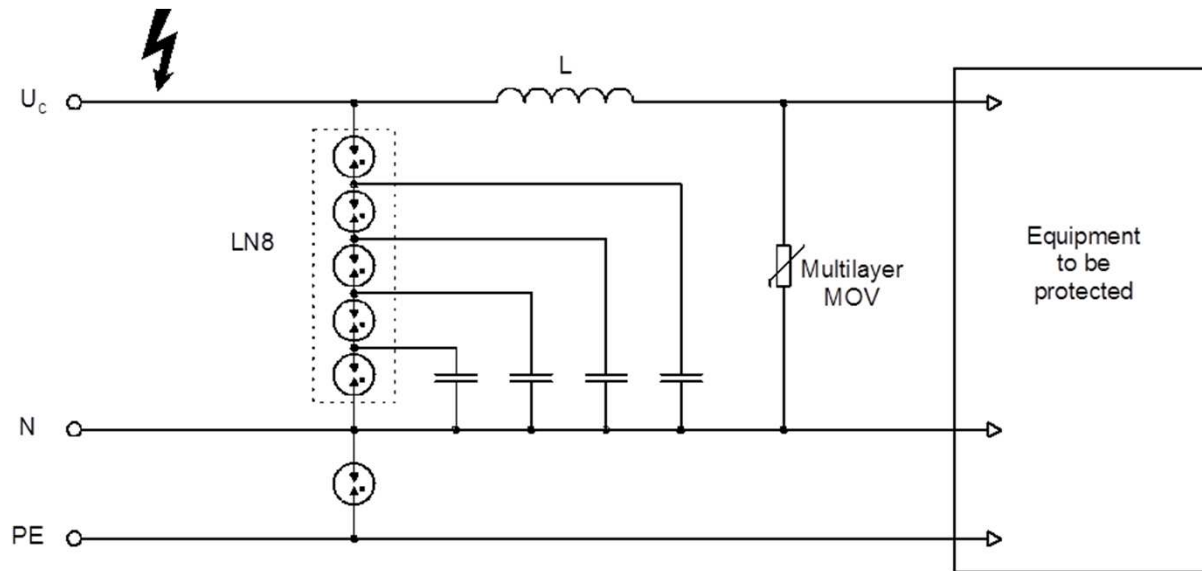
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- **GDT, principal U-t characteristics.** “Switching “ of voltage into the arc mode.
- **Advantages:** Low energy dissipation, can hold high currents with small component size.
- **Disadvantage:** Single GDT cannot extinguish DC currents of higher voltage.



STACKED GAS DISCHARGE TUBE (GDT) AS A NEW OVERVOLTAGE PROTECTION DEVICE FOR RADIO BASE STATIONS (RBS)

- ***New solution for overvoltage protection with stacked gas discharge tubes***
GDT`s: About 2-5 fold stack of GDT`s, coordinated by capacitors.

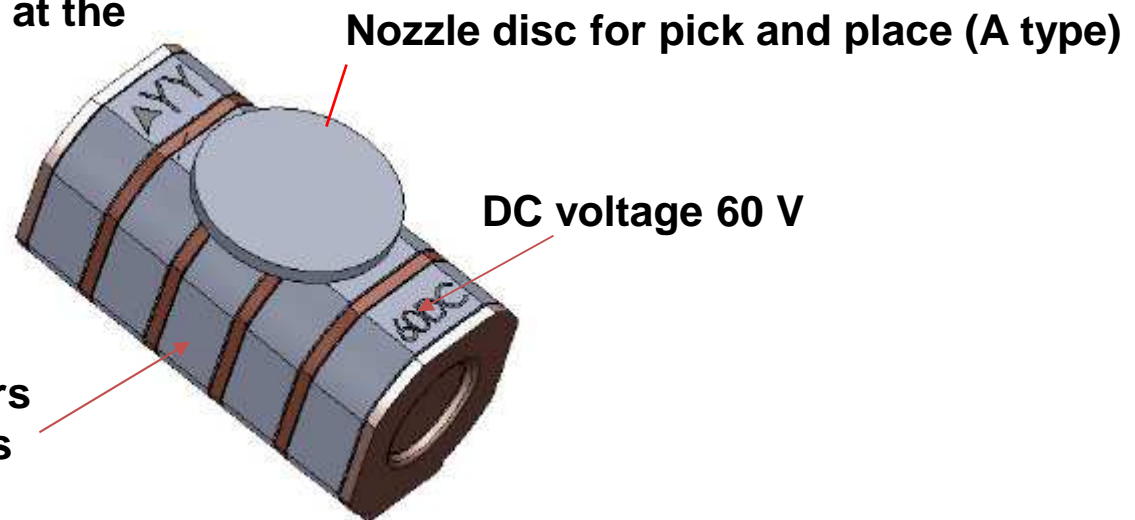


STACKED GAS DISCHARGE TUBE (GDT) AS A NEW OVERVOLTAGE PROTECTION DEVICE FOR RADIO BASE STATIONS (RBS)

LN8 design stacked gas discharge tube:

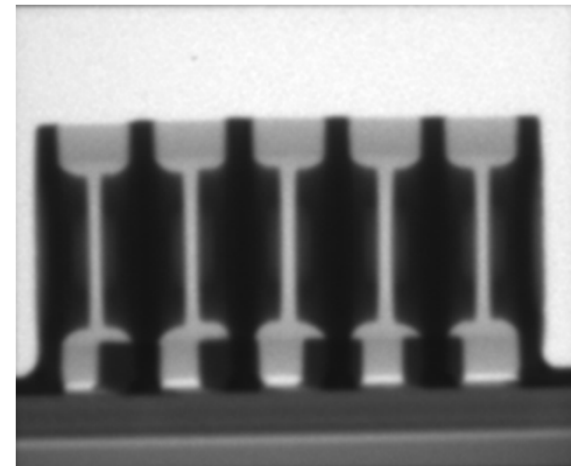
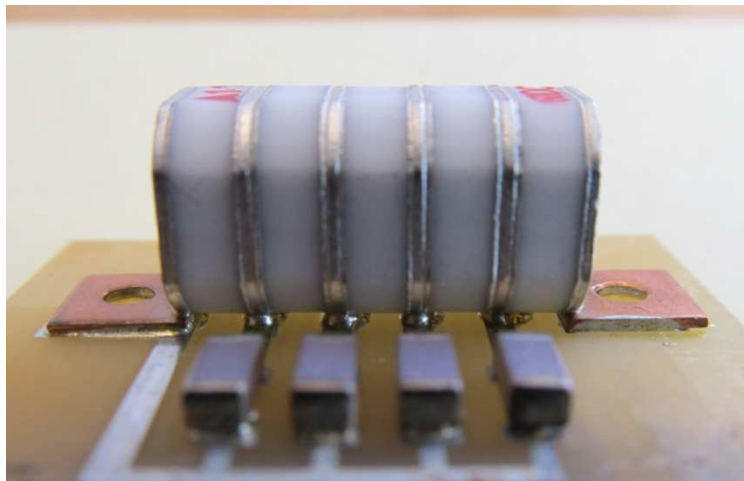
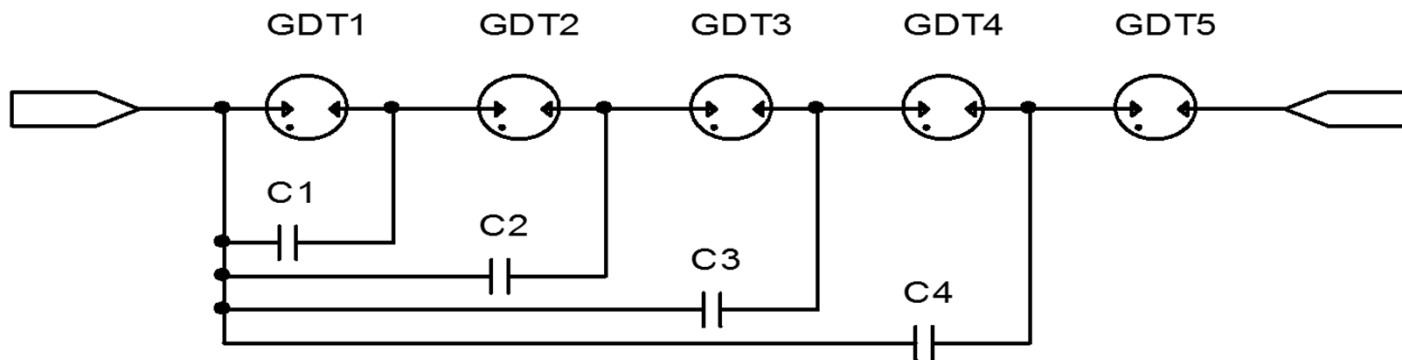
5 fold stacked arrester for overvoltage protection in case of continuous DC voltage at the component

5 independent chambers designed as GDT's, gas discharge tubes



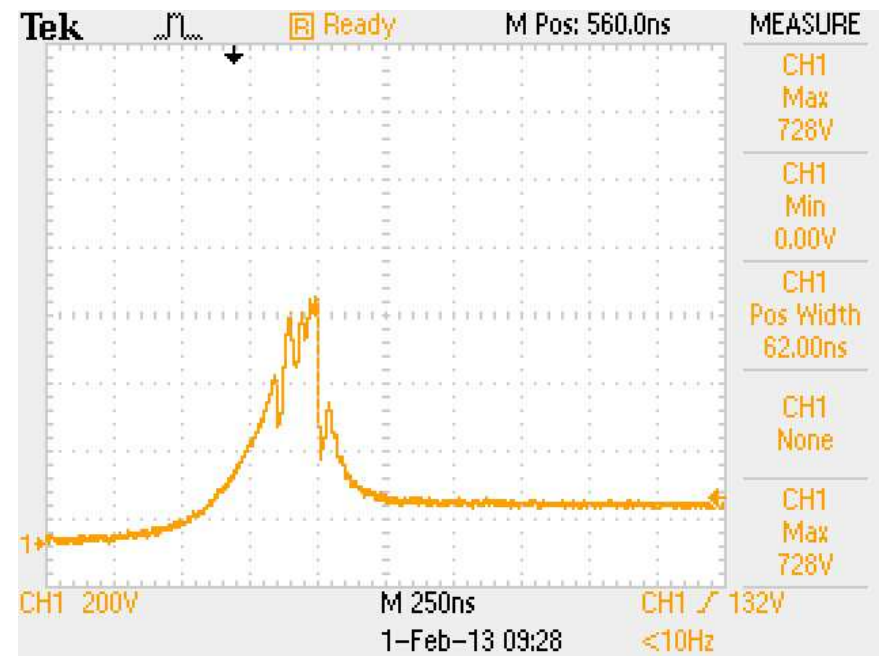
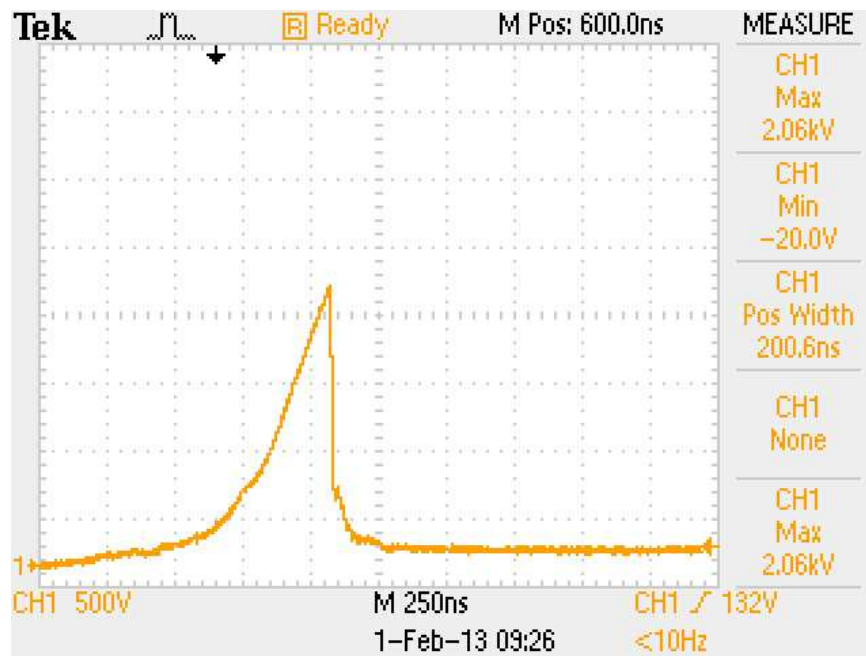
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Improving the protection value Up by matching with capacitors



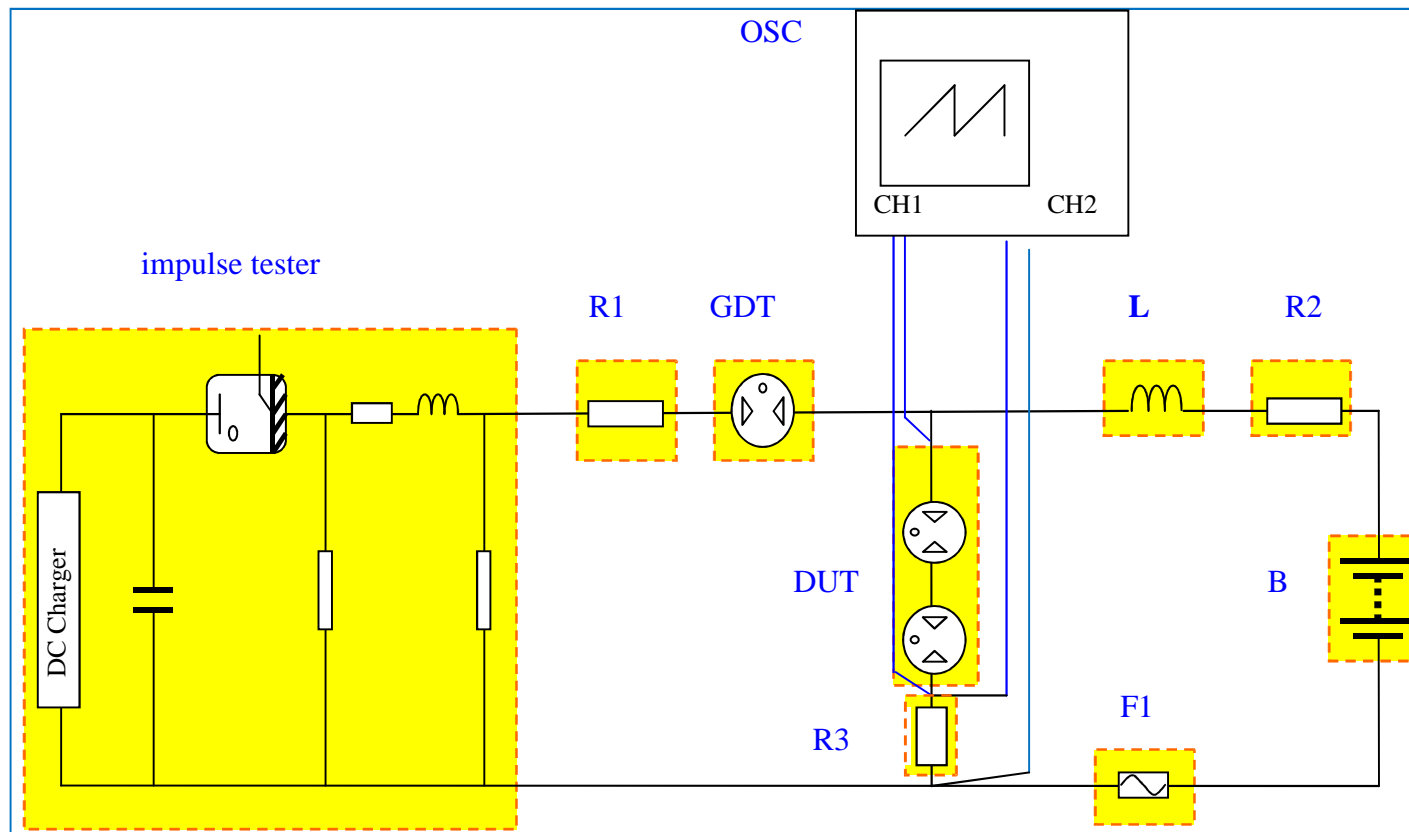
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- **Stacked GDT tested with 6kV, 1.2/50 μ s, without and with capacitor matching: Protection value Up will be reduced from 2kV to 720V.**



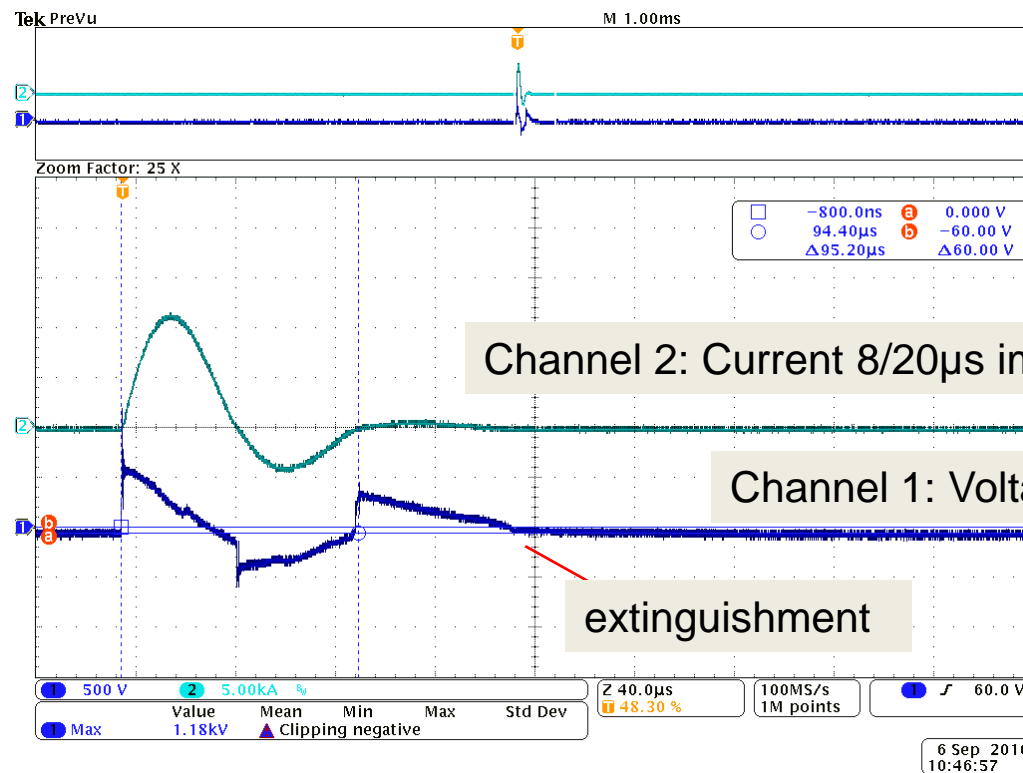
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Test circuit



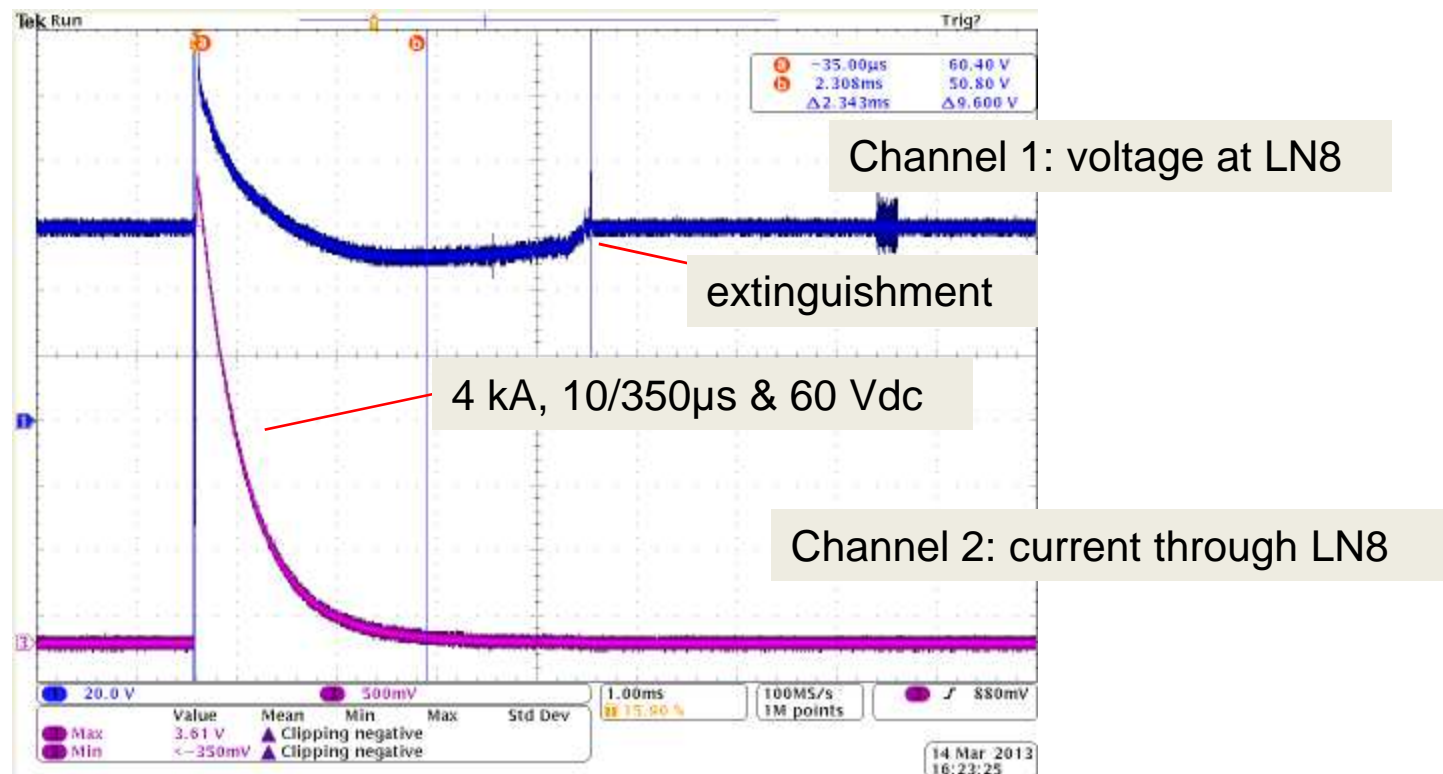
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Testing of LN8 component for the ability to withstand an external current impulse and to extinguish after a 8/20 μ s impulse. 10Ah battery source and - 60 Vdc.



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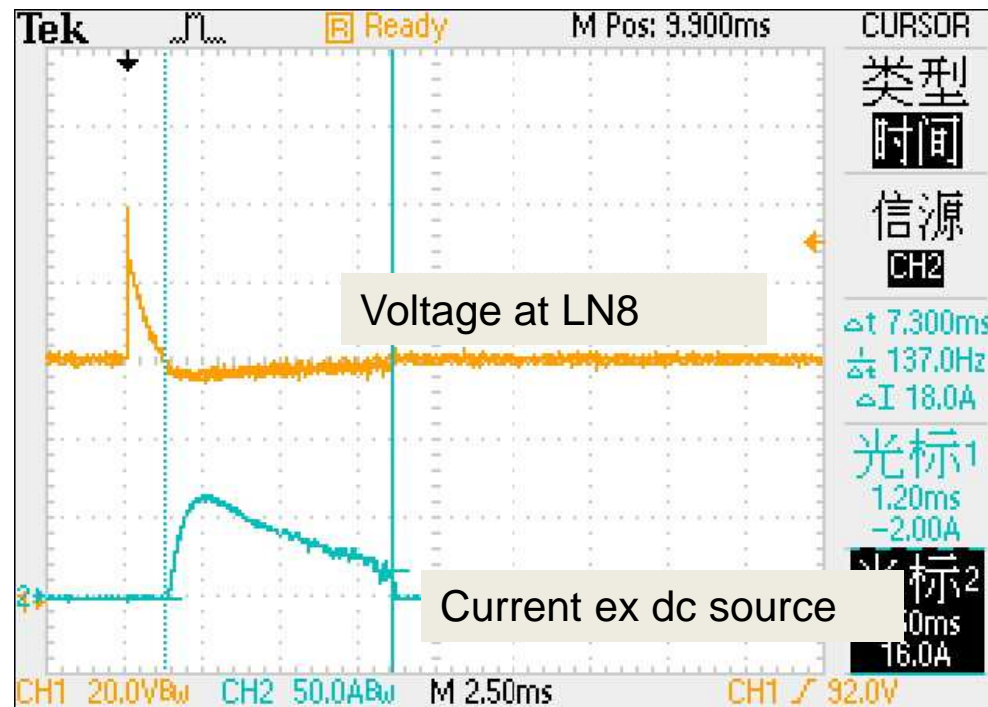
Testing of LN8 component for the ability to withstand an external 4 kA, 10/350 μ s current impulse and to extinguish after the impulse. Test with 10Ah battery set. Current measured with shunt resistor. Extinguish time some ms.



Suspect: Voltage source drops down.

STACKED GAS DISCHARGE TUBE (GDT) AS A NEW OVERVOLTAGE PROTECTION DEVICE FOR RADIO BASE STATIONS (RBS)

Testing of LN8 component for the ability to withstand an external current impulse and to extinguish after a 3.5kA, 10/350 μ s impulse. Test with 300Ah battery set. DC voltage 60V. Extinguish time some ms.



Explanation for extinguish delay time: Pinch effect for arc and possible emission spots on cathode leads to an intermediate lower arc voltage.

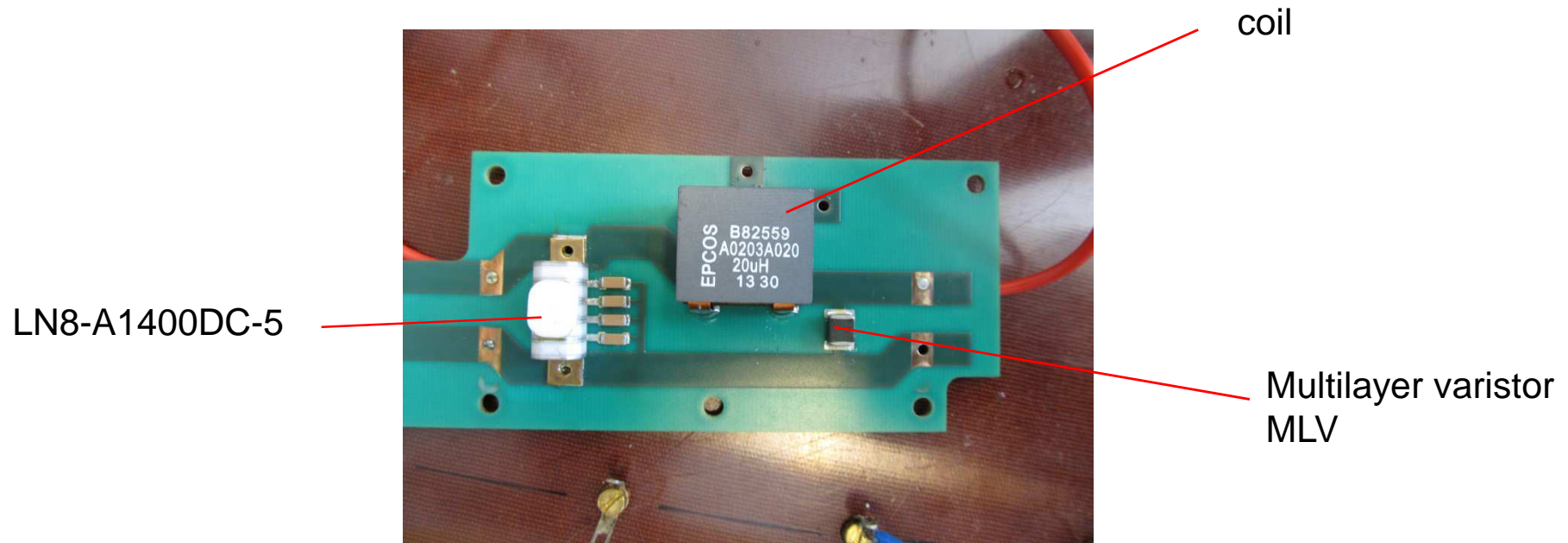
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Conclusion:

- *A stacked GDT is able to protect a device, which is feeded with a DC voltage.*
- *However the time to reduce the voltage after a lightning impulse is too long for a reliable overvoltage protection,*
- *$t = 2\text{-}4\text{ ms}$ in case of a $10/350\mu\text{s}$ impulse.*

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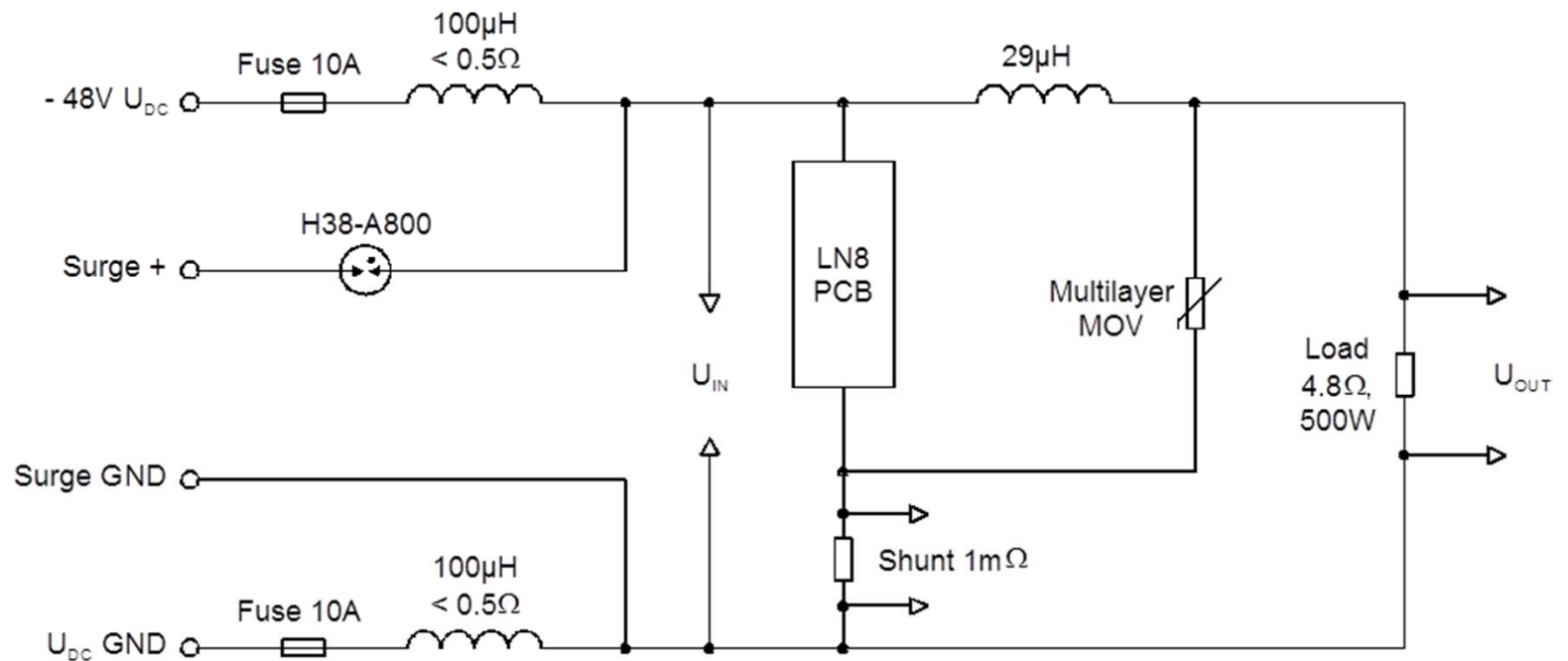
- **Surge protective device SPD:** Testing PCB with primary and secondary protection



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SPD test circuit

Circuit for Surge Protective Device (SPD)



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Estimation of output voltage with secondary protection, example for a complete SPD surge protection device

➤ **Technical data of SPD surge protective device:**

- Testing with 1 kV, 1.2/50µs voltage impulse and combination voltage tester acc. to IEC 61000-4-5
- Current with 2 ohms: 500A, 8/20µs
- Coil inductivity 20µH, ...
- Multilayer MOV LN2220K50E2, 50V-varistor
- Capacitors 470pF, ...
- LN8-A1400DC-5, stack arrester

➤ **Calculation:**

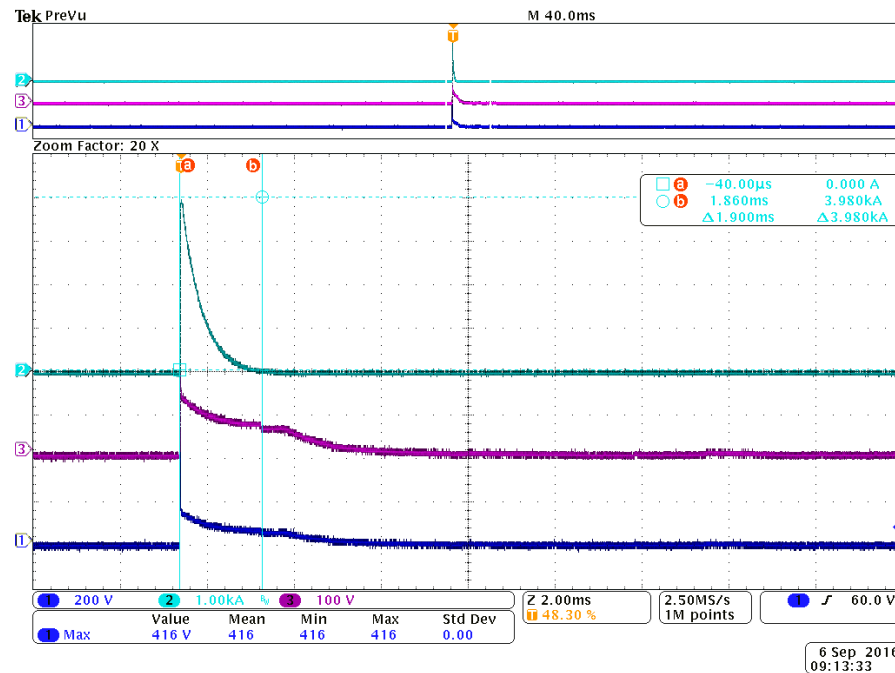
- $U_{ind} = -L * \frac{dI}{dt} = 20\mu H * 500A * 1/(8\mu s) = 1250V$
- $U_p \left(at 1 kV, \frac{1.2}{50} \mu s \right) \leq 1400V$
- $U_{out} \geq 50V$

➤ **Expected result: Output voltage should lay between 50V and 150V.**

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Test result SPD:

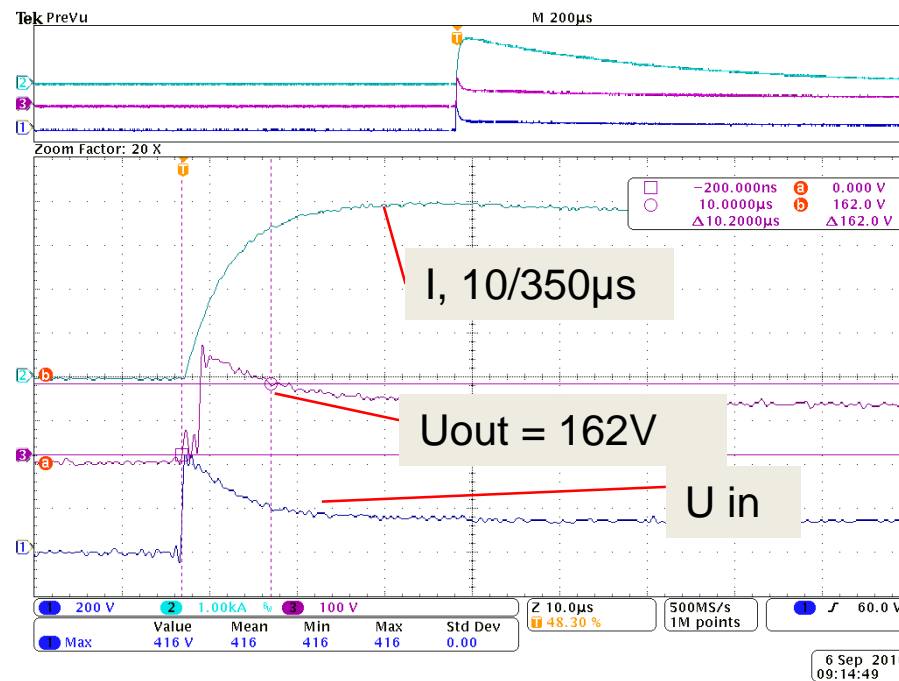
- **4 kA, 10/350 μ s, Vdc = -48 V.**
- Blue: (1) input voltage U_{in} , (2) green: current impulse I , (3) violett: output voltage U_{out} .
- **Result:** Extinguishment LN8 after 1.9ms, complete recovery after about 4ms.



STACKED GAS DISCHARGE TUBE (GDT) AS A NEW OVERVOLTAGE PROTECTION DEVICE FOR RADIO BASE STATIONS (RBS)

Test result SPD:

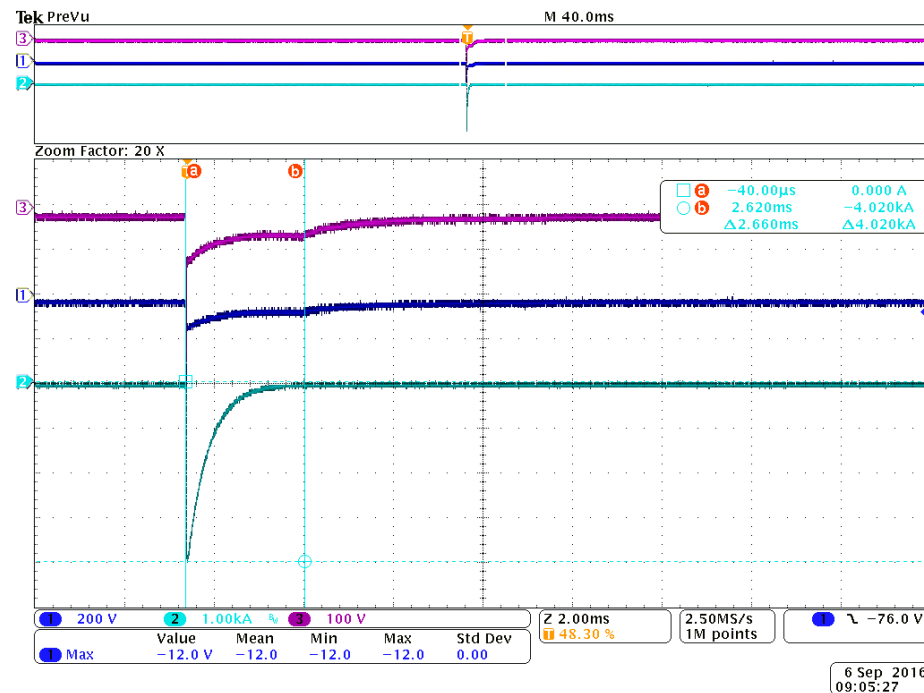
- **4 kA, 10/350 μ s, Vdc = -48 V.**
- Blue: (1) input voltage U_{in} , (2) green: current impulse I , (3) violett: output voltage U_{out} .
- **Result:** $t=10\mu$ s corresponds to 162V.



STACKED GAS DISCHARGE TUBE (GDT) AS A NEW OVERVOLTAGE PROTECTION DEVICE FOR RADIO BASE STATIONS (RBS)

Test result SPD:

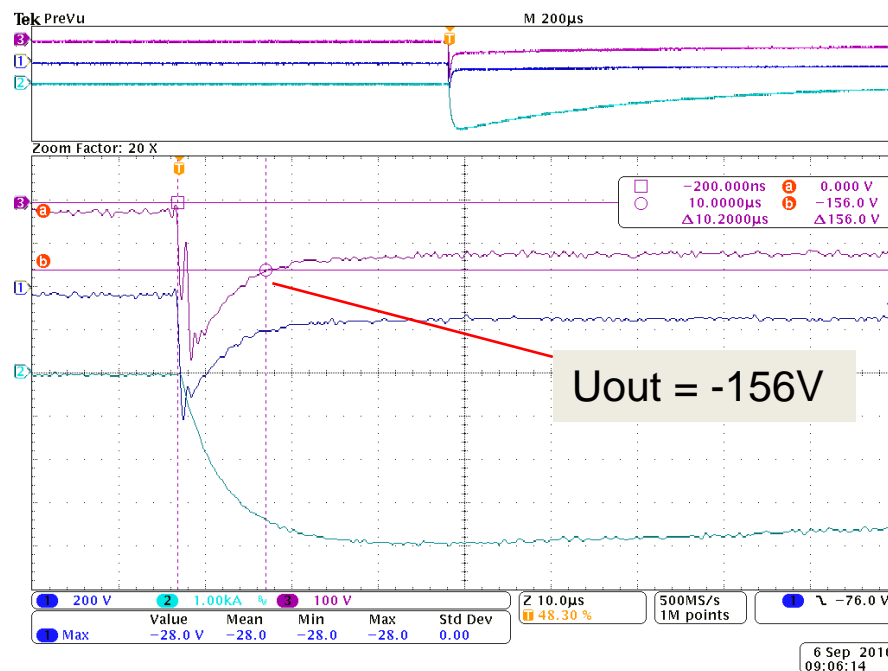
- **-4 kA, 10/350 μ s, Vdc = -48 V.**
- *Blue: (1) input voltage U_{in} , (2) green: current impulse I , (3) violett: output voltage U_{out} .*
- **Result:** Extinguishment LN8 after 2.6ms, complete recovery after about 3ms.



STACKED GAS DISCHARGE TUBE (GDT) AS A NEW OVERVOLTAGE PROTECTION DEVICE FOR RADIO BASE STATIONS (RBS)

Test result SPD:

- **-4 kA, 10/350 μ s, Vdc = -48 V.**
- Blue: (1) input voltage U_{in} , (2) green: current impulse I , (3) violett: output voltage U_{out} .
- **Result:** Delay $t=10\mu$ s corresponds to $U_{out} = -156V$.



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Conclusions:

- ***A stacked GDT fulfills the expectations for overvoltage protection for the DC powerline inputs of RBS electronic circuits.***
- ***The LN8 type with 8mm diameter and 5 stacks can reliably withstand an 8/20 μ s, 20kA and a 10/350 μ s, 4 kA lightning surge on a 48 V DC voltage battery source.***
- ***In combination with coil and secondary protective components like multilayer MOV`s or suppressor diodes the outgoing voltage can be reduced to < 170V after a delay time of 10 μ s only.***



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