



Advancing GDT Technology to Meet Higher Surge and Multi-level Protection Requirements

WHITE PAPER



Bourns® Next-Generation
GDT25 Series

INTRODUCTION

Early generations of Gas Discharge Tube (GDT) technology emphasized long-life performance and high reliability over reaction and turn-on speed. Slower reaction time, however, wasn't considered an issue in the past as designers had integrated coordinated protection layers per GR-1089, ITU K.20 and K.21 requirements.

As time progressed, board level use of GDTs has greatly expanded into a wide range of equipment that has become smaller, more integrated and much more sensitive to transient voltages and currents. These equipment trends make it necessary to address the needs of board level protection with more advanced gas tube designs.

This white paper introduces Bourns' 7th generation GDT series, a new generation of GDT devices to meet higher surge and increasing multi-level protection requirements. This paper outlines why enhanced features such as faster turn-on speeds coupled with higher impulse current ratings are necessary to proactively satisfy the growing protection requirements in today's next-generation applications.



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Figure 1 - Benjamin Franklin (Left), Humphry Davy (Right) and Yale University's Experiments in Electricity are what Lead to GDT and Spark Gap Technology

HISTORY OF GDT TECHNOLOGY

The earliest reference to experiments involving lightning was Benjamin Franklin's kite experiments in 1752. However, it was in 1859 that Yale University described the use of the first spark gap protection solution. The solution used Franklin's experiment to harness the energy of a lightning storm as its starting point. The kite was tied to an insulated post where the metallic string going to the kite was connected to a brass ball on the post. A second brass ball was grounded with a 2-inch gap between it and the isolated ball. If the energy on the kite string became too intense, an arc would occur between the two brass balls to conduct the energy to ground.

It was Humphrey Davy who investigated the basic spark gap and the nature of the arc between the conductors. He discovered that with enough potential difference between the two conductors, the air or the gas between the electrodes would ionize to provide a conductive medium for the current that would produce the arc. The traditional brass ball spark gaps evolved into carbon blocks that still used the local atmosphere to control the point of the arc. Spark gap technology next evolved where the atmosphere or gas between the two electrodes was confined in a container so that the external atmosphere did not affect its arcing performance. The Gas Discharge Tube (GDT) as it has become known has advanced to provide reliable and effective protection solutions during lightning storms and other electrical disturbances.

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GDT OPERATIONAL BASICS

A GDT device is an arrangement of electrodes and gas contained within a ceramic envelope, acting as a surge arrester that operates as a voltage dependent switch. GDT devices are typically placed in a circuit to limit voltage and to divert surge current to ground (common mode) or to a source (differential mode). The GDT device has very high impedance ($>1 \text{ Gohm}$), so it is virtually invisible to the circuit during normal operation. When a voltage appears across the device that is greater than its rated DC breakdown voltage, the gas in the GDT will begin to ionize and conduct until it reaches its impulse sparkover voltage. At this point, the device is fully in its on-state mode and a low arc voltage is maintained irrespective of the discharge current, thereby diverting the surge current and protecting the equipment. When the transient passes, the GDT will reset to its non-conducting state.

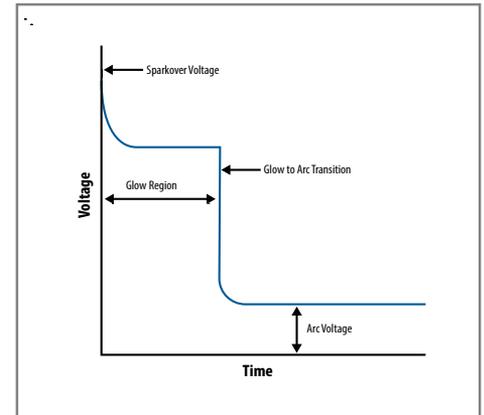


Figure 2 - GDT Voltage Breakdown

What makes GDT technology an excellent protection solution is its capability to handle very high surge currents as well as its exceptionally high off-state insulating resistance and very low capacitance. These features make a GDT ideal as a stand-alone protector or as the primary stage of a multi-stage circuit protection design.

GDTs are constructed as two conducting elements (electrodes) separated by a ceramic insulator. This creates a sealed chamber containing a gas mixture, a defined distance between the elements, carbon lines and a coating on the elements which conducts electricity at a defined voltage and current level.

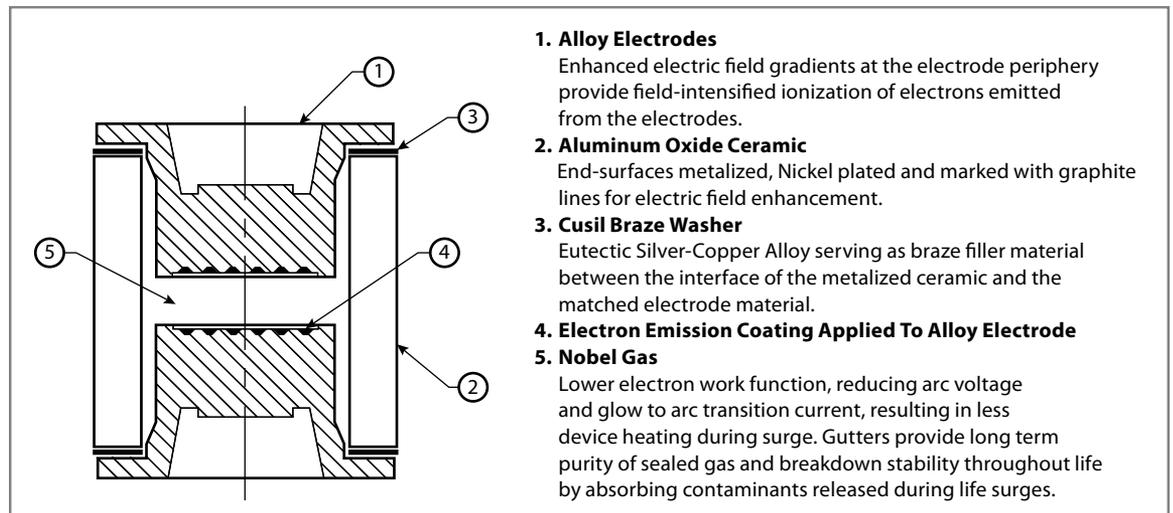


Figure 3 - Cross Section Diagram Depicting a Simplified Construction

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INNOVATION BY DESIGN

Today's smaller and more integrated equipment designs are more sensitive to transient voltages and currents. The enhanced circuit protection they need calls for an extended range of new functionality including faster reaction and turn-on speed performance.

In designing its next-generation 2-Electrode 5 mm GDT25 series, Bourns engineered its 7th generation gas tube components from the ground up. The updated family offers new electrode shapes, internal geometries and emissive coating system features. The Bourns® Model GDT25 series provides lower impulse and DC sparkover voltages. When used as a primary protector, the lower impulse and sparkover voltage allows the use of smaller, lower voltage downstream components, which can lower total BOM costs. With its faster turn-on capabilities, the Model GDT25 series minimizes stress to downstream components by quickly limiting high voltage and current. Plus, the family's lower capacitance improves protection and can lower loss in high-speed I/O (DOCSIS 3.1, GbE, microwave, etc.) lines.

Offering enhanced AC power cross capabilities, the Model GDT25 series delivers robust protection against AC powerline voltage, and improved voltage stability after reflow and varying environmental conditions. In addition, these next-generation devices feature lower arc voltages that can lead to longer GDT life and reduced energy dissipation. Furthermore, the GDT25 series' wide operating temperature range (-55 °C to +125 °C) is well-suited to certain harsh environmental applications.

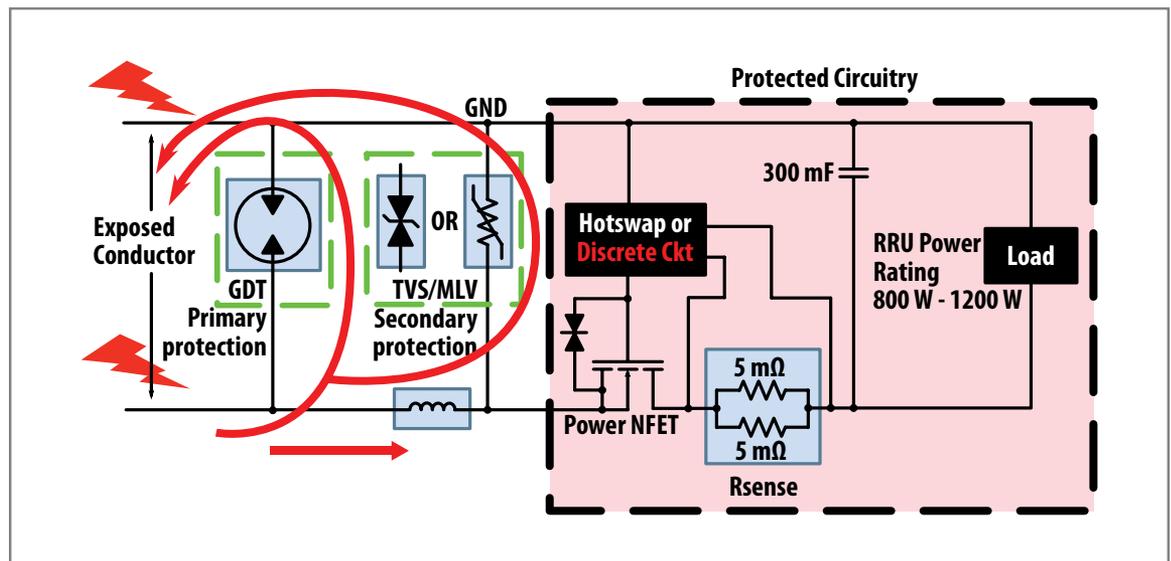


Figure 4 - Next-Generation Turns-On Faster and Helps to Prevent Downstream Circuitry from Exposure to Harmful Surges



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COMPETITIVE GDT COMPARISONS

The ITU K.12 standard defines the tests and test methods to allow manufacturers and users of GDTs to properly specify and compare devices.

Impulse limiting is typically specified using a linear voltage ramp of either 100 V/μs or 1000 V/μs with the higher speed ramp used to simulate a transient event such as lightning. Under this condition, the faster a GDT can turn-on, the lower the voltage exposure of downstream components.

The data below illustrates the performance of Bourns® low-voltage GDT25 designs compared to several similarly-rated GDT components.

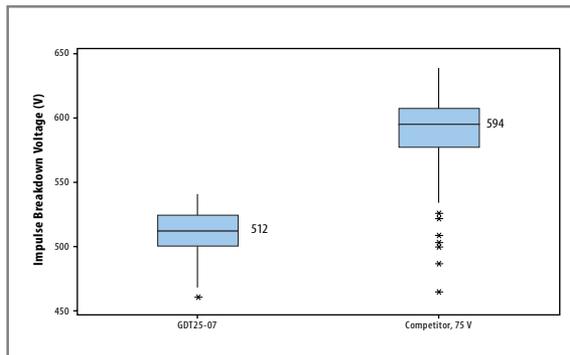


Figure 5 - Impulse Comparison, 1 kV/μs 75 V Models

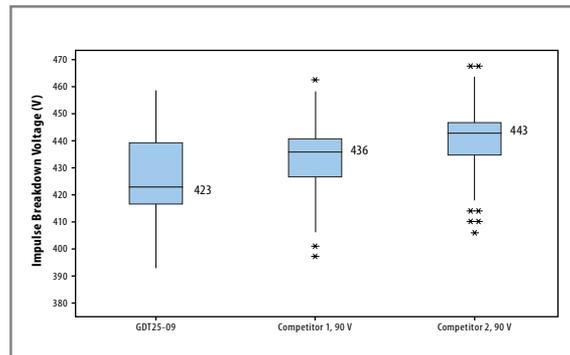


Figure 6 - Impulse Comparison, 1 kV/μs 90 V Models

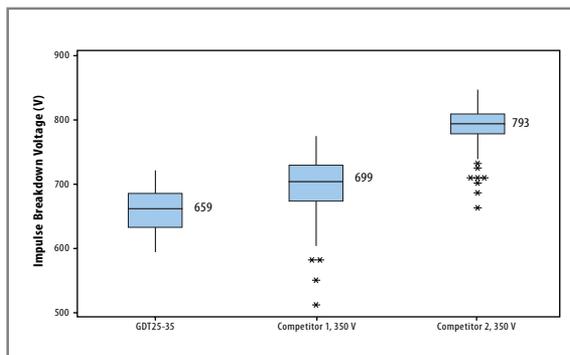


Figure 7 - Impulse Comparison, 1 kV/μs 350 V Models

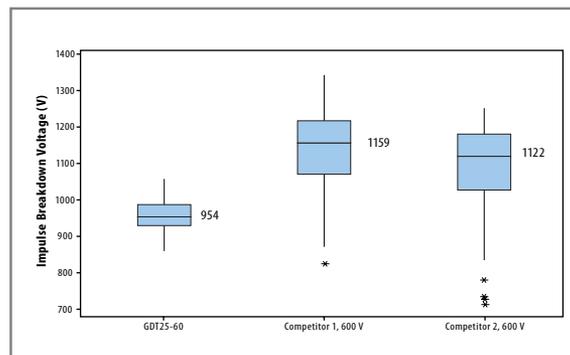


Figure 8 - Impulse Comparison, 1 kV/μs 600 V Models

The internal test results shown above highlight the advanced impulse performance of Bourns® next-generation GDT design against previous generation devices.

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A NEW STANDARD IN VOLTAGE LIMITING PERFORMANCE

Leveraging Bourns' breakthrough gas tube design and new coating technologies, the next-generation GDT25 series achieves superior impulse voltage limiting performance

This performance is what designers of new, more sensitive and highly-integrated applications require to help significantly heighten protection against induced voltage transients. The speed and robustness designed into the next-generation GDT25 series present a new standard for overvoltage surge arrestors.

Bourns' broad GDT product portfolio has a proven track record as reliable primary protectors and are regarded by many to be the industry standard for surge protective devices. With over a billion GDTs deployed across copper and hybrid fiber-copper networks, Bourns' GDTs have commonly experienced a field service life of 20 to 30 years or longer. They also offer stable performance due to their robust design, high surge handling and low on-state resistance features.

Bourns continues to drive innovation of its GDT products. With recent additions of the Bourns® FLAT® GDT series and Hybrid GMOV™ product series, and now the release of the next-generation GDT25 series, Bourns is meeting evolving customer and market needs. In line with its history of advancing GDT device technology, Bourns will soon release additional next-generation GDT models offering even more breakthrough overvoltage protection features.

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