

# Universal AC Power Protection

## *The Art of Circuit Protection*

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Bourns, Inc.

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Session 3: *Electrical Protection/  
Surge Protection*  
March 23, 2022

## Today's Speaker



Wayne Dossey is a **Sr. Technical Marketing Engineer** for the **Circuit Protection** Division at **Bourns**, with a focus on industrial applications of circuit protection products. He has more than **40 years of experience** as a circuit and system design engineer for industrial, telecommunication, and aviation systems. He earned his **MSEE** from the University of Texas at Arlington and is an **IEEE Electromagnetic Compatibility Society Life Member**.

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## Basics of Universal Protection

- Society's prevalent electronic **apparatuses powered from AC mains** are susceptible to **voltage surges**, whatever their origin – they need **more protection** in smaller spaces:
- Lightning (both direct and indirect), AC line surges, Line voltage swells, Heavy machinery switching transients
- Universal Protection circuit needs to be **small, inexpensive**, occupy **minimal space**, and be **benign in the normal operating state** for every application
- Universal covers **worldwide AC mains voltages**; protection is robust and **on-demand**
- The Universal AC Protection (UACP) circuit configuration:

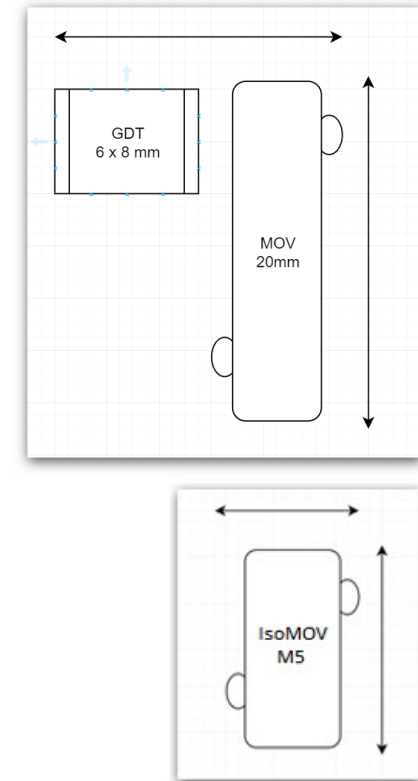
**Minimizes cumulative component degradation and downtime**

**Increases system reliability and equipment lifespan**

- Ideal for **high-value** applications where **service calls** are highly **undesirable** or **prohibitively expensive**

## Constant Need for Circuit Protection Evolution

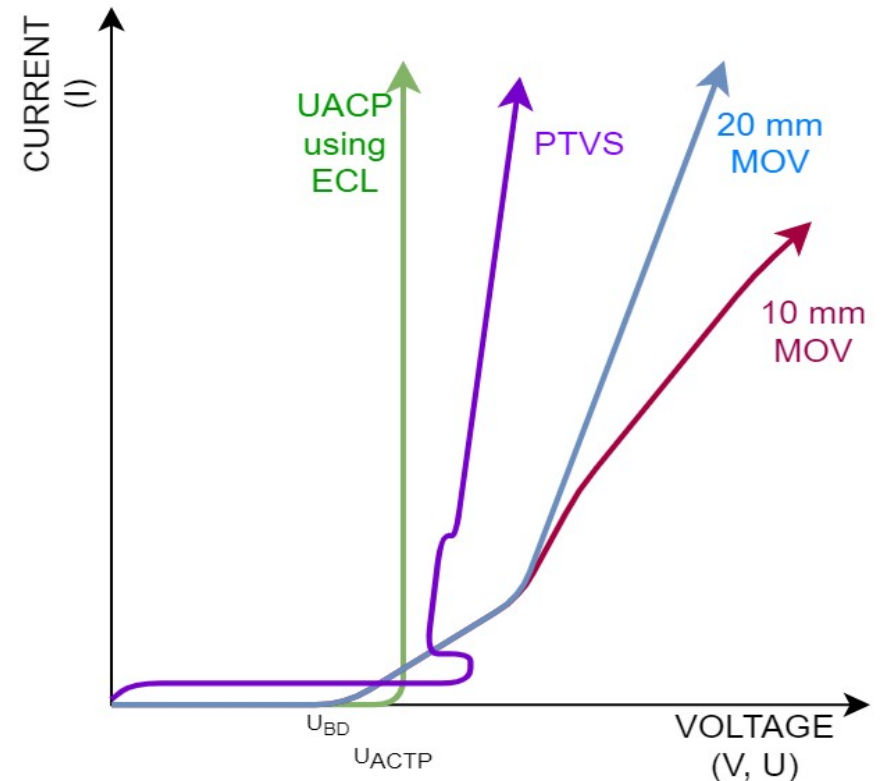
- Components connected **across the AC line** are subject to continuous degradation – **prevented** by using a **hybrid protector**
- GDTs and MOVs are frequently **used in series**, each complementing the best properties of the other, and requiring **significant space**
- **Combining** the GDT and MOV, when used in the coordinated Universal AC Protection **circuit configuration**, combine with the other **coordinated components** to provide **reliable protection** for AC powered equipment
- UACP circuit configuration provides **constant protection** without having the **voltage clamp component** constantly across the AC line



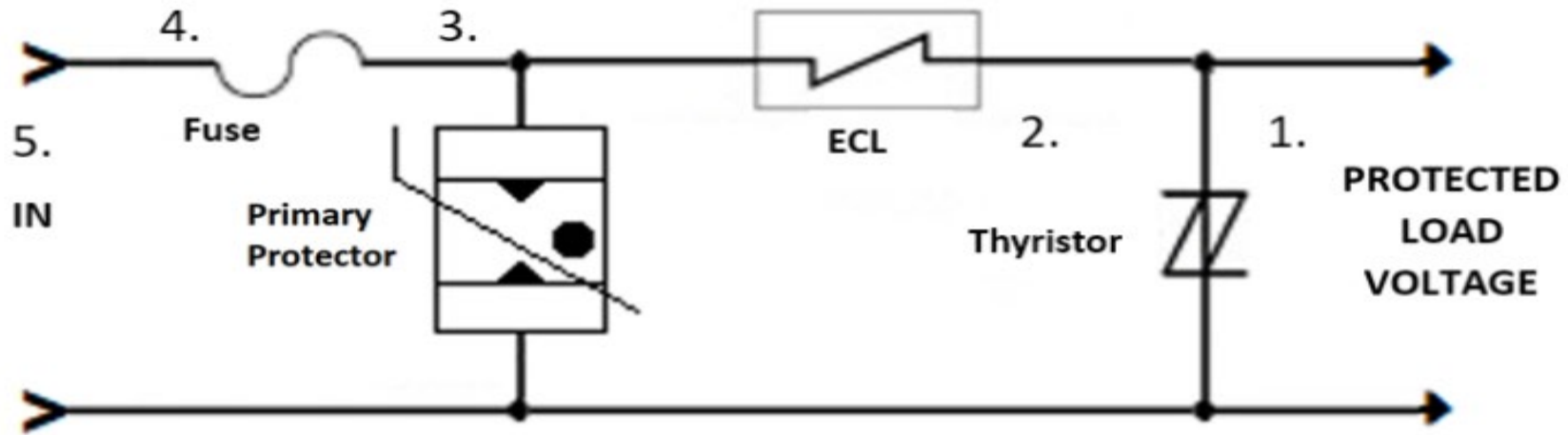


## AC Mains Disturbances, Surges, and Protection

- **Residual voltage** transferred to the load is **minimized** for the Universal AC Power Protector circuit configuration **using an ECL** when compared to primary protectors
- Using the Universal AC Power Protector circuit configuration **reduces the design margin requirements** for the protected load
- **Saves cost** in the protected load since the voltage reaching it is reduced – can use **lower rated** and **fewer secondary protection** components



# AC Power Protection Circuit Operation



5. When the AC input **voltage crosses zero**, the circuit **resets** to the initial state

4. In case of catastrophic **excess current**, the **fuse will open**

3. Input voltage **continues to rise** until the **primary protector** is triggered

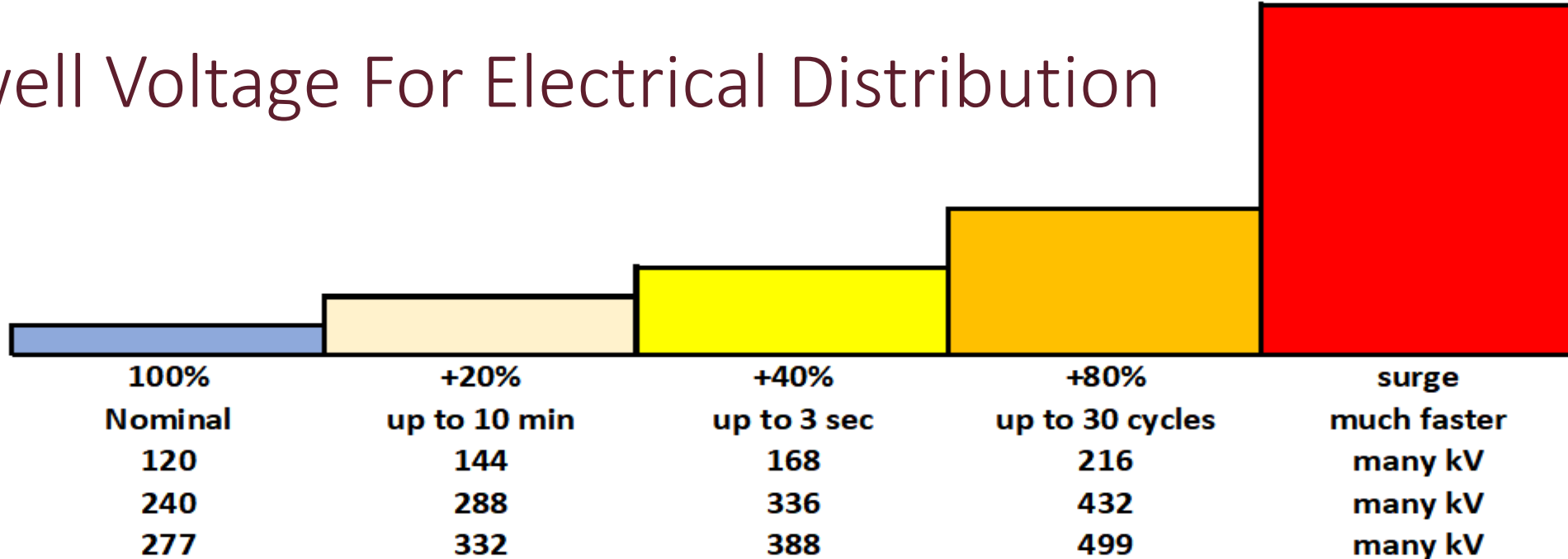
2. The **ECL blocks** the current and **disconnects** the load from the source

1. The **thyristor** detects an **overvoltage** condition, conducts a **high current**, and protects the load

## Advantages of New Universal AC Power (UACP) Protection

- **Maximum** protection, **minimal** residual voltage, **minimizes** protected circuit's design margin, cost, and size; provides **permanent** AC power circuit protection
- Protection circuit **resets itself** every half cycle using the natural AC mains **commutation**
- Uses these components: SMD **fuse**, a **primary protector** such as a series GDT+MOV, an **ECL (electronic current limiter)**, and a **thyristor** surge protector
- Provides **additional overcurrent limiting** capability in the event of the load's internal fault
- Components are **coordinated** so each protects the others
- Increases **reliability**, improves system **up-time**, and contributes to **reduced lifecycle costs and warranty issues** for high value protected loads

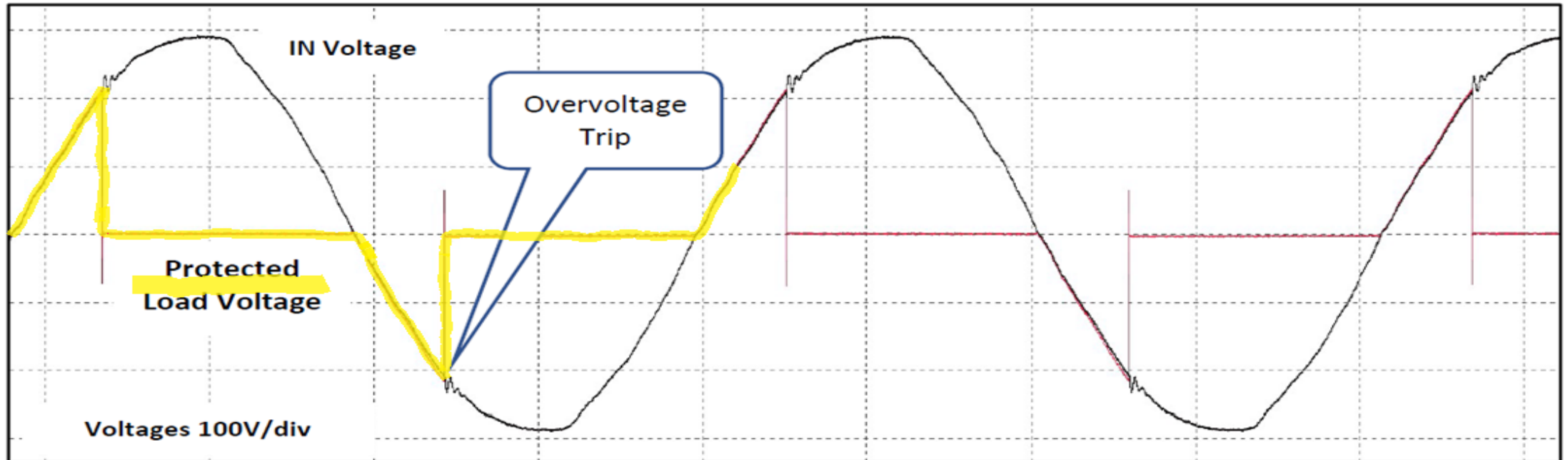
# Swell Voltage For Electrical Distribution



- ANSI C84.1-2006 **Distribution Utilization Voltage Range**, IEEE C62.41-1991, IEEE1159, and EN50160
- Standards define **duration and voltages for swells** (overvoltage) and sags (brownout)
- **Swells do not activate** the primary protector – However they can threaten the **apparatus**
- The **coordinated components** in the UACP circuit configuration protect the apparatus

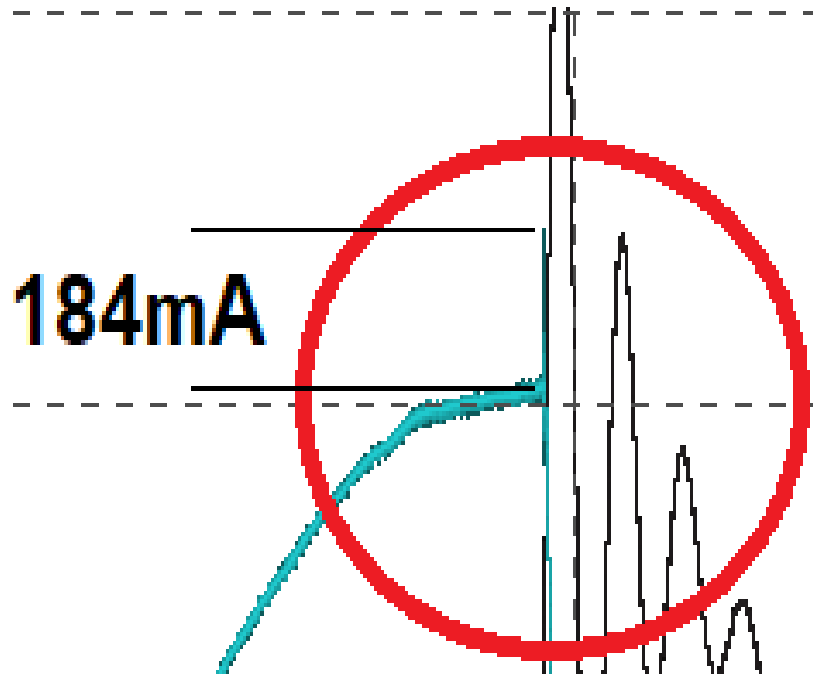


## Operation During Line Voltage Swell

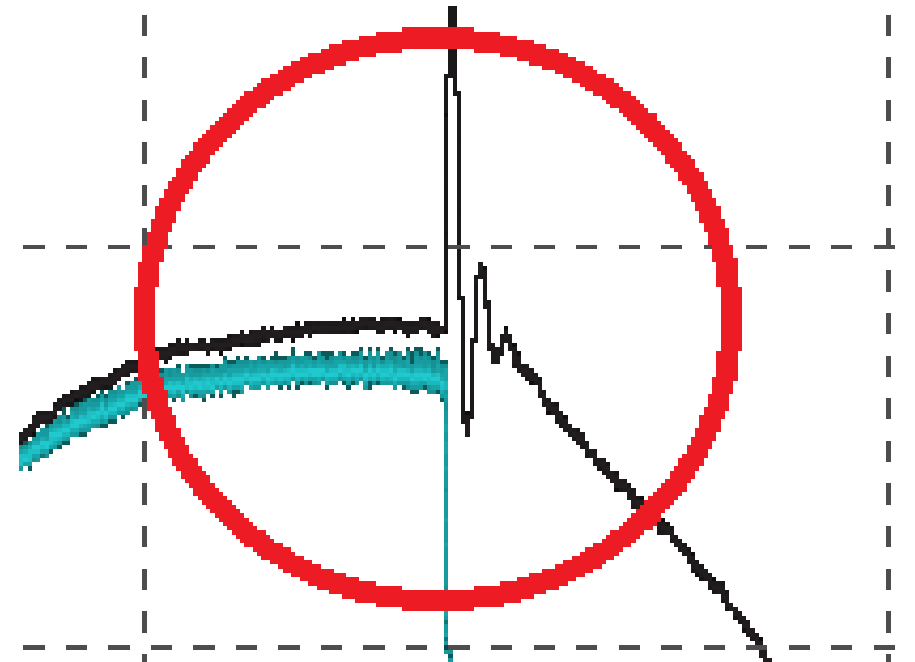


- 120VAC protector uses a **thyristor** that **breaks over** about **220V peak** (equivalent to 155Vrms)
- The thyristor becomes a low impedance and conducts a large current
- The **ECL (electronic current limiter)** switches off and disconnects the load

## Operation When ECL Switches to High Impedance State

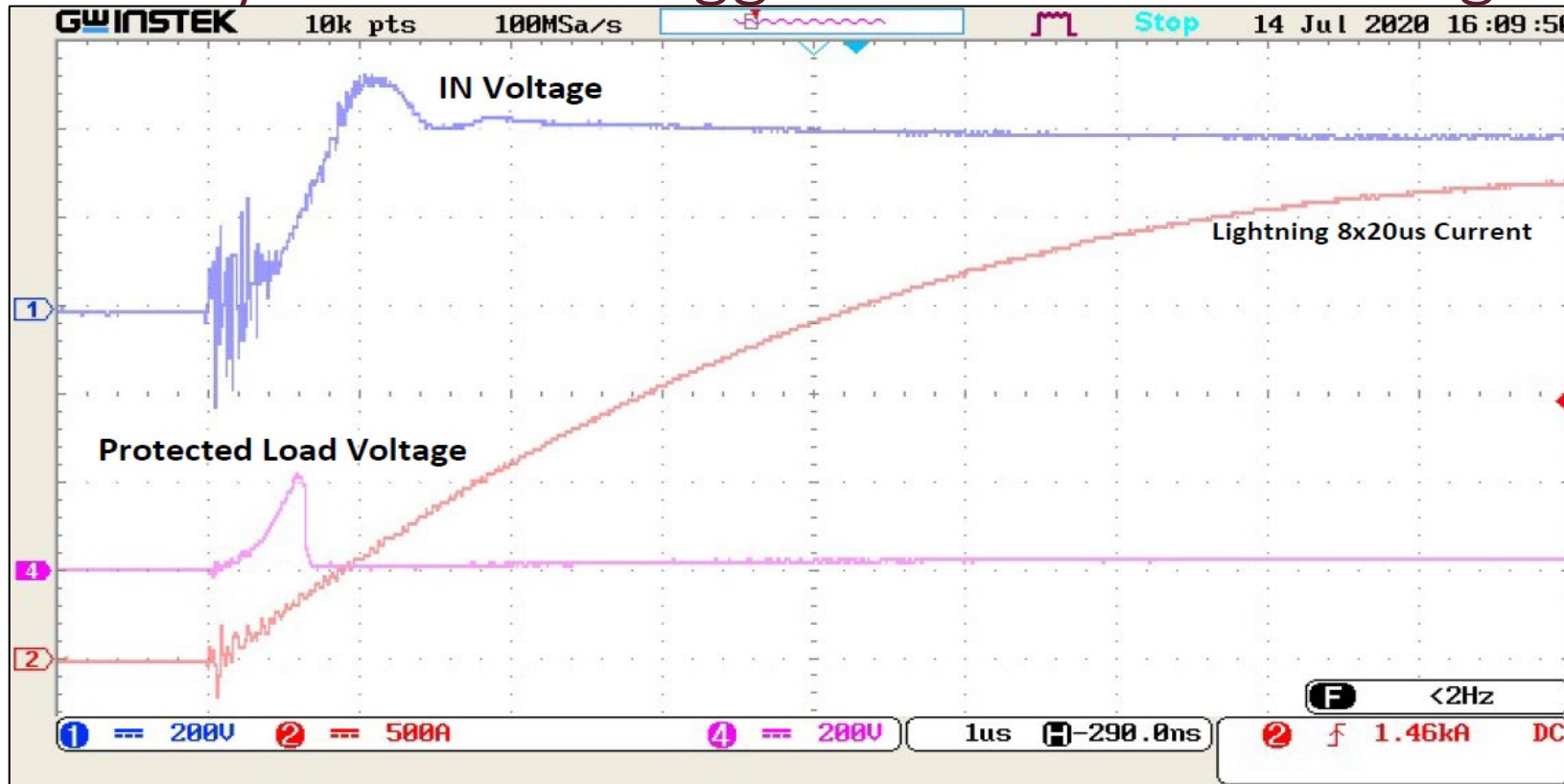


**Overvoltage breaks down the thyristor, causing a current spike, triggering the ECL**



**1 Amp load overcurrent triggers the ECL (electronic current limiter)**

# Primary Protector Triggers For 6kV 8x20us Lightning Transient



The **thyristor** limits load voltage to 230V peak

Maximum voltage on **ECL** is 530V at the Input and clamps at 390V for a 3kA current surge

## Universal AC Power (UACP) Protection

- UACP provides **continuously available protection** in four small components
- Combines cutting-edge components in a space **less than one square inch**
- Protection components are coordinated so they **protect each other** and the designer's load from lightning surges, AC line noise, AC line surges, and AC line swells
- Surge protection is always **on call but not on duty**
- **ECL (electronic current limiter)** provides the “secret sauce” – it replaces large expensive parts and operates as a **switch**
- UACP circuit configuration does **more in a smaller space** than individual parts alone
- UACP circuit using the ECL provides **over current limit** as well as **surge voltage protection**



# Universal AC Power (UACP) Protection

Thank You from Bourns

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