

## GORE High Temperature Capacitors

200°C Film Capacitors for  
Oil & Gas Power Electronics

# INCREASE TOOL RELIABILITY

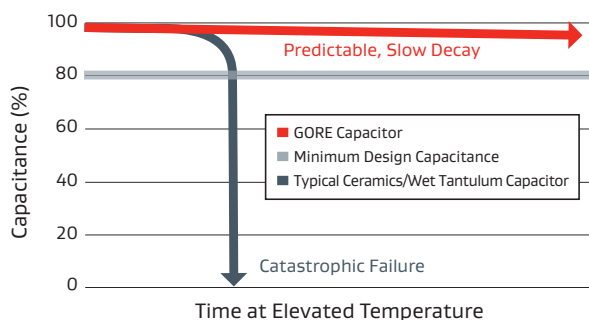
GORE High Temperature Capacitors reduce the risk of tool failure by delivering stable performance for an extended term in demanding downhole environments. Unlike MLCCs and other commonly used capacitors, GORE Capacitors avoid sudden and complete failure for a more predictable mission completion.

With minimal de-rating, GORE Capacitors deliver stable voltage and capacitance at elevated temperatures. System designs that rely on excess capacitance to accommodate de-rating can be simplified, which reduces failure points, and facilitates easier assembly — all while reducing overall electrical stress on other components.

## The Challenge

Power electronics in downhole tools are subjected to some of the harshest operating conditions on the planet. Design teams have had to work around the challenges of legacy capacitor technologies: using multiple capacitors to meet power needs while overcoming de-rating, innovating specialty mounting techniques for shock and vibration, the use of dewar insulation systems, or even cooling systems to resist extreme temperatures. But despite the number of incremental improvements, the critical weakness is hidden in the failure mode of traditional capacitor choices. For when they fail, they fail short leading to risk of downhole tool failure.

## GORE Capacitors Stable for Extended Term Traditional Capacitors Fail Short



## Benefits of GORE Capacitors

- Increased tool reliability and reduced risk of unexpected failure
- Stable and predictable capacitance
- Reduce system electrical stress on neighboring components
- Withstand high temperature and voltage spikes
- Minimal de-rating at fully rated conditions
- Withstand shock and vibration
- Reduce system design complexity and improve installation

## GORE Capacitor Summary

Capacitance Range	1–50 $\mu$ F (single section)
Temperature Rating	-40 up to 200°C (-40 up to 392°F)
Voltage Ratings	400/600 VDC
Typical ESR	5–25 m $\Omega$
Typical ESL	< 40 nH
Typical Heating R <sub>θ</sub>	3–5°C/W
Insulation Resistance Terminal-to-Terminal	7,000,000 M $\Omega$ / $\mu$ F
Withstand Voltage Terminal-to-Case	1500 VDC

*Together, improving life*



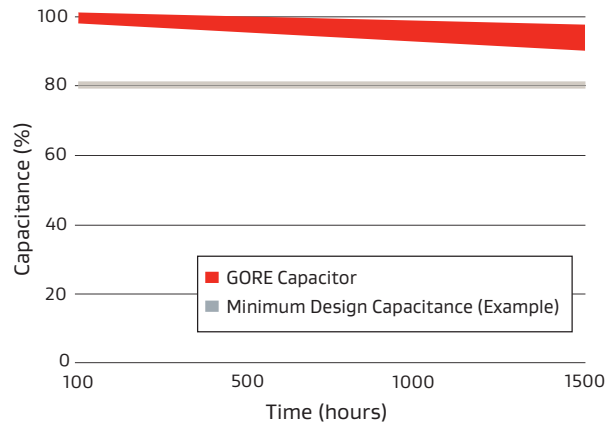
## Stable and Reliable Capacitance for Extended Term

Traditional capacitors used in oil and gas downhole equipment have frustrated operators and their clients with random failures. Commonly used ceramic capacitors (MLCCs) are brittle and susceptible to shorting from shock and vibration. Other technologies such as wet tantalum can fail short as a result of transient voltages. However, GORE Capacitors deliver stable and reliable capacitance over extended periods despite these challenging environments.

The chart at the right indicates 90% probability of capacitor performance based on hundreds of parts tested at maximum conditions.

**Note:** For actual operating conditions below the maximum ratings, expectations of capacitor longevity can be substantially extended.

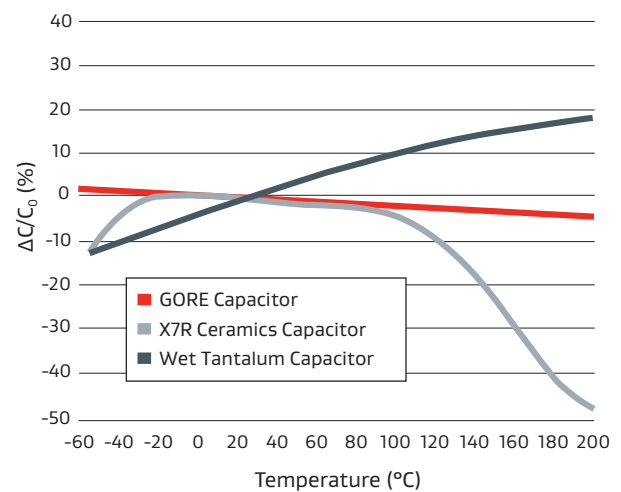
## Endurance Testing of GORE Capacitors 200°C at Maximum Voltage Rating



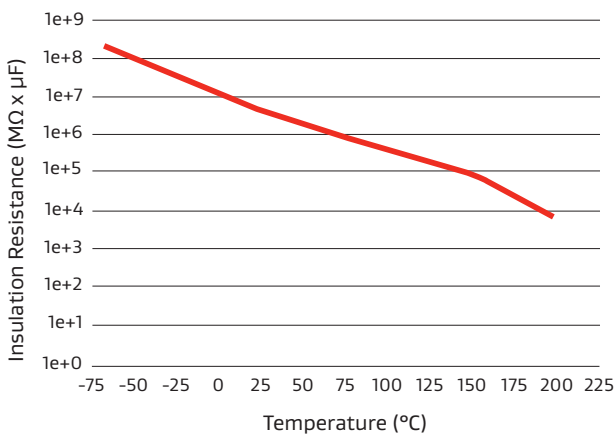
## Simplified Design and Installation with Minimal De-rating

To meet the need for high capacitance/high voltage in high temperature conditions, traditional capacitors require substantial de-rating. Therefore, design engineers are often required to use large quantities of small capacitors resulting in a complex system design, a large number of potential failure points and increased installation costs. Alternatively, a single GORE Capacitor offers a large amount of stable capacitance with minimal de-rating under high temperature and voltage conditions.

## Capacitance Stability Across Temperature

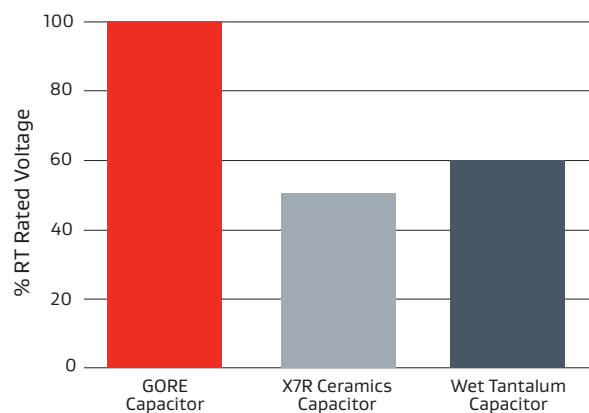


## Insulation Resistance Over Temperature



6μm film tested @ 500V / 1kHz

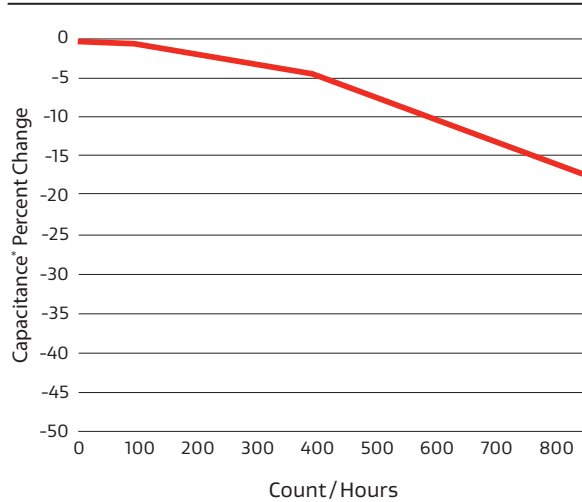
## Category Voltage at Temperature (175-200°C)



## Over-Voltage Conditions

Unlike other high temperature dielectrics, GORE Capacitors resist catastrophic shorting even in over-voltage conditions. The self-clearing capability of the GORE metallized dielectric film resists catastrophic shorts by vaporizing the metal at point defects or areas of voltage concentration. This leads to a very small drop in capacitance, and allows the bulk capacitor to continue to function as designed. Testing shows that even when capacitors are biased +100VDC over the maximum rating at a temperature of 190°C, there are no short failures that result.

### Overvoltage Testing (500 VDC on part rated to 400 VDC)

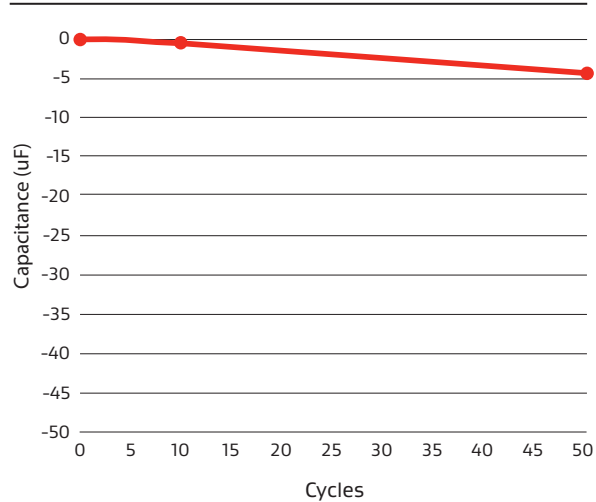


Inquire with Gore for more details

## Thermal Cycle Testing

In addition to endurance testing at steady-state maximum rated conditions, GORE Capacitors have been tested through thermal cycling. Thermal cycle testing held capacitors at -40°C for an hour followed by an 8°C/minute ramp to 200°C where the capacitors were held for 8 hours. Results are found to be similar to endurance testing at steady state conditions, indicating that thermal cycling does not cause accelerated degradation.

### Thermal Cycle Testing (-40 to 200°C; 1 hour/8 hour dwells; 8°C/min) ramprate



## Qualification Testing

GORE Capacitors successfully passed oilfield service company protocols with significantly higher shock and vibration (500 – 750G). The results of additional testing are below.

Examination or Test	Specification or Examination/Test Conditions	Status
Insulation Resistance (DWV)	MIL-STD 202G, Method 301 (1200 VDC)	Pass
Thermal Cycling	MIL-STD 883J, Modified Condition D (-55°C–200°C)	Pass
Mechanical Shock	MIL-STD 202G, Method 213, Test Condition I20–30	Pass
Vibration	MIL-STD 202G, Method 204D, Test Condition D (20 g Peak)	Pass
Lead Pull	MIL-STD 202G, Method 211A, Test Condition A (5 lbf)	Pass

Pass = No visual defects or electrical failures (eg., capacitance and ESR) observed.

## Portfolio

The following table offers dimensional guidance on standard configurations of GORE Capacitors.

### Parts Rated for 600 VDC at 200°C

Capacitance (μF)	Gore Part Number	Maximum Outer Diameter (mm)	Maximum Overall Length (mm)	Typical ESR (mΩ)	Resonant Frequency (kHz)
1	10879459	14.1	34.0	20	> 1500
8	10980617	37.0	40.0	3	> 750
13.5	10998244	39.0	40.0	4	> 400
33	10778286	37.0	100.0	10	> 160
50	10771618	41.0	95.0	5	> 140

### Parts Rated for 400 VDC at 200°C

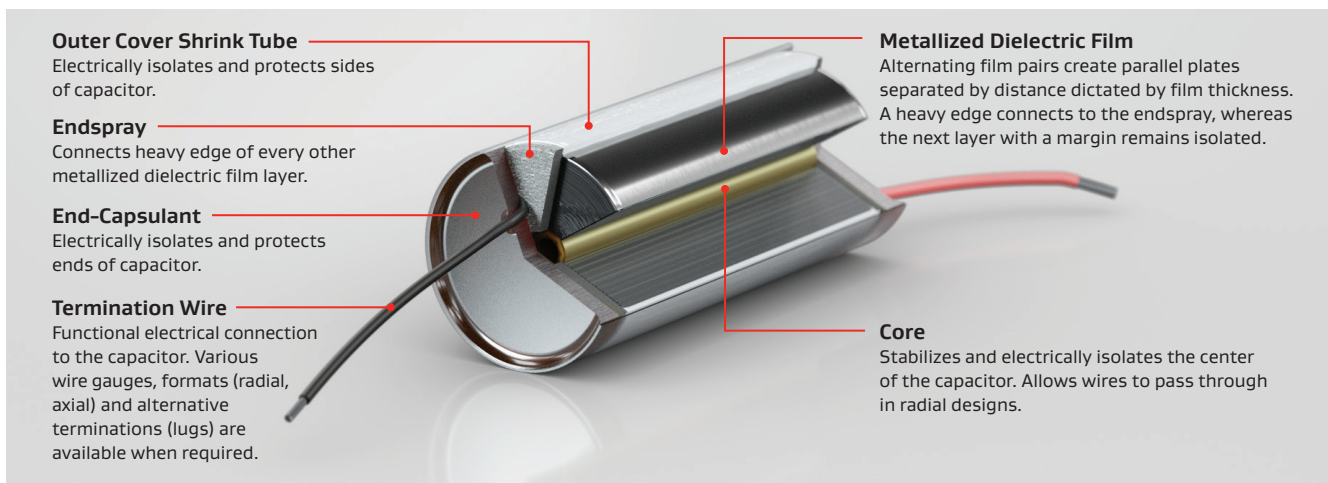
Capacitance (μF)	Gore Part Number	Maximum Outer Diameter (mm)	Maximum Overall Length (mm)	Typical ESR (mΩ)	Resonant Frequency (kHz)
1	10998242	26.0	40.0	6	> 700
13.5	10998241	27.0	40.0	5	> 450
33	10986859	28.0	100.0	23	> 140
50	10998237	31.0	100.0	12	> 120

Electrical parameters are based on capacitor sections.

Terminated wire length and configuration impact final device characteristics. (ESR, ESL, Resonance)

Custom configurations are possible. Please contact Gore to discuss your specific application requirements.

### Film Capacitor Construction



**NOTICE — USE RESTRICTIONS APPLY.** Not for use in food, drug, cosmetic or medical device manufacturing, processing, or packaging operations.

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