

## resistors

special resistor technologies including high precision, high temperature and high frequency





### AMS Technologies – where technologies meet solutions

AMS Technologies is a leading solution provider and distributor of high-tech, leading-edge components, systems and equipment, with more than 35 years of experience to date and currently serving more than 2000 European customers.

for Optical Technology, Thermal Management and Power Technology fields, with access to and long standing relationships with the most advanced manufacturers in each of those fields. Drawing extensively on our experience in each of these differing technologies, and coupling this with our broad system-level competence, we are able to offer seamless and comprehensive solutions incorporating complementary aspects from all three key technology fields.

With an appropriate technical education, an element of Germany. entrepreneurial spirit and many years of design and consultancy expertise, our sales engineers can rapidly comprehend system requirements and provide you the customer with a solution that goes way beyond a simple understanding of our product datasheets. We take active involvement in the design cycle, defining and re-defining your specifications, and leading in many cases to highly specific, customized products and solutions.

Helping you to effectively outsource your production line, we can even provide you with the necessary leading turnkey contract manufacturing services in our key competency fields.

AMS Technologies has been delivering solutions into a variety We are the specialists in both components and complete solutions of high-tech markets, including renewable energies, medical, defence & aerospace, research & scientific and various other industrial segments. Our customer base consists of Europe's largest leading technology corporations, a network of universities and research institutes as well as the most promising start-ups.

> We thrive by working in a 'customer first' environment. Our pan-European customers are serviced from a network of local offices in Germany, the UK, France, Italy, Spain, Poland and Sweden, with a focused operations and logistics centre located in Munich,

> Our commitment: Identifying the best solution for your project enabling you to become your customers' first choice!

Your AMS Technologies team

### resistors

Our broad product portfolio features special resistor technologies with extremely low inductance, rated for very high power (up to 100 kW), high voltage (up to 48 kV) or high temperature (up to +275 °C), variants for RF applications into the GHz domain, as well as components featuring extreme long-term stability (up to 0.01% per 1,000 hours in extended load life) or ultra-low temperature coefficients (as low as 2 ppm/°C). Packages range from surface-mount versions all the way to 1-m-long watercooled high load resistors with 10 cm in diameter.





### axial and radial lead resistors / general purpose resistors up to 100 W

Our power film resistors are available with extremely low inductance, as well as high voltage and high temperature ratings. They are suitable for the most demanding applications. Resistance values range from 0.005  $\Omega$  to 30 M $\Omega$ , ideal for applications from current sensing to high voltage.

Whether axial leaded types with power ratings up to 22 W, or resistors in heat sink mountable T0-126, T0-220 and T0-247 style power package configurations – these components remain reliable in all situations.

### axial and radial lead resistors / high precision resistors

AMS Technologies makes use of Caddock Electronic's proven Tetrinox® and Micronox® resistance systems to meet the longture coefficient requirements of high accuracy, high voltage systems such as TWT power supplies, electron microscopes,

X-ray systems, high-resolution CRT displays and geophysical instruments. These resistors achieve low temperature coefterm stability, precision tolerance as well as tight tempera-ficients of typically 25 ppm/°C to 200 ppm/°C, with some ranges featuring even 2 ppm/°C.

### axial and radial connection resistors / HF resistors

AMS Technologies supplies a comprehensive range of resistors for use at high frequencies as well as high power levels. Whether compact brazed resistors or large non-reactive cer-

met resistors cooled by air, water or oil - our HF resistors are suitable for frequencies well up into the GHz domain, with power ratings from a few Watts all the way to 100 kW.

### SMT resistors / general purpose resistors up to 25 W

Surface mount technology and high power is not necessarily 0.020  $\Omega$  to 1.00 k $\Omega$  and is specified for up to 25 W at +25 a contradiction: Our MP725 family of power film resistors in the D-PAK style surface mount package with its electrically isolated metal tab, features resistance values ranging from

°C. Due to their "non inductive" design, these resistors are ideal for power switching circuits, snubbers or high frequency communications.

### SMT resistors / high precision resistors

AMS Technologies low-resistance precision chip resistors are ideal for current sense tasks in hybrid and SMT applications. They employ technologies like Caddock Electronic's Micro $nox^{\odot}$  resistance film to achieve values down to 0.01  $\Omega$ .

And our high-resistance precision chip resistors are available with values from 10 M $\Omega$  to 100 M $\Omega$ , ideally suited for extremely low signal detection and amplification circuits.

### resistor networks & voltage dividers

Ratio tolerance and ratio performance are key for resistor networks and voltage dividers, Caddock Tetrinox® and Micronox® resistance films enable the necessary ratio performance and stability over time and temperature to be achieved in our precision resistor networks and voltage dividers. For range

switching applications we offer precision 3, 4 and 5 - decade voltage dividers with ratios from 10:1 to 10000:1. Resistance values from 0.5  $\Omega$  to 200 M $\Omega$  are available with ratio tolerance values as low as 0.01 % and ratio temperature coefficients down to 2 ppm/°C for voltage ratings up to 20 kV.







# axial and radial lead resistors – general purpose resistors up to 100 W

Model	Package	Min. Resistance	Max. Resistance	Power Rating	Max. Voltage	Thermal Resistance	Max. Temp.	Comments
MP9xx	T0-126 (-220,-247) Style	0.010 Ω	100 kΩ	15 W to 100 W	200 V to 500 V	1.5 °C/W to 8.33 °C/W	+150 °C	Ceramic mounting surface
MP8xx	T0-220 (-126) Style	0.020 Ω	10.0 kΩ	20 W to 50 W	300 V	2.50 °C/W to 7.50 °/W	+150 °C to +175 °C	Metal mounting tab / Integrated metal mounting surface in molded package
MP2060	TO-220 Style	0.005 Ω	1.00 kΩ	18 W to 60 W	Current Limited / 250 V <sub>rms</sub>	2.08 °C/W to 6.94 °C/W	+150 °C	Electrically isolated case for clip mounting
MS1xx	Ceramic Core, Ni Alloy Endcaps	20 Ω	5 ΜΩ	0.25 W to 0.75 W	200 V to 500 V	_	+275 °C	Power Film Resistors, High Temperature, Non-Inductive
MS2xx	Ceramic Core, Ni Alloy Endcaps	20 Ω	15 ΜΩ	1.0 W to 8.0 W	500 V to 2,000 V	_	+275 °C	Power Film Resistors, High Temperature, Non-Inductive
MS3xx	Ceramic Core, Ni Alloy Endcaps	45 Ω	30 MΩ	10.0 W to 22.0 W	4,500 V to 6,000 V	_	+275 °C	Power Film Resistors, High Temperature, Non-Inductive

## axial and radial lead resistors - high precision resistors

Model	Package	Min. Resistance	Max. Resistace	Power Rating	Max. Voltage	Max. Temp.	Comments
MG6xx	High Temperature Silicone Encapsulation	200 Ω	20 MΩ	0.5 W to 0.8 W	600 V to 2,000V	+225 °C	Precision, High Voltage
MG7xx	High Temperature Silicone Encapsulation	200 Ω	5,000 ΜΩ	0.6 W to 8.0 W	1,000 V to 20,000 V	+225 °C	Precision, High Voltage
MG81x	High Temperature Silicone Encapsulation	1 kΩ	10,000 MΩ	10.0 W 15.0 W	25,000 V to 30,000 V	+225 °C	Precision, High Voltage
MX4xx	High Temperature Silicone Coating	1 ΜΩ	1,000 ΜΩ	2.0 W to 10.0 W	7,500 V to 32,000 V	+175 °C	Precision, High Voltage
MX51x	High Temperature Silicone Coating	5 ΜΩ	2,000 ΜΩ	12.5 W to 15.0 W	40,000 V to 48,000 V	+175 °C	Precision, High Voltage
SR10	Kelvin Terminals (Four Wire)	0.008 Ω	1.00 Ω	1.0 W	Power Limited	+150 °C	Current Sense Resistors
SR20	Kelvin Terminals (Four Wire)	0.005 Ω	1.00 Ω	2.0 W	Power Limited	+150 °C	Current Sense Resistors
USF2xx	Aluminium Oxide Ceramic Sandwich	50 Ω	10 ΜΩ	0.33 W to 0.75 W	300 V to 2,500 V	+85 °C	Ultra-Stable, Low TC, Ultra-Precision
USF3xx	Aluminium Oxide Ceramic Sandwich	50 Ω	25 ΜΩ	0.33 W to 0.75 W	300 V to 2,500 V	+85 °C	Ultra-Stable, Low TC, Ultra-Precision
USG11xx	High Temperature Silicone Encapsulation	50 MΩ	200 ΜΩ	-	5,000 V to 15,000 V	+85 °C	Precise, Low TC, Voltage Division
TG9xx	High Temperature Silicone Encapsulation	1 ΜΩ	400 MΩ	1.0 W to 4.0 W	4,000 V to 20,000 V	+225 °C	Precision, Low TC, High Voltage
TG101x	High Temperature Silicone Encapsulation	5 ΜΩ	1,000 ΜΩ	5.0 W to 6.0 W	25,000 V to 30,000 V	+225 °C	Precision, Low TC, High Voltage

## axial and radial connection resistors – high frequency resistors

Model	Package	Min. Resistance	Max. Resistace	Power Rating	Max. Temp.	Frequency	Capacitance	Comments
A PFS x	Forced Water Cooled, Ø 0.5" to 1.1", Length 5" to 34"	1 Ω	20 ΜΩ	5,000 W to 100,000 W	+90 °C	_	_	Substrate: Alumina
A1 PFS x	Internal Water Cooled, Ø 0.5" to 1", Length 5" to 10"	1 Ω	20 ΜΩ	325 W to 1,200 W	+100 °C	_	_	Convenient Hose Connections
CP PFS x	Air Cooled, Ø 0.5" to 2", Length 1.75" to 24"	1 Ω	20 ΜΩ	10 W to 1,000 W	+350 °C	_	_	Platinum/Silver Terminals
0 PFS x	Oil Cooled, Ø 0.5" to 0.625", Length 10" to 17.25"	1 Ω	20 ΜΩ	50 W/in <sup>2</sup>	+250 °C	_	_	
1 Series	Brazed Resistors, Flanged, Package Styles: A, B(B), E, F, J, U, VF, VH, Y	1 Ω	1 kΩ	20 W to 250 W	+250 °C	2 GHz to 6 GHz	0.75 pF to 4.50 pF	Substrate: BeO, Resistive Element: Thin Film / Thick Film
1 361163	Brazed Resistors, Tab, Package Styles: L, M, Q, UU, VV	50 Ω	100 Ω	30 W to 300 W	+250 °C	2 GHz to 6 GHz	0.75 pF to 2.50 pF	Substrate: BeO, Resistive Element: Thin Film
S1 Series	Soldered Resistors, Flanged, Package Styles: A, B(B), E, F, J, U, VF, VH, Y	1 Ω	1,6 kΩ	10 W to 250 W	+180 °C	2 GHz to 6 GHz	0.75 pF to 4.50 pF	Substrate: BeO/AIN, Resistive Element: Thick Film
31 361163	Soldered Resistors, Tab, Package Styles: L, M, Q, UU, W	50 Ω	100 Ω	30 W to 300 W	+180 °C	2 GHz to 4 GHz	0.75 pF to 2.50 pF	Substrate: BeO/AIN, Resistive Element: Thick Film
2 Series	Brazed Attenuators, Flanged, Package Styles: A, E, J, JZ, Y, Z	Attenuation: 1 dB	Attenuation: 30 dB	20 W to 250 W	+250 °C	1 GHz to 6 GHz	_	Substrate: BeO, Resistive Material: Thin Film
2 361168	Brazed Attenuators, Tab, Package Styles: L, Q, ZZ	Attenuation: 1 dB	Attenuation: 30 dB	40 W to 250 W	+250 °C	2 GHz to 4 GHz	_	Substrate: BeO, Resistive Material: NiChrome
3 Series	Brazed Terminations, Flanged, Package Styles: C, CL, CR, D, DD, G, H, K, UC, UL, UR, VF, VL, VR	50 Ω	100 Ω	20 W to 250 W	+250 °C	2 GHz to 4 GHz	2.0 pF to 6.0 pF	Substrate: BeO, Resistive Element: Thin Film
	Brazed Terminations, Tab, Package Styles: N, P, R, UU, VV	50 Ω	50 Ω	30 W to 300 W	+250 °C	2 GHz to 6 GHz	_	Substrate: BeO, Resistive Element: Thin Film
S3 Series	Soldered Terminations, Flanged, Package Styles: C, CL, CR, D, DD, G, H, K, T, UC, UL, UR, VF, VL, VR	50 Ω	100 Ω	20 W to 500 W	500 V to 2,000 V	2 GHz to 4 GHz	2.0 pF to 6.0 pF	Substrate: BeO/AIN, Resistive Element: Thick Film
	Soldered Terminations, Tab, Package Styles: N, P, R, UU, W	50 Ω	50 Ω	30 W to 300 W	_	2 GHz to 4 GHz	_	Substrate: BeO/AIN, Resistive Element: Thin Film /Thick Film



# surface mount resistors – general purpose resistors up to 25 W



Model	Package	Min. Resistance	Max. Resistance	Power Rating	Max. Voltage	Thermal Resistance	Max. Temp.	Comments
MP725	D-Pak Style SMT	0.020 Ω	1.00 kΩ	25 W	200 V	_	_	Metal tab assists in post surface mount soldering inspections

### surface mount resistors – high precision resistors

Model	Package	Min. Resistance	Max. Resistance	Power Rating	Max. Voltage	Thermal Resistance	Max. Temp.	Comments
CCxxxxFC	Flip Chip for SMT Applications, Solder Coated Pads	0.010 Ω	10.0 Ω	0.75 W to 1.5 W	_	11.5 °C/W to 22.7 °C/W	+150 °C	Low Resistance, Precision, Chip Resistors
CC2xxxWB	Wire (Al) Bond for Hybrid Applications	0.020 Ω	10.0 Ω	_	_	8.33 °C/W to 13.9 °C/W	+150 °C	Low Resistance, Precision, Chip Resistors
CDxxxxFC	Flip Chip for SMT Applications, Solderable Pedestal	0.010 Ω	0.20 Ω	1.0 W to 1.5 W	_	9.0 °C/W to 12.0 °C/W	+150 °C	Low Resistance, Precision, Chip Resistors
CD2xxxWBA	Wire (Al) Bond for Hybrid Applications	0.010 Ω	0.20 Ω	_	_	5.00 °C/W to 8.33 °C/W	+150 °C	Low Resistance, Precision, Chip Resistors
CHR2520FC	Flip Chip for SMT Applications, Solderable Pads	10 ΜΩ	100 MΩ	_	150 V	_	+85 °C	High Resistance, Precision, Chip Resistors

## surface mount resistors — high frequency resistors

Model	Package	Min. Resistance	Max. Resistance	Power Rating	Max. Voltage	Thermal Resistance	Max. Temp.	Comments
R Series	Chip Resistors & Terminations, Package Styles: R, RS, RW	2 Ω	1 kΩ	1 W to 250 W	_	_	_	Substrate: BeO/AIN, Resistive Element: Thin Film / Thick Film
T Series	Chip Resistors & Terminations, Package Styles: T, TW	2 Ω	1 kΩ	20 W to 250 W	_	_	_	Substrate: BeO/AIN, Resistive Element: Thick Film
A Series	Chip Attenuators, Package Style: A	Attenuation: 1 dB	Attenuation: 30 dB	1 W to 300 W	_	_	+150 °C	Substrate: Alumina, AIN, BeO, Resistive Element: Thin Film / Thick Film

## resistor networks & voltage dividers

Model	Туре	Comments
T912 / T914	Precision Networks with Low Ratio TC	Two resistor and four resistor networks with precise ratio performance, ratio tolerance from 0.1% to 0.01%, Ratio TC 10ppm/°C to 2 ppm/°C
1776	Precision Decade Resistor Voltage Dividers	39 models up to 1,200 V, voltage division of 10,000:1, 1,000:1, 100:1, 10:1, ratio tol. 0.5% to 0.02%, ratio TC 50 ppm/°C to 5 ppm/°C
1787	Precision Current Sense Resistor Networks	3- and 4-step current sense resistor networks for current sensing in multi-range instrumentation, absolute tolerance of 0.25% to 0.05%
T1794	Custom Low Ratio TC, Precision SIP Resistor Networks	Ratio TC to 5 ppm/°C, ratio tolerance to 0.01%, resistance range from 500 $\Omega$ to 50 $M\Omega$
1789	Custom Low Resistance, Precision SIP Resistor Networks	Ratio TC to 15 ppm/°C, ratio tolerance to 0.05%, resistance range from 0.5 $\Omega$ to 10 $k\Omega$
THV	Precision High Voltage Divider Networks	Ratio temperature coefficient to 10 ppm/°C from -55°C to +125°C, ratio tolerance to 0.25% at 10 kVDC, 15 kVDC or 20 kVDC
HVD	Ultra-Precision Voltage Divider Networks	Up to 5 kVDC, ratio temperature coefficient 5 ppm/°C from -40°C to +85°C, ratio tol. of 0.05%
USVD	Ultra-Precision Voltage Divider Networks	Up to 2 kVDC, ratio temperature coefficient 2 ppm/°C from -40°C to +85°C, ratio tol. to 0.01%





### associated products

### temperature sensors



Accurate and fast temperature sensors are essential for precision temperature control. Amongst the different types of temperature sensors, thermistors provide very high sensitivity, small size and appropriate speed.

AMS Technologies' extensive range of NTC thermistor temperature sensor probes with base resistance values from 5 k $\Omega$  to 231.5 k $\Omega$  include various types ranging from ultraminiature bare bead, epoxy coated and pipe versions (polyimide, brass, brass nickel, stainless steel – threaded and unthreaded) to flange mount and plate models. Sizes range from 0.5 mm to 6.5 cm with Teflon coated lead lengths from 5 cm to 45 cm.

### ceramic capacitors



Designed for HF and high voltage operation and with a very broad capacitance range, AMS Technologies' ceramic capacitors cater to all applications from antenna matching units to high voltage testing systems.

Our product portfolio includes many different package forms, including the classical disc capacitor as well as the standard hockey puck package style (standard designs used frequently in antenna matching units as part of an active circuit that matches the RF generator to the load), with the extra subassemblies of daisy chain and ferris wheels. For high power applications there are also water-cooled ceramic capacitors rated to 4,000 kVA.

### filter capacitors



Filter capacitors are used in numerous applications, such as for maintaining power quality, in pulse forming networks, for snubbers and for filtering of output power. They are available in a wide range of sizes,

package styles and power capabilities and encompass a voltage range spanning 16 V to 100 kV. By utilizing various dielectric systems such as electrolytic or polypropylene, and with a capacitance ranging from nanofarads up to millifarads, AMS Technologies can provide the right capacitor for most applications.

## capacitors for high energy storage, pulse discharge



These capacitors are an energy storage device. Many applications demand an energy storage device that is slowly charged but then discharged in a very short period of time (down to less than milliseconds), thus

generating a pulse of electrical energy – like these capacitors. AMS Technologies can provide numerous solutions for your discharge capacitor needs, including commercially-priced products, variants with extreme high energy density, self-healing capabilities or very special shapes and designs. Custom designed capacitors tailored to your project's requirements are also available on request.

### high frequency capacitors



Specialised capacitors for RF use are available in many different variations (such as ceramic or evacuated) to match various applications. AMS Technologies has almost 30 years of experience in consulting and helping our

customers to find the correct fixed or variable capacitor to suit their specific needs. Our ceramic disc and hockey puck HF capacitors use different ceramics, such as NPO, N750 and N3300, to yield specific characteristics (for example temperature coefficient). Our vaccum and gas filled capacitors (fixed and variable) are predominately used in antenna matching units, for applications like plasma generators, RF generators and for high power communication systems.

### hi-rel components



AMS Technologies provides a unique range of solid body, current limiting fuses as well as high reliability ferrite chip beads for demanding and mission critical applications such as in aerospace, space and mis-

sile systems. Our Hi-Rel fuses feature consistent minimum and maximum clear-times at overload currents regardless of vacuum conditions. Their solid body construction does not outgas (therefore not subject to de-rating factors of Mil-Std-975) and can withstand heavy vibration and shock exposure without damage. And the Hi-Rel ferrite chip beads are intended for high reliability use where replacement is not an option.

### relays



Different types of relays are used extensively in high frequency and high voltage applications. AMS Technologies provides a comprehensive range of unique relays to cover most high frequency applications,

whether fast switching RF relays for portable communication systems, or high power relays for switching high power RF on and off. In high voltage systems, using vacuum or certain gases as the dielectric in switches is a very effective way to inhibit breakdowns across the contacts. AMS Technologies can provide its customers with compact relays suitable for high voltages and currents.

### wound components



AMS Technologies' portfolio of wound components includes inductors, transformers, chokes and coils for industrial and commercial use. Using state of the art windings, AMS offers a range of cost-effective

wound components either as a standard product or custom made. Our inductors are available in axial, radial, toroidal and common mode variants, with high current capability and cores made of a choice of high flux density ferrite and iron powder material. Further features are good efficiency due to high Q-values, tolerances down to  $\pm 1\%$ , stable cores also at high frequencies and high saturation flux densities at high temperatures.





### associated products

### Rogowski coils



The basic function of a Rogowski coil is to measure a current through a conductor placed within the coil and to reproduce the current fluctuations via the induced voltage. A selection of flexible "rope" coils provides an easy

method of measuring fluctuating currents from Hz to MHz range without saturation. This is achieved through a non-contact loop that does not interrupt the power or place additional power consumption to the line being measured. The coil opens at the connector junction and can be installed on an existing cable or bus-bar in a matter of seconds – ideal for retro-fit installations. Custom length, output, and other parameters are available.

### current transformers



Used to very accurately measure DC, AC and pulsed currents at very high levels, AMS' current transformers are suitable for many applications such as plasma research, laser technology, semiconductor gate

switching and power harmonics analysis. They use a non-destructive and non-contact technology and can be employed to measure currents from µA up to kA over a frequency range of DC to 500MHz and beyond. The output signal of the transformer gives an accurate voltage waveform representation for an oscilloscope or spectrum analyser. The devices are available with various diameters, to provide the user with the correct device depending on the outside diameter of the cable to be measured.

### heat sinks

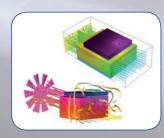


Selection, design and production of high performance heat sinks is a challenging task. Not only surface area, but factors such as efficiency of heat transfer in the vicinity of the heat source and pres-

sure drop need to be considered. For both our high performance aluminium extrusions and copper brazed heat sinks, thermal performance curves for different component sizes and pressure drop are on hand.

more than 240 thermal design reports produced by AMS Technologies. Most studies are based on numerical calculations with computational fluid dynamics (CFD), although many studies are also based on empirical tests generated in close cooperation with

### thermal design services



Optimised cooling solutions require thermal design expertise, engineering resources and access to the manufacturers' technologies. In the past years, many customers have received their solutions in

more than 240 thermal design reports produced by AMS Technologies. Most studies are based on numerical calculations with computational fluid dynamics (CFD), although many studies are also based on empirical tests generated in close cooperation with our manufacturing partners. AMS Technologies engineers will conceive and develop your optimised solutions and supply comprehensive documentation. We and our partner companies utilise analytical, numerical and empirical methods in order to ensure most accurate prediction of performance.

### from technology components to turnkey solutions

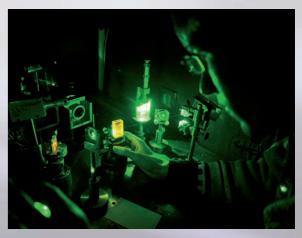
We want to accelerate your success, which is why AMS Technologies has invested in two design centers:

- Our design center for thermal management and electronics in Krakow, Poland, supports your ideas with design services like CAD, schematics, PCB design & layout, CFD simulation, prototyping and test.
- Our design center and cleanroom for optical technology in Daventry, United Kingdom is well positioned for your projects in the optical domain, with design services like CAD, CAE, characterisation, prototyping, simulation or test. With a dedicated class 8 cleanroom and an ESD protected area, we design your optical technology solution for you.

Our goal is to augment your team's key competencies by providing engineering services that are not core to you or where you may struggle with available resources to finish your projects. From design services to prototype development to complete turn-key solutions, our collaborative approach has already helped many customer projects to move from concept to production. With our manufacturing facilities in Skawina, Poland, we are also prepared to build your thermal, power or optical solution for you.

- Design, prototyping and "proof of concept"
- Development of turnkey solutions to the customer's order
- Design-in, systems integration, realization of entire design projects
- Development of customized specification sheets
- Effective project management of any product development
- Interdisciplinary system-level integrated design
- Appropriate subcontractor selection and production support
- Simulations and modeling of system-level designs
- Installation, training and servicing

















# enabling your ideas.

Optical, Power and Thermal Management Technologies

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