Sfernice Division

March 9 – 12, 2026

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Sfernice Division Introduction

Division Presentation, Markets and Technology Focus

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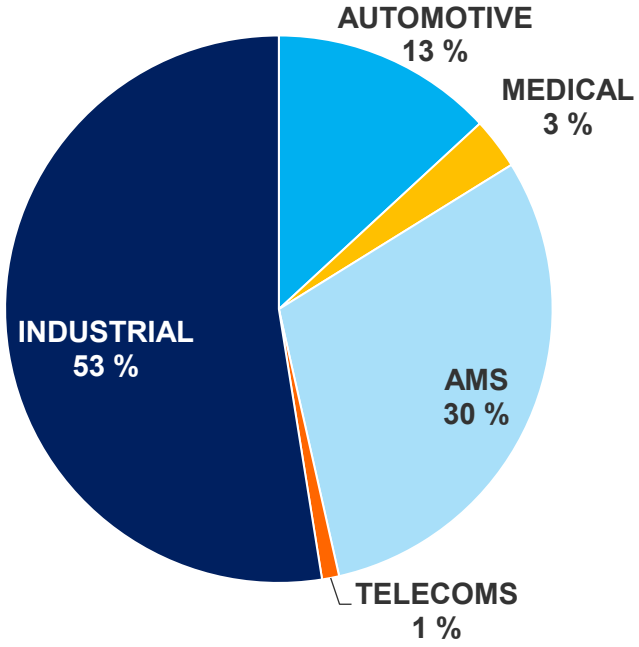
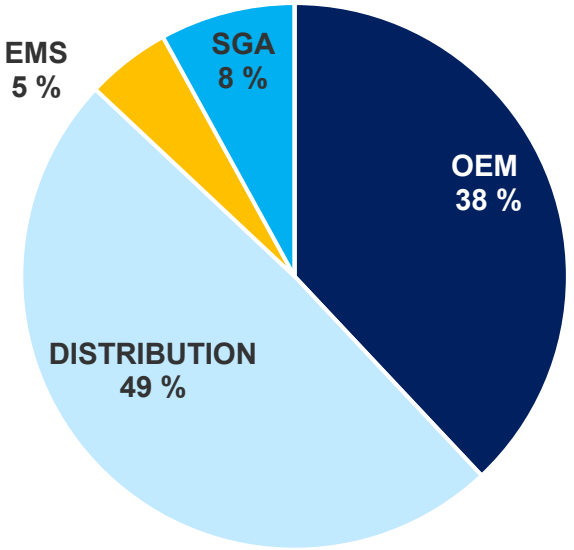
Sfernice Division at a Glance

- **Sales 2025: $163M**
- **1300 employees**
- **Headquartered in Nice, France**

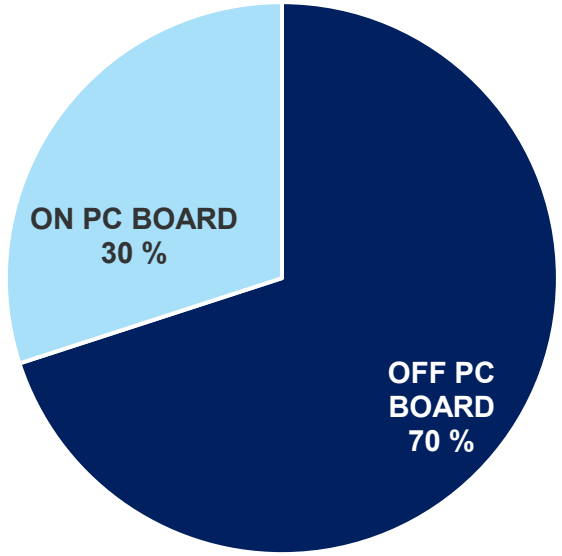
END MARKETS



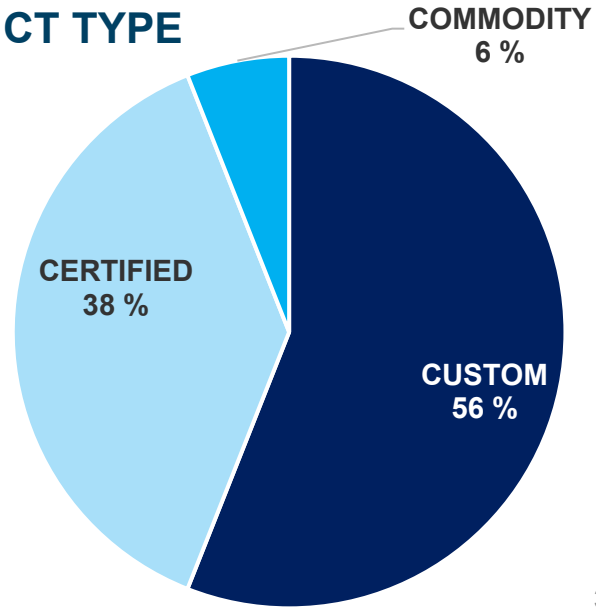
SALES CHANNELS



MOUNTING TYPE

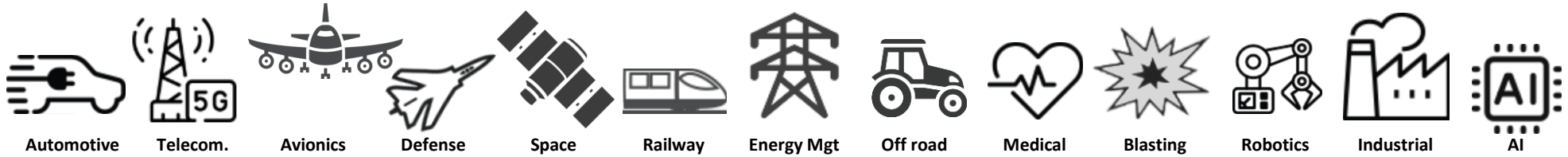


PRODUCT TYPE



Markets and Technology focus

Major position
Minor position



	Automotive	Telecom.	Avionics	Defense	Space	Railway	Energy Mgt	Off road	Medical	Blasting	Robotics	Industrial	AI
Power Thick Film	●		○	○		●	●		○			○	○
Wirewound	○		○	○		●	●		○			●	
Thin Film	○	○	●	●	●				○	○		○	○
RF Thick film		●	○	●	○				●			●	○
Braking Resistors						●	○	●				○	
Position Sensors		○	●	●	○	○		●	○		○	○	
Trimmers & Pots			●	●				●	○			○	
Igniters										●			
Inductives			●	●	○								
Fuses	○											○	

Portfolio Overview, Roadmap, Focus Products

Portfolio Overview, Product Development Roadmap, Americas Growth Strategy

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Sfernice Portfolio Overview

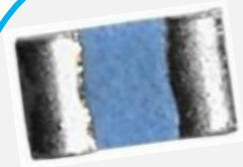
> 82 000 references

FIXED RESISTORS


Power Thick film

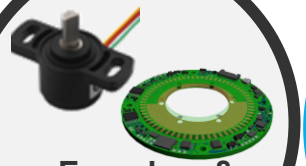
High Frequency


Wirewound

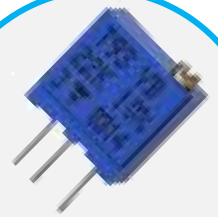

High Precision (Thin Film)


High Power Resistors (Metal Plate)

VARIABLE RESISTORS

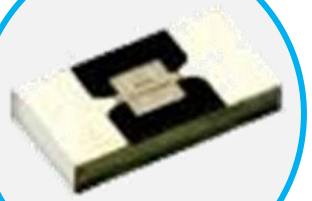

Encoders & Position Sensors


Panel Potentiometers


Trimmers


Knobs

OTHERS


Ignitors

Inductives

Fuses

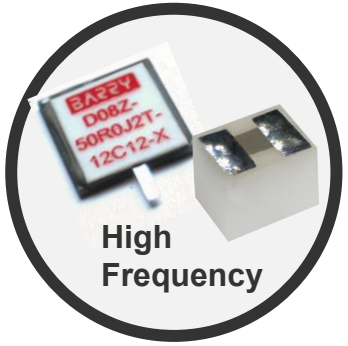
Sfernice products are known for their HIGH RELIABILITY & HIGH PERFORMANCE

Sfernice Portfolio Focus

Americas Select Products

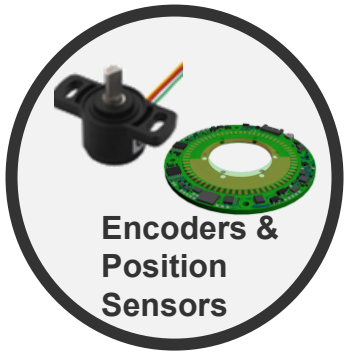
FIXED RESISTORS

Power Thick film



High Frequency

VARIABLE RESISTORS



Encoders & Position Sensors

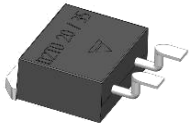
Sfernice products are known for their HIGH RELIABILITY & HIGH PERFORMANCE

Market Needs – Product Development 2026

HIGHER POWER

TFCA

RCEC2000



D2TO 35
Reverse Soldering

HIGHER VOLTAGE

D3TO

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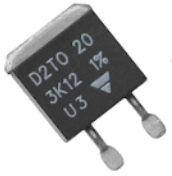
HIGHER INTEGRATION

RPWA

ISOA MR

POWER
THICK FILM

LOWER COST



D2TL

Market Needs – Product Development 2026

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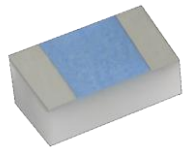
HIGH FREQUENCY

LOWER COST

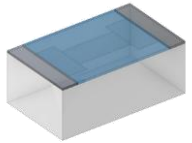
B-CR

B-TR

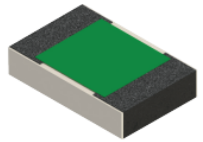


CHW

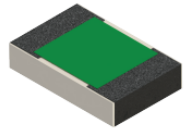
HIGHER POWER



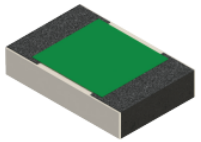
CHEP0402/0603



B-RD

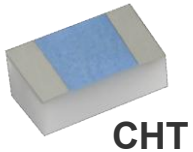


B-HR



B-RP

HIGHER PERFORMANCE



CHT

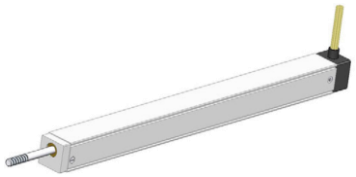
HIGHER INTEGRATION

WLKN-001

Market Needs – Product Development 2026

Focus on Inductive Technology and Wireless Communication

HIGHER PERFORMANCE



LAIE12

LAIE 115

LOWER COST

RAIK045 MP

RAIK040

COMMUNICATION

WLMO

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ENCODERS & POSITION SENSORS

Americas Marketing Growth Strategy

- Focus on high potential markets and products:

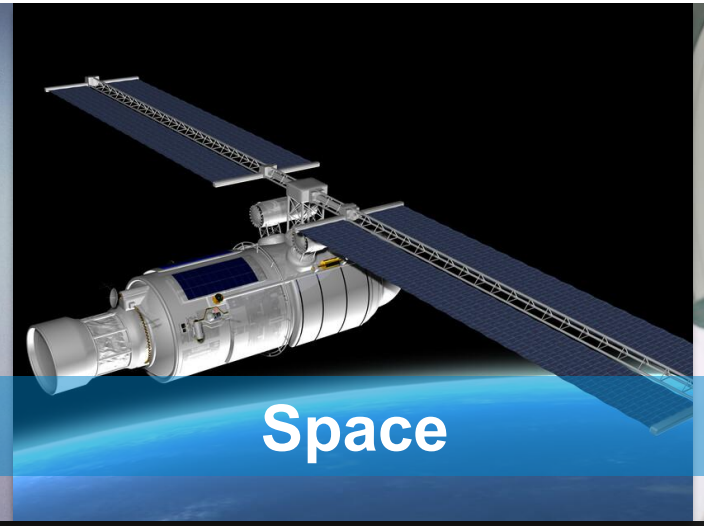
Power Thick Film Resistors

High Frequency Products

Power Thick Film Resistors

Americas Marketing Growth Strategy

- Intensify custom product development for our core markets to capture all opportunities:



All product lines

Americas Marketing Growth Strategy

- Find the next growth drivers:

Encoders and Position Sensors, High Frequency Products, Power Resistors

Capacity Investments to Support Growth

Sfernice Industrial Strategy

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Sfernice Industrial Strategy

1

Focus on fast-growing applications

with innovative and competitive technologies, capacity increases, and automation for power thick film and thin film

2

Pursue industrial expansion and optimize our current industrial floor space,

relying on the Vishay campus, subcontracting, or remote workshops in Mexico and Asia

3

Pursue our cost-saving efforts on all our products,

including design to cost and cost reduction projects to support customer demand

4

Protect our positions on legacy products

through continued efforts in product customization and

Long term aerospace and defense programs

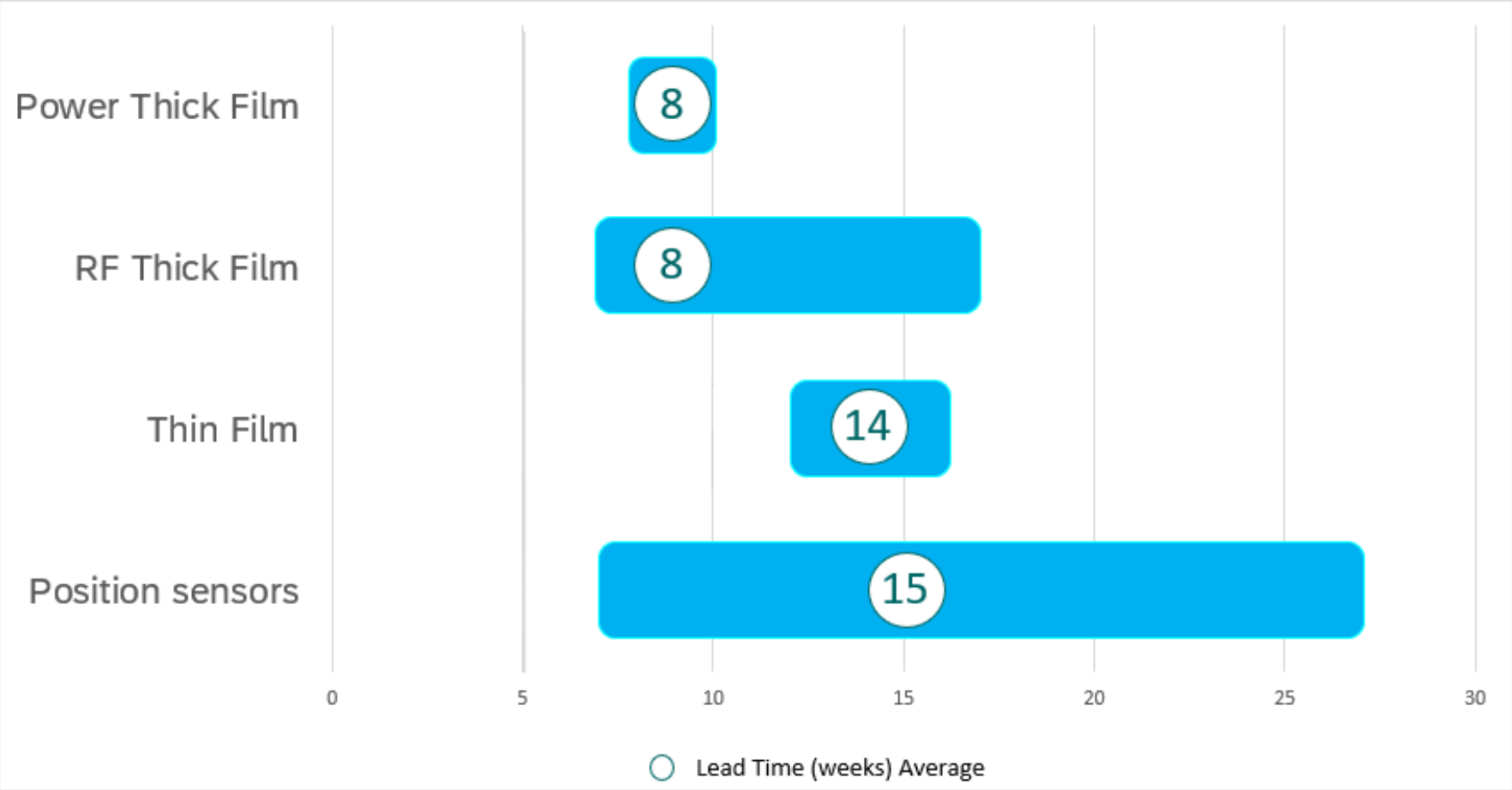
5

Push operational excellence

by continuing to improve our quality and service performance, and by implementing new tools (data science & AI)

Capacity – Lead times

- No capacity issues. Lead times back to normal



Value Proposition – Technology and Commercial

Power Thick Film Resistors, High Frequency Products, Encoders, and Position Sensors

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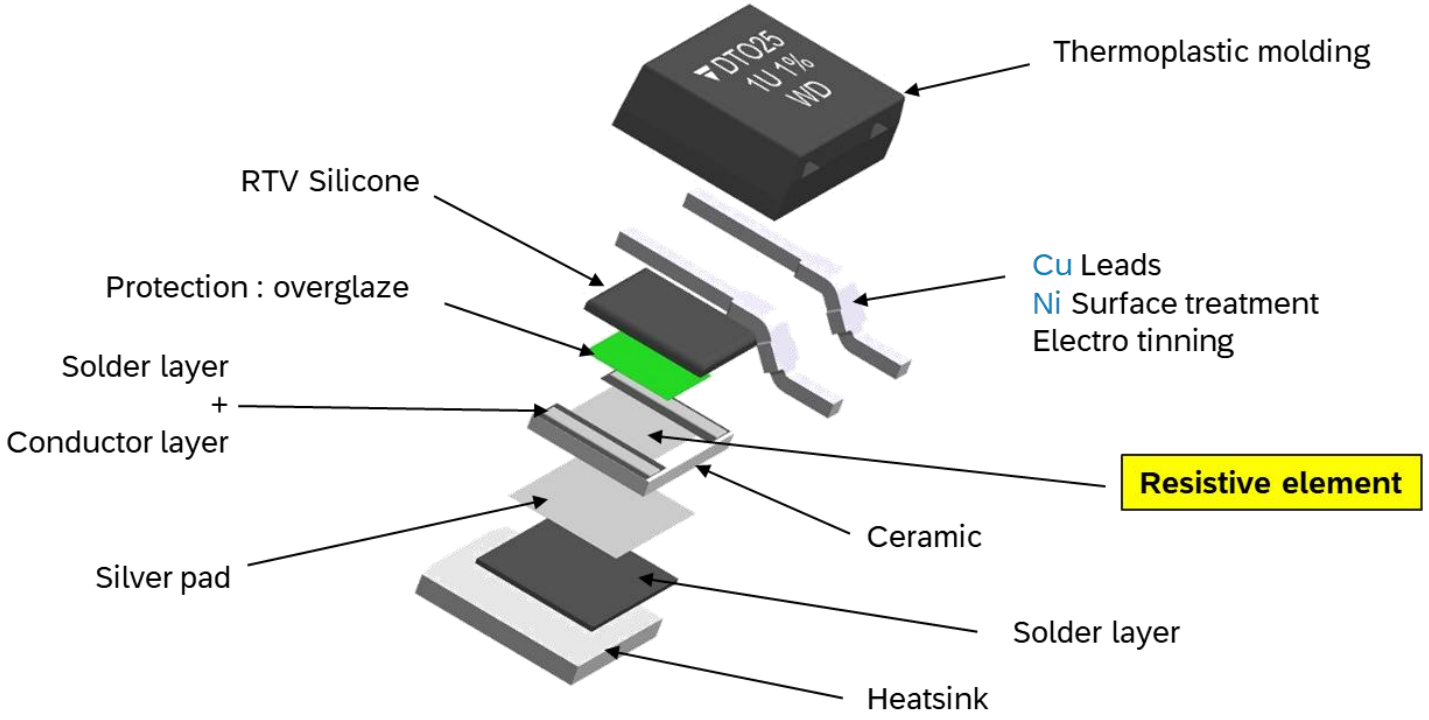
Power Thick Film Resistors

Technology and Portfolio Presentation

Power Thick Film Resistors



Screen Printing Process

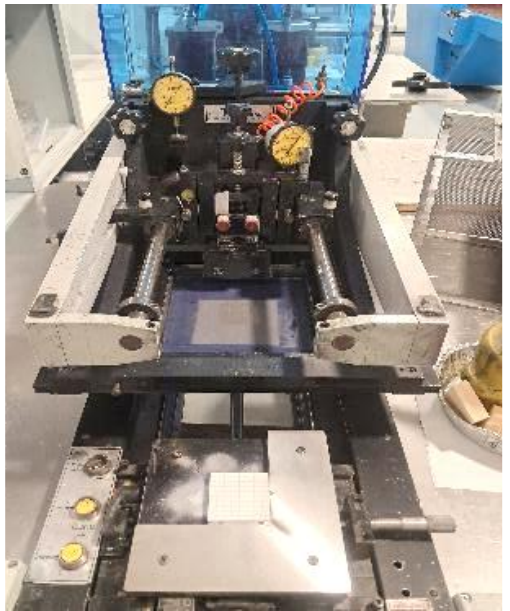
Deposition of a **resistive element** onto a ceramic substrate.

What are Power Resistors?

Power resistors are resistors designed to resist and dissipate substantial amounts of power and / or energy.

They are typically used in:

- Power supplies
- Power conversion circuits



Power Thick Film Resistors
Selection by Added Value

MOUNTING

POWER

ENERGY

VOLTAGE

OPTION TYPE

Portfolio Overview – Medium Power

DTO, D2TO, and LTO series

Features

- **SMD** (DTO / D2TO) or **through-hole** (LTO)
- **Power**: 20 W - 35 W to 150 W
- **Energy**: from 8.81 J to 75 J @100 ms
- **Voltage**: 500 V
- **Dielectric strength**: up to 2000 V
- Standard semiconductors TO packages

Additional Features

- Top-side cooling – D2TO S
- Bended – LTO series

Proven Quality

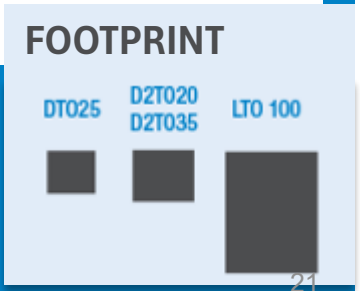
Proven Reliability

AECQ 200

Automotive Grade

PCB mounting

Space Saving



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Portfolio Overview – High Power

ISOA - LPS, LPSA - RCEC

Industry First

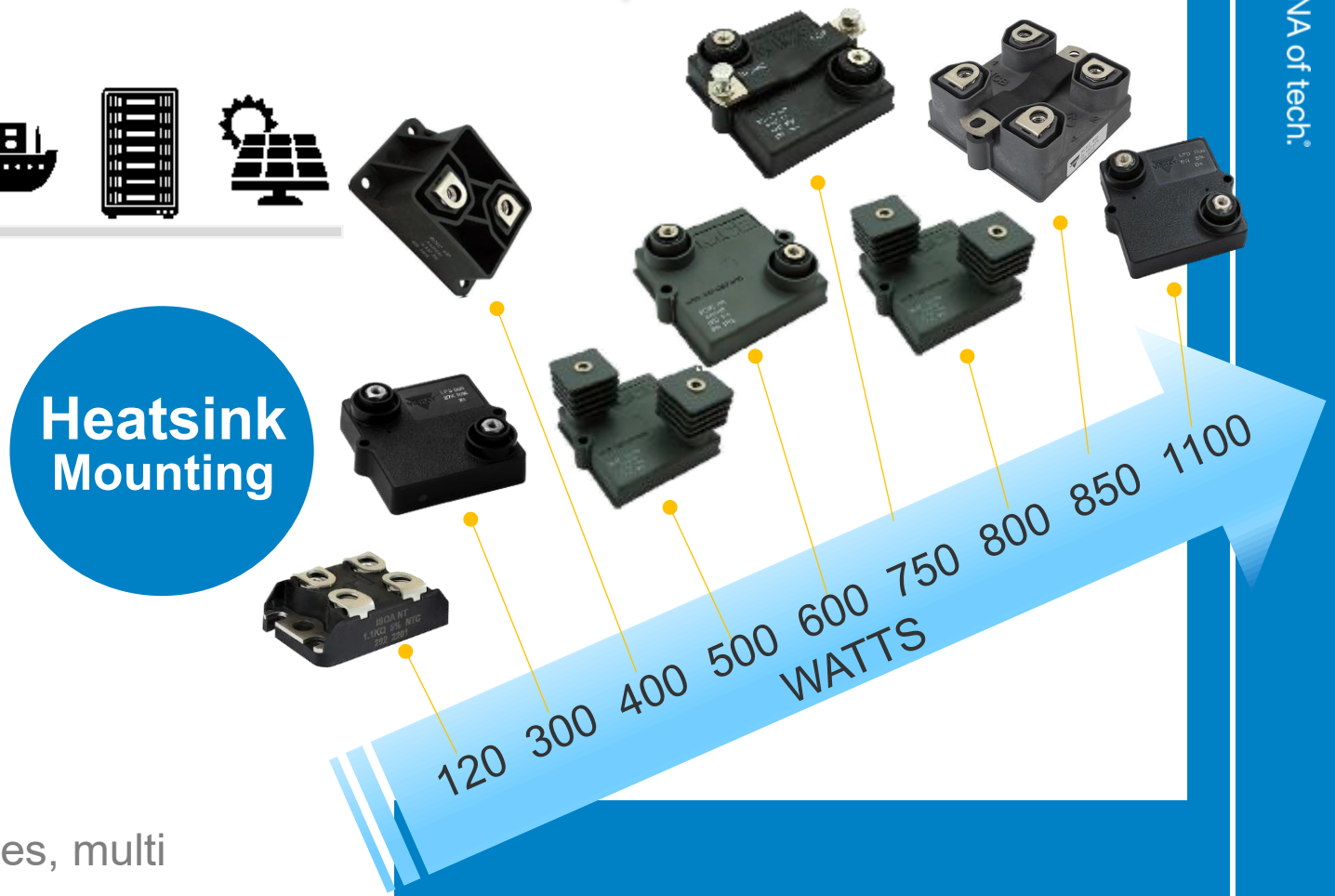
Custom Friendly

Features

- **Power**: 120 W to 1100 W
- **Energy**: 100 J to 1100 J @ 100 ms
- **Voltage**: 1500 V - 5000 V
- **CTI > 600 V** (ISOA, RCEC)
- **High dielectric strength up to 12 000 V**
- Thermal Interface Material (TIM) available

Additional Features

- Many options possible, including NTC, cables, multi resistors…



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Power Thick Film Resistors

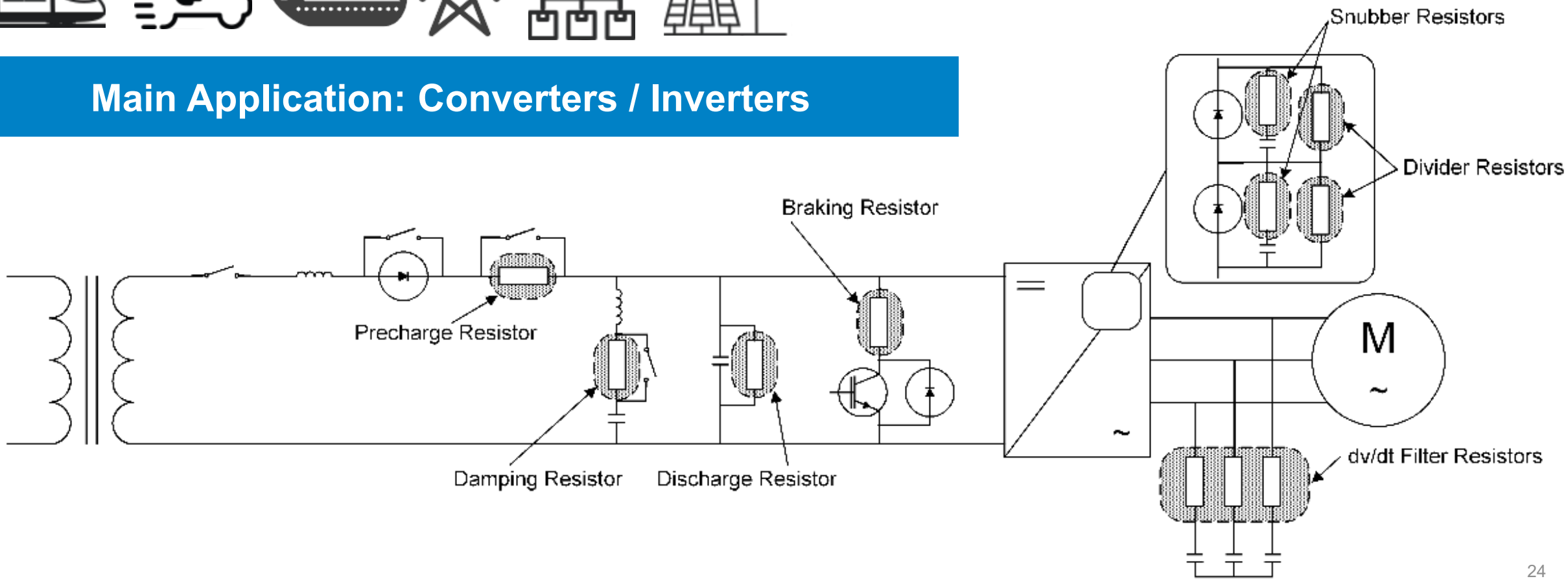
Where to Hunt.

Functions, Segments, Applications, Competitors

Power Thick Film Resistors
Main Functions

- Precharge / Discharge Resistors
- Crowbar / Damping / Braking Resistors
- Divider / Snubber Resistors
- Filter Resistors

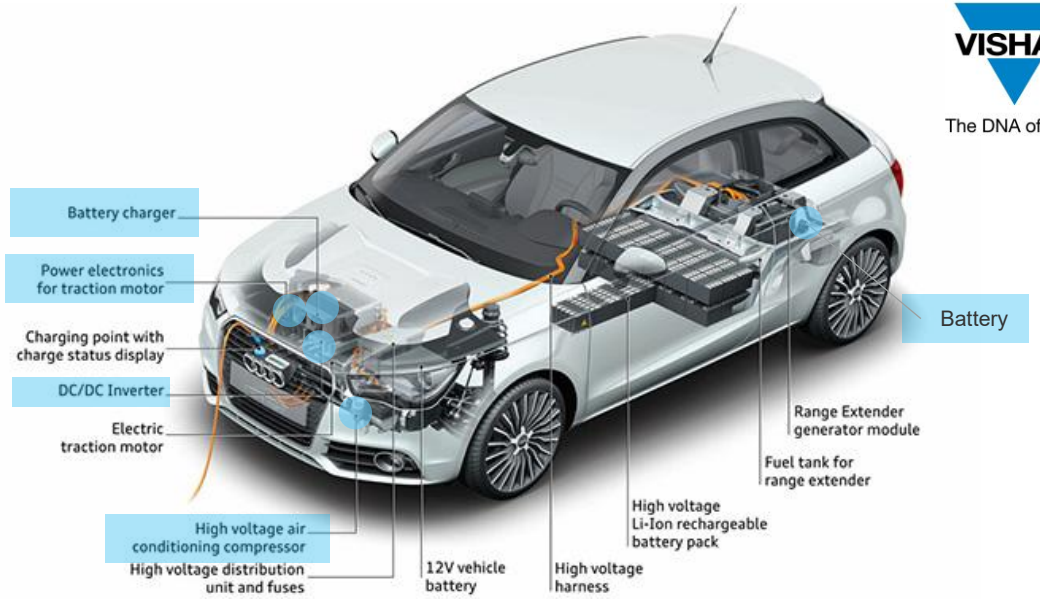
Main Application: Converters / Inverters

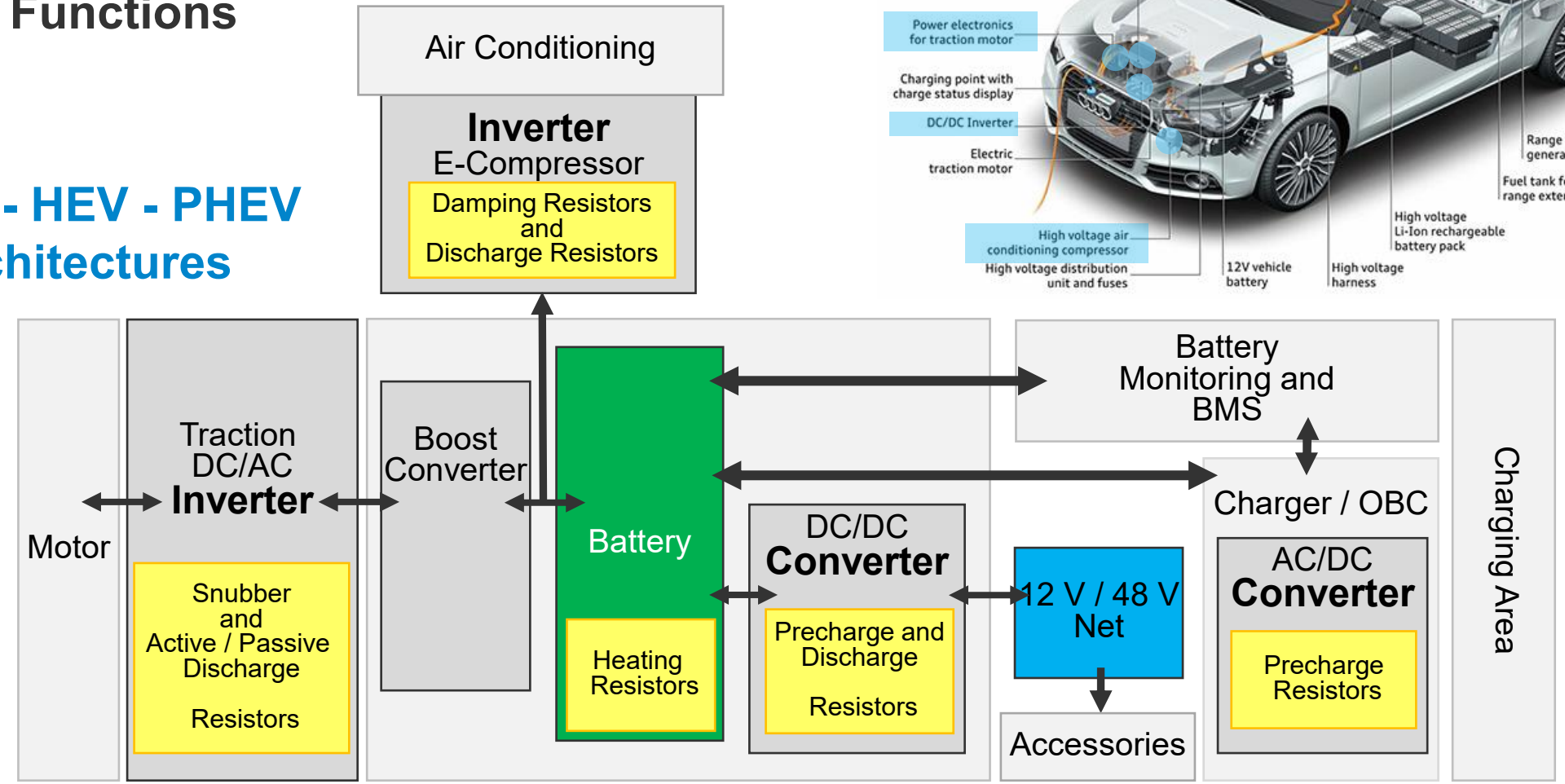


Automotive Applications: Focus

Main Functions

EV - HEV - PHEV Architectures





Our Solutions

Power Thick Film Markets

Automotive

- On-board chargers (OBC)
- Battery management systems
- DC/DC converters
- Power inverters - motor controls
- E-compressors
- Battery heating

Aero and Defense

- Avionics power conditioning
- Radar and communication equipment
- Missile guidance and control electronics
- High reliability current sensing

Industrial and Automation

- Motor drives and soft starters
- High power test benches and load testing
- Robotic power electronics
- Industrial drives
- Current sensing for control systems

Rail

- Traction systems for rail and metro
- Protection systems
- Dynamic braking

Medical

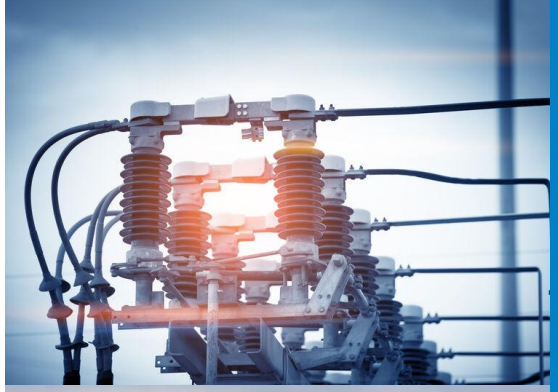
- Imaging systems power control
- Instrumentation
- Diagnostic equipment

Energy and Power Generation

- HVDC stations
- Wind turbine converters
- Solar inverters
- Energy storage systems (ESS)

Marine & Offshore

- Ship propulsion controls
- Power distribution onboard vessels
- Emergency backup systems
- Load banks for generator testing



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Power Thick Film Resistors

Market Segments / Applications

- Automotive:
  - Inverters
  - DC/DC converters
  - BMS
  - A/C e-compressors
- Industrial
- Power supplies
- Motor drives
- Commercial aviation
- Medical instrumentation and diagnostic equipment
- Defense
- Renewable energy

Technology Advantages

- Will dissipate more power / energy than multiple resistor solutions
- High power density in compact packages
- Weight / space savings vs classic wirewounds
- Solution with multiple resistors in same component
- Non-inductive
- Cold components without thermal radiation

Features

- AEC-Q200 qualified
- PCB-mounted and off-board packages
- 25 W and up to 1100 W at 85 °C
- Resistance range from 0.3 Ω to 900 kΩ
- Compact low profile packages
- Up to 1 kJ pulse for 0.1 s
- High dielectric strength up to 12 kVrms

Competitors

- Bourns
- EBG / MIBA Resistor
- Caddock
- Ohmite
- TE Connectivity

Power Thick Film Resistors

How to Engage Customers

How to Engage Customers

Door Opener Questions and Positioning

- Do you use power resistors from any of those manufacturers (Bourns, EBG / MIBA, Caddock, Ohmite, and TE Connectivity) or have any need for power resistors?
- Do you use those resistors in converters or inverters applications, for charging, discharging, dumping, filtering, balancing, or heating?
- Which power levels are needed in those functions?
- Do you use heatsinks or PCBs?
- What do you use to cool the resistors?
- Do you have any dielectric constraints?

Power Thick Film Resistors

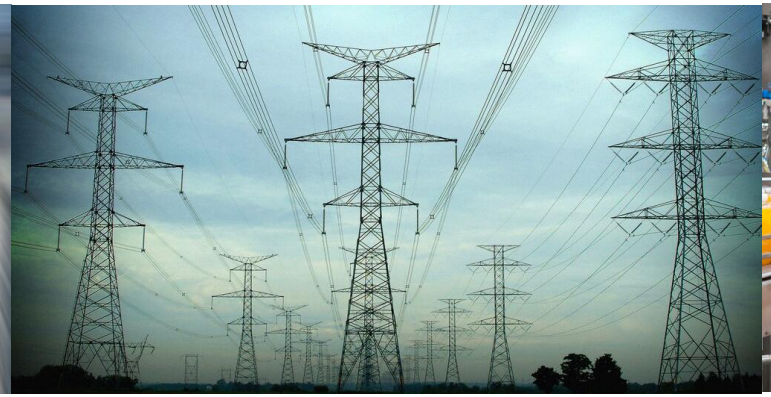
How to Win

Power Thick Film resistors

How to Win – Vishay's Advantages vs. Competition

- Proven expertise: industry-first for high power (RCEC)
- Proven quality and reliability: very stringent qualification testing for AEC-Q200 products / severe partial discharge tests for high power products
- Customization through simulations / prototyping / testing (thermal, pulses, vibrations, etc.)
- Excellent and responsive design support
- Excellent environmental and dielectric performances
- Manufactured in Europe (non-China)






High Frequency Products

Technology and Portfolio Presentation

High Frequency Products

Resistors, terminations, and attenuators are specifically designed to maintain stable performance when used in high frequency circuits, typically in the RF (radio-frequency), microwave, or GHz range.

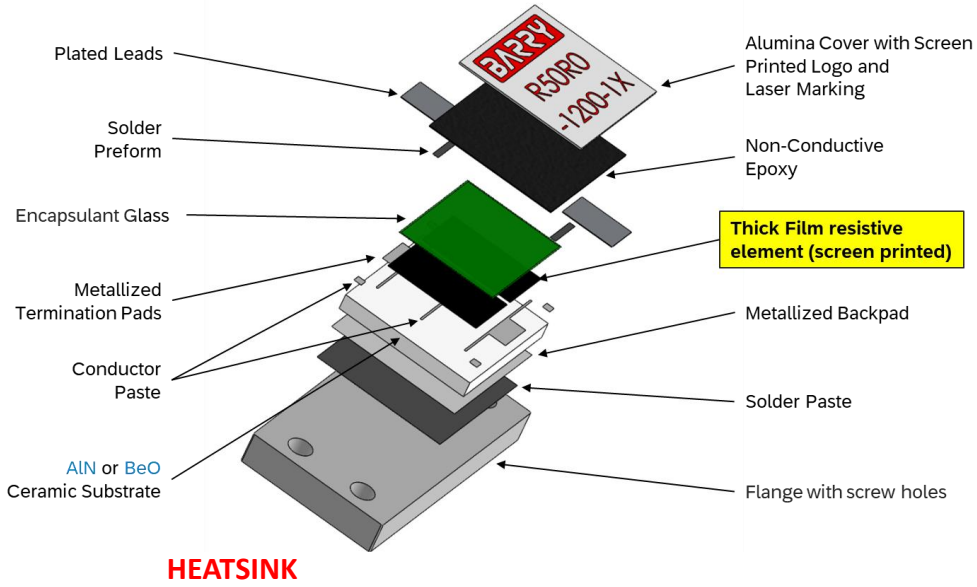
At high frequencies, a resistive component's real behavior deviates from its ideal value because of parasitic effects (inductance and capacitance).

High frequency resistors, terminations, and attenuators are engineered to minimize these parasitics to maintain predictable impedance and minimize return loss.

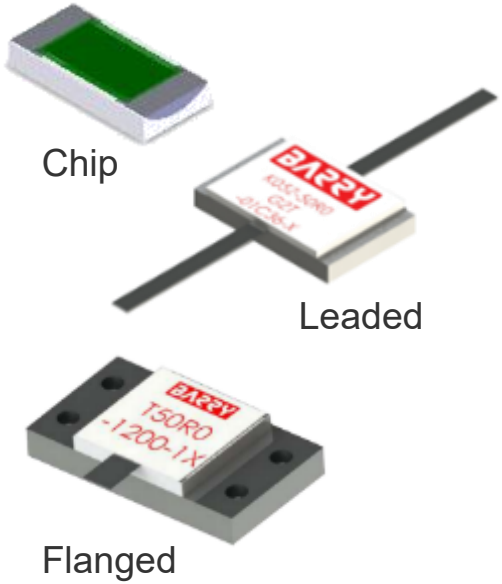
2 Technologies:

Thin Film - RF Thick Film

RF Thick Film Technology

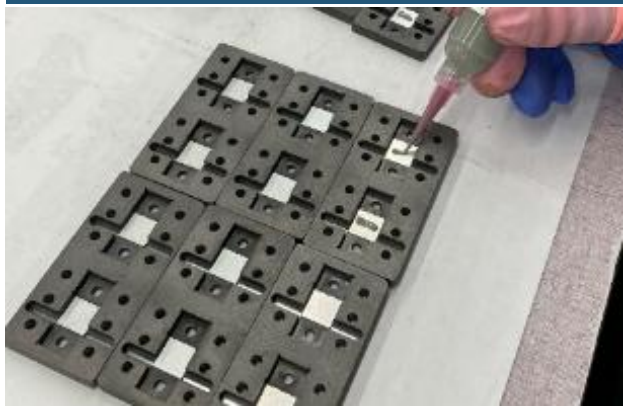


HEATSINK

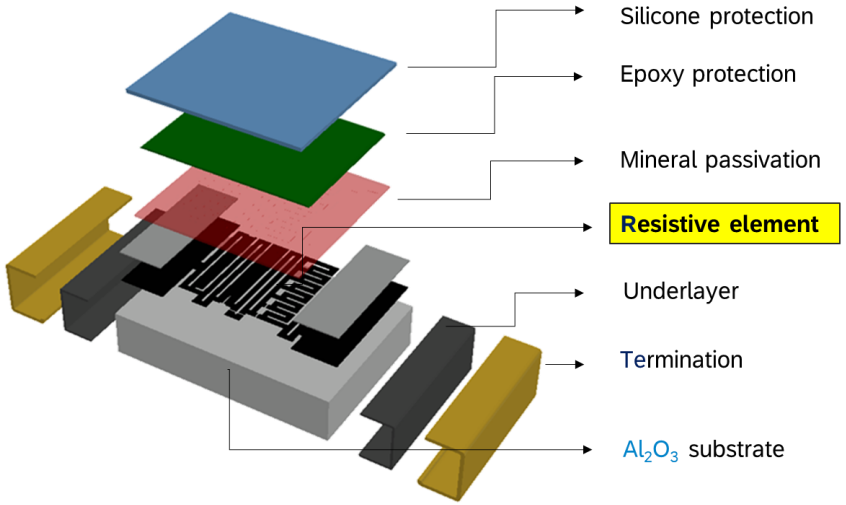


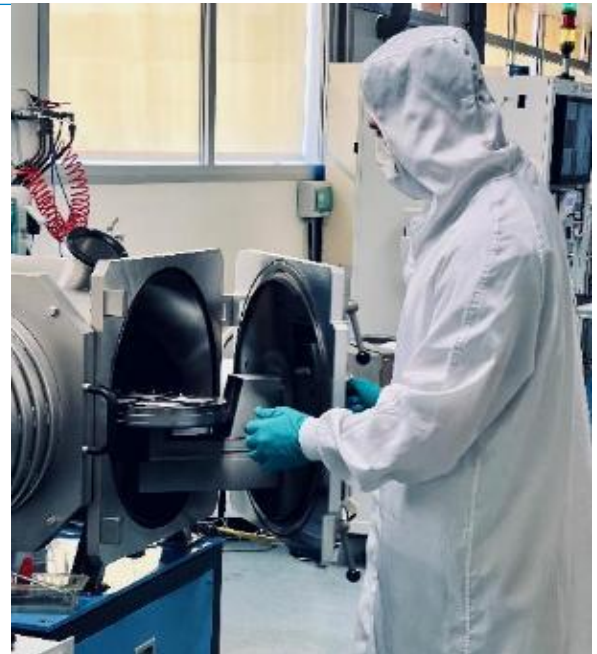
SCREEN PRINTING PROCESS

Heatsink solutions are screw-mounted directly onto actively cooled heatsink via Au-plated Cu flange.

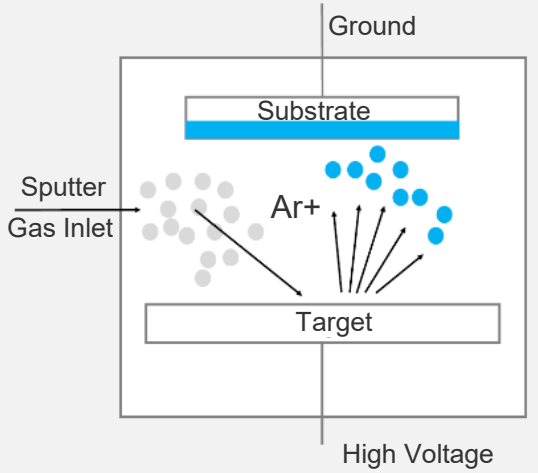


Thin Film Technology





SPUTTERING PROCESS



High Frequency Products
Selection by Added Value

MOUNTING

HIGH FREQUENCY

HIGH POWER

CUSTOMIZABLE OPTIONS

Portfolio Overview

SMD Resistors / Attenuators / Terminations

IoT

5G

Test Systems

Features

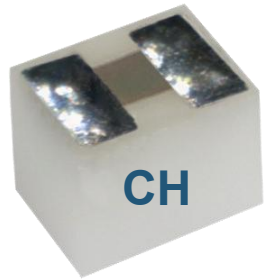
- **Beyond 5G – up to 70 GHz**
- **02016 to 5050** sizes available
- **Up to 250 W power** handling
- **Operating temperature range**: -55 °C to +250 °C
- **Extremely high power to size ratios**
- Alumina / AlN / BeO substrates
- S-parameters / Modelithics / HFSS available
- RoHS-compliant
- AEC-Q200 qualified: CHA

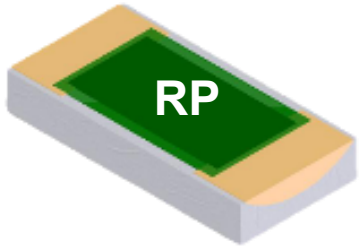
« Best in Class » Frequency Behavior

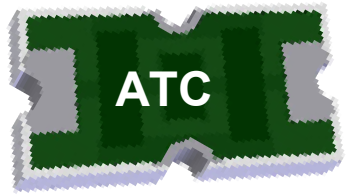
AECQ 200

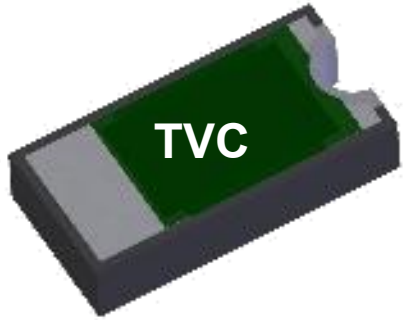
RoHS Compliant

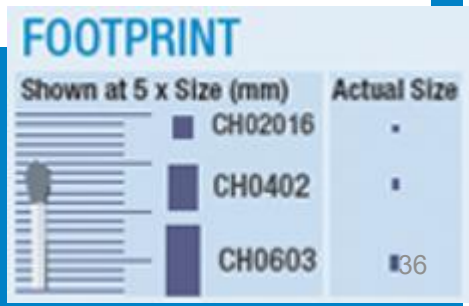
PCB Mounting











VISHAY

The DNA of tech.®

Portfolio Overview

High Power RF Flanged Resistors

Features

- **Power rating**: 10 W to 5000 W+
- **Frequency range**: 1 GHz to 18 GHz (termination)
- **Resistance range**: 0.1 Ω to 1 GΩ (50 Ω and 100 Ω standard for terminations)
- **Temperature range**: -55 °C to +250 °C
- **Low return loss**

Additional Features

- Substrate options: AlN, BeO
- Upscreen to MIL-PRF-55342 available
- CTE matched materials allowing for > 500 k expansion
- Cycles vs < 1 k for standard flange device

RoHS / Custom Designs Available

Heatsink Mounting

T Series

R Series

BARRY

Power Up to 5000 W+

VISHAY

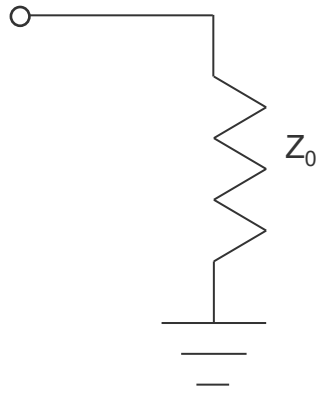
The DNA of tech.®

High Frequency Products

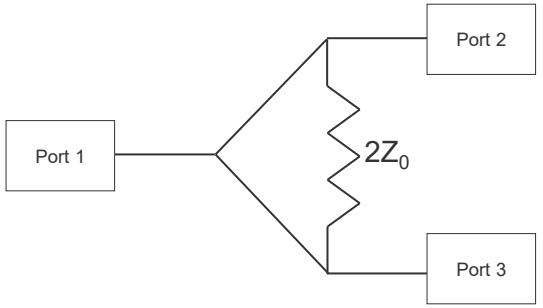
Where to Hunt. Functions, Segments, Applications, Competitors

High Frequency Products - Main Functions

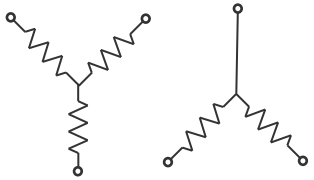
RF Circuit Line Termination



Splitters and Combiners

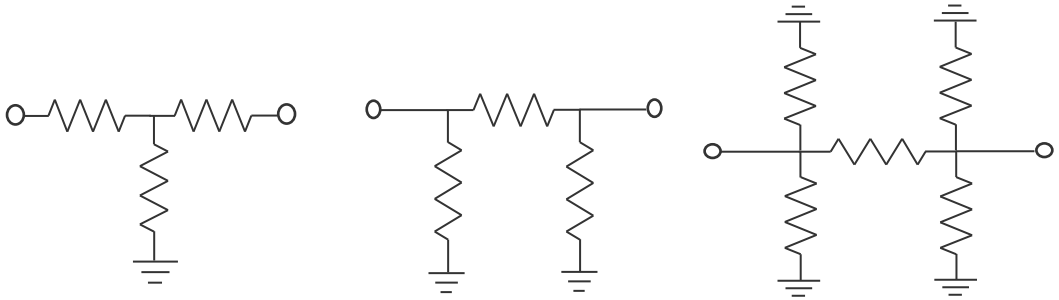


Wilkinson Power Divider



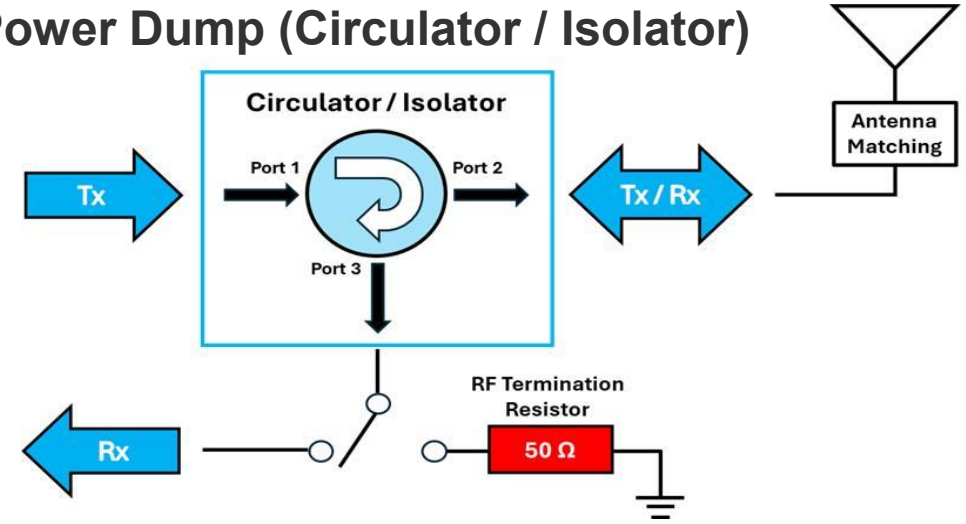
Splitters / Combiners

Attenuators and Resistor Networks

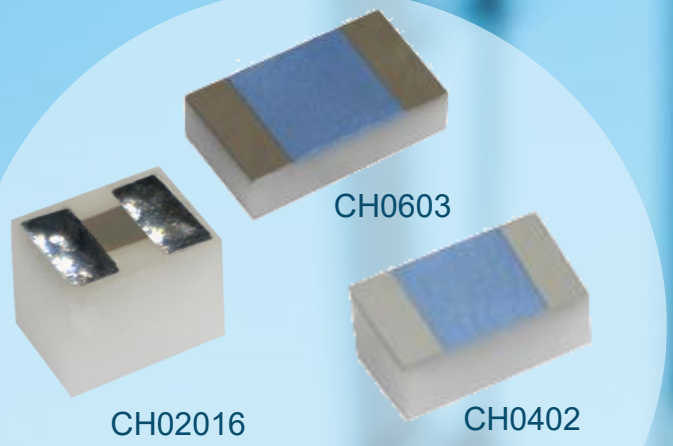


Tee *Pi* *Balanced- Pi*

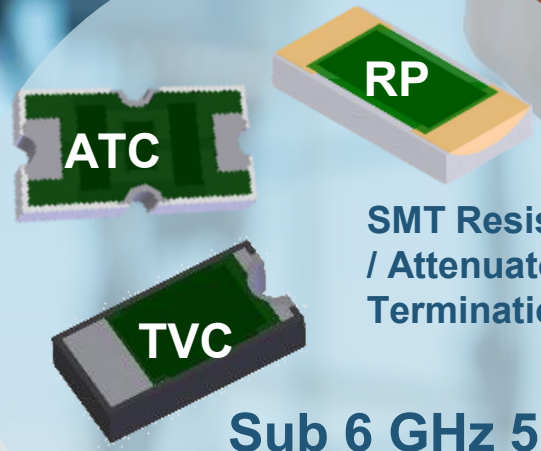
Power Dump (Circulator / Isolator)



Telecom Applications: Focus



mmWave 5G



SMT Resistors / Attenuators / Terminations

Sub 6 GHz 5G

BARRY

Optical Transceiver Module

High frequency termination resistor needed to improve signal fidelity at the receiver side

5G RRU (Remote Radio Units)

RF chip components needed in Wilkinson combiners / dividers for antennas

Base Stations & Repeaters

RF Chip Components
Higher frequency – shorter distance

High Frequency Markets

Industrial

- Plasma generators
- RF generators
- Power amplifiers
- Solid-state amplifiers
- Circulators
- Isolators

Aero / Defense / Space

- Phased-array radar
- Radio communications
- LEO satellites
- Ground terminals
- SATCOM

Automotive

- 4D radar
- Lidar
- ADAS
- Connected car (5G)

Medical

- MRI
- Ablasion

Test and Measurement

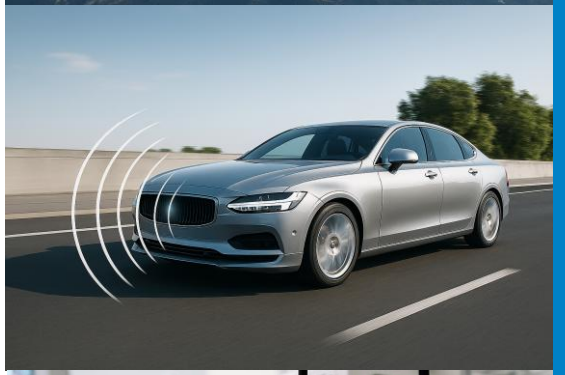
- Custom test equipment
- Power protection and dummy loads
- Signal attenuation

Telecom

- Base stations
- Remote radio units
- mmWave
- Repeaters
- Broadcast
- 5G
- 6G

Data Center (AI)

- Optical modules
- GPU test loads



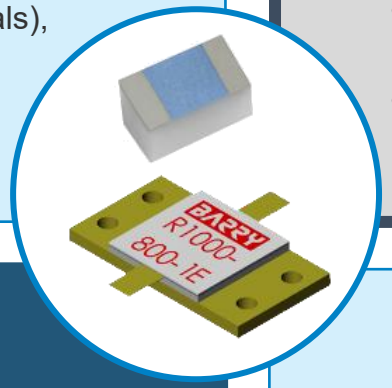
VISHAY

The DNA of tech.®

High Frequency Products

Market Segments / Applications

- **Telecommunications (5G / 6G): o**ptical communication modules
- **Data centers (AI)**
- **Industrial:** power amplifiers, circulators / isolators
- **Automotive**: lidar, 4D radar, connected car (5G)
- **AMS**: space (SatCOM), LEO satellites (base terminals), radars / AESA
- **Test and measurement**



Technology Advantages

- Thin film technology offers best in class RF performance across entire frequency range (Z/R)
- Thick film technology combined with flange mounting offers the best compromise between RF performance and power dissipation
- Sole global supplier of CTE matched copper tungsten resistive solutions for Hi-Rel applications
- Widest range of customization options available vs competition

Features

- Large resistance range (0.1 Ω to 1 GΩ)
- Up to 400 W for chip devices
- Up to 5000 W for flanged devices
- DC to 70 GHz frequency range
- Solder, epoxy, and wirebond available
- Flip-chip, wraparound, cavity, heatsink mounting options
- RoHS-compliant
- > 500 K+ duty cycles without failure for Hi-Rel solution

Competitors

- TTM / Anaren
- Smiths Interconnect
- ATC / AVX Kyocera
- Diconex
- IMS
- Knowles

High Frequency Products

How to Engage Customers

How to Engage Customers

Door Opener Questions and Positioning

1. **What applications are you working on?**
   - Depending on the customer, the following keywords should be a cue for potential RF opportunities:

Market	Application Keywords					
General	Antenna	Receive and Transmit (Rx / Tx)	Wilkinson Divider / Combiner	Power Splitter	Heating Resistor	Load Test
Industrial	Plasma Generator	RF Generator	Power Amplifer	Solid-State Amplifer	Circulator	Isolator
Space	LEO Satellite	Ground Terminal	Satellite Communication			
Military	Phased-Array Radar	Radio Communication	Data-Link Array			
Medical	MRI					
Automotive	4D Radar	LiDAR	Connected Car (5G)			
Telecom	Base Station	Remote Radio Unit (RRU)	5G / mmWave / 6G			
Data Center (AI)	Optical Modules	GPU Test Loads				

2. **Resistors and terminations:**
   - What is the operating frequency range?
   - How much power will you need to dissipate?
   - Is this power CW or pulsed?
     - If pulsed – what is the peak power, pulse width, and duty cycle?
   - What is the maximum return loss you can tolerate?

3. **Attenuators**
   - Do you need to attenuate signals after or before an amplifier stage?
     - What is the attenuation level needed?
     - How much power will need to be dissipated?
     - Do you require Tee, Pi, or balanced Pi circuit configuration?

4. **What are your size requirements?**

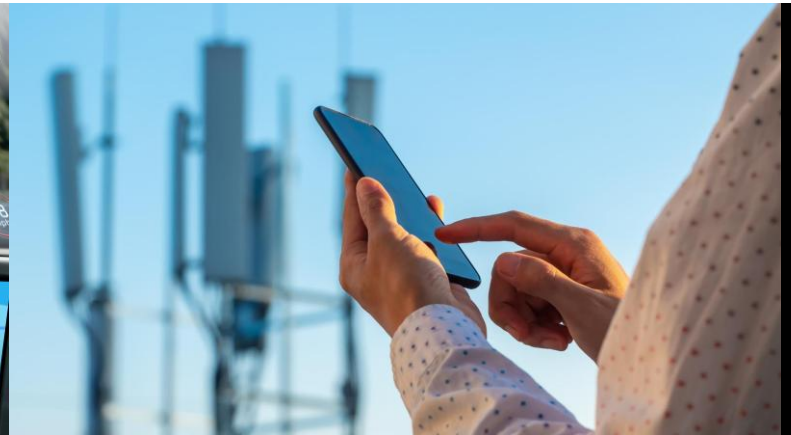
High Frequency Products

How to Win

High Frequency Products – Thin Film Products

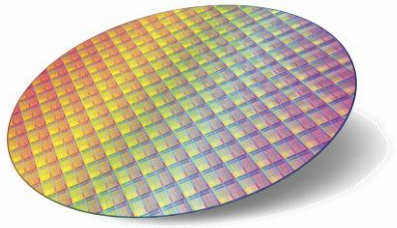
How to Win

- **RF Performance:** CH series microwave resistors offer best in class frequency behavior close to a pure resistor across the entire range up to 70 GHz for size 02016 and 50 GHz for sizes 0402 and 0603
- **Size / Mounting Options**: Available in 02016, 0402, and 0603 with flip-chip, wraparound, and wirebondable configurations
- **AEC-Q200 Qualified**: CHA series has been proven to maintain RF performance across the entire frequency range after undergoing stringent testing and qualifications to meet the standard
- **S-Parameters:** Available for electrical simulations
- **Modelithics Library:** MLDX Broadband Microwave Global Models™ (PCB and pad scalable)
- **3D Models:** Available for multi-physics simulations with Ansys HFSS
- **Application Notes:** Comprehensive documentation demonstrating CHA guaranteed frequency performance under harsh conditions
- **Manufactured in Europe:** Non-China



High Frequency Products – RF Thick Film Products

How to Win



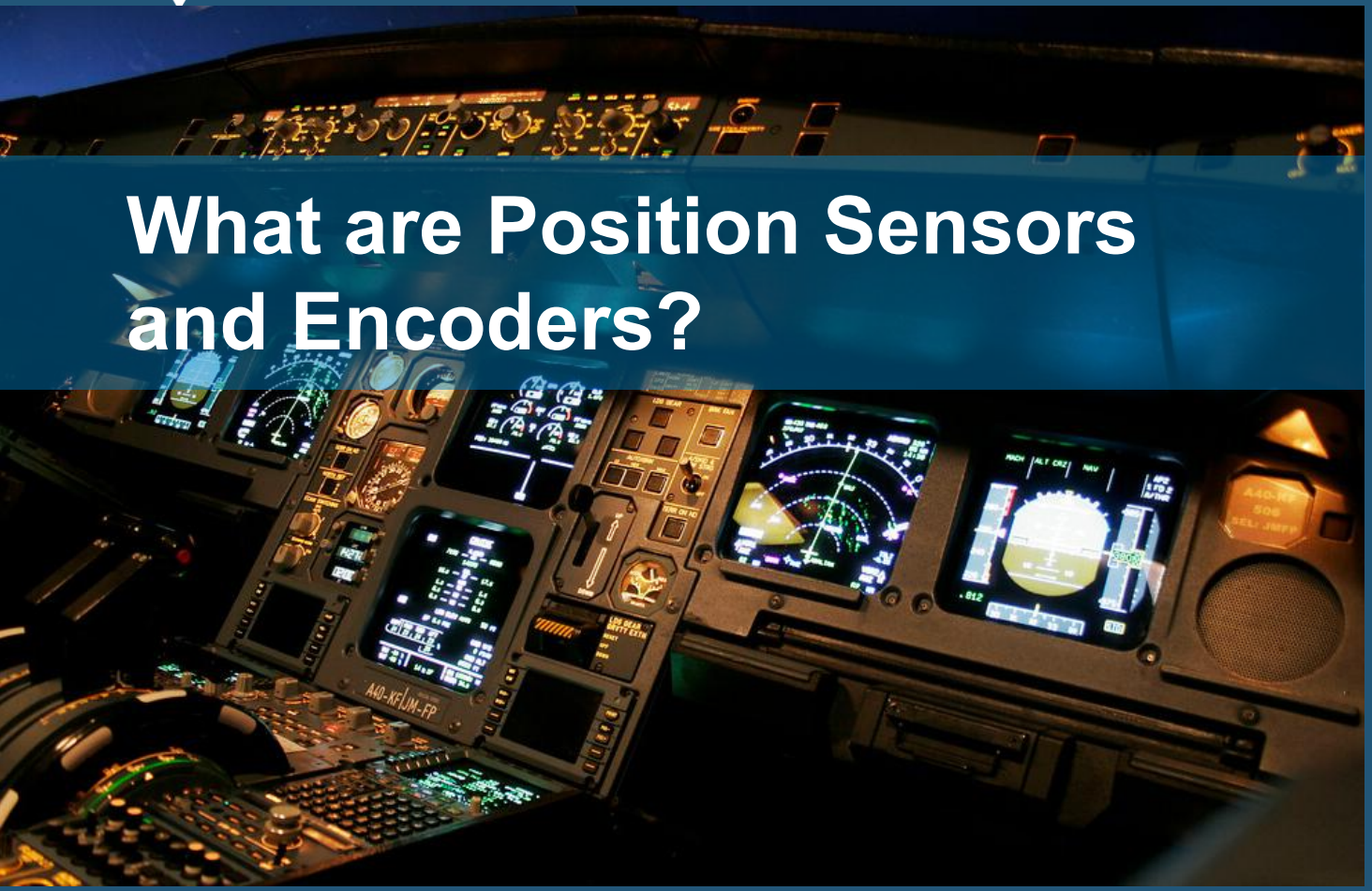
- **Extensive Portfolio:** One of the industry's largest catalogs — thousands of products ranging from DC to 60 GHz, up to 5000 W
- **Material Superiority:** Alumina, AlN, and BeO substrate materials available, with BeO offering 30 % higher power dissipation than AlN
- **Hi-Rel Technology:** CTE matched copper-tungsten flange (E type) resistors support 500 000+ power cycles — far exceeding standard parts (600 cycles) in challenging pulse applications
- **Custom Engineering:** In-house design team, with full lab and HFSS suite, enables customization, testing, and up-screening up to MIL-PRF-55342 specifications (Group A, B, C)
- **No Obsolescence:** Built on core RF thick film technology with near-zero EOL across the portfolio
- **Made in the USA:** 45+ years of consistent supply from Attleboro, Massachusetts

BARRY

Encoders and Position Sensors

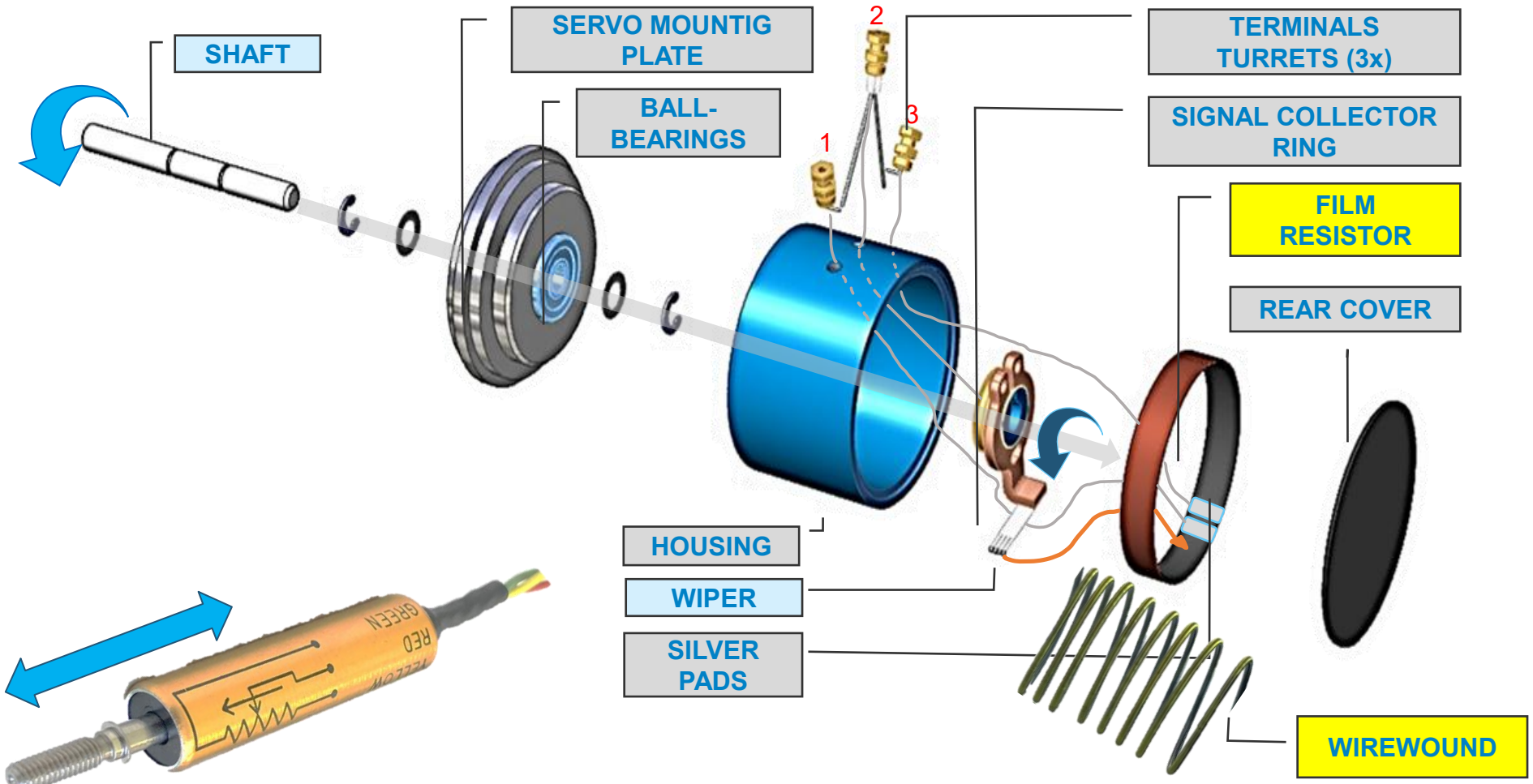
Technology and Portfolio Presentation

What are Position Sensors and Encoders?

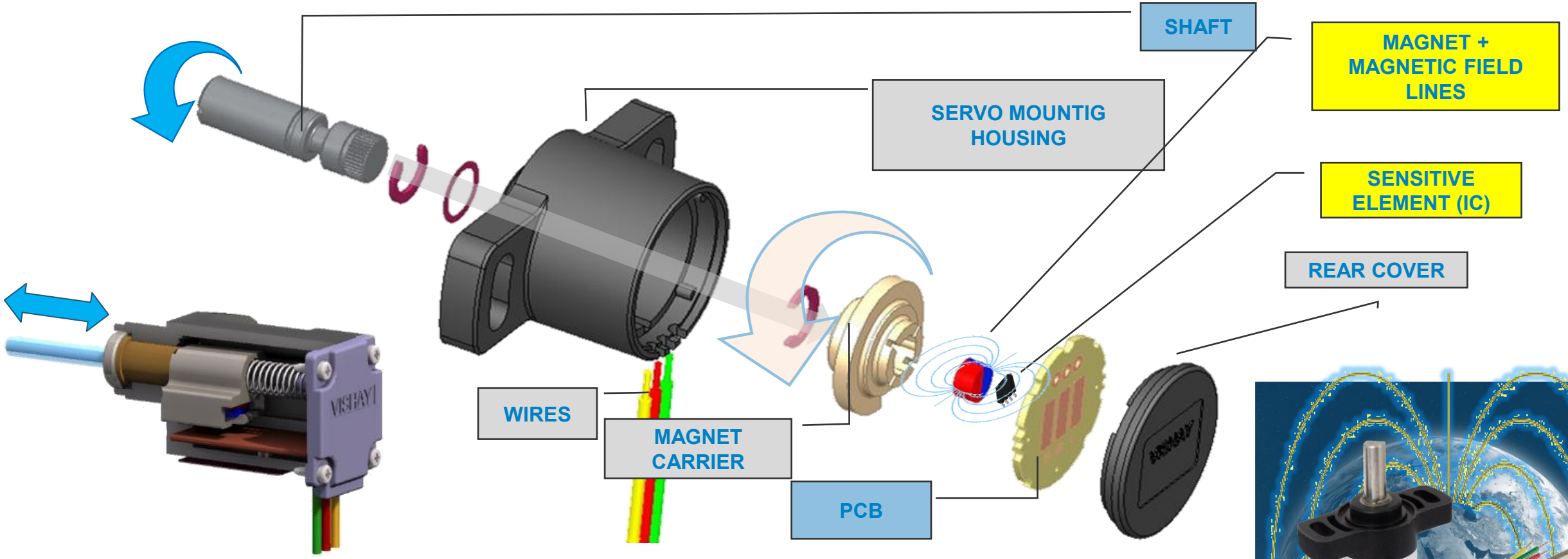


- Position sensors and encoders are devices that tell machines where an object is or how it's moving.
- They translate movement into data.
- When something moves - slides, rotates, or shifts - the sensor detects it and sends a signal to the system.
- Linear or rotary position sensors and encoders rely on several contacting or contactless technologies.

Contacting Technology: Film Resistor or Wirewound

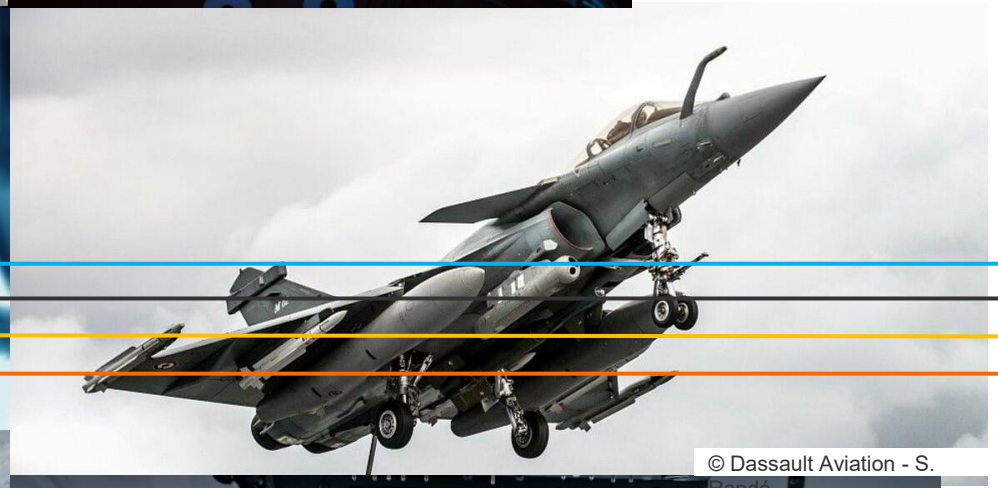


Contactless Technology: Magnetic or Inductive



- There is no resistive track but rather an IC that detects a magnetic field generated by an embedded magnet
- The magnetic effect can be replaced by an inductive effect

Position Sensors an Encoders Selection by Added Value

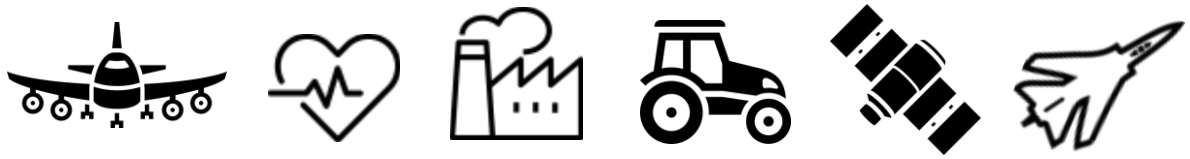


© Dassault Aviation - S. Randé

- LIFESPAN
- ACCURACY
- PRODUCT TYPE
- OPTION TYPE

Portfolio Overview

Contacting Position Sensors



Features

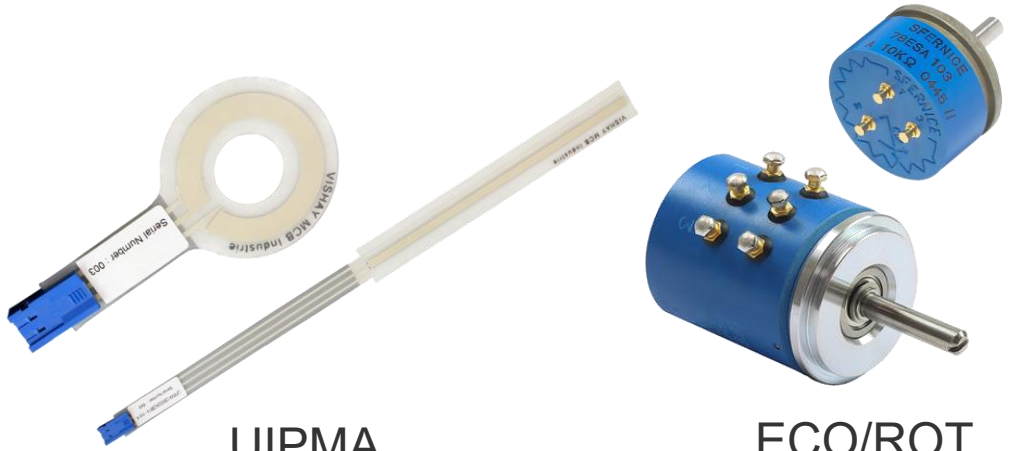
- **Lifespan**: Up to 10 million cycles
- **Linearity / accuracy**: ± 1 % down to ± 0.015 %
- **Resolution**: essentially infinite
- **Excellent repeatability**
- **Temperature range**: -55 °C to +125 °C

Additional Features

- Single or multi-turns
- Linear or rotational
- Kit or body designs
- **Highly customizable**

High Absolute Position

KITPL



UIPMA

ECO/ROT

Robust for Harsh Environments

Portfolio Overview

Contactless Position Sensors and Encoders

Features

- **Extremely long lifespan**: ≥ 50 million cycles
- **Resolution**: from 12 bits to 21 bits
- **Absolute accuracy**: from 8 bits to 16 bits
- **Repeatability**: up to17 bits
- **Latency time**: down to 5 µs
- **Outputs**: analog, PWM, SPI, SSI, or BiSS-C
- **Temperature range**: -40 °C to +105 °C

Additional Features

- Single or multi-turns
- Linear or rotational
- Kit or body designs
- **Highly customizable**

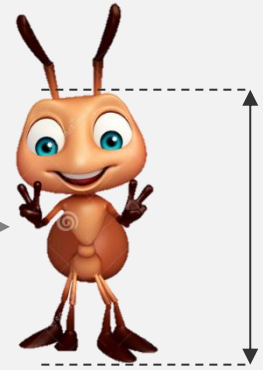
Extremely Long Lifespan

High Accuracy

What are Resolution and Accuracy?

Resolution of 21 bits = 0.00005 % = 0.00017°

1000 m / 0.62 miles



3 mm /
0.12 in

Accuracy of 16 bits = 0.002 % = 0.00549°

Error max
96 mm /
3.78 in

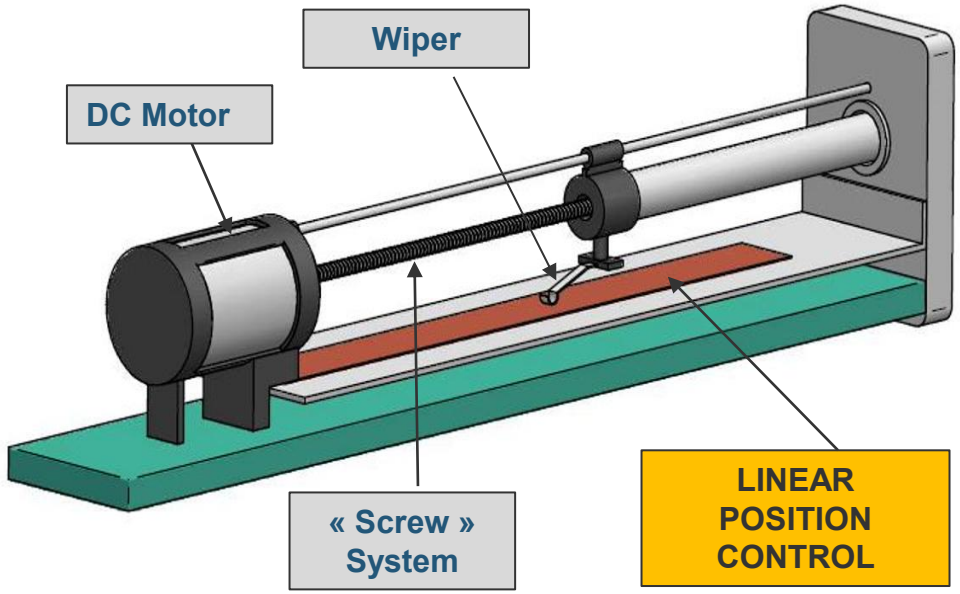
1000 m / 0.62 miles

Encoders and Position Sensors

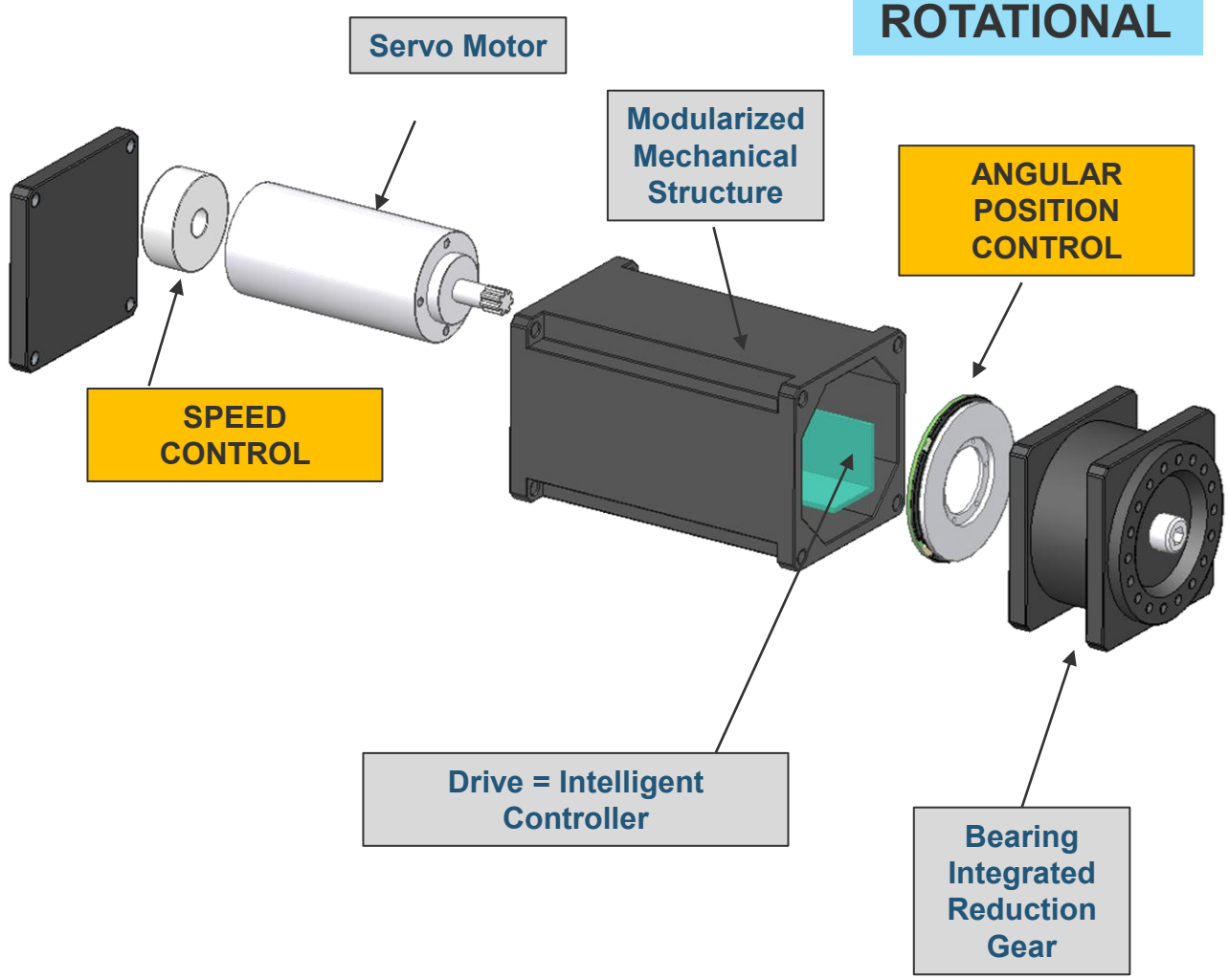
Where to Hunt. Functions, Segments, Applications, Competitors

Position Sensors Main Functions

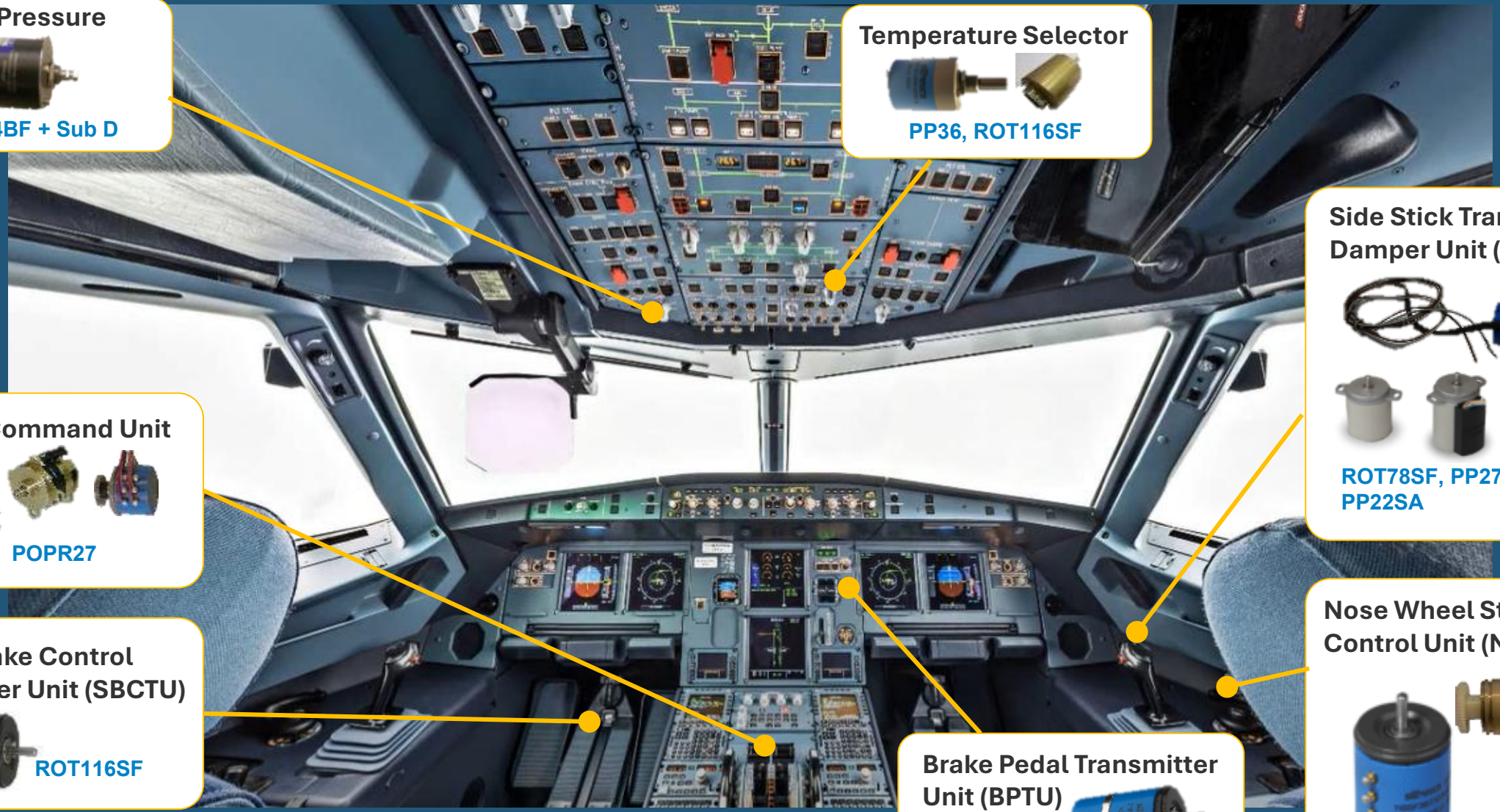
LINEAR



ROTATIONAL



Civil Avionics Cockpit Applications: Focus



Cabin Pressure

ROT134BF + Sub D

Temperature Selector

PP36, ROT116SF

Side Stick Transmitter Damper Unit (SSTDU)

ROT78SF, PP27EA, PP22SA

Throttle Command Unit (TCU)

POPR27

Speed Brake Control Transmitter Unit (SBCTU)

ROT116SF

Brake Pedal Transmitter Unit (BPTU)

ROT

Nose Wheel Steering Control Unit (NWSCU)

ROT116SF

Position Sensors and Encoders Markets

Industrial

- Collaborative and industrial robot arm positions
- Humanoids
- Machine tools
- Automation devices
- Valves

Off Road

- Autonomous lawnmowers
- Steering wheel position
- Throttle and break pedals
- Suspension systems monitoring…

Defense

- Fin actuators and gimbals (missiles)
- Optical devices
- Fighter aircraft actuators
- Missile launchers
- Ground vehicles

Space

- Antenna and solar panel actuators

Avionics

- Cockpit functions
- Side stick units
- Fly by wire controls
- Brake pedals
- Throttle command
- Actuators
- Angle of attack

Medical

- Diagnosis (CT scan, X-ray)
- Imagery robots
- Syringe pumps
- Surgical tables / bed actuators

Contacting Position Sensors

Market Segments / Applications

- **Off road vehicles**
- **Industrial / automation**
- **Medical:** diagnosis machines (CT scan, X-ray) syringe pumps, etc.
- **Avionics:** cockpit functions (side stick unit, fly by wire controls, brake pedals, throttle commands, etc.
- **Defense**: fin actuators and gimbals (missiles), optical devices, fighter aircraft actuators
- **Space**: antenna and solar panel actuators

Technology Advantages

- Infinite resolution (conductive plastic element)
- Pure passive solution
- Low power consumption
- Mature and proven technology
- Temperature range

Features

- Linearity / accuracy : ± 1 % down to ± 0.015 %
- Resolution: essentially infinite
- Lifespan: up to 10 million cycles
- Excellent repeatability
- Temperature range -55 °C to +125 °C

Competitors

- Bourns
- Gefran
- Novotechnik
- Exxelia (Eurofarad)
- Semip
- BI (TE Connectivity)
- BEI (Sensata)
- Clarostat (Honeywell)
- Penny&Giles (Curtis Wright)
- Pepperl&Fuchs
- Spectra Symbol
- Hoffmann+Krippner
- Betatronix
- ETI

Contactless Position Sensors and Encoders

Market Segments / Applications

- **Off Road:** autonomous lawnmowers, steering wheel position, throttle and break pedals, suspension systems monitoring
- **Industrial**: drive controls, collaborative and industrial robot arm position, humanoids, automated guided vehicles, machines tools, automation devices, valves
- **Medical**: diagnosis and imaging robots / scanners
- **Defense**: missile thin actuators and gimbals, fighter aircraft actuators

Technology Advantages

- Extremely long lifespan
- High absolute precision
- Analog and digital (various protocols) outputs
- “True power on” absolute position sensor
- Versatile product
- Robust for harsh environment
- High level of integration (kits) / customization and flexibility

Features

- Resolution: from 12 bits to 21 bits
- Absolute accuracy: from 8 bits to 16 bits
- Repeatability: up to 17 bits
- Latency time: down to 5 µs
- Outputs: analog, PWM, SPI, SSI, or BiSS-C
- Temperature range: -40 °C to +105 °C
- Extreme long lifespan: ≥ 50 million cycles

Competitors

- Bourns
- Gefran
- Novotechnik
- Renishaw (RLS)
- Sick
- Zettlex
- Netzer
- Turck
- Opkon
- Exxelia (Eurofarad)
- Codechamp
- BI (TE Connectivity)
- BEI (Sensata)
- Clarostat (Honeywell)
- Penny&Giles (Curtis Wright)
- Pepperl&Fuchs

Encoders and Position Sensors

How to Engage Customers

How to Engage Customers

Door Opener Questions and Positioning

Exploring Automation and Control Needs

- Are you currently using any automation or control systems that rely on real-time feedback?
- How do you currently monitor or verify the position of moving elements?
- What do you expect in terms of specific performances such as accuracy, resolution, lifespan, and repeatability?

Integration and Environment Considerations / Constraints

- Are there space, environmental (dust, moisture, vibrations), connectivity, or safety constraints we should consider?
- Would you prefer contactless sensing or are mechanical solutions acceptable?
- Would you be open to exploring some tailored sensor options for your setup?

Encoders and Position Sensors

How to Win

Contacting and Contactless Position Sensors

How to Win

- Wide portfolio of reliable contacting and contactless technology position sensors and encoders
- Both can be engineered to meet the most demanding customers specifications with close support of our US and EU R&D teams
- Thanks to the unique homemade conductive resistive element, our conductive plastic technology offers a pure passive solution for high accuracy, almost infinite resolution, and long lifespan needs
- Newly designed patented encoders bring customers digital solutions – through versatile communication protocols - for extremely high accuracy and high speed applications




Contacting and Contactless Position Sensors

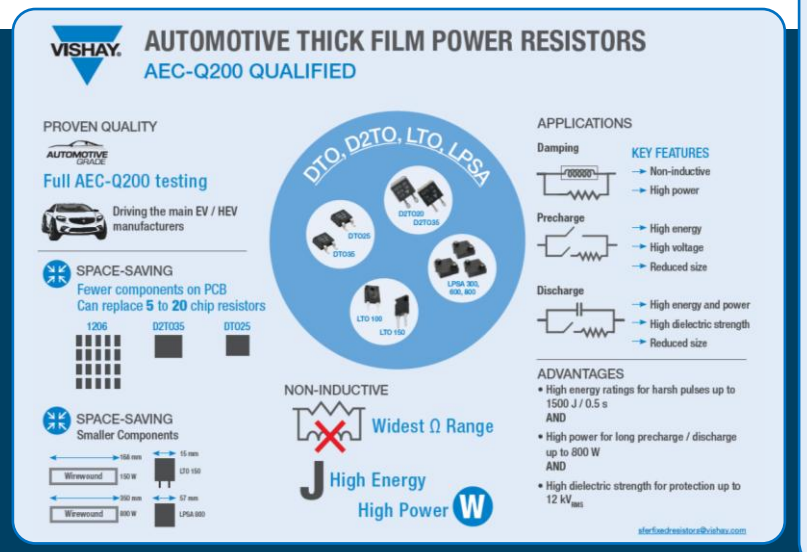
How to Win

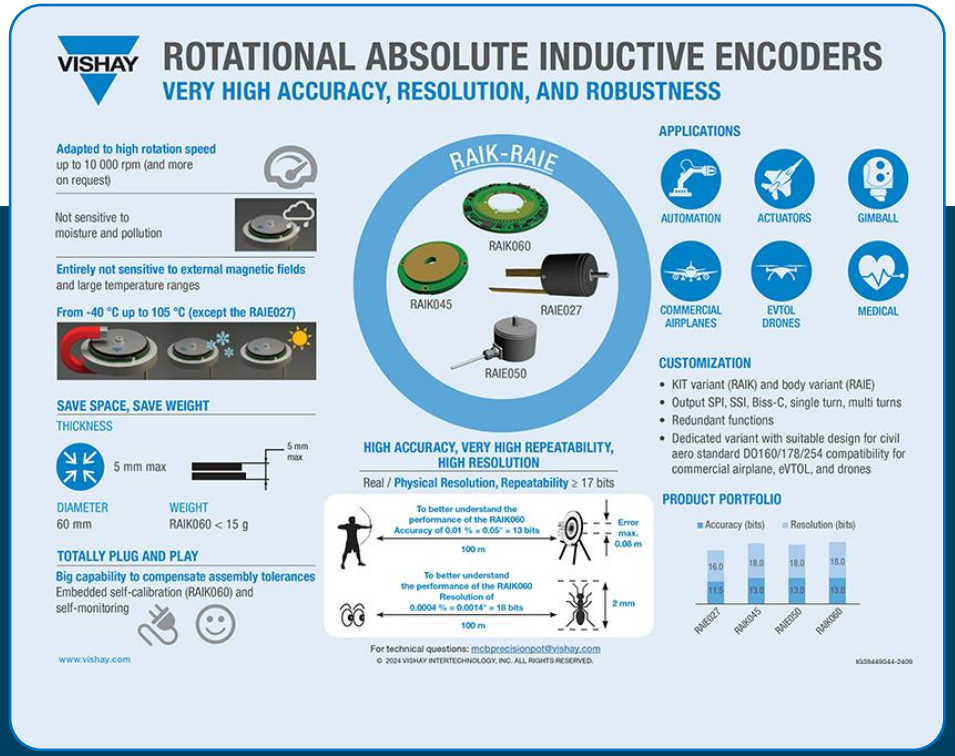
- Our European and American production lines offer flexibility and capacity to address production range quantities from a unit to a million pieces a year
- Our position sensors and encoders are designed and manufactured in respect to the highest quality systems (ISO9001, EN/AS9100,) and environmental regulations and standards (RoHS, REACH, ISO14001, ISO45001)
- We leverage our 40+ years experience in the aerospace and defense market to bring benefits to all projects for any market segment (industrial automation, off road, medical)
- Manufactured in Europe and Americas (non-China)

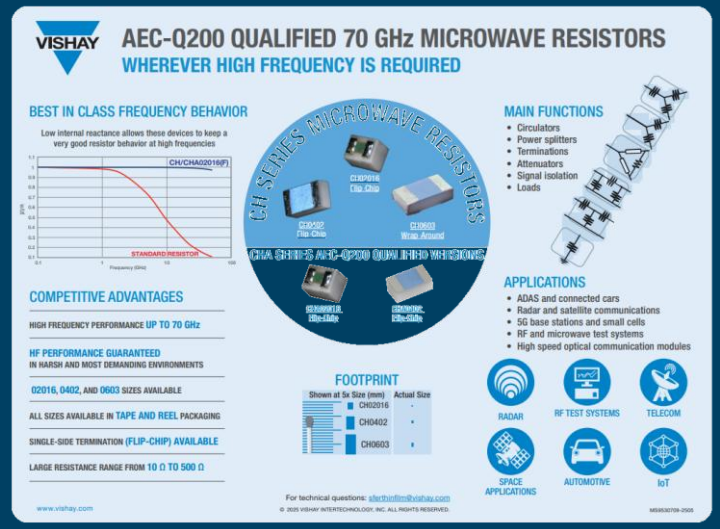


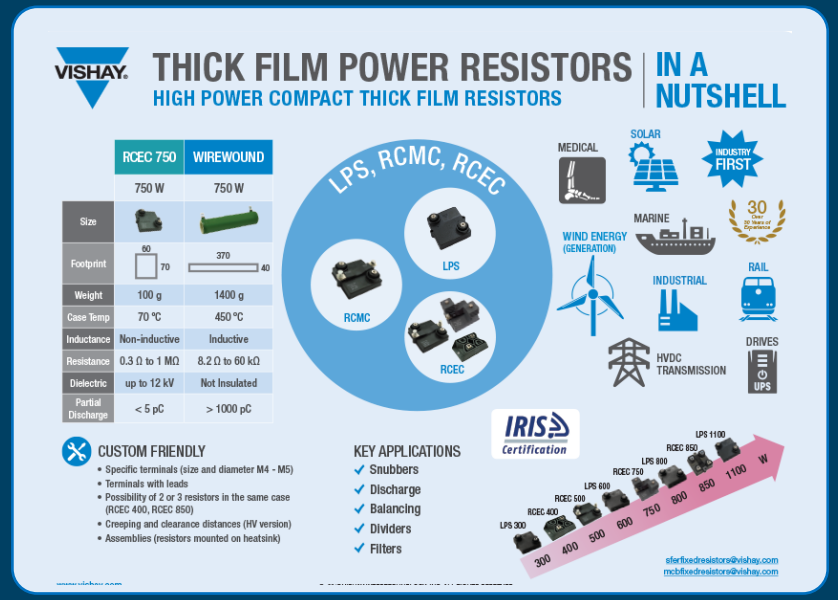

Design Resources and Selling Tools

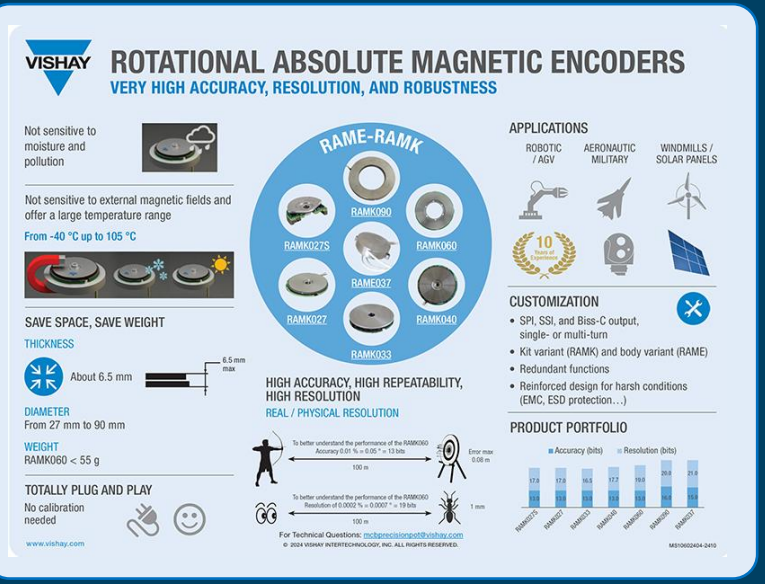
Promotional Materials

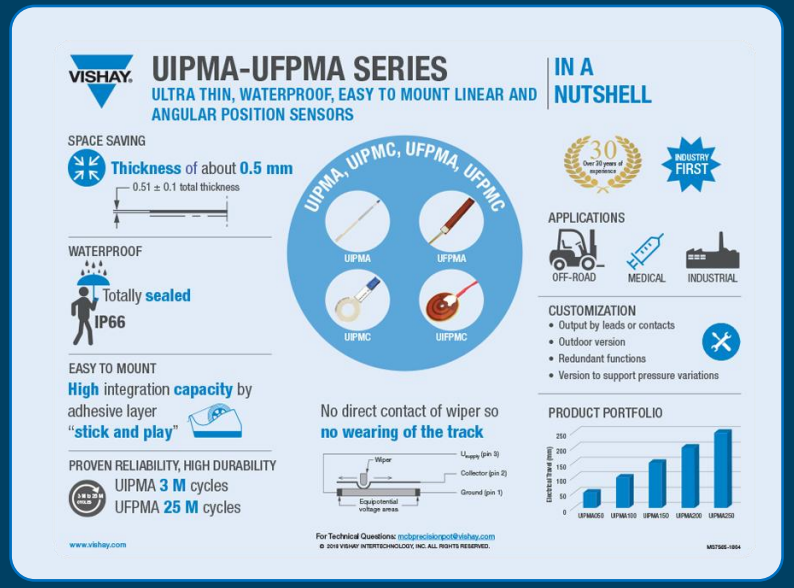












Promotional Materials

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Microwave Thin Film Resistors | Application Note

High Frequency Behavior of CHA Series Resistors Following AEC-Q200 Qualification Tests

By Benjamin Nicolle and Alexandre Moulin

SUMMARY

This application note describes ways to measure S-parameters and deduce impedance values of chip resistors at frequencies up to 70 GHz.

A good board design, alongside precise measurements, allows for a comparison of the impedance over frequency before and after AEC-Q200 tests, and shows the high stability of CHA series thin film chip resistors.

Precise measurements at high frequencies require suitable characterization boards and assembly and analyzing methods. Supplying these while demonstrating the impedance stability of Vishay resistors - particularly in demanding automotive environments, where electronic components must endure harsh conditions and continue to operate flawlessly - is the primary objective of this application note.

CHA SERIES RESISTORS

Vishay's unique CHA series of microwave AEC-Q200 qualified resistors, available with gold (P) and tin / silver (F) terminations, offers best in class performance for IoT, mmWave, 5G, radar, and other high frequency applications. These miniaturized components are designed in such a way that their internal reactance is very small. When correctly mounted and used, they function as almost pure resistors over a very large range of frequencies up to 70 GHz. CHA series devices are available with ohmic values between 10 Ω and 500 Ω.

This application note focuses on 50 Ω and 100 Ω resistors in the 02016 package, which are often used in high frequency applications, such as Wilkinson dividers, splitters, and attenuators.

For additional details, please refer to the CHA series datasheet: www.vishay.com/ppg?53086.

HIGH FREQUENCY RESISTOR SUMMARY

Parasitic elements inherent to resistors by construction are generated by the resistor-circuit interface (described in www.vishay.com/doc?53077).

The S-parameters shown in Fig. 1 are defined according to a scattering matrix where incidents (a1, a2) and reverse waves (b1, b2) are defined as the square root of the power.

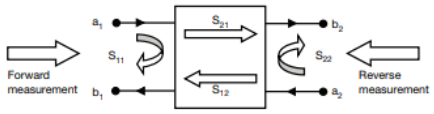

Fig. 1 - S-Parameter Fundamentals

Where:

- $S_{11} = b_1 / a_1$ with $a_2 = 0$
- $S_{21} = b_2 / a_1$ with $a_2 = 0$
- $S_{12} = b_1 / a_2$ with $a_1 = 0$
- $S_{22} = b_2 / a_2$ with $a_1 = 0$

APPLICATIO

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Thin Film Resistors | Application Note

Microwave Thin Film Resistors

By Benjamin Nicolle and Tony Qi

ABSTRACT

High frequency field is strongly anchored in the evolution of wireless technologies and shows a powerful way to exchange data faster and faster answering to a human need continuously more demanding. That concerns almost all the communication markets, as for instance: military, aerospace, automotive and obviously mobile 5G communication. Technologies of passive components must comply with the physical specificities linked to these frequencies. Resistors are not an exception. The "microwave" frequency range is given from 300 MHz to 300 GHz [1], but lumped resistors while entering into this range are more limited.

The aim of this application note is to present few basis about the microwave properties and to describe the behavior of the Sfernice CH / CHA resistors in the frequencies between 100 MHz and 70 GHz and the AEC-Q200 certification for harsh environments.

A FEW WORDS ABOUT HISTORY [2]

James Clerck MAXWELL (Scotland) was the founder of the microwave theory expressing his famous formulas in the 1860s. His "Treatise on electricity and magnetism" was published in 1873. Heinrich HERTZ (German Confederation) was the first to produce an electromagnetic wave about 1 GHz frequency in 1888. His work had a great impact on the development of the radio engineering. In the 1930s, Guglielmo MARCONI (Italy) demonstrated that it was possible to connect 2 points on the earth by electromagnetic waves in the air. It was the beginning of the radio communication. The following years, numerous other applications were found and developed in many applications: medicine, industrial heating, radio astronomy, particle accelerator, electronics, ...

MICROWAVE FREQUENCY BANDS

It might be useful to remind the frequency ranges covered by the microwaves. According to the International Telecommunication Union [1], the microwave frequency range covers 3 bands: UHF, SHF and EHF.

SYMBOLS	F RANGE [1] (GHz)	SOME APPLICATIONS
UHF (Ultra High Frequency)	0.3 to 3	Television broadcast, microwave oven, radio astronomy, mobile phone, bluetooth, ...
SHF (Super High Frequency)	3 to 30	Radio astronomy, communication, radars, cable and satellite television broadcasting...
EHF Extremely High Frequency)	30 to 300	Radio astronomy, microwave remote sensing, amateur radio, satellite radio

Note

[1] The lower limits are exclusive; the upper limits are inclusive

Between 1 GHz and 110 GHz, the Institute of Electrical and Electronics Engineers (IEEE) Association defines sub-bands as shown in the table below.

BANDS	F RANGE	WAVELENGTH
L	1 GHz to 2 GHz	30 cm to 15 cm
S	2 GHz to 4 GHz	15 cm to 7.5 cm
C	4 GHz to 8 GHz	7.5 cm to 3.75 cm
X	8 GHz to 12 GHz	3.75 cm to 2.5 cm
Ku	12 GHz to 18 GHz	2.5 cm to 1.67 cm
K	18 GHz to 26.5 GHz	1.67 cm to 1.13 cm
Ka	26.5 GHz to 40 GHz	1.13 cm to 0.75 cm
Q	33 GHz to 50 GHz	9 mm to 6 mm
V	50 GHz to 75 GHz	6 mm to 4 mm
W	75 GHz to 110 GHz	4 mm to 2.73 mm

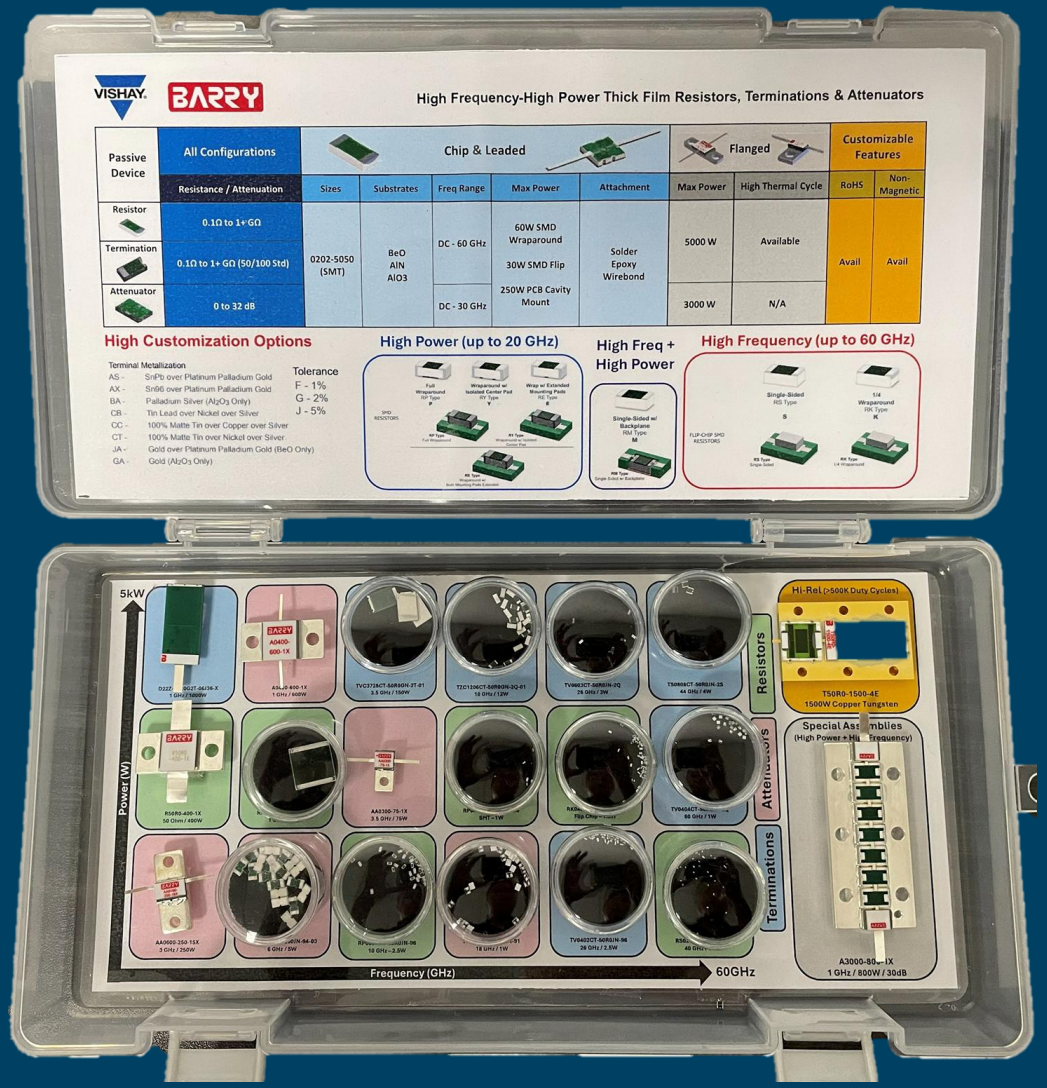
BASIC KNOWLEDGE

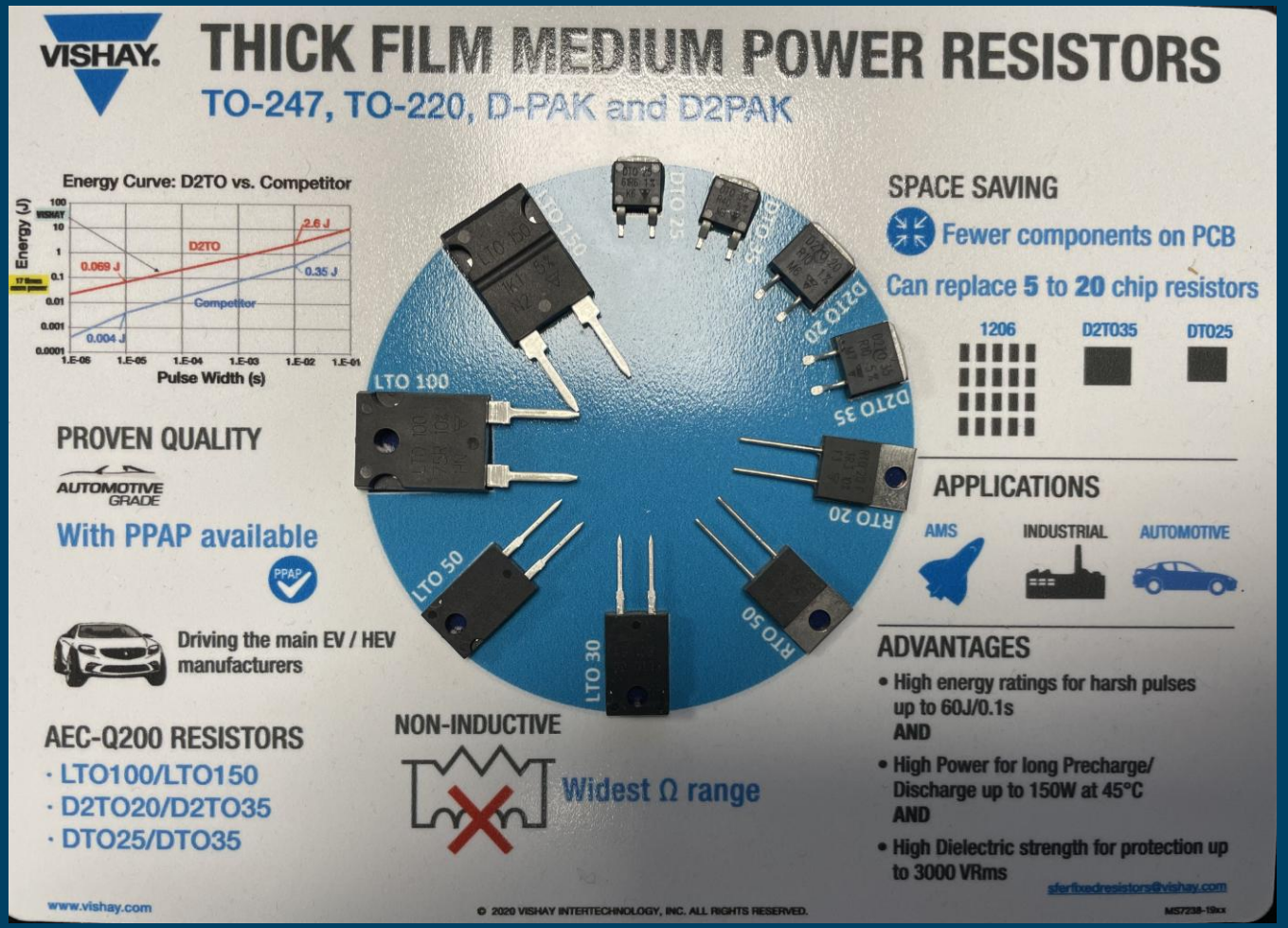
In low frequencies, resistors behave like "pure" resistance values showing negligible parasitic inductance and capacitance values. These parasitic elements are inherent to resistors by construction but also generated by the interface resistor-circuit. They become more troublesome as the frequency increases deviating progressively the resistor soldered on the circuit from its initial "pure" resistance value to complex impedance. The drawback of this phenomenon is a possible impedance mismatching with the circuit.

APPLICATION NOTE

Sample Boards, Design Kits

Show and Tell Boards





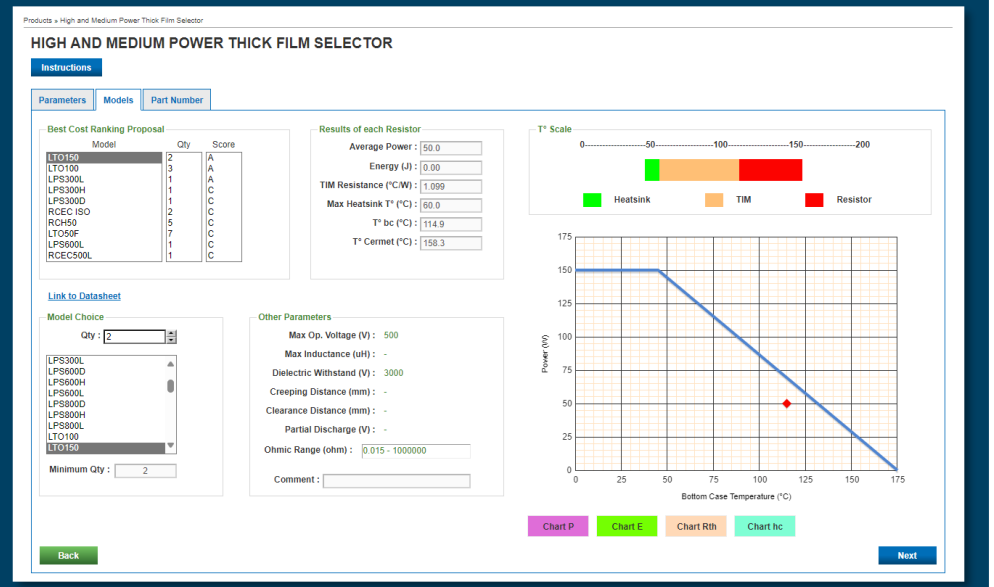
Sample Boards, Design Kits

Medium Power Thick Film Design Kits

DTO_D2TO_35 / D2TO_20 / D2TO_35 / DTO_25_35

Simulation Tools

Medium Power Thick Film Online configurator



[High and Medium Power Thick Film Selector | Vishay]

Promotional Video: Dedicated to Promoting the Online Configurator

[Sfernice Thick Film Power Resistors]

Sfernice is all about HIGH

- **High** Power
- **High** Frequency
- **High** Accuracy

…and **High** value Products and Solutions for You and Our Customers

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