Passive Components for Power Converters 2022

Market and Technology Product Brochure 2022
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COMPANIES CITED IN THIS REPORT

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The cost of passive components will represent about 15% of total power converters' cost by 2027

Power converters are a crucial component of power electronics systems. The power converter market will grow from $54 billion in 2021 to $76 billion by 2027 with a Compound Annual Growth Rate (CAGR) of 2021-2027 of 5.9%. In a power converter, both active and passive electronic components play important roles. Active components such as transistors and diodes supply energy to a circuit. The passive components such as resistors, inductors, capacitors, and transformers store electrical charges and limit current flow, filter, suppress surges, measure, time, and tune. In this report, Yole Développement investigates the passive components, specifically capacitors, inductors, resistors, and laminated busbars, related to power converters. We look at six end-applications, motors, electric and hybrid electric vehicles (EV/HEV), photovoltaics (PV), wind, rail, and Uninterruptible Power Supplies (UPS). The overall passive components market for power converters will grow from around $7.4 billion in 2021 to $11.7 billion by 2027, with a CAGR 2021-2027 of 8%, representing around 15% of the power converters market by 2027. Among the passive components, capacitors will reach a market value of $4.9 billion by 2027, with a CAGR 2021-2027 of 8.3%. On the other hand, the inductor market will reach $4.4 billion by 2027, with a CAGR of 2021-2027 of 8.0%. The demand for resistors will grow from $1.2 billion in 2021 to $1.9 billion by 2027.

EV/HEV applications increasingly drive technology trends in passive components.

In the past, passive component needs were mainly driven by industrial applications. However, today EV/HEV applications increasingly drive technology trends in passive components. Actually the requirements for high-frequency operation, high efficiency, robustness, reliability, small size, and weight of automotive passive components are often more severe than industrial products due to increased vehicle safety standards and a harsh environment. Therefore, highly reliable passive components are needed. This offers an opportunity for passive component manufacturers to improve their market position by providing solutions adapted to continuously evolving customer needs. Moreover, the high and further rapidly growing demand for EV/HEV applications enables rapid payback of development costs for innovative solutions.

Passive components are a very fragmented and diverse market.

There are many passive component suppliers, and the growing market attracts new players. The leading passives component companies include Nippon Chemi-Con, Murata, Kyocera/AVX, TDK, all in Japan; Vishay in the USA; Yageo in Taiwan and Samsung Electro-mechanics in Korea. In the case of capacitors, Nippon Chemi-Con, Nichicon, Rubycon, and Panasonic are the top electrolytic capacitor manufacturers, and Panasonic, TDK, Nichicon, and Vishay are the top film capacitor manufacturers. Likewise, TDK, Samsung Electro-mechanics, Yageo, and Murata are the top inductor manufacturers. Finally, Rogers Corporation and Mersen are the leading laminated busbar manufacturers. Yole observes a clear trend among passive components companies to diversify their businesses and regional portfolios. Many passive component suppliers involved in one component are also supplying other passive components. Many passive component companies have presences and manufacturing capacities in several countries. Manufacturing in countries like China, India, or Latin America offers lower costs than in Europe or Japan. Because of the growing demand Yole expects that passive component companies’ mergers and acquisitions will continue in coming years, aiming to add new product lines, increase profitability, access more customers, or eliminate competition.

Find more on www.i-micronews.com
WHAT’S IN THE REPORT

WHAT’S NEW

• Market forecast 2021-2027 in $M and units for capacitors, inductors, transformers, resistors, and laminated busbars
• Market evolution analysis for these passive components in EV/HEV, photovoltaics, wind turbines, rail traction, UPS, and industrial motor drives
• Passive component manufacturer landscape, supply chains and market shares
• Presentation of the main technologies, innovations and challenges for capacitors, magnetics, resistors, and laminated busbars
• Passive components demand and shortage analysis
• Focus on how new trends including higher temperatures and higher switching frequencies at system level will impact the requirements for passive components
• Analysis of the presence, functionality, and trends for passive components in power converters
• Future technology roadmaps

KEY FEATURES

• The passive component market is over 15% of the size of the converter market, reaching $7.4B in 2021
• The EV/HEV industry will drive a remarkable expansion of the capacitor, inductor, and transformer markets over the next five years, with a CAGR 2021-2027 exceeding 18%
• The laminated busbar market for the rail industry represents over $75M
• Nippon Chemi-Con, Nichicon, Rubycon, and Panasonic are the top electrolytic capacitor manufacturers, and Panasonic, TDK/Epcos, Nichicon, and Vishay are top film capacitor manufacturers
• Rogers Corporation and Mersen are the leading laminated busbar manufacturers
• In the power capacitor industry, film technology continues to be the mainstream
• The specific requirements of passive components for automotive applications, such as vibration tolerance, downsizing, high-temperature tolerance, high reliability, and better thermal management, offer the opportunity for passive component manufacturers to improve their market position by providing solutions adapted to continuously evolving customer needs

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REPORT OBJECTIVES

• Identify and analyze the main market segments for different passive devices
• Analyze the dynamics of different markets and provide insight into drivers, restraints and challenges
• Analyze the supply chain structure and evolution, and identify the key players. Provide an insight into vertical and horizontal integration trends, recent investments and M&A.
• Provide a clear overview of current passive component technologies.
• Highlight the main challenges and proposed innovations.
This report analyzes the technology and market trends for **passive components** (capacitors, magnetics, resistors, and laminated busbars) used in power converters.

The report scope is limited to **high power applications only** such as EV/HEV, PV, wind turbines, rail traction, UPS, and industrial motor drives.
Electronic components in power converters are categorized as **active or passive** depending on the functions they can perform.

**Active components:**
- inject power into a circuit
- capable of electrically controlling and amplifying the flow of electrical current
- require a source of energy, typically in the form of a direct current, in order to perform their specific function

**Passive components:**
- influence the flow of electricity running through them
- For example, they can resist its flow, store energy for later use, or produce inductance
- cannot control or amplify electricity themselves.

**Examples of active components**
- Transistor
- MOSFET
- Amplifier
- Logic gates

**Examples of passive components**
- Capacitor
- Inductor
- Resistor
- Laminated busbar

In this report, Yole investigates the market, supply chain, and technology aspects of passive components related to the six end-applications (motor, EV/HEV, photovoltaic, wind, rail, and UPS) of power electronics systems.
PASSIVE COMPONENTS – KEY MESSAGES

Power converters are a crucial component of power electronics systems. Due to the growing power electronics market, the power converter market will grow from $54 billion to $76 billion with a CAGR 202021-2027 of +5.9%. The main applications driving the power electronics market are EVs/HEVs and motor drives, followed by renewable energy sources.

Passive components, including capacitors, resistors, and inductors, Laminated busbars play equally crucial roles in all power converters as active components do. They store electrical charges, limit current flow, and are used for filtering, surge suppression, measurement, timing, and tuning applications. Therefore, the market for passive components in power converters also has a promising future.

The overall passive components market for power converters will grow from around $7.4 billion in 2021 to $11.6 billion by 2027, with a CAGR 2021-2027 of 7.9%, representing around 15% market share in the power converters market.

In 2021, the biggest market for passive components was industrial motors. However, by 2027 the most significant demand for passive components will be in electric vehicles. Therefore, many passive component companies are willing to expand their business and focus on the automotive industry's current and future needs.

There are specific requirements of passive components for automotive applications such as vibration tolerance requirement, downsizing, high-temperature tolerance, high reliability, better thermal management, etc. At the same time, the companies with multiple product portfolios for EV/HEV have a better starting position to attract automotive customers.

The top passives component manufacturers are Nippon Chemi-Con, Rubycon, Murata, Kyocera/AYX, and TDK, all in Japan; Vishay in the USA; Yageo in Taiwan; Samsung Electro-mechanics in Korea etc. In addition, Rogers Corporation (USA) and Mersen (France) are top laminated busbar manufacturers.

Yole observes a clear trend among passive components companies to diversify their business and regional portfolios. Many passive component suppliers involved in one component are also supplying other passive components.

Many passive components companies have presence and manufacturing capacities in several countries. Manufacturing in low-cost countries like China, India, or Latin America offers lower manufacturing costs than in Europe or Japan. On the other side, local manufacturing provides advantages such as better access to local incentives, more accessible access to customers involved in specific applications, higher flexibility, reactivity to customer demand, etc.

In the past few years, passive component mergers and acquisitions (M&A) have been increasing to add new product lines, increase profitability, access more customers, or eliminate competition. As a result, Yole expects more and more M&A in the field of passive components in the coming years to access many new products and customers and vastly expand its presence in many countries.

In case of passive components production, raw materials (copper, aluminum…) are one of the most expensive variables, and any fluctuation in price or availability for these key feedstocks can hurt the profit margins of passive component manufacturers.
The overall passive components market for power converters will reach from $7.4 billion in 2021 to $11.7 billion by 2027.

- Capacitor: $4.9B, CAGR: 8.3%
- Inductor: $4.4B, CAGR: 8.0%
- Resistor: $1.9B, CAGR: 7.2%
- Laminated busbar: $1.3B, CAGR: 7.2%
- CAGR_{2021-2027}: 7.9%

2021:
- Capacitor: $2.8B
- Inductor: $3.1B
- Resistor: $1.3B
- Laminated busbar: $0.23B
PASSIVE COMPONENTS MARKET EVOLUTION

Evolution between 2021 and 2027

Capacitor market evolution $M

Driven by EV/HEV and motors

Clearly pushed by EV/HEV

Resistor market evolution

Driven by EV/HEV and motors

Driven by rail

Inductor market evolution

Laminated busbar market evolution

- Motors
- UPS
- Rail
- Wind
- EV/HEV
- PV
Many companies are involved in several passive component businesses.

<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Magnetics</th>
<th>Resistors</th>
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<tbody>
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<td>TDK/ EPCOS</td>
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<td>MERITEK ELECTRONICS CORPORATION</td>
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<td>Non-exhaustive list</td>
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Example: EV/HEV Powertrain

Passive Components Location in Power Converter

Resistors
- DC link capacitor precharge resistor

Capacitors
- DC link capacitor (film, ~500 µF)
- Decoupling capacitor (before the boost stage)

Magnetics
- Boost power inductor
- Motor output filters
- DC/DC transformer
- DC/DC smoothing inductor

Laminated busbars
- Power module + capacitor connections at the inverter level (for power > 20 - 30kW)
- Not the mainstream though!
PASSIVE COMPONENTS

Constraints and future development axes

Main development axes passive components
Yole Développement
FUTURE POWER ELECTRONICS CHALLENGES

New passive component requirements

- Three main challenges in power electronics greatly influence passive components’ technology:
  - Higher temperature operation for dies
  - Higher switching frequencies for converters
  - Shrinkage and integration needs for converters in overall systems

- WBG devices, i.e. SiC and GaN, are already accelerating (and will further accelerate) this process, and passive components are obliged to adapt to a new era of power converters

T_j: 150°C → 175°C

High Switching frequency

System size reduction
WHAT NEEDS FOR WBG?

Requirements for passive components in converters using WBG devices

Converter designers are evaluating WBG devices integration into their prototypes, due to the enhanced device performance they exhibit compared to silicon devices.

However, if the other components comprising the power chain feature weak characteristics, overall power converter performance will not be improved.

That said, let’s see which requirements/technologies will be needed from the passive components side to accompany the features provided by WBG devices:

**Capacitors**
- **Higher temperature** (up to 125°C /130°C) needed
- **Higher power-density** capacitors (reduced size with higher current handling)
- **Low inductance** capacitors
- **High-frequency capacitors needed**
  - **PEN**
  - **<5-10nH**
  - **PET**
  - **PPS**

**Magnetics**
- **Enhanced magnetic core material properties** (temp. stability, etc.)
- Inductor & transformer saturation limits increased
- **Higher frequency magnetic cores** (up to few MHz)
- Transformer’s **winding losses reduced**
  - **Nanocrystalline**
  - **Winding capacitive reduction**
  - **Up to few MHz**
  - **Low core losses**

**Resistors**
- **Lower inductance resistors**
- Thick-film technology preferred for higher power densities
- **Improved thermal management**
- **Higher power density**
- **Thick-film resistors**

**Laminated busbars**
- **The glue’s temperature limit must be increased (>105°C)**
- **With fast-switching low inductance required, and due to higher current densities, laminated busbar usage will increase**
- **New glue types**
- **New isolation materials**
- **>105°C**
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