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EARLY ENGAGEMENT WITH DESIGN:

EMS PROVIDER ROLE AND IMPACT

ABSTRACT

The document explores the advantages early engagement with Electronics Manufacturing Services (EMS) providers in the product design process. It emphasizes the importance of co-designing a product and production process to achieve the product design requirements, performance goals, and price constraints, ensuring that the design aligns with the customer's vision and market needs. Design for Excellence (DFX) principles, which include Design for Manufacturability (DFM), Design for Assembly (DFA), Design for Testability (DFT), and Design for Reliability (DFR) are emphasized to not only meet the product requirements, but optimize the production process prior to production launch. Additionally, the document discusses how early engagement can reduce production risk though careful selection of components to avoid supply chain disruptions and reduce costs, defined as Design for Supply-chain (DFS). component obsolescence, supplier performance, manufacturing process design, and ability to inspect the product during the production process are also reviewed. Full inclusion in building the prototypes and testing with root cause analysis are also emphasized to refine the design and ensure it meets quality standards before full-scale production. All findings are documented and clearly communicated to insure they are considered in the next design revision. Each revision of the product is priced to enable real-time decisions on component selection, board layout, process routing, and ability to inspect the product. The document also outlines the benefits of early collaboration with EMS providers, including accelerated speed to market, scalability, regulatory compliance, innovation, cost efficiency, advanced manufacturing techniques, and continuous improvement. These advantages help in enhancing the overall quality and consistency of the product while fostering a culture of continuous improvement.

INTRODUCTION

Early Engagement in the design process is crucial for aligning the design with the customer's product vision and market needs. By engaging with the customer's design early, EMS (Electronics Manufacturing Services) providers can concurrently define a production process that meets design requirements, performance goals, and pricing constraints. This collaborative approach ensures that the final product is not only technically sound, but also economically viable and built to the quality level required by the market.

Early engagement allows for a seamless integration of the EMS provider's expertise in manufacturing, assembling, testing, and supply chain management into the design process. This integration helps in identifying potential issues early, reducing time-to-market, and ensuring that the product meets all necessary regulatory and quality standards.

There are many levels of service that an EMS company offers, Build-to-Print (BTP) is one of them that focuses on manufacturing products based on customer-owned designs.

CUSTOMER-OWNED DESIGN:
The customer provides detailed design specifications, including assembly drawings, schematics, test specifications, and bills of materials. The EMS company does not alter the design but follows it precisely.

MANUFACTURING AND ASSEMBLY EXPERTISE:
The EMS company uses its manufacturing and assembly capabilities to produce the product as per the provided design. This includes collaboratively sourcing materials, assembling components, and performing quality control.

TESTING AND VALIDATION:
The EMS provider also offers testing services to ensure the final product meets the required standards and specifications. Inspection is a key element of validating that a good product is produced. The EMS company performs a number of inspection steps through automated and manual optical inspection, X-Ray inspection and pin checking of connection points.

SUPPLY CHAIN MANAGEMENT:
They manage the supply chain, by proper placement of procurement contracts, ensuring timely procurement of components and materials, and offer solutions to mitigate risks like component obsolescence or stockout.

END-TO-END SERVICES:
EMS companies provide additional services such as logistics, packaging, and after-sales support. These services enable goods to move safely to their final destination and be supported in the field.

Early engagement with design allows customers to leverage the expertise of EMS providers while retaining control over the product design.

Does it mean EMS cannot contribute to the design?

EMS'S CONTRIBUTION

When an EMS supplier receives new design specifications, several key actions are essential to ensure the success of the project. These actions include implementing Design for Excellence (DFX) principles, selecting appropriate components, managing risks, prototyping, testing, maintaining clear documentation, and providing real-time pricing feedback.

DESIGN FOR EXCELLENCE (DFX)

Implementing DFX principles is a critical step in optimizing the product for production, testing, long-term reliability and cost. DFX encompasses several sub-disciplines, including Design for Manufacturability (DFM), Design for Assembly (DFA), Design for Testability (DFT), and Design for Reliability (DFR).

DESIGN FOR MANUFACTURABILITY (DFM)

DFM focuses on designing products that are easy to manufacture. This involves considering factors such as material selection, manufacturing processes, and manufacturing tolerances. By designing with manufacturability in mind, EMS providers can reduce production costs, improve component quality, and shorten lead times.

DESIGN FOR ASSEMBLY (DFA)

DFA takes up where DFM leaves off with assembling the components that have been manufactured for the final product. With DFA, sequencing operations, optimizing and error proofing process steps and insuring assembly steps are verified is essential. Defining assembly at an early stage insures efficiency in process and quality in the end product.

DESIGN FOR TESTABILITY (DFT)

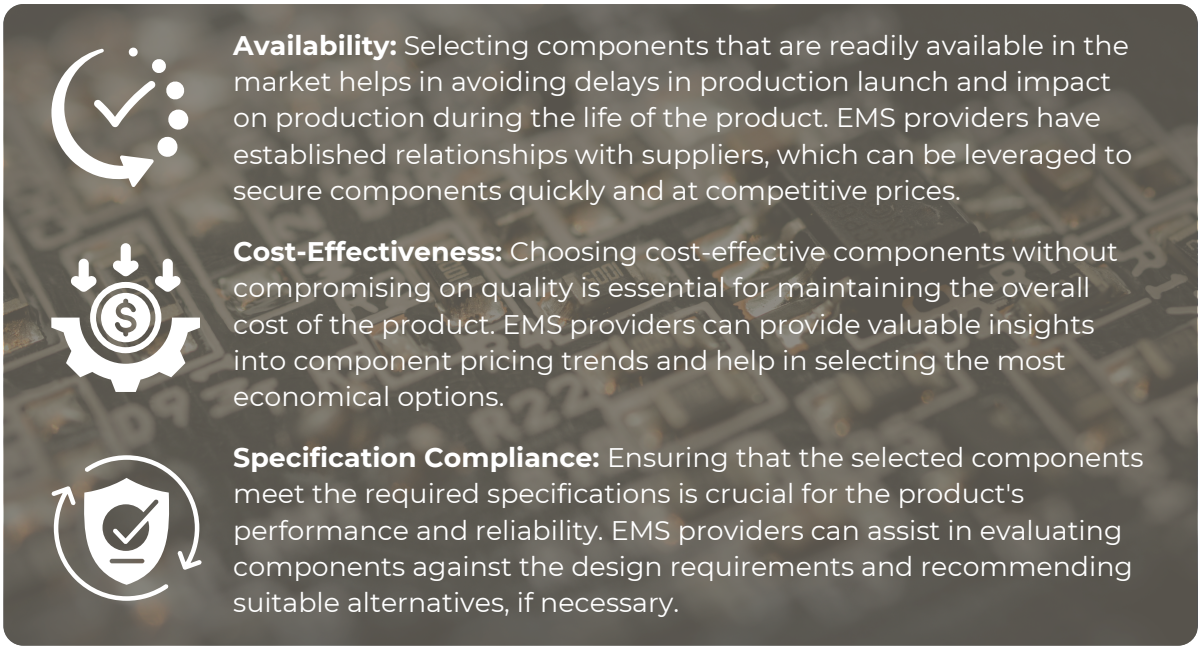
DFT ensures that the product can be easily tested during production, provides the greatest level of test coverage, and drives the greatest yield in the production process. This involves designing in test points for greatest test coverage, incorporating self-test features to the design, and ensuring that the product can be tested using automated equipment. Effective DFT practices help in identifying defects early in the production process where they are the least costly to fix, reducing the risk of field failures through greater test coverage, and improving overall product quality in the field.

DESIGN FOR RELIABILITY (DFR)

DFR focuses on ensuring that the product will perform reliably over its intended lifespan. This involves selecting high-quality components, ensuring the process has validation steps, like AOI, AXI and Pin Check, and conducting reliability testing. By prioritizing reliability in the design phase, EMS providers can reduce warranty claims and enhance customer satisfaction.

COMPONENT SELECTION

Another aspect of DFX is Design for Supply Chain (DFS). DFS involves carefully selecting components that are readily available when the product goes into production and for the life of the product, cost-effective, and meet the required specifications. This helps in avoiding supply chain disruptions and reducing costs.



Availability: Selecting components that are readily available in the market helps in avoiding delays in production launch and impact on production during the life of the product. EMS providers have established relationships with suppliers, which can be leveraged to secure components quickly and at competitive prices.

Cost-Effectiveness: Choosing cost-effective components without compromising on quality is essential for maintaining the overall cost of the product. EMS providers can provide valuable insights into component pricing trends and help in selecting the most economical options.

Specification Compliance: Ensuring that the selected components meet the required specifications is crucial for the product's performance and reliability. EMS providers can assist in evaluating components against the design requirements and recommending suitable alternatives, if necessary.

RISK MANAGEMENT

Identifying potential risks early in the design process and developing mitigation strategies is crucial for the success of the project. This includes considering factors like component obsolescence, supplier performance, process complexity, and the ability to inspect the product.

Component Obsolescence: Components can become obsolete due to changes in technology or market demand. EMS providers can help in identifying components that are at risk of obsolescence depending on their phase in the component lifecycle or product technology and recommend suitable alternatives.

Supplier Performance: The performance of suppliers can impact the quality and availability of components. EMS providers can evaluate supplier performance based of historical interaction with the supplier and their investment in technology and develop strategies to mitigate risks associated with unreliable or under invested suppliers.

Process Complexity Impacts: Product designs often present manufacturing and assembly challenges that create risk in the production process. Items such as board layout, component package selection, and post assembly coatings can affect the EMS provider’s ability to produce a quality product at a specified price point. EMS providers can help in assessing these risks and developing strategies to mitigate their impact.

Inspection and Testing: Ensuring that the product can be inspected and tested effectively is crucial for maintaining quality. EMS providers can assist in designing for inspectability and developing testing process steps to identify defects early.

PROTOTYPING AND VALIDATION

Early prototyping and thorough validation help identify and address potential issues, enabling refinement of the design to meet quality standards before the production process is finalized. Prototyping allows for the evaluation of the design in a real-world environment, providing valuable feedback for further refinement.

Prototype Development:
Developing prototypes early in the design process allows for the identification of design flaws and areas for improvement. EMS providers can assist in building prototypes quickly and cost-effectively. Additionally, Production personnel can view the developmental builds to gain a full understand of what is required in the production process.

Testing and Validation:
Conducting thorough testing on prototypes helps in identifying potential issues and validating the design against the required specifications. EMS providers can provide testing services, including in-circuit testing, functional testing, environmental testing, and reliability testing.

DOCUMENTATION AND COMMUNICATION

Maintaining clear and detailed documentation of the proposed production process, including product specifications, product and process changes, and validation results that drive changes to the product or process, ensures effective communication between the EMS provider and the customer. Clear documentation helps in addressing issues promptly and making informed decisions.

Specifications -
Documenting the design specifications in detail ensures that all stakeholders have a clear understanding of the requirements. This includes mechanical drawings, electrical schematics, board layouts, and software requirements.

Change Management -
Documenting changes to the design and production process helps in tracking modifications and their impact on the program. EMS providers assist in managing change requests and ensuring that all changes are properly documented.

Test Results -
Documenting test and validation results provides valuable insights into the performance and reliability of the product. EMS providers assist in conducting functional tests, running validation experiments, and documenting the results for further analysis.

PRICING

Regularly updating pricing to provide real-time feedback on design changes that impact the final product's cost ensures the lowest cost upfront. This is similar to performing VAVE (Value Analysis/Value Engineering) events during the design process.

Cost Analysis:
Conducting a detailed cost analysis early helps in identifying cost drivers and areas for cost reduction. EMS providers can provide insights into component pricing, manufacturing and assembly costs, and potential cost-saving opportunities.

Real-Time Feedback:
Providing real-time feedback on design changes that impact the cost of the final product helps in making informed decisions. EMS providers can assist in evaluating the cost impact of design modifications and recommending cost-effective alternatives.

EXAMPLES

FET SELECTION

Choosing the right Field-Effect Transistor (FET) for the design involves considering factors such as voltage rating, current rating, and switching speed. EMS providers can assist in evaluating different FET options through testing expected to actual performance and selecting the most suitable one for the application.

Selecting the right FET is crucial for the design and performance of automotive braking systems, particularly Electro Mechanical Brake (EMB) systems. Here are several ways FET selection can influence the design:

PERFORMANCE AND RELIABILITY

Current Handling
FETs must handle high currents efficiently to ensure reliable operation of the braking system. High current handling capability is essential for the electrical motors used in EMB.

Thermal Management
FETs with low thermal resistance help in managing heat dissipation, which is critical for maintaining performance and preventing overheating.

Avalanche Ruggedness
FETs used in ABS must be avalanche rugged to withstand voltage spikes and ensure reliable operation during sudden braking.

EFFICIENCY

Low On-Resistance

FETs with low on-resistance reduce power losses, improving the overall efficiency of the braking system. This is particularly important for maintaining battery life and reducing energy consumption in electric vehicles.

Switching Speed

Fast switching FETs enable precise control of the braking system, allowing for quick response times during emergency braking situations.

COMPACT DESIGN

Footprint

FETs with a compact footprint, such as those in LFPAK56 packages, allow for a more compact and thermally stable design. This is beneficial for integrating the braking system into the limited space available in modern vehicles.

SAFETY AND PROTECTION

Reverse Polarity Protection

FETs can be used to provide reverse polarity protection, ensuring the system remains safe even if the battery is connected incorrectly.

Robustness

FETs must be robust enough to handle the harsh automotive environment, including temperature variations and vibrations.

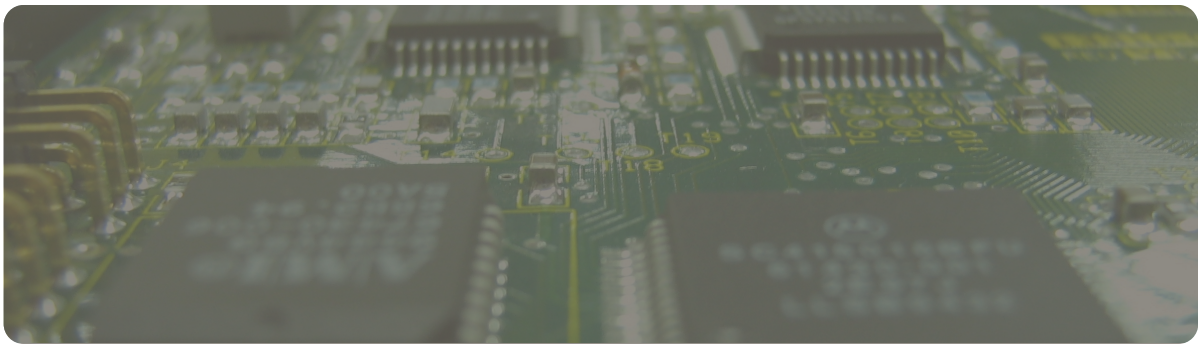
COST AND AVAILABILITY

Cost-Effective Components

Selecting cost-effective FETs without compromising on quality helps in reducing the overall cost of the braking system.

Availability

Ensuring that the selected FETs are readily available in the market helps in avoiding supply chain disruptions and ensures timely production.



The selection of FETs plays a pivotal role in the design of automotive braking systems by influencing performance, efficiency, compactness, safety, and cost. By carefully choosing FETs that meet the specific requirements of the braking system, designers can ensure reliable and efficient operation, ultimately enhancing vehicle safety and performance. The EMS provider can validate specifications of the FETs in product as a whole during the Prototype and Validation phase of development. Data from this validation is useful in completing the typical Design Failure Mode and Effects Analysis (DFMEA), Production Failure Mode and Effects Analysis (PFMEA), and Production Part Approval Process (PPAP).

PCB MANUFACTURER	CONFORMAL COATING
Selecting a PCB manufacturer considering capability to produce the Printed Circuit Board (PCB), quality record based on experience with the supplier, and geopolitical factors, such as tariffs and trade restrictions, can help to insure a supplier is chosen to meet the design and quality specification for the PCB and avoid supply chain disruptions, all at the lowest cost. EMS providers can provide insights into the capabilities, reliability, and cost of different PCB manufacturers.	Defining machine routes, keep-outs and head selection for conformal coating involves considering factors such as coating material, application method, and curing process. EMS providers can assist in developing a conformal coating process that meets the required specifications at the lowest cost point.

Conformal coating is a critical aspect of designing automotive braking systems, particularly for protecting the electronic components involved in systems like EMB. Here's how the conformal coating influences the design and performance of braking systems:

PROTECTION FROM ENVIRONMENTAL FACTORS

Moisture and Humidity:
Conformal coatings protect electronic components from moisture and humidity, which can cause corrosion and electrical shorts. This is particularly important in braking systems exposed to varying weather conditions.

Dust and Debris:
The coating prevents dust and debris from settling on the circuit boards, which can interfere with the operation of the braking system.

Chemical Exposure:
Automotive braking systems are often exposed to harsh chemicals used in the operation of a vehicle. Conformal coating provides a barrier against these chemicals, preventing damage to the electronic components.

ELECTRICAL INSULATION

Preventing Short Circuits:
Conformal coatings provide electrical insulation, preventing short circuits between closely spaced components on the circuit board. This is essential for the reliable operation of the braking system.

Dielectric Properties:
The dielectric properties of conformal coatings allow for tighter spacing of components, enabling more compact and efficient designs.

MECHANICAL PROTECTION

Vibration and Shock:
Automotive braking systems are subject to significant vibration and mechanical shock. Conformal coatings help in absorbing and mitigating these forces, as well as acting as an adhesive to protect the integrity of the electronic components.

Abrasion Resistance:
The coatings provide a protective layer that resists abrasion, which can occur due to friction and movement during the installation process to the vehicle.

LONGEVITY AND RELIABILITY

Improved Reliability:
The enhanced protection and insulation provided by conformal coatings improve the overall reliability of the braking system, reducing the likelihood of failures and extending the lifespan of the braking system.

The conformal coating is crucial in the design of automotive braking systems as it provides essential protection against environmental, thermal, electrical, and mechanical stresses. By ensuring the longevity and reliability of electronic components, conformal coatings play a vital role in maintaining the safety and performance of braking systems.

Common Label Placement: Standardizing label placement for automated inspection across multiple products helps in improving inspection efficiency and reducing errors. EMS providers can assist in developing labeling guidelines and implementing automated inspection systems.

Optimizing Automated Inspection: Ensuring that automated inspection can detect the presence of foreign objects and absence of components without sacrificing cycle time, involves designing for inspectability and selecting appropriate inspection technologies. EMS providers can assist in developing inspection protocols and selecting inspection equipment.

COLLABORATION BENEFITS

Speed to Market: Working with EMS providers can accelerate the development and deployment of EMB systems, thanks to their established manufacturing infrastructure and expertise. EMS providers can help in streamlining the design and production process, reducing time-to-market, and ensuring that the product is ready for launch on schedule.

Scalability: EMS providers can scale production efficiently, accommodating both small and large volume requirements. Additionally, providing regional assembly of products is a specialty of EMS providers, ensuring you can not only scale efficiently, but also effectively in the region where the product is consumed. This flexibility allows for the efficient ramp-up of production to meet market demand, ensuring that the product is available when and where needed.

Regulatory Compliance: EMS providers are well-versed in industry standards and regulations, ensuring that EMB systems meet all necessary compliance requirements for manufacturing, assembling, and sourcing. This includes compliance with environmental regulations, safety standards, and industry-specific requirements for automotive systems.

Innovation: EMS providers can contribute to innovation by incorporating the latest technologies for manufacturing, assembling, and materials into EMB designs, keeping the systems at the forefront of advancements. This includes leveraging new manufacturing and assembly techniques, materials acquisition and validation processes, and inspection and test hardware to ensure product performance and reliability.

COLLABORATION BENEFITS (CONTINUED)

Cost Efficiency: Collaborating with EMS providers can reduce manufacturing and assembly costs through optimized product design for the production process, creating a process tailored to the design. This enables the high utilization of production equipment and personnel, creating the highest probability of economies of scale at the projected volumes. EMS providers can assist in identifying cost-saving opportunities in the initial design that enables the greatest cost efficiency in the manufacturing and assembly processes.

Advanced Manufacturing Techniques: EMS providers often employ advanced manufacturing techniques, such as automated assembly, precision soldering, and state-of-the-art inspection processes, which improve the quality and consistency of EMB systems. These techniques help in reducing defects, improving product reliability, and ensuring consistent quality.

Continuous Improvement Mindset: Early engagement of the systems and staff that will build production and the push for launching an optimized product for the manufacturing process fosters a culture of continuous improvement. By regularly reviewing processes and seeking feedback from all stakeholders this continuous improvement process is instilled. This helps in identifying areas for improvement and implementing best practices early and often.

CONCLUSION

Early engagement with an EMS (Electronics Manufacturing Services) provider in the design process is essential for aligning the design with the customer's product vision, cost requirement, and market needs. This collaborative approach ensures that the final product is technically sound, economically viable, and market-ready.

EMS providers contribute significantly by implementing Design for Excellence (DFX) principles, selecting appropriate components, managing risks, prototyping, and validating, maintaining clear documentation, and providing real-time pricing feedback. These actions help optimize the product for production, inspection, testing, cost, and long-term reliability.

Key examples of EMS contributions include selecting the right Field-Effect Transistor (FET), choosing PCB manufacturers, defining conformal coating routes, standardizing label placement for automated inspection, and optimizing automated inspection processes.

The benefits of collaborating with EMS providers include accelerated speed to market, scalability, regulatory compliance, innovation, cost efficiency, advanced manufacturing techniques, and a continuous improvement mindset. By engaging early and leveraging the expertise of EMS providers, companies can ensure their products are optimized for manufacturability, cost-efficiency, and market success.