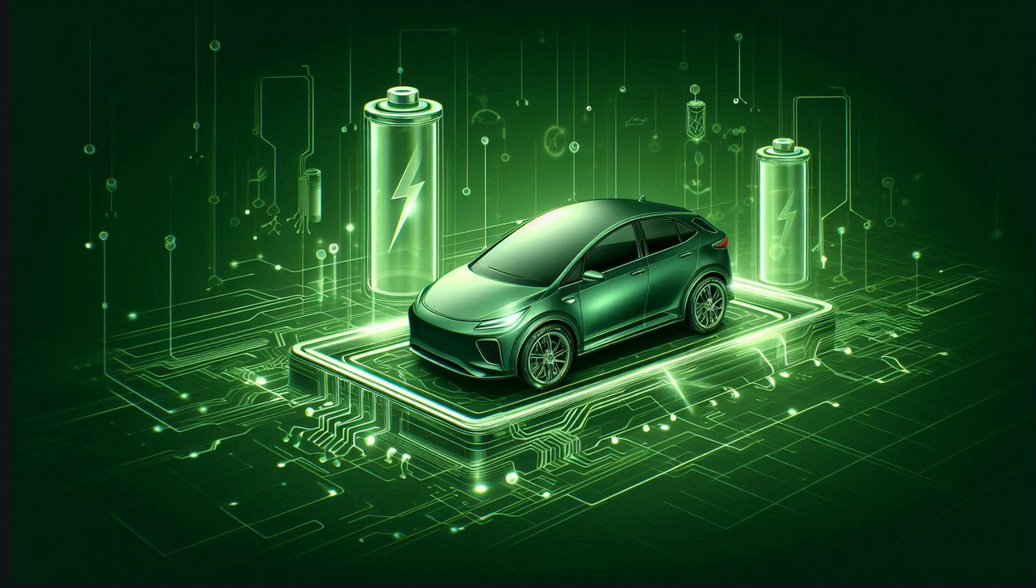

EV Battery Management

Standards and Protocols

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Agenda

1. Battery Safety Standards
2. Battery Performance Standards
3. Communication and Protocol Standards
4. Battery Management System (BMS) Standards
5. Battery Recycling and Environmental Standards
6. Charging Standards (Relevant to EV Batteries)
7. Battery Packaging, Transport, and Handling Standards
8. Battery Test Standards
9. Standards for Battery Energy Density and Efficiency
10. Regional and National Standards
11. Cybersecurity Standards for EV Batteries

Battery Safety Standards

These standards ensure the safe design, manufacturing, and operation of EV batteries.

- **ISO 26262** : Functional safety for electrical and electronic systems in vehicles.
- **UL 2580** : Safety requirements for batteries used in electric and hybrid vehicles.
- **IEC 62660** : Specifies safety and performance for lithium-ion cells in EVs.
- **SAE J2464** : Safety requirements for battery abuse testing.
- **IEC 62485** : Safety requirements for battery installations.
- **GB 38031 (China)** : Safety standards for EV battery systems.

Battery Performance Standards

These define the performance characteristics of EV batteries.

- **IEC 61982** : Performance testing for secondary batteries used in EVs.
- **ISO 12405** : Electrical testing of battery packs and systems.
- **SAE J1798** : Performance requirements for rechargeable energy storage systems (RESS).
- **GB/T 31484 (China)** : Lifecycle requirements and test methods for EV batteries

Communication and Protocol Standards

These enable interoperability between the battery, vehicle, and charging infrastructure.

- ISO 15118 : Vehicle-to-grid (V2G) communication interface.
- CAN (Controller Area Network) : Widely used for in-vehicle communication.
- SAE J1939 : Higher-layer CAN protocol for heavy-duty vehicles.
- GB/T 32960 (China) : Communication protocol for EV battery monitoring.
- CHAdeMO Protocol : Enables communication between the battery and charger for DC fast charging.
- Open Charge Point Protocol (OCPP) : Communication between charging stations and management systems.

Battery Management System (BMS) Standards

BMS standards ensure the effective monitoring and control of EV batteries.

- **SAE J2936** : Communication between the BMS and charging system.
- **ISO 21782** : Focuses on electric drive components, including BMS.
- **IEC 60747-17** : Guidelines for power isolation within BMS.

Battery Recycling and Environmental Standards

These ensure the sustainability of EV batteries through proper recycling and disposal practices.

- EU Battery Directive (2006/66/EC) : Regulation for the collection, recycling, and disposal of batteries.
- ISO 14001 : Environmental management system (indirectly applicable to battery production).
- UN 38.3 : Transportation testing requirements for lithium batteries to ensure safety in handling and shipping.

Charging Standards (Relevant to EV Batteries)

Charging protocols indirectly define requirements for the EV battery.

- **IEC 61851** : Electric vehicle conductive charging system.
- **IEC 62196** : Plugs, socket outlets, and connectors for charging vehicles.
- **SAE J1772** : Electric vehicle conductive charge coupler.
- **IEC 60364-7-722** : Safety for charging installations.

Battery Packaging, Transport, and Handling Standards

These standards focus on the safe handling and transport of EV batteries.

- **UN 38.3** : Transportation safety testing for lithium-ion batteries.
- **IATA Dangerous Goods Regulations (DGR)** : Air transport regulations for batteries.
- **ADR (European Agreement)** : Transport of dangerous goods by road.

Battery Test Standards

These cover testing methods to assess battery safety, durability, and performance.

- **IEC 62660-1/2/3** : Standards for lithium-ion cells, focusing on performance, reliability, and safety.
- **ISO 16750** : Testing of environmental conditions for electrical components, including batteries.
- **SAE J537** : Testing storage batteries for automotive applications.

Standards for Battery Energy Density and Efficiency

These govern energy measurement and efficiency evaluation.

- **IEC 61960** : Specifies capacity and energy density requirements for lithium-ion cells.
- **ISO 18243** : Energy efficiency standards for EV batteries.

Regional and National Standards

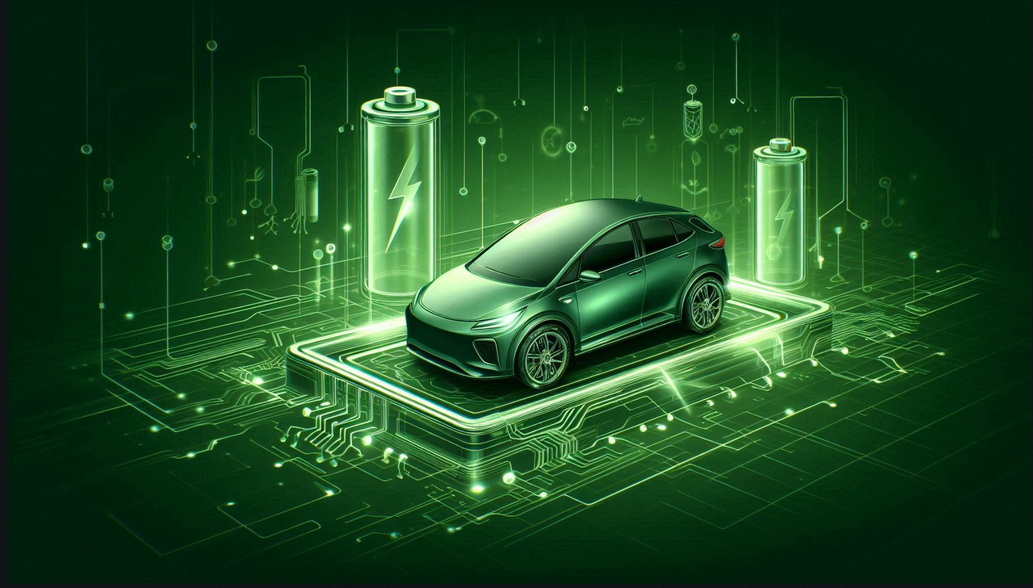
Different regions have their own specific standards:

- **China (GB/T Standards)** : GB/T 31467, GB/T 31485, etc., for battery system requirements.
- **Europe (ECE R100)** : Standards for battery safety in electric and hybrid vehicles.
- **United States (SAE Standards)** : Extensive standards like SAE J2929, J2464, etc., for EV batteries.

Cybersecurity Standards for EV Batteries

With increasing connectivity, cybersecurity for battery systems is crucial.

- **ISO/SAE 21434** : Security engineering for road vehicles.
- **NIST Cybersecurity Framework** : Guidelines for secure management of connected systems.



SAE J2936

Communication between the BMS and Charging System

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SAE J2936 - Key Aspects & Scope

SAE J2936 is a standard from the **Society of Automotive Engineers (SAE)** that defines the requirements and communication protocols for the **Battery Management System (BMS)** used in hybrid electric vehicles (**HEVs**), plug-in hybrid electric vehicles (**PHEVs**), and battery electric vehicles (**BEVs**).

It focuses on the integration of the BMS with other vehicle systems, ensuring safe and efficient operation of high-voltage battery systems.

- Guidance for the interaction between the BMS and other vehicle systems, including the electric powertrain, thermal management systems, and chargers.
- Specifications for ensuring safe operation, efficient energy use, and reliable communication between systems.

SAE J2936 - Key Features

System Integration

- Defines how the BMS interacts with other critical vehicle systems, such as:
  - Electric motors and inverters.
  - Charging systems (both AC and DC).
  - Vehicle control units (VCUs).
  - Thermal management systems.
- Ensures seamless communication and operation between these components.

Communication Protocols

- Specifies the use of Controller Area Network (CAN) for real-time data exchange between the BMS and other systems.
- Outlines protocols for exchanging data such as:
  - State of Charge (SoC).
  - State of Health (SoH).
  - Battery temperature.
  - Voltage and current readings.
- Supports advanced functions like **Vehicle-to-Grid (V2G)** communication.

SAE J2936 - Key Features

Safety Monitoring

- Defines protocols for real-time fault detection and management.
- Includes safety features to handle:
  - Overvoltage and under voltage conditions.
  - Overcurrent scenarios.
  - Overheating or thermal runaway events.

Energy Management

- Provides guidelines for managing the battery’s energy use to optimize range and performance.
- Includes support for regenerative braking to recover energy during deceleration.
- Coordinates power delivery and charging/discharging cycles to extend battery life.

SAE J2936 - Key Features

Thermal Management

- Specifies how the BMS communicates with the vehicle’s thermal management system to ensure the battery operates within safe temperature limits.
- Supports cooling and heating strategies for battery performance optimization.

Diagnostics and Maintenance

- Includes requirements for self-diagnosis of the BMS and reporting of errors or faults.
- Supports remote diagnostic capabilities for troubleshooting and maintenance.

Scalability and Modularity

- Ensures that the standard can be applied to a variety of EV architectures, from compact electric cars to commercial vehicles.
- Supports modular battery designs with multiple battery packs or cells.

SAE J2936 - EV Applications

Battery Monitoring

- Continuous monitoring of battery cell voltages, currents, and temperatures.
- Prevents unsafe operating conditions, such as thermal runaway or overcharging.

Charging Communication

- Ensures compatibility with both AC Level 1/2 and DC fast charging systems.
- Facilitates Vehicle-to-Grid (V2G) and Vehicle-to-Home (V2H) energy transfer.

Powertrain Control

- Shares battery status with the vehicle control unit (VCU) to optimize energy delivery to the motor.
- Enables dynamic power allocation based on driving conditions.

Safety Systems

- Integrates with vehicle safety systems to initiate protective measures in case of battery faults.
- Triggers system shutdowns or isolation of faulty battery modules when necessary.

SAE J2936 - Testing and Validation

- **Functional Testing**
  - Verifies communication between the BMS and other systems.
  - Tests the BMS’s ability to monitor and manage battery parameters effectively.
- **Environmental Testing**
  - Includes thermal, vibration, and humidity testing to simulate real-world conditions.
- **Fault Tolerance Testing**
  - Ensures the BMS can detect, report, and manage faults (e.g., over voltage, under voltage).
- **Energy Efficiency Testing**
  - Evaluates the BMS’s ability to optimize energy use and maximize battery life.

SAE J2936 - Related Standards

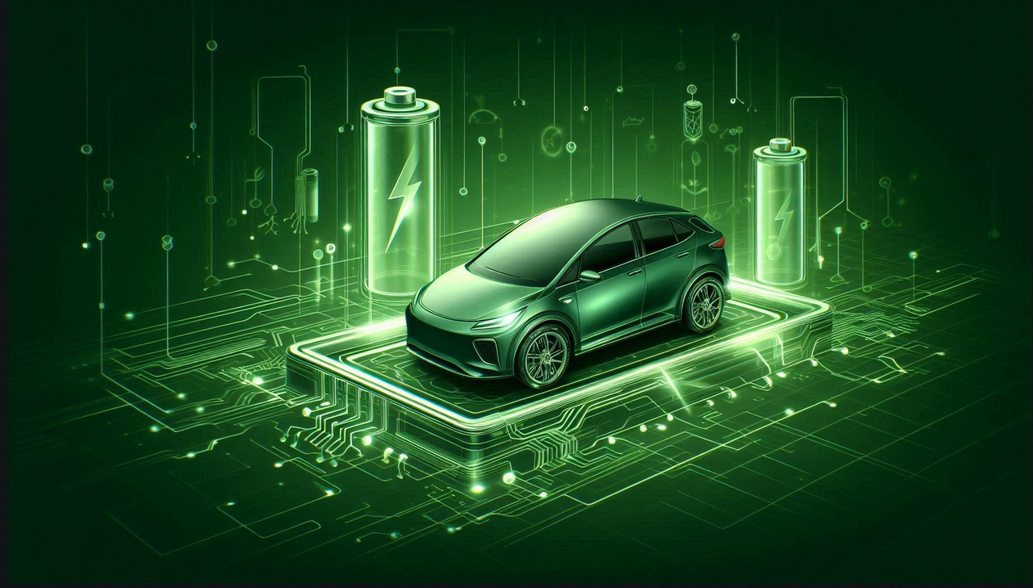
- **ISO 15118** : For vehicle-to-grid communication.
- **SAE J2464** : Safety testing for rechargeable energy storage systems.
- **SAE J1772** : Charging connector and protocol standard for EVs.
- **ISO 26262** : Functional safety for road vehicles.
- **IEC 62660** : Performance and safety standards for lithium-ion battery cells

SAE J2936 - Key Advantages

- **Safety** : Provides robust safety protocols for preventing battery-related failures.
- **Interoperability** : Ensures seamless integration of the BMS with EV subsystems and external charging infrastructure.
- **Efficiency** : Supports energy-efficient operation and prolongs battery life.
- **Scalability** : Applicable to various vehicle types, from light-duty EVs to heavy-duty commercial vehicles.
- **Global Relevance** : Aligns with international standards, making it suitable for global EV development.

SAE J2936 - Practical Implementation in EV

- **Battery Pack Design** : Ensures the design of modular battery packs with efficient energy management.
- **Thermal OptimiSation** : Helps maintain optimal battery temperature for extended performance and safety.
- **Fault Handling** : Manages faults proactively to avoid catastrophic failures.
- **Regenerative Braking** : Integrates with powertrain systems to recover energy during braking.



ISO 21782

Focuses on electric drive components, including BMS

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ISO 21782 - Key Aspects

- ISO 21782 is a set of standards that focuses on the electrification of road vehicles, particularly covering electric drive components used in hybrid electric vehicles (HEVs) and electric vehicles (EVs).

- It provides guidelines and specifications for various components in the electric drive system, including the Battery Management System (BMS), motors, inverters, and related subsystems.

- This standard ensures the safe, reliable, and efficient design, testing, and operation of electric drive systems, which are critical for EV performance and safety.

Scope of ISO 21782

The ISO 21782 series addresses:

- Electric drive systems for road vehicles, particularly in the low voltage (<60 V) and high voltage (>60 V up to 1,500 V DC or 1,000 V AC) ranges.
- Testing and performance requirements for individual components and subsystems in the electric drive system.
- Interactions between components like batteries, inverters, and motors.

Structure of ISO 21782

The ISO 21782 standard consists of several parts, each focusing on a specific component or subsystem within the electric drive system. Below are the primary parts:

ISO 21782-1 : General requirements and definitions

- Provides overarching definitions and general requirements for electric drive systems.
- Outlines the voltage classification for HEVs and EVs.
- Addresses system integration and high-level safety considerations.

ISO 21782-2 : Electric propulsion systems — Performance test methods

- Specifies test methods for assessing the performance of electric propulsion systems.
- Includes evaluation of efficiency, thermal behaviour, and power output under various conditions.

Structure of ISO 21782

ISO 21782-3 : Electric drive inverters

- Focuses on requirements for inverters used to control electric motors.
- Provides guidelines for testing their performance, efficiency, and electromagnetic compatibility (EMC).

ISO 21782-4 : Electric motors

- Specifies requirements and test methods for electric motors used in EV propulsion systems.
- Covers torque, power output, and thermal characteristics.

ISO 21782-5 : Batteries and Battery systems

- Details requirements for the safe integration of batteries into the electric drive system.
- Focuses on battery durability, reliability, and system compatibility.

Structure of ISO 21782

ISO 21782-6 : Battery Management System (BMS)

- Provides specifications for BMS, including monitoring, control, and protection of the battery pack.
- Includes standards for communication with other EV subsystems, voltage balancing, and fault handling.

ISO 21782-7 : System-level integration and testing

- Ensures proper integration of all components (batteries, inverters, motors) in the electric drive system.
- Covers vehicle-level testing to ensure overall system performance and safety.

ISO 21782 - Key Features

- **Voltage Classifications** : Defines safe voltage levels for components and systems to reduce the risk of electric shock.
- **Testing and Verification** : Provides standardised test methods to validate the performance, safety, and reliability of components.
- **Thermal Management** : Addresses thermal behaviour and cooling requirements for batteries, motors, and inverters to prevent overheating.
- **Energy Efficiency** : Establishes benchmarks for energy efficiency, which is critical for maximising EV range and performance.
- **Interoperability** : Ensures compatibility between different components of the electric drive system.

Relevance of ISO 21782 to Battery Management Systems (BMS)

ISO 21782 includes specific guidelines for BMS, which is a critical part of any EV's electric drive system:

- **Battery Monitoring** : Defines protocols for monitoring cell voltage, temperature, and state of charge (SoC).
- **Safety** : Outlines measures for fault detection, isolation, and protection against thermal runaway or overcharging.
- **Communication** : Specifies communication standards for data exchange between the BMS, motor controller, and other systems.
- **Control Algorithms** : Sets standards for battery balancing, power management, and efficiency optimisation.

ISO 21782 - Integration with Other Standards

ISO 21782 is designed to work in conjunction with other relevant standards:

- **ISO 15118** : For vehicle-to-grid (V2G) communication and charging protocols.
- **IEC 62660** : For lithium-ion battery cell performance and safety.
- **ISO 26262** : For functional safety of the electric drive system and BMS.

ISO 21782 - Importance

- **Safety** : Ensures safe operation of high-voltage systems in EVs.
- **Reliability** : Guarantees the durability and performance of electric drive components over time.
- **Interoperability** : Enables integration of components from different manufacturers.
- **Energy Efficiency** : Promotes the development of highly efficient drive systems to extend EV range.
- **Compliance** : Helps manufacturers meet regulatory requirements and standards for global markets.

IEC 60747-17

Guidelines for power isolation within BMS

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IEC 60747-17

- IEC 60747-17 is a standard that focuses on semiconductor devices used for galvanic isolation, particularly in Battery Management Systems (BMS), inverters, and other electrical systems in electric vehicles (EVs).

- It provides guidelines for the safe and reliable isolation of high-voltage components, which is critical for preventing electrical hazards, ensuring system reliability, and maintaining operational safety.

IEC 60747-17 - Key Aspects & Scope

IEC 60747-17 is part of the broader IEC 60747 series, which deals with discrete semiconductor devices and integrated circuits. Specifically, IEC 60747-17 focuses on:

- **Semiconductor devices with galvanic isolation** (e.g., optocouplers, capacitive and magnetic isolators).
- **Electrical isolation** requirements for components in high-voltage systems.
- Test methods to ensure the reliability and safety of isolation devices under various conditions.

It is commonly applied in **BMS**, **EV inverters**, **onboard chargers (OBCs)**, and **powertrain systems** where isolation is required between high-voltage and low-voltage domains.

IEC 60747-17 - Key Features

Isolation Standards

- Defines the minimum isolation voltage for semiconductor devices used in systems with high-voltage components.
- Establishes the safe working voltage across the isolation barrier (up to 1,500 V for EV applications).
- Specifies requirements for insulation resistance to prevent current leakage.

Semiconductor Device Types

- **Optocouplers**: Semiconductor devices that use light for signal transmission across an isolation barrier.
- **Capacitive Isolators**: Use electric fields for signal isolation.
- **Magnetic Isolators**: Use magnetic coupling for data or signal transmission while maintaining isolation.
- These devices are integral to **BMS**, ensuring that sensitive low-voltage electronics can communicate safely with high-voltage systems.

IEC 60747-17 - Key Features

High Voltage and Surge Testing

- Ensures devices can withstand surge voltages and high-voltage spikes without breaking down.
- Provides test methods for evaluating surge immunity and transient overvoltage tolerance.

Thermal and Environmental Conditions

- Specifies operational temperature ranges, ensuring performance under extreme conditions (common in EV systems).
- Includes aging and stress testing to simulate long-term use in challenging environments.

IEC 60747-17 - Key Features

Performance Metrics

Defines parameters such as:

- **Creepage and clearance distances**: Physical spacing to avoid electrical arcing across the isolation barrier.
- **Propagation delay**: Timing delays in signal transmission across the isolation device.
- **Common Mode Transient Immunity (CMTI)**: Resistance to voltage changes between the two sides of the isolation barrier.
- **Power consumption** and **data rate** capabilities.

IEC 60747-17 - Applications in EV Systems

Battery Management Systems (BMS)

- Ensures safe communication between the high-voltage battery and the low-voltage controller.
- Prevents electrical hazards like short circuits or voltage surges in battery modules.

Power Inverters

- Provides isolation for high-voltage switching circuits.
- Protects sensitive control circuitry from voltage spikes generated by power electronics.

Onboard Chargers (OBCs) : Protects the control systems in EV charging systems from high-voltage inputs.

Electric Motor Controllers : Isolates the motor drive circuits from the vehicle control system.

Vehicle-to-Grid (V2G) Systems : Provides galvanic isolation in bidirectional charging systems to ensure safety during grid interaction.

IEC 60747-17 - Testing and Verification

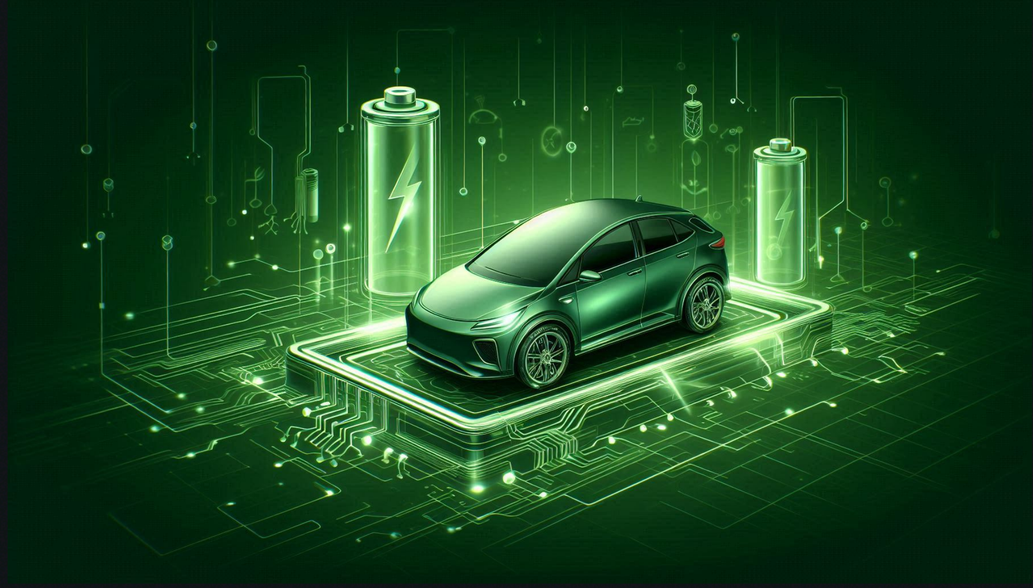
- **Dielectric Withstand Testing** : Verifies the ability of the isolation barrier to handle high voltage without breakdown.
- **Partial Discharge Testing** : Detects any partial electrical discharges within the isolation material to ensure long-term durability.
- **Temperature Cycling** : Simulates extreme temperature fluctuations to evaluate thermal expansion and contraction effects on isolation.
- **Voltage and Surge Testing** : Evaluates the device's resistance to over-voltage and electrical surges.
- **Electromagnetic Compatibility (EMC) Testing** : Ensures the device does not emit or is not affected by electromagnetic interference.

IEC 60747-17 - Integration with Other Standards

- **IEC 60664** : Insulation coordination for equipment within low-voltage systems.
- **ISO 26262** : Functional safety for road vehicles.
- **IEC 62433** : Electromagnetic compatibility (EMC) requirements for electronic systems.

IEC 60747-17 - Importance

- **Safety** : Provides robust isolation to prevent high-voltage components from damaging low-voltage circuits or endangering users.
- **Reliability** : Ensures devices can operate under high-stress conditions without degradation.
- **Efficiency** : Optimises performance by specifying low-power, high-speed isolation devices.
- **Global Compliance** : Helps manufacturers meet international safety and quality standards for EV systems.



Thank you

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