MANAGEMENT OF PROGRAMMABLE SAFETY SYSTEMS

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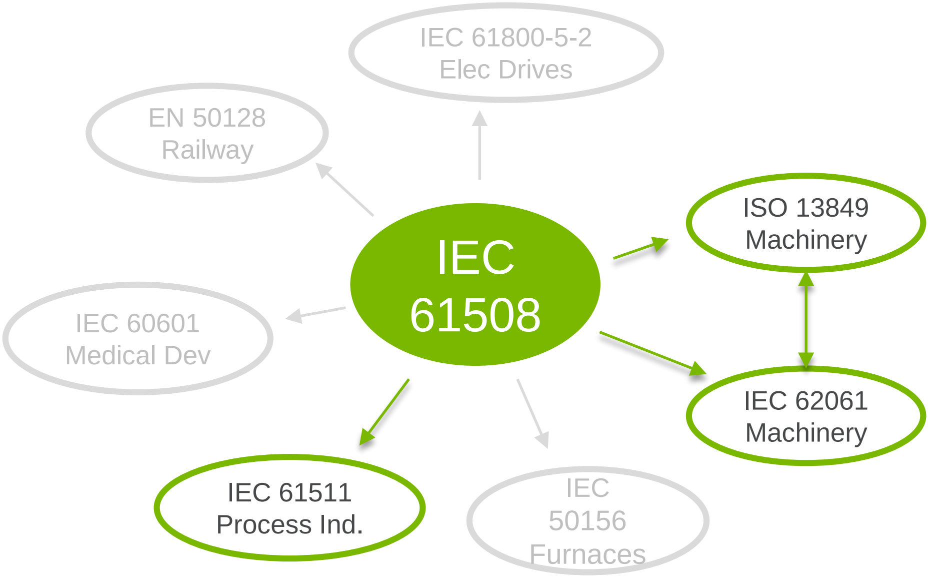
Applicable Standards



- IEC 61508 is the parent standard
  - Applicable in any situation
  - Used when no applicable child standard exists
  - Very general, many requirements are overly complex
- Child Standards
  - Specialize the requirements of 61508 for a specific application
  - If you meet the requirements of the child, you meet the relevant requirements of 61508
- Best fit for Accelerators
  - IEC 62061
  - ISO 13849
  - IEC 61511

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Certified hardware benefits

- Use of a single PLC
  - Eliminates redundant systems and associated wiring.
  - Ability to clearly separate safety from non-safety tasks
  - Built-in diagnostics
  - Safety I/O allows reduction of relays
- Programming
  - Use of certified and proven functions reduces programming effort
    - Easier to apply = Less errors
  - Reduces safety and standard programs/tasks
    - Reduced size of safety program
    - Reduces review & test time

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Vendor Software Management

- Programming tool updates
  - Only when necessary
    - The “Microsoft“ effect
    - Development platform support
- Firmware Updates
  - Quarterly reviews unless alert

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Software

- The latest generation of PLCs bring with them a lot of new features.
  - Tag based instead of memory based programing
  - User defined data types or structures (UDTs)
  - Add on instructions or functions (AOIs)
  - Arrays
- Proper use of these features can allow for
  - Improved code readability
  - Improved code reviewability
  - Enforcement of tag naming consistency
  - Simplification of functional changes
  - Reduction of errors cause by repetitive tag entry for similar devices
  - Reduce errors caused by repetitive programming of same function for similar devices

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Certified software function benefits

- Use certified functions where possible
  - Dual channel inputs
  - Dual channel outputs
- More diagnostics
  - More complete than at the I/O module level
  - Readily available in the program
    - Don’t have to query module for data
- Testing is done for you
  - Independently examined by third party
  - High confidence in execution
  - Lowers end user testing

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Software – Code Structure, UDTs, AOIs

- Modular Code Structure
  - Breakup code by functionality
  - Smaller routines
    - Easier to review
    - Easier to test
- User Defined Tags (data structures)
  - Organize data around function or structure
  - Enforces naming consistency
- Use of Add On Instructions (functions)
  - User Developed
  - Encapsulates common functions
  - Helps enforce common data naming
  - Can be tested independently
    - Lock the AOI with signature
    - Confidence that AOI is unchanged

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Limits impact of software changes

- Without AOIs
  - Code Changes typically requires testing of all functions
  - Time consuming
- With AOIs selective regression testing
  - Limit the scope of test
    - Analysis required
  - Reduces time and resources

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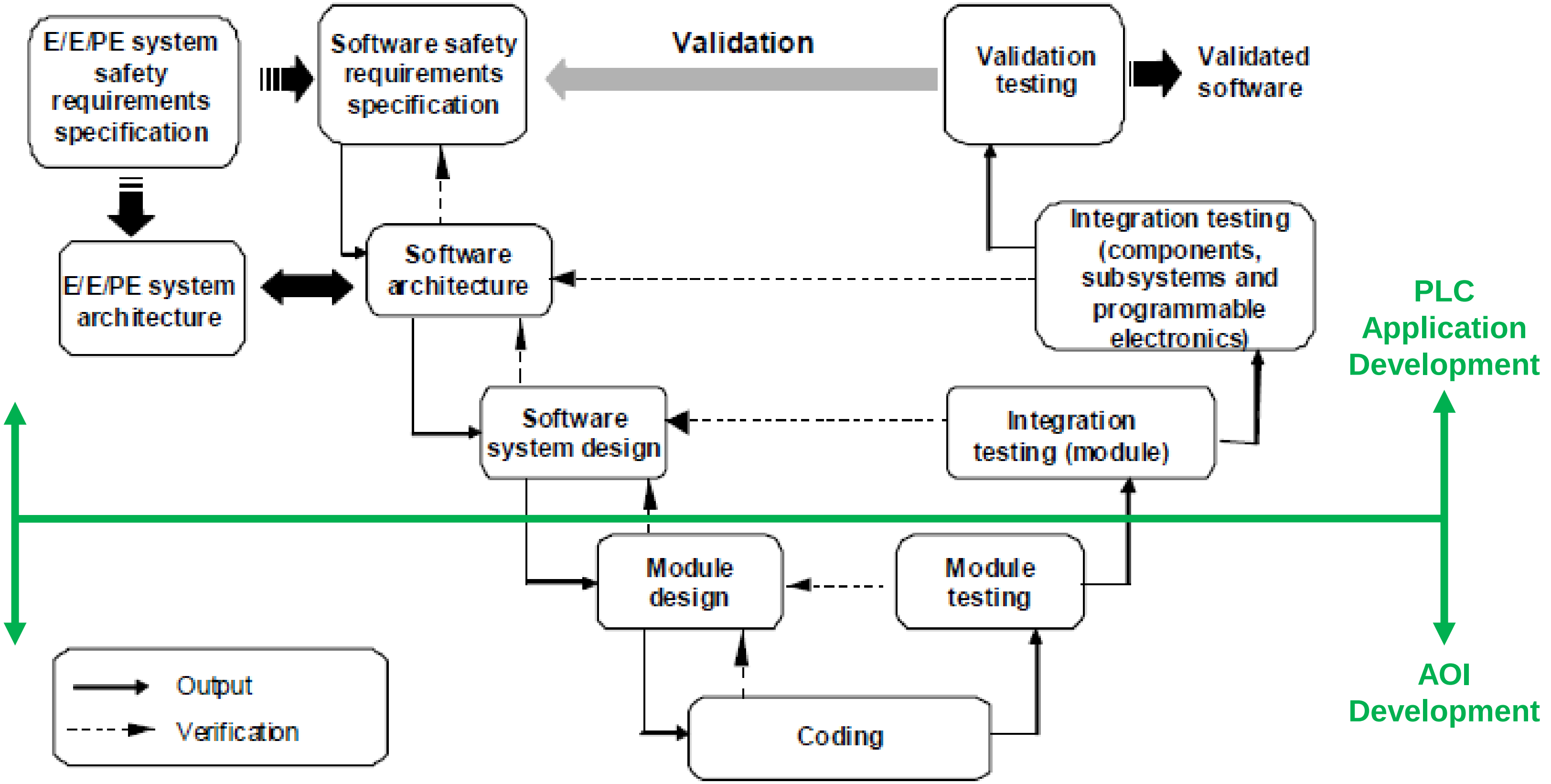
Relating the IEC 61508 V-model to PLC application development


E/E/PE system safety requirements specification
Software safety requirements specification
Validation
Validation testing
Validated software
E/E/PE system architecture
Software architecture
Integration testing (components, subsystems and programmable electronics)
PLC Application Development
Software system design
Integration testing (module)
Module design
Module testing
Coding
AOI Development
Output
Verification

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V-Model Software Implementation at the APS

- Create Functional Specification
  - Define safety functions
  - Hardware defined and I/O identified
- Create Software Specification
  - Implement safety function logic, diagnostics, operations interfaces
  - Software architecture and design
- AOI Development (Module)
- Review/Test modules
  - Review code
  - Built prototype / simulator
  - Test
- Verification Testing
  - Complete testing of safety function logic, diagnostics, operations interfaces
  - Confirms design meets specification
  - Real hardware or simulator
- Validation Testing
  - Developed from Functional Specification

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Configuration Control

- Revision Control
  - Module (AOI)
    - Electronically signed module after test
    - Safety lock after verification
  - Safety Code
    - Locked after validation
    - Stored in ICMS by developer
    - Policy dictates formal release and change control
- Change Control
  - APS maintains a design review process
    - Graded approach