Bent Pin Analysis

Methodology and Best Practices

NORTHROP GRUMMAN

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Challenges

- Smaller fuzes
  - Higher pin density
  - Less space for connectors
  - Example different “D-Sub” families
- Considerations
  - Safety – Prevent arming sequence progression
  - Reliability – Minimize number of mission failures
  - Testability – Interface to arm w/o environments
- Analysis
  - Deciding on number of connectors
  - Which connections to analyze
  - Assigning pins
  - Determining the effect

Traditional
(MIL-DTL-24308)
Pitch ~0.10in

↓

50% pitch

↓

Micro
(MIL-DTL-83513)
Pitch .050in

↓

50% pitch

↓

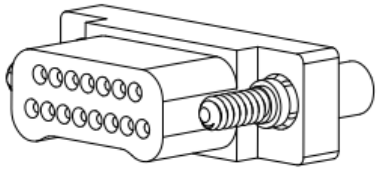
Nano
(MIL-DTL-32139)
Pitch .025in

L717DE09PST

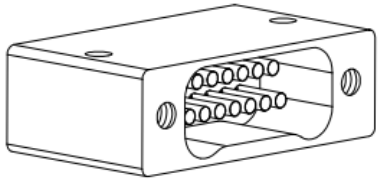
L77DE09SST

1532209-1

1532187-1



STL00911500PCN



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Connector images from Digikey

Smaller Fuzes Increase Challenges that Methodical Analysis can Address

Considerations for Connector(s) in Design

- Requirement flow down
  - JOTP-053 Section 5.1.8 Shorting of I/O (Electrical Stress Test)
  - Test where analysis cannot predict output
  - Criteria for analysis not defined
- Order of preference – no perfect option
  1. Only assign signals necessary for the fuze to function
  2. Assign test signals to a separate connector
  3. Single connector w/ test signals/functional signals & mitigations
- Option 3 is often preferred choice
  - Connectors are large components
  - Can be some of the most expensive components
  - Long lead times
  - Mitigations can be designed to reduce safety impact

- Testability mitigation examples
  - Isolating test signals with no connects/grounds
  - Unique signals (level/pattern)
  - Omitting signals in system wiring
  - Multiple Inputs

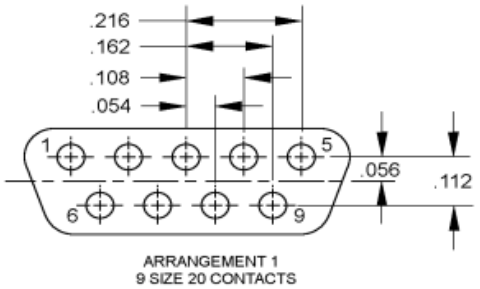
Preference	Safety	Design Complexity	Testability
1. Only Functional Signals			
2. Two Connectors			
3. Single Conn w/ Mitigations			
4. Single Conn w/o Mitigations			

Intentional Design Principles Needed to Ensure Safety and Testability Needs are Met in System Footprint

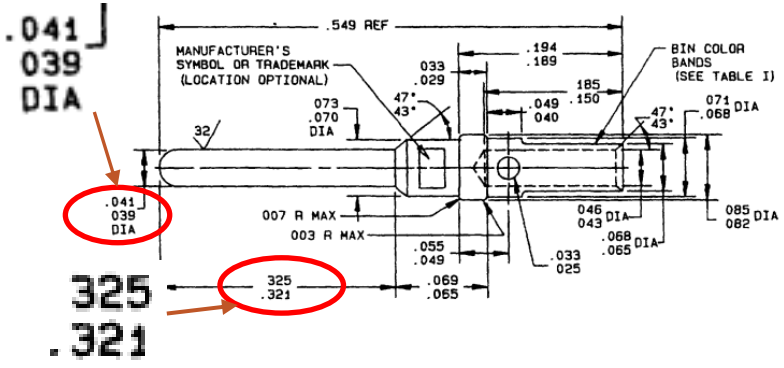
Pins Combinations to Analyze

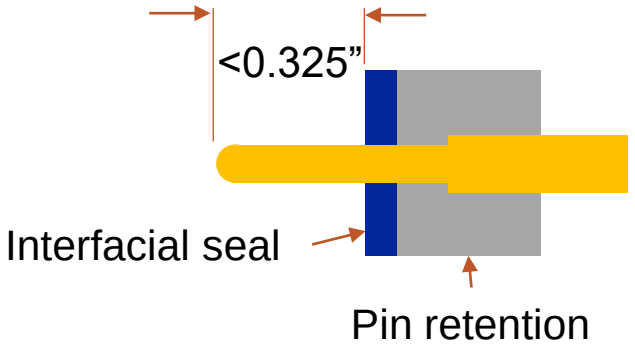
- Which pins can be contacted
  - Dimensions to consider
    - Pin spacing/length/diameter
    - Interfacial seal/insulation/retention dimensions
  - Dimensions can be hard to find work with supplier
  - Just pin length can be overly conservative
  - Multiple pins possible
  - Don't forget shell
- Observations about example
  - Pin 3 is long enough to contact all pins depending on length of pin retention material
  - Multiple pins can be contacted horizontally and diagonally

MIL-DTL-24308 Appendix A



MIL-C-39029/64C





Consideration of Pin/Connector Interface Required to Determine Number of Contacts

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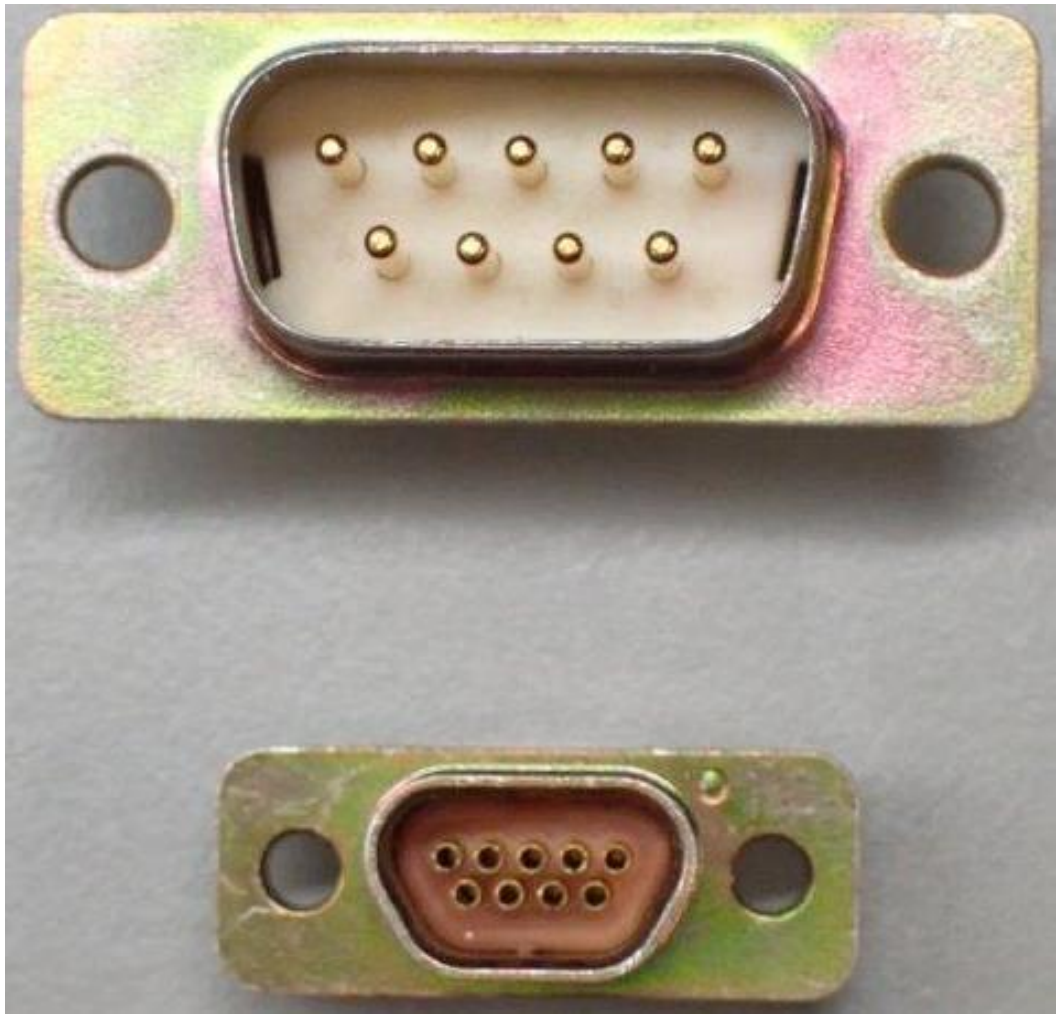
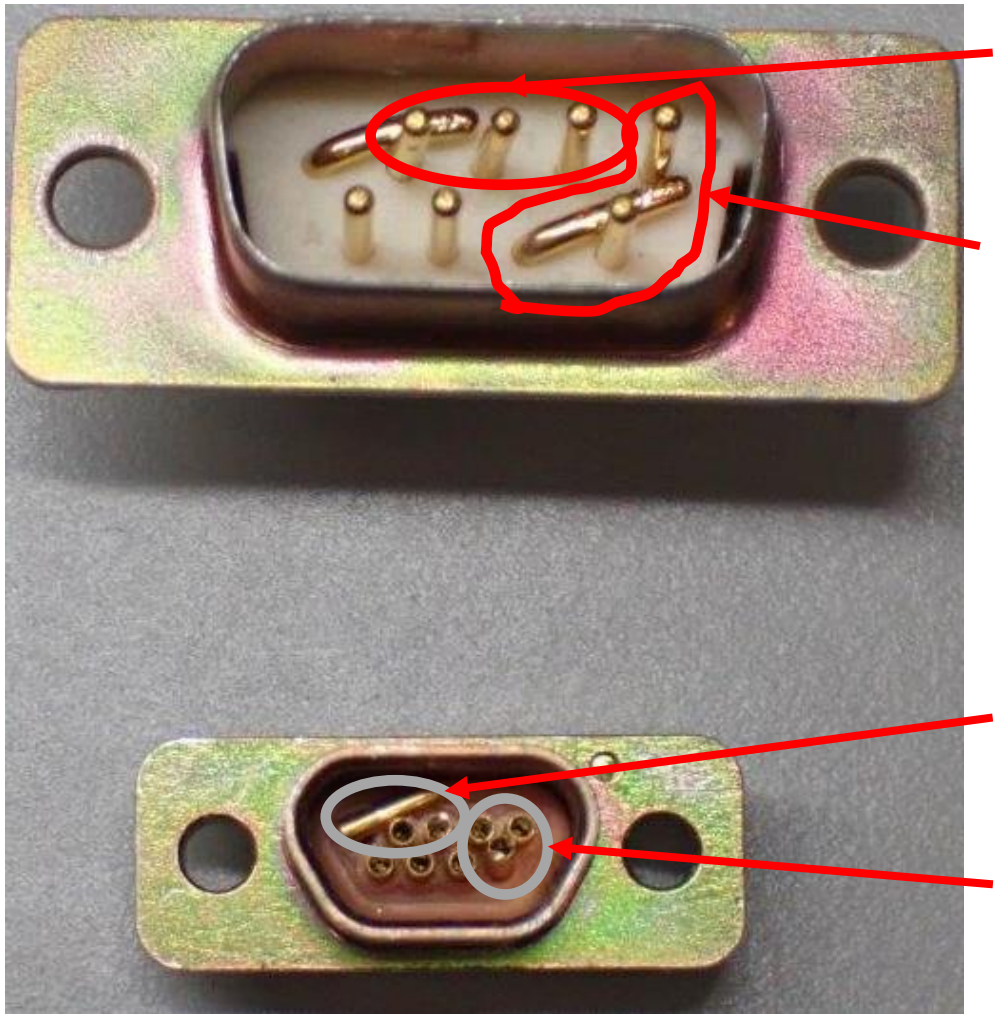
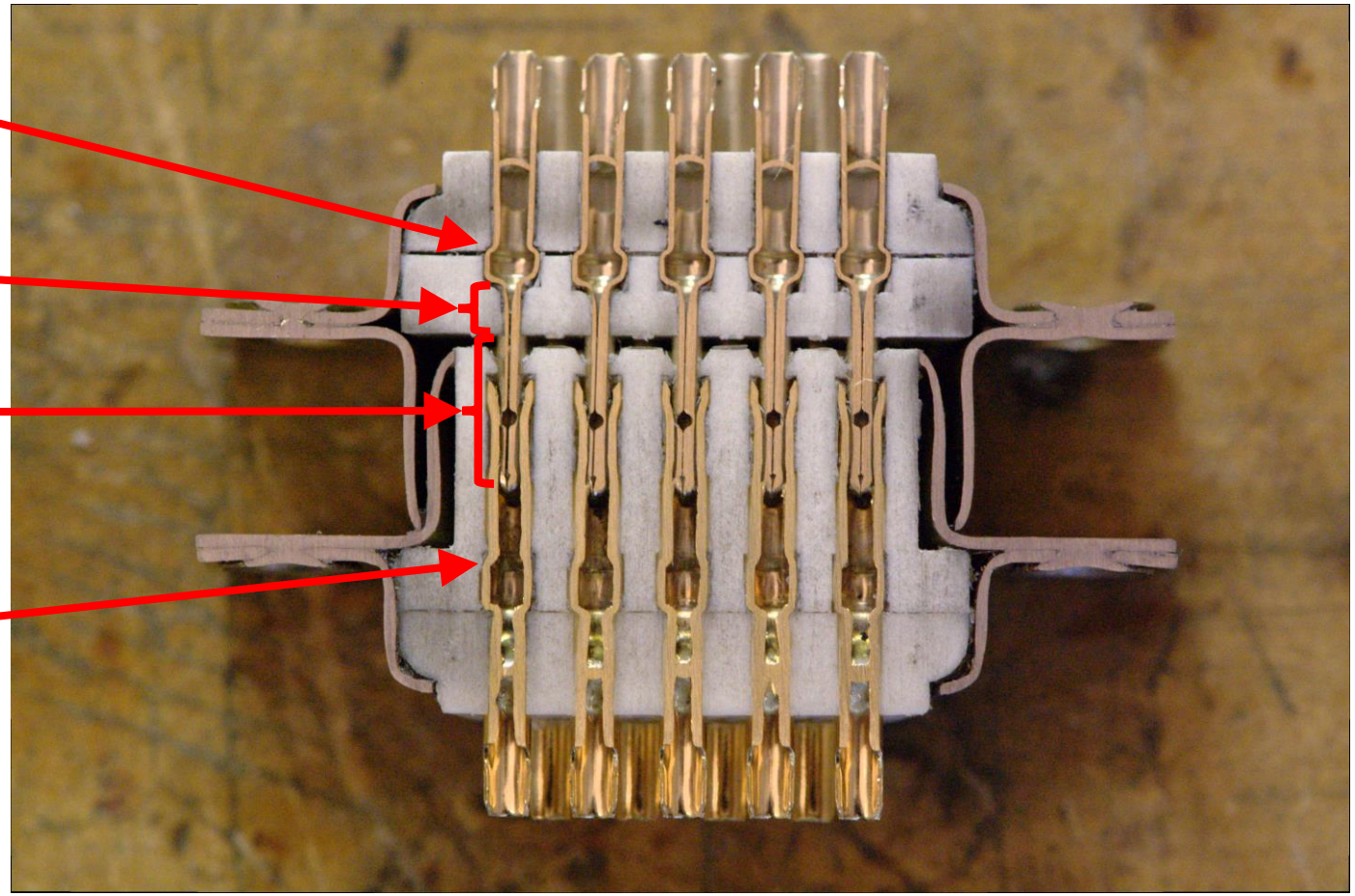
Pins Combinations to Analyze





Muti Pin Contact Can be Contacted in Multiple Orientations

Pins Combinations to Analyze – Mated Pair Cross Section

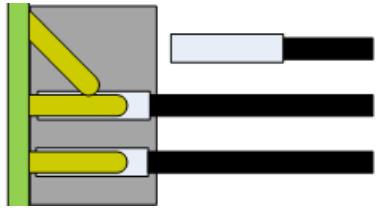


See Citation for Picture at End of Presentation

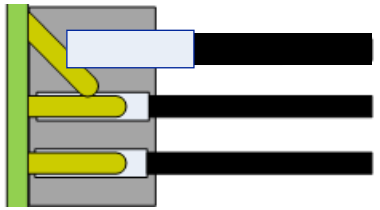
Understanding the Structure of the Connector Is Necessary to Determine Bendable Pin Length

Signal Analysis

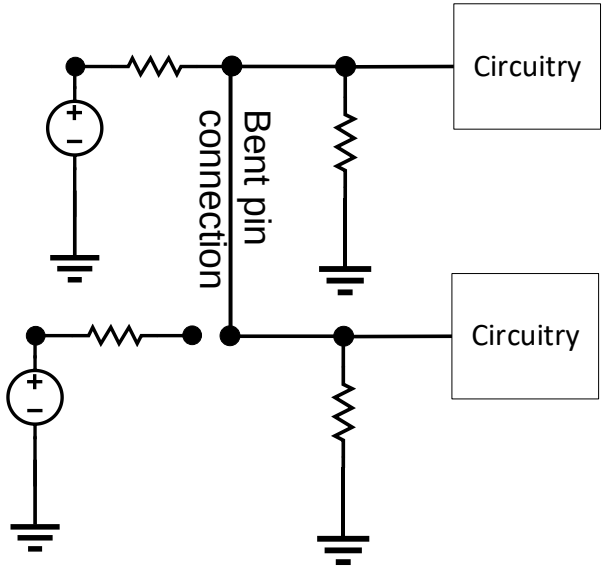
- Two sets
  - Connected to own socket
  - Not connected to own socket
- Types
  - Loads – Pulled down
  - Sources/Loads Pulled up
- Understand combinations of circuits
  - Extra sources – bus contention/voltage levels
  - Extra loads – thresholds/pull down source
  - Extra sources and loads
  - Multi-pin contact combinations

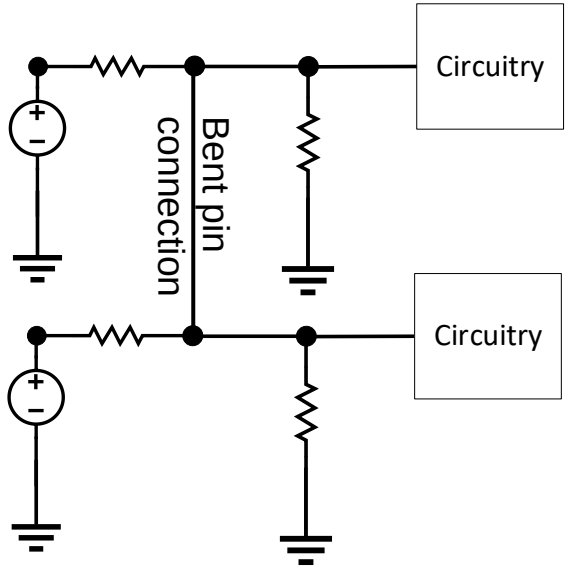


Without Connection to Own Socket



With Connection to Own Socket

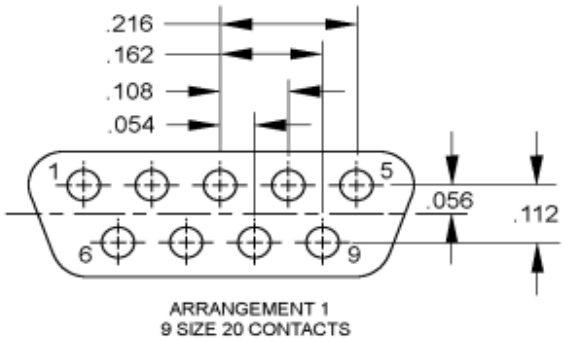




Methodical Approach to Determining Circuitry Interactions

Picking Pin Assignments

- Understand which pins can contact
- Characteristics of signals at connector/how circuits interact
- Mission Phase
  - Pre-commit (e.g., communications power, external firing, umbilical)
  - Post-commit (arming power, status lines)
- Functionality
  - Power
  - Sensor or event (eg umbilical)
  - Status
  - Test
- Group Signals Best Practice
  - Separate Pre-commit/post commit to limit back drive risk
  - Pay special attention to sensor/event combinations
  - Ensure test signals cannot be driven to an active state by bent pin combinations
  - Grounds can be effective assignments for challenging locations



Connector Geometry, Signal Characteristics, and Signal Usage Provide Information Needed to Assign Pins

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Analysis Output

- Safety Impacts
  - Ensure environment is sensor input not validated
  - Ensure environment is not bypassed
- Reliability Impacts
  - Degraded functionality (Modes/features)
  - Loss of mission (Shorts/Loss of Arming)
- Results
  - Fuze Level
    - Update design interface to tolerate bent pin
  - System Level
    - Factory access connectors for mission critical signals
    - System/sub-system level resistance checks

Verify No Safety Faults, Minimize Reliability Impacts via Design and System Test

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Takeaways

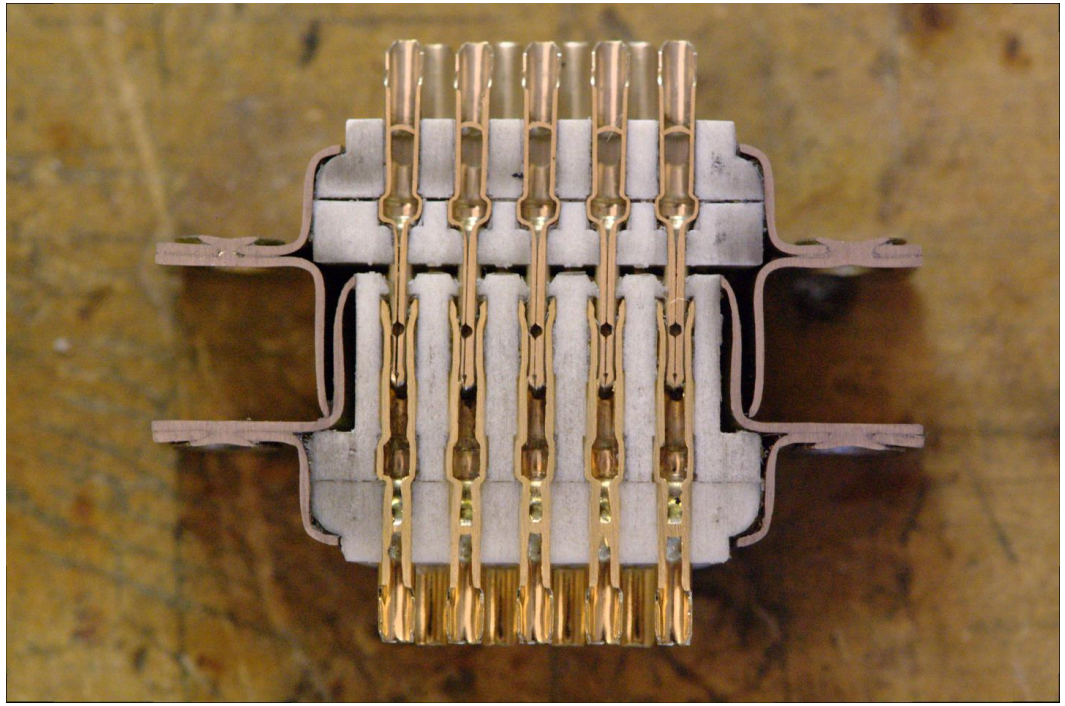
- Smaller systems are driving pin pitch/size smaller
- Balance safety, reliability, and testability when designing a fuze connection interface
- Determining which pins can contact requires detailed information about connector construction
- Signal categorization and analysis identifies most sensitive interfaces
- Assign pins to prevent safety faults first, reliability impact second
- Use analysis results to aid in system testability

Smaller Fuzes Increase Challenges that Methodical Analysis can Address

Questions?

Citations

Citation



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