

Component Qualification

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DUNE Electronics Review

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Cold-Test Methodology

- Select components having a good chance of surviving temperature extremes
- Mount components on a test vehicle
- Measure characteristics at room temperature and at Liquid Nitrogen temperature
- Repeat temperature cycles

Cold-Tested Components

- Multi-Layer SMT Ceramic Capacitors
- Thick-Film SMT Resistors
- Bias Connectors
- Mill-Max Receptacles

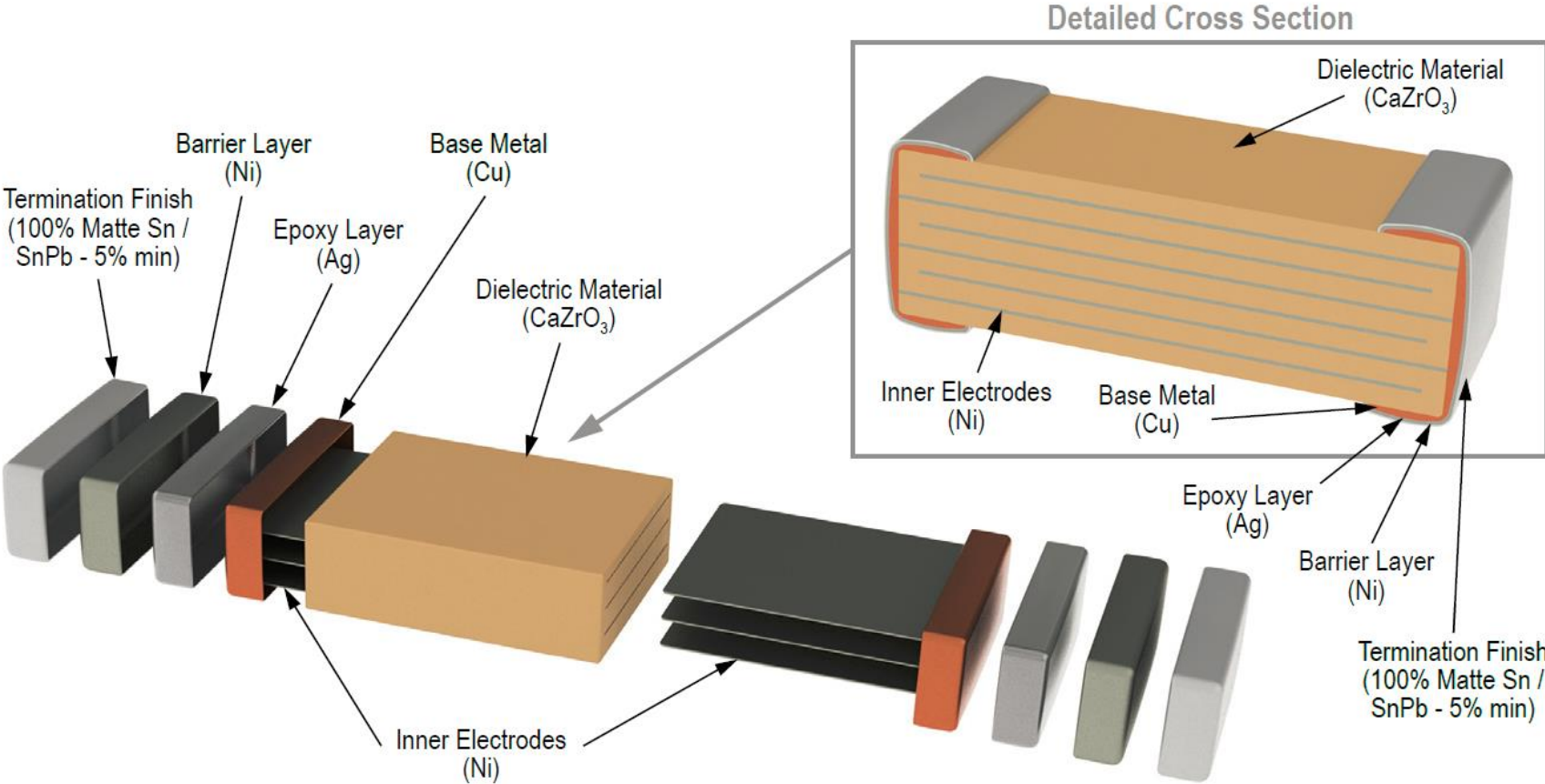
Component Selection

- Research options having necessary specs
- Only evaluate components rated for -55C
- Study component structure and materials
- Read manufacturer's process guidelines

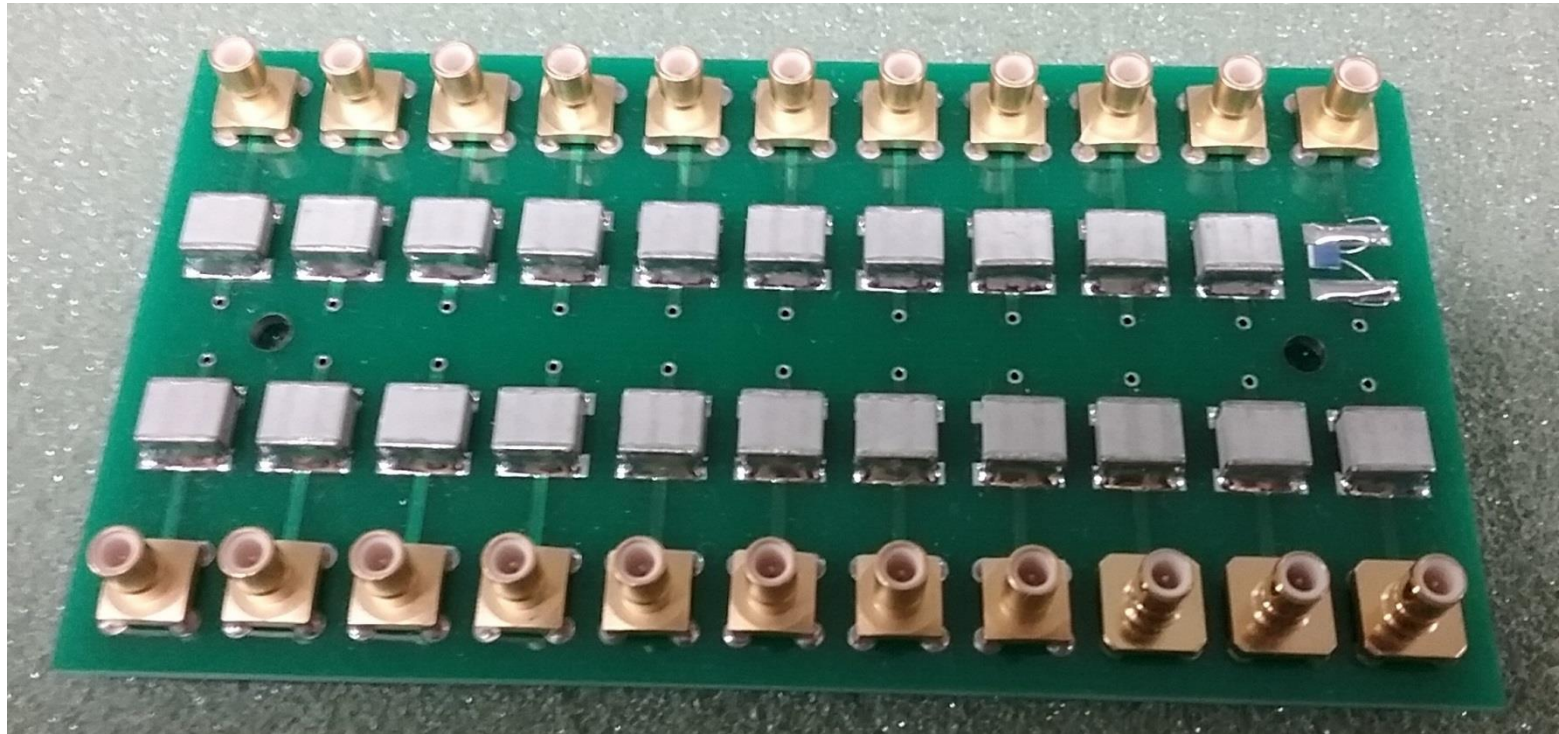
Capacitor Choice

- Kemet part number C2225X392JGGACTU
- 3.9 nF +/- 5% COG (NP0) 2 kV Surface Mount
- Usable for all coupling and filter functions
- High immunity to flex cracks
- Pliable silver epoxy between the base metal and nickel barrier layers of the termination system.
- Inhibits the transfer of board flex stress to the rigid ceramic body

Capacitor Construction



Capacitor Cold Test Fixture

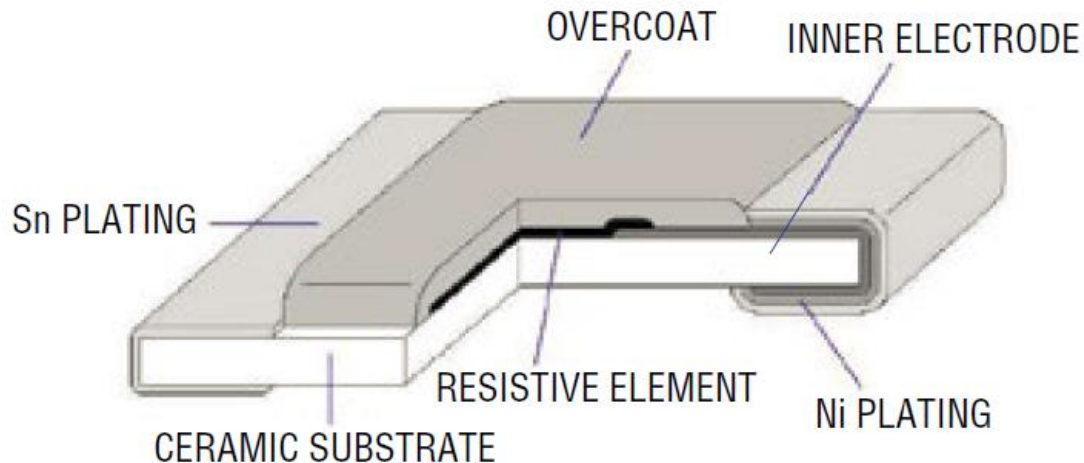


Capacitor Cold Test Results

- 42 Samples tested hot and cold, five cycle
- Room temperature: 3.79 to 4.02 nF (+/- 0.5%)
- In liquid nitrogen: All increased ~ 0.02 nF
- No changes over five temperature cycles
- No leakage currents exceeded 0.1 nA at 1 kV

Resistor Choice

- Bourns CHV Series Thick Film High Voltage Chip Resistors (rated for -55C)
- CHV2010 Package: 2000 Volts
- Reliable for UL/IEC safety certifications
- Tolerance +/- 1% for 5 or 10M, +/- 5% for 51M



Resistor Cold Test Results

- 21 Samples of 51M tested hot and cold (x5)
- Room temperature: 48.8 to 52.0 (+/- 2%)
- In liquid nitrogen: Increased by 1.5 to 1.9
- 21 Samples of 4.7M tested hot and cold (x5)
- Room temperature: 4.69 to 4.71 (+/- 0.2%)
- In liquid nitrogen: Increased by 0.15 to 0.16
- No changes seen over five temp. cycles

Bias Connector Choices

- Phoenix Contact 1808190 SMT receptacle
- Phoenix Contact 1778832 plug
- No temperature range given, only hot derating
- Body material is a Liquid Crystal Polymer
- Same class of material used in Samtec parts
- Contact resistance measured warm and cold
- Mating forces measured warm and cold

Bias Connector Cold Test Results

- Room-temperature mating and removal forces: 1 to 2 pounds
- Liquid Nitrogen mating and removal forces: 1.5 to 2.5 pounds
- Change in contact resistance: none seen

Mill-Max Board-to-Board Connectors

- ProtoDUNE components were off-the-shelf
- Mechanical stability problems were not recognized early enough to explore options for customized components
- Mechanical stability was enhanced using 3M 2216 Clear epoxy
- Components were tested warm and cold to ensure good electrical performance

M-M Connector Cold Test Results

- 200 mated components were mounted in a head board stack and connected in series
- Most of the combined resistance was contributed by jumper wires and on-board wire traces
- A four-wire Ohm-meter measured combined resistance repeatable to ± 0.002 Ohms
- After 10 temperature cycles, no change in combined resistance value

Mill-Max Board-to-Board Connectors

- DUNE uses custom designs
- Mechanical stability was thoroughly tested at room temperature
- Mechanical stability is assured for an acceptable range of through-hole diameters
- Components were tested warm and cold to ensure good electrical performance

M-M Connector Cold Test Results

- 160 mated components were mounted in a head board stack and connected in series
- After 10 temperature cycles, no change in combined resistance value was noted
- Total resistance was continually monitored during temperature transitions to detect any intermittent contact (same as for ProtoDUNE)
- More testing using larger arrays is planned

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