PREFERRED
RELIABILITY
PRACTICES

EEE PARTS SCREENING

Practice:

Implement a 100% nondestructive screening test on EEE parts prior to assembly, which would prevent early-life failures (generally referred to as infant mortality).

Benefits:

A lower rework cost during manufacturing and lower incident of component failures during flight.

Program That Certified Usage:

All Goddard Space Flight Center (GSFC) flight programs.

Centers to Contact for More Information:

- GSFC
- Jet Propulsion Laboratory (JPL) for missions referencing long-life, high reliability, or more stringent requirements.

Implementation Method:

Screening for each part can be established as follows:

- Refer to NASA's compilation of screening criteria for use with various EEE part types. An example may be found in Appendix C of the GSFC Preferred Parts List.
- If Class S parts are purchased, the screening tests shown in Table 1 have already been conducted. When Class S parts are not available, the screens of Table 1 should be used.
- Failure criteria during screening should specify Percent Defectives Allowable (PDA) and allowable parameter drift. Typical PDA criterion is 5%.

A sample listing of failure mechanisms, the associated distribution of failures, and related screening tests are provided in Table 2.

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Table 1. 100% Parts Screening Matrix

Test and Inspection Requirements / Part Type	Semiconductors			Capacitors									Resistors									Miscellaneous						
	Transistors, MIL-S-19500, JANS	Diodes, MIL-S-19500, JANS	Microcircuits, MIL-M-38510, Class S	Ceramic, G.P., MIL-C-39014	Ceramic, T.C., MIL-C-20	Ceramic, Chip, MIL-C-55681	Film, MIL-C-83421	Film, MIL-C-19978	Glass, MIL-C-23269	Mica, MIL-C-39001	Tantalum, Solid, MIL-C-39003	Tantalum, Foil/Slug, MIL-C-39006	Carbon Composition, MIL-R-39008	Film, G.P., MIL-R-39017	Film, Hi Stability, MIL-R-55182	Film, Chip, MIL-R-55342	Wire Wound, Accurate, MIL-R-39005	Wire Wound, Power, MIL-R-39007	Wire Wound, Chassis, MIL-R-39009	Variable, Non - WW, MIL-R-39035	Variable, Wire Wound, MIL-R-39015	Inductors	Transformers	Relays	Crystals	Fuses	Thermistors	Sensistors
1. Supplier Precap Visual	●	●	●																					●	●			
2. SEM (Sample)			●																					●	●			
3. Stabilization Bake	●	●	●																								●	
4. Temperature Cycle	●	●	●	●	●		●	●			●				●	●						●	●		●	●	●	●
5. Constant Acceleration	●	●	●																									
6. PIND	●	●	●																					●				
7. Seal	●	●	●				●	●	●		●	●												●	●			
8. HTRB	●	●	●																									
9. Power Burn-In	●	●	●																									●
10. Radiographic	●	●	●	●				●			●														●			
11. Parameter Measurements	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
12. Vibration																								●	●			
13. Power Conditioning														●			●	●	●	●	●							
14. Voltage Conditioning				●	●	●	●	●	●	●	●	●																
15. Overload															●													
16. Aging																									●			
17. Room Temperature Miss Test																								●				
18. High Temperature Miss Test																								●				
19. Low Temperature Test																								●				
20. Resist.-Temp. Characteristics																											●	
21. Contact Resistance Variation																				●								
22. Immersion																				●	●							

TABLE 2. FAILURE MECHANISMS/SCREENING METHODS

Failure Mechanism	Distribution of Failures	Screen Tests
Metallization	11%	Burn-in, Internal Visual, Temperature Cycling, Scanning Electron Microscope for Metallization
Diffusion	1%	Burn-in
Oxide Faults	14%	Burn-in
Bulk	3%	Stabilization Bake, Burn-in, Temperature Cycling
Surface	21%	Internal Visual, Radiography, PIND, Constant Acceleration, Stabilization Bake, Burn-in
Interconnect	9%	Temp. Cycling, Burn-in, Constant Acceleration
Wirebond	1%	Nondestructive Bond Pull, Stabilization Bake, Temperature Cycling, Constant Acceleration, Internal Visual, Burn-in, Radiography, PIND
Package	40%	PIND, Radiography, Seal, External Visual, Temperature Cycling, Constant Acceleration

<u>Technical Rationale</u>:

The EEE parts manufacturing is controlled by military specification requirements covering a variety of areas such as: starting materials, process controls, electrical or electromechanical

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performance characteristics, and periodic inspections of some characteristics of finished product. Despite these requirements, defects that cause early-life failures can be randomly built into a product. The screening tests are designed to be destructive to parts with particular defects but nondestructive to good parts.

As an example, integrated circuits such as CMOS are highly susceptible to electrical performance failures caused by ionic contamination on the die surface. The contamination can be introduced by any of several uncontrollable avenues during manufacture and cannot be ruled out as an occurrence in any given lot of parts. To avoid early-life failures at higher assembly levels, the lot of parts is subjected to a 100% static burn-in. The burn-in is designed to drive contamination into the die areas where it will interfere with proper circuit operation and cause electrical failures before parts are installed on boards.

Impact of Nonpractice:

Without screening, there could be latent failure mechanisms that could cause flight delays and/or failures. For example, two circuits on the Solar Maximum Mission (SMM) spacecraft failed. The failed parts were analyzed upon return from the repair mission and found to contain defects that would have been revealed through screening. In one case, the microcircuit had a metallization flaw; in the second, the CMOS microcircuit had contamination on the die. In another example, screening tests performed on microcircuits resulted in an 85% failure rate. Subsequent failure analysis revealed that improper parts had been used.

References:

1. NASA GSFC Preferred Parts List (NPPL) 18/19.

2. Seidl, Raymond H., Garry, William J., "Pi Factors Revisited," Proceedings of the Annual Reliability and Maintainability Symposium, 1990.