Blue Cell™

LTCC Product Reliability Report

AN-40-003

Mini-Circuits

Brooklyn, NY 11235

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www.minicircuits.com

Table of Contents

1.0 Introduction

Mini-Circuits has extensive experience in developing products using the following technologies:

1) Core and Wire
2) Semiconductors
3) Microstrip
   and now,
4) LTCC

DARPA (Defense Advanced Research Projects Agency) funded $30 million in the early 1980's to various companies to develop a highly dense, reliable packaging medium for RF and microwave circuits. The result is Low Temperature Co-fired Ceramic (LTCC) technology, which provides the means to manufacture multilayer circuits using multiple layers of ceramic substrate tape. This allows stacking the circuits vertically, reducing the size of the product. LTCC incorporates low-loss conductors such as gold, silver, and copper for performance advantage, instead of lossy conductors such as tungsten, molybdenum, and molymanganese that are used in HTCC (high-temperature co-fired ceramic).

Up to 1986 various foundries used LTCC tapes and the associated metal systems purely for internal use. In 1986 (ref 1), Dupont announced a complete LTCC tape and metal system for commercial use. Various foundries around the world currently use the DuPont system or other proprietary systems. Military and aerospace industries started using LTCC designs in the mid-1980s, and automotive industries at the beginning of the 1990s. Computer industries such as IBM started using LTCC around the mid-1990s (per DuPont, private communication). Mini-Circuits has been working on LTCC for the last 4 years.

There is world-wide activity in use of LTCC to reduce the size and cost of RF and microwave components. To support this activity DuPont, for example, has developed an ample set of materials needed to produce products with LTCC (see ref 2).

DuPont completed an 18,000-hour THB (temperature-humidity bias) reliability study in 1992 comparing silver and gold as internal metallization in LTCC, and found that silver is very robust (see ref 3). Two papers in the 1983 ISHM Proceedings (refs 4 and 5) and a paper from the 1986 Electronic Components and Technology Conference (ref 6) lend further confidence that LTCC is very reliable. A recent search for "LTCC" on the IEEE website (www.ieee.org) yielded a list of 134 down-loadable papers and listings from 1955 to the present, and on the International Microelectronics and Packaging Society's website (www.imaps.org) a search for LTCC found 147 items. This shows that LTCC continues to be an active subject of research, development, and application. Reliability is very well documented.

Circuits implemented in LTCC can become large below 500 MHz. Core and wire technology, when used with LTCC, combine the best features of both technologies and reduces size and cost compared with circuits made with LTCC alone ("pure LTCC"). Mini-Circuits has produced millions of components with core and wire over the years. Mini-Circuits pioneered the use of welding instead of soldering for highly reliable

magnet wire connection to ceramic board. This expertise is now used with LTCC to create several unique patent pending products.

Semiconductors such as schottky barrier diodes and amplifiers, used in hundreds of mixer products produced in millions, with proven reliability throughout Mini-Circuits history, are incorporated in die form on LTCC substrates to further reduce the size of the products.

LTCC technology has been in existence for a long time. However, due to vertical stacking of conductor patterns on the layers, design of circuits in LTCC is extremely complex. Mini-Circuits already had extensive experience in the use of 2½D and 3D electromagnetic tools for the analysis and design of microstrip circuits. This expertise is now applied to advantage in the design of LTCC structures (see ref 1).

Most of the components developed today by Mini-Circuits are surface mount types. Various terminating methods are used to provide interface to the customer's motherboard. It is important that customers get reliable products for use in their applications. This report describes the generic properties of products developed and how Mini-Circuits ensures the reliability of the products via qualification.

2.0 Qualification

Mini-Circuits products can be broadly classified into several families (see tables 2.1 through 2.5). New products in each family are designed using the design rules provided by the foundries. Extensive qualification tests have been conducted to prove the reliability of the designs in each family. New products in a given family are then qualified by similarity where applicable.

2.1 Purposes of qualification via physical and environmental tests

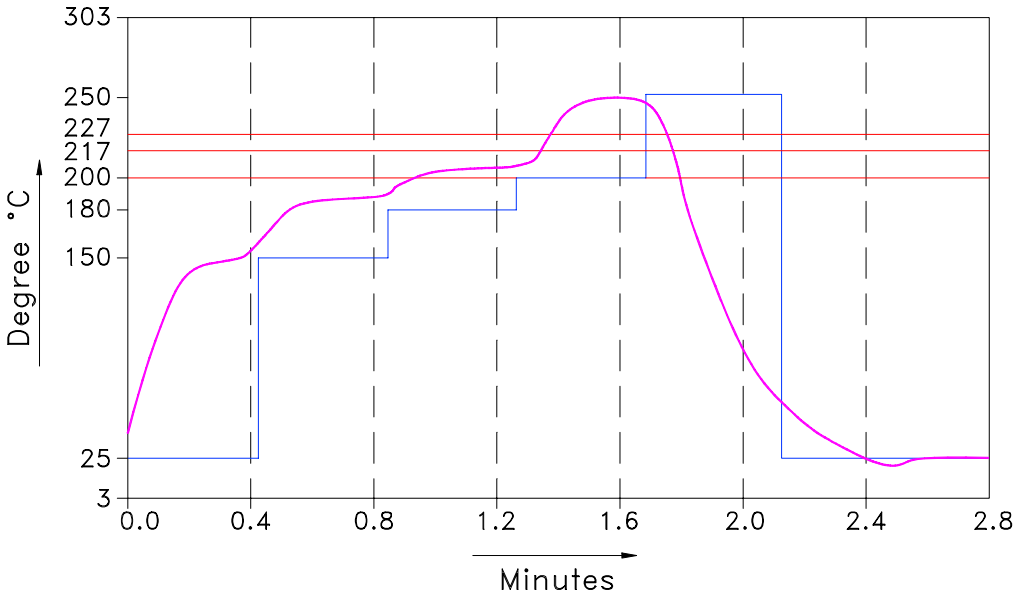
Mini-Circuit products are used by our customers in a variety of environments ranging from air conditioned rooms to hostile environments typical of military equipments. A set of qualification test plans was derived, based on industry, Telcordia (Bellcore) and military standards. It is important to understand the intent of the various tests in order to assess their importance to a potential application. The following paragraphs provide an explanation of the tests.

2.1.1 Soldering heat:

Determines whether products can withstand the effects of the heat to which they will be subjected during the specified soldering process such as dipping or reflow, without degradation of electrical or mechanical characteristics. (Ref: MIL-STD-202)

Conditions of test:

1) Solder Technique: Conduction
2) Number of heat cycles: 3
3) Reflow Profile: See below



Peak Temperature	Min. Temperature	Total Time above 200 °C, Sec.	Total Time above 217 °C Sec.	Total Time above 227 °C Sec.
249.9	18.2	52.89	28.32	25.22

2.1.2 Vibration:

Determines whether products can withstand, without degradation of electrical or mechanical characteristics, the effect of high frequency mechanical vibration as may be encountered in aircraft, missiles, and tanks. (Ref: MIL-STD-202)

Conditions of Test: MIL-STD-202F, Method 204D, Condition D, 10-2000Hz, 20 G peak, 3 axis, 12 times each axis.

2.1.3 Mechanical shock:

Determines the integrity of products when subjected to shocks such as those which may be expected as a result of rough handling, transportation and military operations, as simulated using a specified waveform. (Ref: MIL-STD-202)

Conditions of test: MIL-STD-202F, Method 213B, Condition A, 50 G, 11ms, 3 Axis, 18 shocks

2.1.4 Life test:

Determines the effects on electrical and mechanical characteristics of a product resulting from exposure to an elevated ambient temperature for a specified length of time, while it is performing its operational function. This test can demonstrate the reliability over an extended time period. (Ref: MIL-STD-202, MIL-STD-883)

Conditions of test: MIL-STD-202, Method 108, Condition D, length of test 1000 hours, temperature +125 deg. C

2.1.5 Thermal shock:

Determines whether products can withstand, without degradation of electrical or mechanical characteristics, exposures at extremes of high and low temperatures, and to the shock of alternate air-to-air exposures to these extremes, such as would be experienced when transferred to and from heated shelters in arctic areas. These conditions may also be encountered in equipment operated non-continuously in low-temperature areas or during transportation. (Ref: MIL-STD-202)

Conditions of test: MIL-STD-202F, 107G, Condition A3, -55/100º C, 15 min dwell

2.1.6 HAST- Highly-Accelerated Temperature and Humidity Stress Test

Evaluates the reliability of non-hermetic packaged devices in humid environments. This test employs combined severe conditions of temperature, humidity, and bias that accelerate the penetration of moisture through the protective package material (encapsulant or seal) or along the interface between that material and the metallic conductors which pass through it. The stress usually activates the same failure mechanisms as the "85/85" Steady-State Humidity Life Test. For parts that reach absorption equilibrium in 24 hours or less, the HAST test is equivalent to at least 1000 hours at 85ºC/85% RH. (Ref: JESD22-A110)

Conditions of test: 130ºC, 85% RH, 96 hours

2.1.7 Autoclave:

Evaluates the moisture resistance of non-hermetic packaged, unbiased solid state devices. It is a highly accelerated test which employs conditions of pressure, humidity and temperature under condensing conditions to accelerate moisture penetration, and is used to identify failure mechanisms internal to the package. (Ref: JESD22-A102)

Conditions of test: 121°C, 100%RH, 29.7/205 (psia/kPa), 96hours

2.1.8 Humidity, steady state:

Evaluates the influence of absorption and diffusion of moisture and moisture vapor. This is an accelerated environmental test, accomplished by the continuous exposure of the samples to high relative humidity at an elevated temperature. The conditions impose a vapor pressure on the material in the product under test which constitutes the force behind the moisture migration and penetration. (Ref: MIL-STD-202)

Conditions of test: MIL-STD-202F Method 103 B, Condition A, except increased temperature of 50°C instead of 40°C, 240 hours, 95% RH

2.1.9 Mechanical Inspection including co-planarity

Evaluates mechanical dimensions and co-planarity of the part under consideration. Mechanical dimensions should meet specifications provided in the outline drawing.
Purpose of co-planarity inspection: to measure the deviation of the terminals from the mounting plane. Co-planarity is very important for successful soldering of components. If

the co-planarity requirement is not met, some of the leads may fail to be soldered to the customer's board. (Ref. JESD22-B108A)

Conditions: 1) co-planarity 0.004" max: criteria is pass/fail.
2) Catalog dimensions: Cpk 1.5 min.

2.1.10 Solderability:

Determines that the finish on terminations provides a solderable surface of sufficient quality to be wetted by solder and to form a suitable fillet resulting from a specified method of solder application. (Ref: MIL-STD-202)

Solderability test done after steam aging evaluates the shelf life by simulating 1 year of storage. 8 hours of steam aging is sufficient to accomplish this in most cases, as shown by studies of increase in wetting time vs. steam-aging time. (Ref. IPC-TR-464, and Addendum dated Dec. 1987)

Conditions of test: J-STD-002A, paragraph 4.2.5, Test S and MIL-STD-883, Method 2003, 235 +/-5 ºC, five (5) seconds dwell time

2.1.11 Resistance to solvents:

Verifies that markings will not become illegible, and that protective coatings and encapsulant materials incorporated into the product will not be degraded, when subjected to solvents and processes normally used to clean solder flux and other contaminants. (Ref: MIL-STD-202)

Conditions of test: MIL-STD-202F, Method 215J

2.1.12Lead integrity/ Terminal Strength:

Determines whether the design of the terminals and their method of attachment can withstand the applicable mechanical stresses to which they will be subjected during installation or disassembly in equipment. These stresses must be withstood by the component part without sustaining damage which would affect either the utility of the terminals or the operation of the product itself. (Ref: MIL-STD-202)

Conditions of test: MIL-STD-202 Method 211A Condition A, 2 lb

Table 2.1 Power Splitter Qualification Chart

	Product Sub Class	Size	Photo	Pre-Conditioning Resistance to soldering Heat	Vibration	Mechanical Shock	Life	Thermal Shock	HAST	and/or Autoclave	Or Humidity Steady State	Lead Integrity	Mechanical Inspection	Solderability	Resistance to solvents	Electrical over temperature	Qualification Report See Appendix -
1	2-Way In-Phase SCL type	Base: 0.25" X 0.31" Height: .05"		PASS	PASS	PASS	PASS	PASS	PASS	PASS	------	PASS	PASS	PASS	PASS	N/A	A
2	2-Way In-Phase SBTC type	Base: 0.15"X0.15" Height: 0.15"		PASS	PASS	PASS	PASS	PASS	------	------	PASS	N/A	PASS	PASS	N/A	PASS	B
3	2-Way In-Phase SBB type	Base: 0.2" X 0.2" Height: .07"		PASS	PASS	PASS	PASS	PASS	PASS	------	------	PASS	PASS	PASS	PASS	PASS	C
4	2-Way In-Phase SCN type	Base: 0.12" X 0.06" Height: .035"		PASS	PASS	PASS	PASS	PASS	PASS	PASS	------	N/A	PASS	PASS	N/A	PASS	D
5	2-Way-90° In-Phase QBA type	Base: 0.25" X 0.3" Height: .05"		PASS	PASS	PASS	PASS	PASS	------	------	PASS	PASS	In Progres	PASS	PASS	PASS	E

Table 2.1 Power Splitter Qualification Chart (Continued)

	Product Sub Class	Size	Photo	Pre-Conditioning Resistance to soldering Heat	Vibration	Mechanical Shock	Life	Thermal Shock	HAST	and/or Autoclave	Or Humidity Steady State	Lead Integrity	Mechanical Inspection	Solderability	Resistance to solvents	Electrical over temperature	Qualification Report See Appendix -
6	2-Way-90° QCC type	Base: 0.15" X 0.15" Height: .032"		PASS	PASS	PASS	PASS	PASS	-------	-------	PASS	N/A	PASS	PASS	N/A	N/A	F
7	2-Way-90° QCN type	Base: 0.12" X 0.065" Height:		PASS	PASS	PASS	PASS	PASS	PASS	PASS	-------	N/A	PASS	PASS	N/A	PASS	G
8	2-Way –180° -Phase SBTCJ type	Base: 0.15"X0.15" Height: 0.2"		PASS	PASS	PASS	PASS	PASS	-------	-------	PASS	N/A	PASS	PASS	PASS	PASS	H
9	3-Way In-Phase SCA type	Base: 0.30" X 0.25" Height: .18"		PASS	PASS	PASS	PASS	PASS	-------	-------	PASS	In progress	In progress	In progress	N/A	In progress	J

Table 2.1 Power Splitter Qualification Chart (Continued)

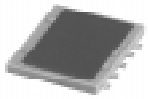
	Product Sub Class	Size	Photo	Pre-Conditioning Resistance to soldering Heat	Vibration	Mechanical Shock	Life	Thermal Shock	HAST	and/or Autoclave	Or Humidity Steady State	Lead Integrity	Mechanical Inspection	Solderability	Resistance to solvents	Electrical over temperature	Qualification Report See Appendix -
10	4-Way In-Phase SCA type	Base: 0.30” X 0.25” Height: .045”		PASS	PASS	PASS	PASS	PASS	PASS	PASS	------	PASS	PASS	PASS	N/A	N/A	K
11	4-Way In-Phase SCA type	Base: 0.30” X 0.25” Height: .18”		Under Qual													L
12	4-Way-90° In-Phase SBD type	Base: 0.38” X 0.4” Height: .067”		PASS	PASS	PASS	PASS	PASS	------	------	PASS	PASS	PASS	PASS	PASS	PASS	M
13	3-Way, 4-Way 5-Way & 6- Way ADXPS type	Base: 0.385” X 0.31” Height: .215”		PASS	PASS	PASS	PASS	PASS	------	------	PASS	PASS	PASS	PASS	PASS	PASS	N

Table 2.2 Mixer and Mixer-Amplifier Qualification Chart

	Product Sub Class	Size	Photo	Pre-Conditioning: Resistance to soldering Heat	Vibration	Mechanical Shock	Life	Thermal Shock	Humidity	Lead Integrity	Mechanical Inspection	Solderability	Resistance to solvents	Electrical over temperature	Qualification Report See Appendix -
1	a)Triple Balanced-MCA type b)FET MCA-XXF type	Base: 0.25”X0.3” Height: .180”		PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	P
2	Double balanced MCA1 type	Base: 0.25”X0.3” Height: 0.06”		PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	Q
3	FET with a) LO amplifier: MACY type a) LO and IF amplifier: MAX type	Base: 0.35”x0.5” Height: .230”		Under Qualification	Under Qualification	Under Qualification	Under Qual	Under Qualification	Under Qualification	Under Qualification	Under Qualification	Under Qual	Under Qualification	Under Qualification	R

Table 2.3 Coupler Qualification Chart

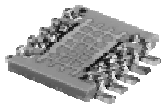
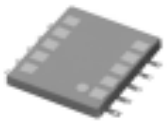
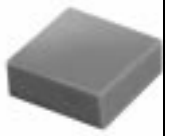
	Product Sub Class	Size	Photo	Pre-Conditioning Resistance to soldering Heat	Vibration	Mechanical Shock	Life	Thermal Shock	Humidity	Lead Integrity	Mechanical Inspection	Solderability	Resistance to solvents	Electrical over temperature	Qualification Report See Appendix -
1	Directional Couplers DBTC type	Base: 0.15”X0.15” Height: .15”		PASS	PASS	PASS	PASS	PASS	PASS	N/A	PASS	PASS	N/A	N/A	S
2	Bi-directional Couplers BDCA type	Base: 0.25”X0.30” Height: .07”		PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	T
3	Bi-directional Couplers BDCA1 type	Base: 0.25”X0.30” Height: .07”		PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	U

Table 2.4 Filter Qualification Chart

	Product Sub Class	Size	Photo	Mechanical Inspection	Solderability	Resistance to solvents	Soldering Heat	Vibration	Mechanical Shock	Electrical over temperature	Life	Thermal Shock	Humidity	HAST	Autoclave	Qual Report See Appendix -
1	Filter: LFCN and HFCN type	Base: 0.126”X0.063” Height: .039”		PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	-------	PASS	PASS	V
2	Filter: LFTC and HFTC type	Base: 0.15”X0.15” Height: .028”		PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	-------	-------	W
3	Filter: LPCH type	Base: 0.32”X0.70” Height: .07”		Under Qualification	Under Qualification	Under Qualification	Under Qualification	PASS	PASS	PASS	Under Qualification	Under Qualification	Under Qualification			Y

Table 2.5 Transformer Qualification Chart

	Product Sub Class	Size	Photo	Pre-Conditioning Resistance to soldering Heat	Vibration	Mechanical Shock	Life	Thermal Shock	HAST	and/or Autoclave	Or Humidity Steady State	Lead Integrity	Mechanical Inspection	Solderability	Resistance to solvents	Electrical over temperature	Qualification Report See Appendix -
1	Transformer: TCC type	Base: 0.15”X0.15” Height: .050”		PASS	PASS	PASS	PASS	PASS	PASS	PASS	------	N/A	PASS	PASS	N/A	N/A	Z
2	Transformer: 0805 type (Under development)	Base 0.08”x0.05”		Under qual	Under qual	Under qual	Under qual	Under qual	Under qual	Under qual	Under qual	Under qual	Under qual	Under qual	Under qual	Under qual	AA

3.0 Conclusions

Mini-Circuits has developed a series of LTCC products. Extensive qualification tests have been conducted to prove the reliability of the products developed. Semiconductor components such as diode quads used in the LTCC mixers have more than 10 years' history of reliable usage in hundreds of Mini-Circuits products, manufactured in millions over the years.

4.0 References:

1) Blue Cell Designer's Handbook, Mini-Circuits, BC/HB-03
2) http://www.dupont.com/mcm/ceramic.html
3) Draudt, R.R. et al, "18,000 Hour Silver Migration Study on 951 Green Tape™ Substrates" (Preliminary Report)
4) Gasper, D.J et al, "Silver Reliability in a Multilayer Ceramic Package", ISHM '83 Proceedings
5) Vitriol, W.A. and J. Steinberg, "Development of a Low Temperature Cofired Multilayer Ceramic Technology", ISHM '83 Proceedings
6) Eustice, A.L. et al, "Low Temperature Co-fireable Ceramics: a New Approach for Electronic Packaging", 1986 Electronic Components and Technology Conference

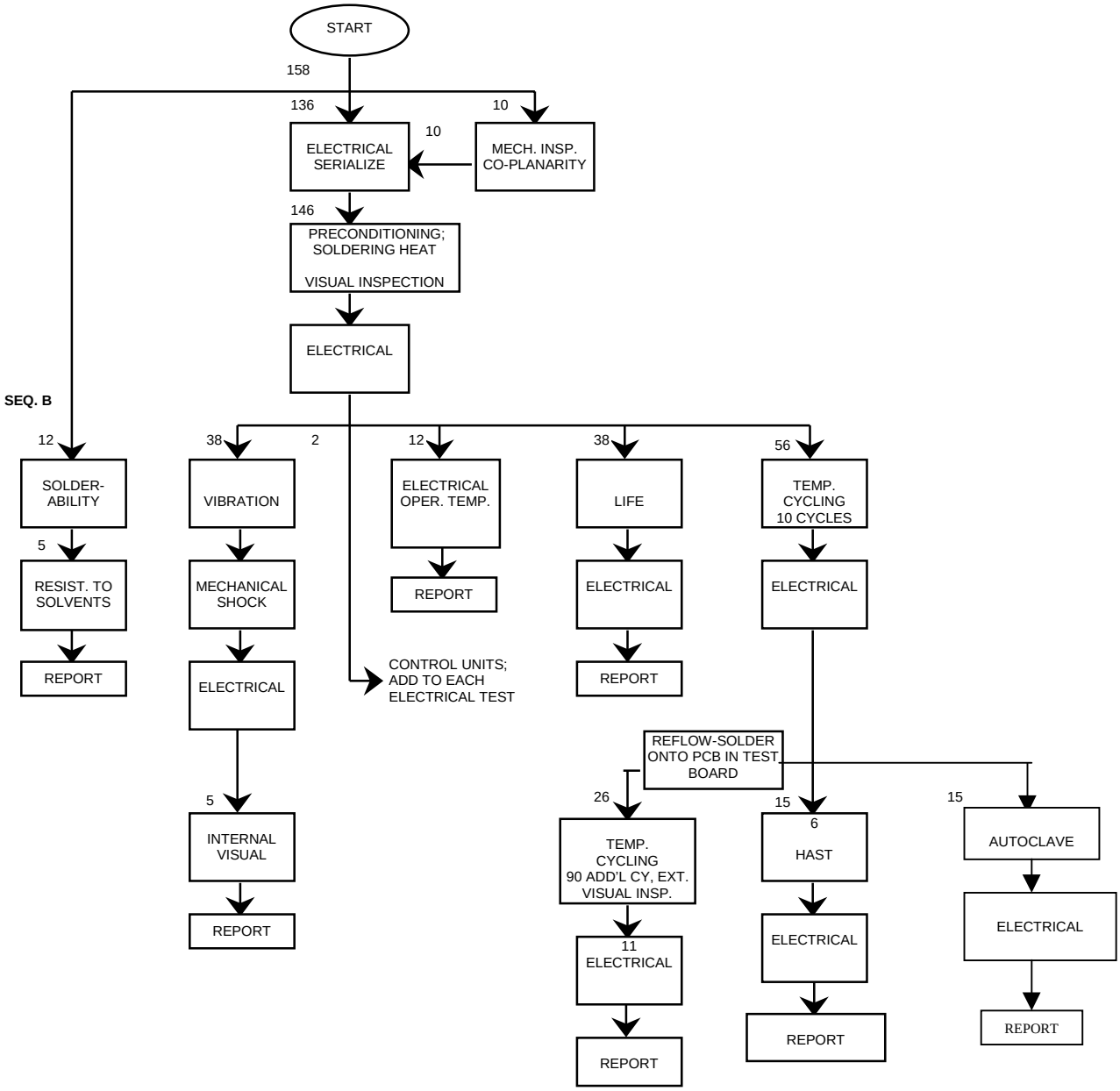
Appendix

Appendix A

Model Type: SCL Model Tested: LRPS-2-980A

Qualification Test Flowchart

Justification for qualification by similarity: SCL-2-10 has same Bill of Materials as LRPS-2-980A, except SCL-2-10 omits ceramic cover.



Appendix A (Continued)

Qualification Report For Model Type: SCL Ref: LRPS-2-980A, D4-QR-QQQ-2, ED-9389			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to LRPS-2-980A)**
Initial Electrical	Electrical Test	Appendix A1	146/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	146/0
	Electrical Test	Appendix A1	146/0
Mechanical	Vibration	2.1.2	38/0
	Mechanical Shock	2.1.3	38/0
	Electrical Test		38/0
Life	Life Test	2.1.4	38/0
	Electrical Test	Appendix A1	38/0
Thermal Shock	Thermal Shock	2.1.5 10Cycles 90 Cycles	 56/0 26/0
	Electrical Test		All Pass
Humidity	HAST	2.1.6	15/0
	Autoclave	2.1.7	15/0
	Electrical Test	Appendix A1	All Pass
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	10/0
	Solderability after Steam aging	2.1.10	12/0
	Resistance to solvents	2.1.11	5/0
	Lead Integrity Terminal Strength	2.1.12	5
	Electrical over full operating temperature	Appendix A1	12/0

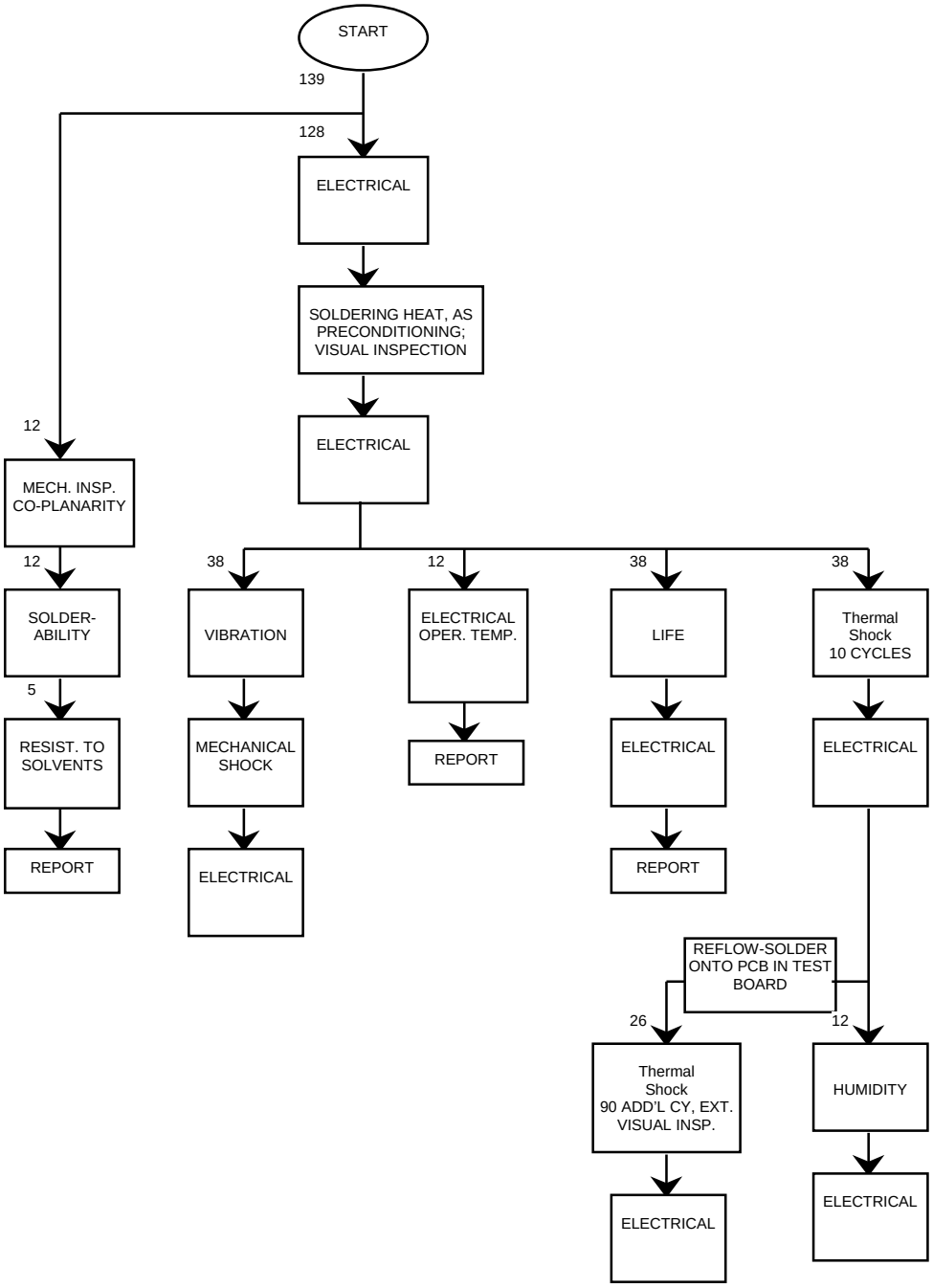
Appendix A1
Test Conditions

1.0	**Insertion Loss, Unbalance**	
	Test Conditions	
	Freq. (MHz)	Power (dBm)
1.1	800	-10
1.2	890	-10
1.3	980	-10
2.0	**Isolation bet. Outputs**	
	Test Conditions	
	Freq. (MHz)	Power (dBm)
2.1	800	-10
2.2	890	-10
2.3	980	-10
3.0	**Phase Unbalance bet. Outputs**	
	Test Conditions	
	Freq. (MHz)	Power (dBm)
3.1	980	-10

Appendix B

Model Type: SBTC Model Tested: SBTC-2-10

Qualification Test Flowchart



Appendix B (Continued)

Qualification Report For Model Type: SBTC Ref: SBTC-2-10, D4-QR-AT-2, ED-9354/10001			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail**
Initial Electrical	Electrical Test	Appendix B1	139/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	128/0
	Electrical Test	Appendix B1	146/0
Mechanical	Vibration	2.1.2	38/0
	Mechanical Shock	2.1.3	38/0
	Electrical Test		38/0
Life	Life Test	2.1.4 2W DC across resistors	10/0
	Electrical Test	Appendix B1	38/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles +90 cycles	38/0 26/0
	Electrical Test		26/0
Humidity	Humidity Steady State	2.1.8	12/0
	Electrical Test	Appendix B1	All Pass
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	10/0
	Solderability after Steam aging	2.1.10	10/0
	Resistance to solvents	2.1.11	N/A
	Lead Integrity Terminal Strength	2.1.12	N/A
	Electrical over full operating temperature	Appendix B1	12/0

Appendix B1
Test Conditions

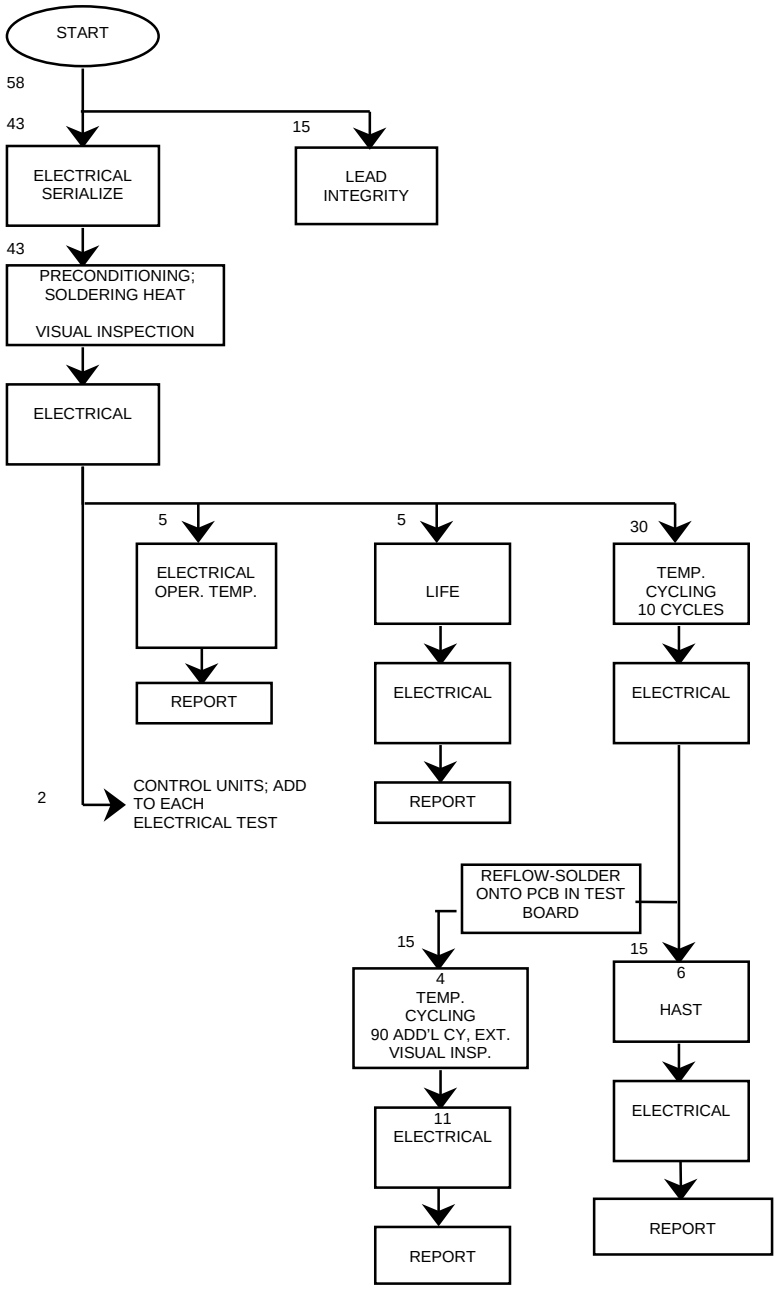
1.0	**Insertion Loss, Unbalance**	
	Test Conditions	
	Freq. (MHz)	Power (dBm)
1.1	5	-10
1.2	500	-10
1.3	1000	-10
2.0	**Isolation bet. Outputs**	
	Test Conditions	
	Freq. (MHz)	Power (dBm)
2.1	5	-10
2.2	500	-10
2.3	1000	-10
3.0	**Phase Unbalance**	
	Test Conditions	
	Freq. (MHz)	Power (dBm)
3.1	5	-10
3.2	500	-10
3.3	1000	-10

Appendix C

Model Type: SBB Model Tested: SBB-2-18

Justification for qualification by similarity to SCL:
Both are "pure LTCC" with leads, SBB has smaller area.

Qualification Test Flowchart of SBB-2-18



Appendix C (Continued)

Qualification Report For Model Type: SBB-Preliminary Ref: SBB-2-18, Ref: MQ00550			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (or Similar to)**
Initial Electrical	Electrical Test	Appendix C1	43/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	43/0
	Electrical Test	Appendix C1	146/0
Mechanical	Vibration	2.1.2	Similar to SCL
	Mechanical Shock	2.1.3	Similar to SCL
	Electrical Test		Similar to SCL
Life	Life Test	2.1.4 Survival test as combiner, 1.5W	5/0
	Electrical Test	Appendix C1	5/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles +90 cycles	 30/0 15/0
	Electrical Test		All Pass
Humidity	HAST	2.1.6	15/0
	Electrical Test	Appendix C1	15/0
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	Similar to SCL
	Solderability after Steam aging	2.1.10	Similar to SCL
	Resistance to solvents	2.1.11	Similar to SCL
	Lead Integrity Terminal Strength	2.1.12	15/0
	Electrical over full operating temperature	Appendix C1	5/0

Appendix C1
Test Conditions

1.0	**Insertion Loss, Unbalance**	
	Test Conditions	
	Freq. (MHz)	Power (dBm)
1.1	1425-1800	-10
2.0	**Isolation bet. Outputs**	
	Test Conditions	
	Freq. (MHz)	Power (dBm)
2.1	1425-1800	-10
3.0	**Phase Unbalance bet. Outputs**	
	Test Conditions	
	Freq. (MHz)	Power (dBm)
3.1	1425-1800	-10
4.0	**Return Loss**	
	Test Conditions	
	Freq. (MHz)	Power (dBm)
4.1	142	-10
4.2	1600	-10
4.3	1800	-10

Appendix D

Model Type: SCN Model Tested: LFCN-800

For Qualification Test Flowchart, see Appendix V

Justification for qualification by similarity to:

LFCN: Both are “pure LTCC” with wrap-around terminations, same size.

SCL: LTCC in SCN has smaller area.

Appendix D (Continued)

Qualification Report For Model Type: SCN Ref: LFCN-800, (D4-QR-FV-1), see Appendix V			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to LFCN-800)**
Initial Electrical	Electrical Test		100/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	20/0
	Electrical Test		20/0
Mechanical	Vibration	2.1.2	Similar to SCL
	Mechanical Shock	2.1.3	Similar to SCL
	Electrical Test		Similar to SCL
Life	Life Test	2.1.4	Similar to SCL
	Electrical Test		Similar to SCL
Thermal Shock	Thermal Shock	2.1.5 10 Cycles	20/0
	Electrical Test		20/0
Humidity	HAST	2.1.6	Similar to SCL
	Autoclave	2.1.7	Similar to SCL
	Electrical Test		Similar to SCL
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	10/0
	Solderability after Steam aging	2.1.10	30/0
	Resistance to solvents	2.1.11	N/A
	Lead Integrity Terminal Strength	2.1.12	N/A
	Electrical over full operating temperature		1/0

Appendix E

Model Type: QBA Model Tested: MCA-50H

For Qualification Test Flowchart of MCA-50H, see Appendix P

Justification for qualification by similarity to MCA:
Same size LTCC substrate, similar leads. QBA is simpler.

Appendix E (Continued)

Qualification Report For Model Type: QBA Ref.: QBA-07, ED-8943/03 Ref: MCA-50H, see Appendix P			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to MCA-50H)**
Initial Electrical	Electrical Test		Similar to MCA
Pre-conditioning	Resistance to Solder Heat	2.1.1	Similar to MCA
	Electrical Test		Similar to MCA
Mechanical	Vibration	2.1.2	Similar to MCA
	Mechanical Shock	2.1.3	Similar to MCA
	Electrical Test		Similar to MCA
Life	Life Test	2.1.4	Similar to MCA
	Electrical Test		Similar to MCA
Thermal Shock	Thermal Shock	2.1.5 10 Cycles	Similar to MCA
	Electrical Test		Similar to MCA
Humidity	Humidity Steady State	2.1.8	Similar to MCA
	Electrical Test		Similar to MCA
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	In progress
	Solderability after Steam aging	2.1.10	Similar to MCA
	Resistance to solvents	2.1.11	Similar to MCA
	Lead Integrity Terminal Strength	2.1.12	Similar to MCA
	Electrical over full operating temperature	Appendix E1	5/0

Appendix E1
Test Conditions

1.0	**Insertion Loss, Unbalance**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
1.1	340	-10
1.2	530	-10
1.3	680	-10
2.0	**Isolation bet. Outputs**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
2.1	340	-10
2.2	530	-10
2.3	680	-10
3.0	**Phase Unbalance bet. Outputs**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
3.1	340	-10
3.2	530	-10
3.3	680	-10
4.0	**Return Loss**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
4.1	340 - 680	-10

Appendix F

Model Type: QCC Model Tested: SBTC-2-10

For Qualification Test Flowchart, see Appendix B

Justification for qualification by similarity to SBTC:
Same size lead-less LTCC. Simpler than SBTC, which has transformer.

Appendix F (Continued)

Qualification Report For Model Type: QCC Ref: SBTC-2-10, D4-QR-AT-2 see Appendix B			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to SBTC-2-10)**
Initial Electrical	Electrical Test		139/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	128/0
	Electrical Test		146/0
Mechanical	Vibration	2.1.2	38/0
	Mechanical Shock	2.1.3	38/0
	Electrical Test		38/0
Life	Life Test	2.1.4 2W DC across resistors	10/0
	Electrical Test		38/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles +90 cycles	 38/0 26/0
	Electrical Test		26/0
Humidity	Humidity Steady State	2.1.8	12/0
	Electrical Test		All Pass
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	10/0
	Solderability after Steam aging	2.1.10	10/0
	Resistance to solvents	2.1.11	N/A
	Lead Integrity Terminal Strength	2.1.12	N/A
	Electrical over full operating temperature		12/0

Appendix G

Model Type: QCN Model Tested: LFCN-800

For Qualification Test Flowchart, see Appendix V

Justification for qualification by similarity to:

LFCN: Both are “pure LTCC” with wrap-around terminations, same size.

SCL: LTCC in QCN has smaller area.

Appendix G (Continued)

Qualification Report For Model Type: QCN Ref: LFCN-800, (D4-QR-FV-1) see Appendix V			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to LFCN-800)**
Initial Electrical	Electrical Test		100/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	20/0
	Electrical Test		20/0
Mechanical	Vibration	2.1.2	Similar to SCL
	Mechanical Shock	2.1.3	Similar to SCL
	Electrical Test		Similar to SCL
Life	Life Test	2.1.4	Similar to SCL
	Electrical Test		Similar to SCL
Thermal Shock	Thermal Shock	2.1.5 10 Cycles	20/0
	Electrical Test		20/0
Humidity	HAST	2.1.6	Similar to SCL
	Autoclave	2.1.7	Similar to SCL
	Electrical Test		Similar to SCL
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	10/0
	Solderability after Steam aging	2.1.10	30/0
	Resistance to solvents	2.1.11	N/A
	Lead Integrity Terminal Strength	2.1.12	N/A
	Electrical over full operating temperature		1/0

Appendix H

Model Type: SBTCJ Model Tested: SBC-2-10

For Qualification Test Flowchart, see Appendix B

Justification for qualification by similarity to SBTC:
Same size LTCC, mechanically similar parts.

Appendix H (Continued)

Qualification Report For Model Type: SBTCJ Ref: SBTC-2-10, D4-QR-AT-2 see Appendix B			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to SBTC-2-10)**
Initial Electrical	Electrical Test		139/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	128/0
	Electrical Test		146/0
Mechanical	Vibration	2.1.2	38/0
	Mechanical Shock	2.1.3	38/0
	Electrical Test		38/0
Life	Life Test	2.1.4 2W DC across resistors	10/0
	Electrical Test		38/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles +90 cycles	38/0 26/0
	Electrical Test		26/0
Humidity	Humidity Steady State	2.1.8	12/0
	Electrical Test		All Pass
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	10/0
	Solderability after Steam aging	2.1.10	10/0
	Resistance to solvents	2.1.11	N/A
	Lead Integrity Terminal Strength	2.1.12	N/A
	Electrical over full operating temperature		12/0

Appendix J

Model Type: SCA, 3-way, .18" height (New Leads and Weld Method)

Model Tested: SCA-4-10

For Qualification Test Flowchart see Appendix L

Justification for qualification by similarity to SCA-4-10:
Mechanically similar parts and construction.

Appendix J (Continued)

Qualification Report For Model Type: SCA, 3-way, .18" height Ref: SCA-4-10 see Appendix L			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to SCA-4-10)**
Initial Electrical	Electrical Test	Appendix L1	67/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	67/0
	Electrical Test	Appendix L1	67/0
Mechanical	Vibration	2.1.2	25/0
	Mechanical Shock	2.1.3	25/0
	Electrical Test		25/0
Life	Life Test	2.1.4	5/0
	Electrical Test	Appendix L1	5/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles 90 Cycles	 30/0 15/0
	Electrical Test		All Pass
Humidity	Humidity Steady State	2.1.8	15/0
	Electrical Test	Appendix L1	15/0
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	In progress
	Solderability after Steam aging	2.1.10	In progress
	Lead Integrity Terminal Strength	2.1.12	In progress
	Electrical over full operating temperature	Appendix L1	In progress

Appendix K

Model Type: SCA, 4-way, .045" height (New Leads and Weld Method)
Model Tested: MCA-50H

For Qualification Test Flowchart, see Appendix P

Justification for qualification by similarity to MCA:
Same size LTCC substrate, similar leads. SCA is simpler.

Appendix K (Continued)

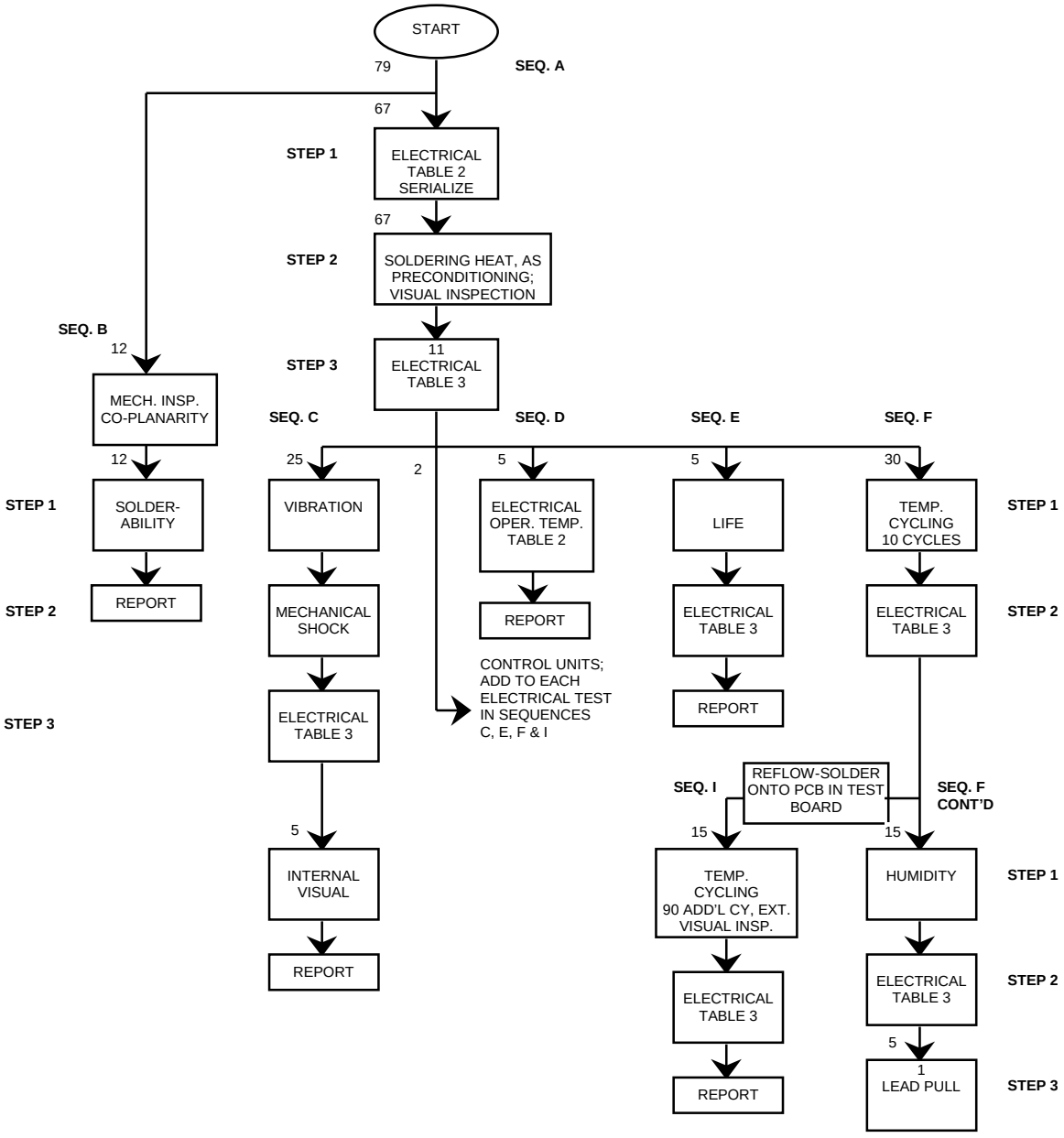
Qualification Report For Model Type: SCA Ref: MCA-50H, D4-QR-DZ-1 see Appendix P			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to MCA-50H)**
Initial Electrical	Electrical Test		101/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	101/0
	Electrical Test		101/0
Mechanical	Vibration	2.1.2	38/0
	Mechanical Shock	2.1.3	38/0
	Electrical Test		38/0
Life	Life Test	2.1.4 LO Power=17 dBm, Freq= 1 GHz	20/0
	Electrical Test		20/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles 90 Cycles	 38/0 26/0
	Electrical Test		All Pass
Humidity	Humidity Steady State	2.1.8	12/0
	Electrical Test		12/0
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	12/0
	Solderability after Steam aging	2.1.10	12/0
	Resistance to solvents	2.1.11	5/0
	Lead Integrity Terminal Strength	2.1.12	5/0
	Electrical over full operating temperature		5/0

Appendix L

Model Type: SCA, 4-way, .18" height (New Leads and Weld Method)

Model Tested: SCA-4-10

Qualification Test Flowchart



Appendix L (Continued)

Qualification Report For Model Type: SCA, 4-way, .18" height Ref: SCA-4-10, ED-10669			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail**
Initial Electrical	Electrical Test	Appendix L1	67/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	67/0
	Electrical Test	Appendix L1	67/0
Mechanical	Vibration	2.1.2	25/0
	Mechanical Shock	2.1.3	25/0
	Electrical Test		25/0
Life	Life Test	2.1.4	5/0
	Electrical Test	Appendix L1	5/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles 90 Cycles	 30/0 15/0
	Electrical Test		All Pass
Humidity	Humidity Steady State	2.1.8	15/0
	Electrical Test	Appendix L1	15/0
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	12/0
	Solderability after Steam aging	2.1.10	12/0
	Lead Integrity Terminal Strength	2.1.12	5/0
	Electrical over full operating temperature	Appendix L1	5/0

Appendix L1
Test Conditions

1.0	**Insertion Loss, Unbalance**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
1.1	5	-10
1.2	500	-10
1.3	1000	-10
2.0	**Isolation bet. Outputs**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
2.1	5	-10
2.2	500	-10
2.3	1000	-10
3.0	**Phase Unbalance bet. Outputs**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
3.1	5	-10
3.2	500	-10
3.3	1000	-10
4.0	**Return Loss**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
4.1	5 - 1000	-10

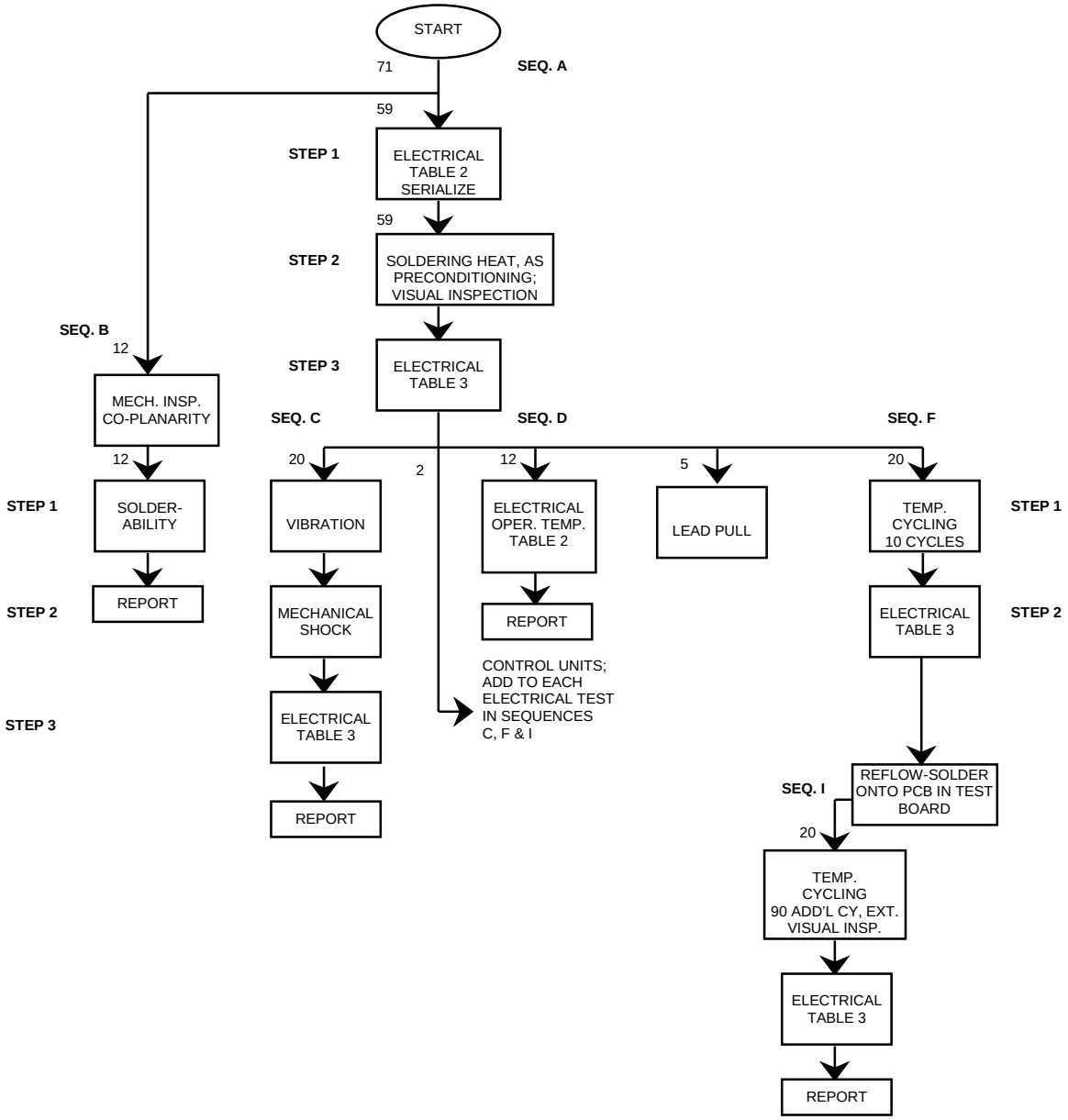
Appendix M

Model Type: SBD Model Tested: SBD-4-25

For Qualification Test Flowchart of LRPS-2-980A, see Appendix A

Justification for qualification by similarity to LRPS for Life and Humidity tests: Same kind of LTCC substrate material.

Qualification Test Flowchart of SBD-4-25



Appendix M (Continued)

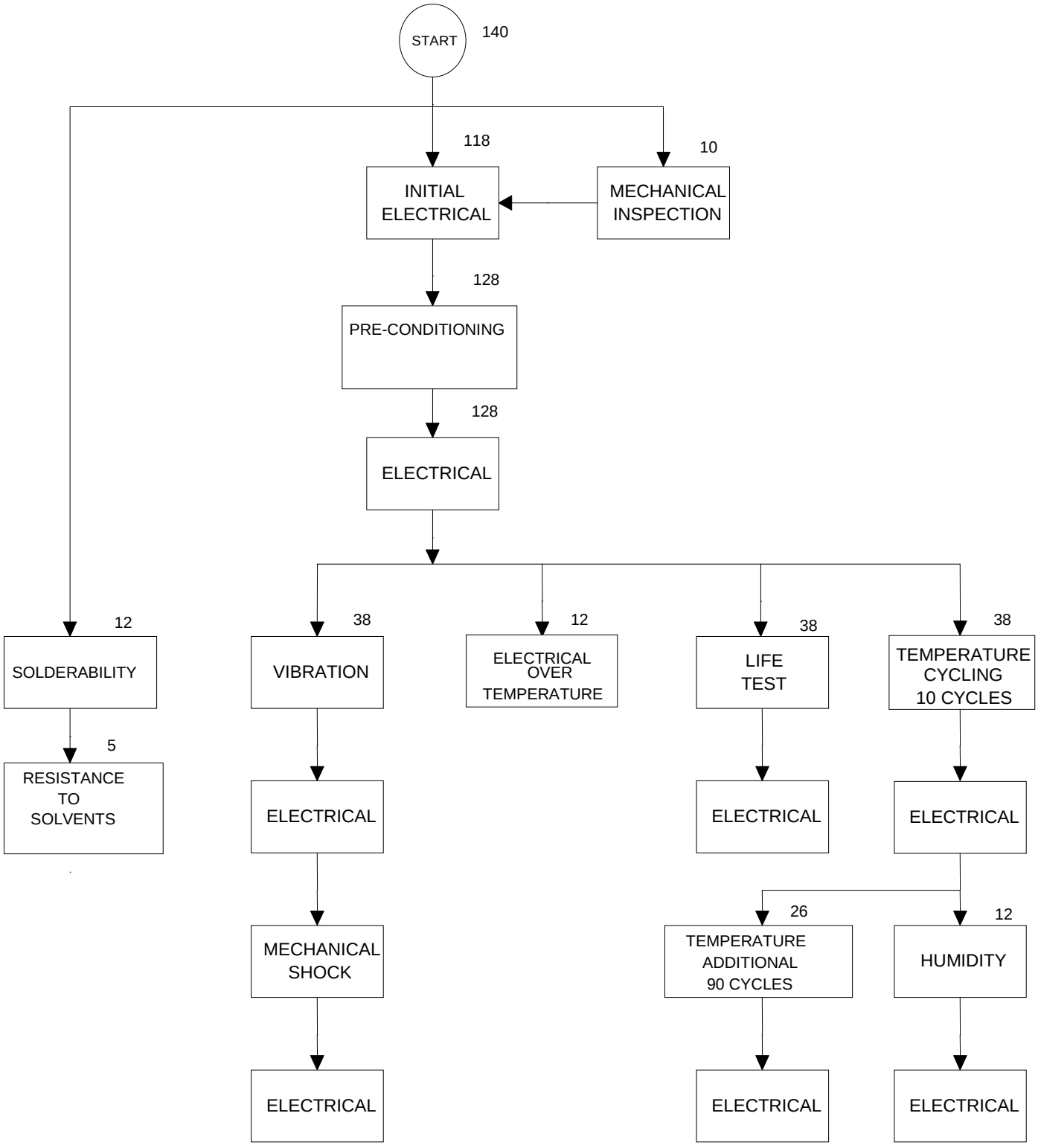
Qualification Report For Model Type: SBD Ref: SBD-4-25, ED-10477 For similarity to LRPS-2-80A see Appendix A			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail**
Initial Electrical	Electrical Test	Appendix M1	59/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	59/0
	Electrical Test	Appendix M1	59/0
Mechanical	Vibration	2.1.2	20/0
	Mechanical Shock	2.1.3	20/0
	Electrical Test		20/0
Life	Life Test	2.1.4	Similar to SCL
	Electrical Test		Similar to SCL
Thermal Shock	Thermal Shock	2.1.5 10Cycles 90 Cycles	 20/0 20/0
	Electrical Test	Appendix M1	All Pass
Humidity	HAST	2.1.6	Similar to SCL
	Autoclave	2.1.7	Similar to SCL
	Electrical Test		Similar to SCL
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	12/0
	Solderability after Steam aging	2.1.10	12/0
	Resistance to solvents	2.1.11	Similar to SCL
	Lead Integrity Terminal Strength	2.1.12	5
	Electrical over full operating temperature	Appendix M1	12/0

Appendix M1
Test Conditions

1.0	**Insertion Loss, Unbalance**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
1.1	1000	-10
1.2	2000	-10
1.3	2100	-10
1.4	2200	-10
1.5	2400	-10
1.6	2500	-10
1.7	2600	-10
2.0	**Isolation bet. Outputs**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
2.1	1000	-10
2.2	2000	-10
2.3	2100	-10
2.4	2200	-10
2.5	2400	-10
2.6	2500	-10
2.7	2600	-10
3.0	**Phase Unbalance bet. Outputs**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
3.1	1000	-10
3.2	2000	-10
3.3	2100	-10
3.4	2200	-10
3.5	2400	-10
3.6	2500	-10
3.7	2600	-10
4.0	**Return Loss**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
4.1	1800 - 2600	-10

Appendix N
Model Type: ADXPS Model Tested: AD4PS-1-2

Qualification Test Flowchart



Appendix N (Continued)

Qualification Report For Model Type: ADXPS Ref: AD4PS-1-2, ED: 9992			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail**
Initial Electrical	Electrical Test	Appendix N1	128/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	128/0
	Electrical Test	Appendix N1	128/0
Mechanical	Vibration	2.1.2	38/0
	Mechanical Shock	2.1.3	38/0
	Electrical Test		38/0
Life	Life Test	2.1.4 Across resistor, ½ Watt	38/0
	Electrical Test	Appendix N1	38/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles	38/0 26/0
	Electrical Test		All Pass
Humidity	Humidity Steady State	2.1.8	12/0
	Electrical Test	Appendix N1	12/0
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	10/0
	Solderability after Steam aging	2.1.10	12/0
	Resistance to solvents	2.1.11	5/0
	Lead Integrity Terminal Strength	2.1.12	5/0
	Electrical over full operating temperature	Appendix N1	12/0

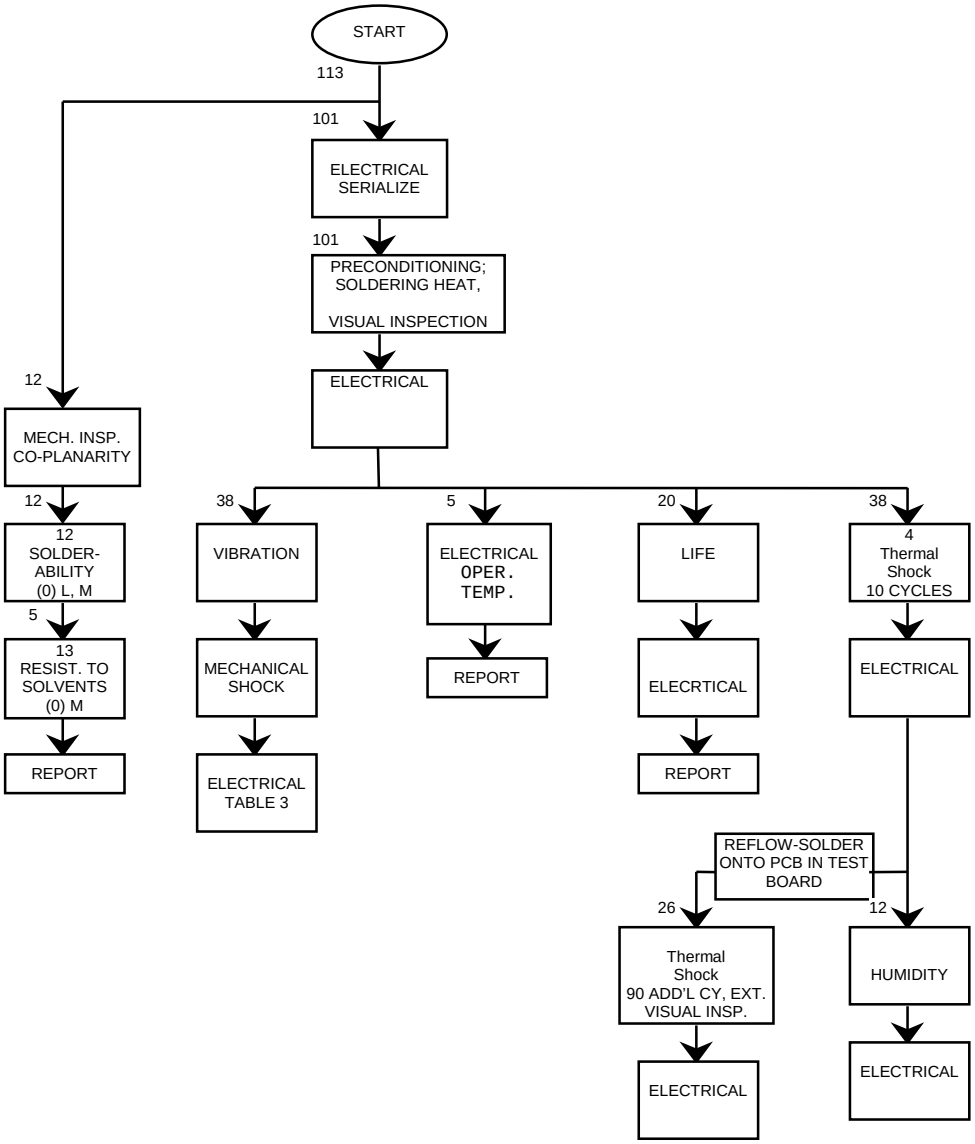
Appendix N1
Electrical Test Conditions

1.0	**Insertion Loss, Unbalance**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
1.1	156-174	-10
2.0	**Isolation bet. Outputs**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
2.1	156-174	-10
3.0	**Phase Unbalance bet. Outputs**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
3.1	174	-10
4.0	**Return Loss**	
	Test Conditions	
	Freq.	Power
	(MHz)	(dBm)
4.1	156-174	-10

Appendix P

Model Type: MCA **Model Tested: MCA-50H**

Qualification Test Flowchart



Appendix P (Continued)

Qualification Report For Model Type: MCA Ref: MCA-50H, D4-QR-DZ-1, ED-9595/1			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail**
Initial Electrical	Electrical Test	Appendix P1	101/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	101/0
	Electrical Test	Appendix P1	101/0
Mechanical	Vibration	2.1.2	38/0
	Mechanical Shock	2.1.3	38/0
	Electrical Test	Appendix P1	38/0
Life	Life Test	2.1.4 LO Power=17 dBm, Freq= 1 GHz	20/0
	Electrical Test	Appendix P1	20/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles 90 Cycles	 38/0 26/0
	Electrical Test	Appendix P1	All Pass
Humidity	Humidity Steady State	2.1.8	12/0
	Electrical Test	Appendix P1	12/0
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	12/0
	Solderability after Steam aging	2.1.10	12/0
	Resistance to solvents	2.1.11	5/0
	Lead Integrity Terminal Strength	2.1.12	5/0
	Electrical over full operating temperature	Appendix P1	5/0

Appendix P1

Electrical Test Conditions

Conversion Loss

Freq (MHz)		Power Level (dBm)	
RF	LO	LO	RF
1000	1400	+17	-5
1400	2000	+17	-5
2000	2600	+17	-5
3000	4500	+17	-5
4500	5000	+17	-5

Isolation (L-R/L-I)

Freq (MHz)	LO Level (dBm)
1400	+17
2000	+17
2600	+17
4500	+17
5000	+17

Compression

Freq (MHz)		Power Level (dBm)	
RF	LO	RF	LO
1000	1400	+14	+17

Appendix Q

Model Type: MCA1 Model Tested: MCA-50H

For Qualification Test Flowchart, see Appendix P

Justification for qualification by similarity to MCA:
Same size LTCC, same type of encapsulated diode quad and leads. MCA1 has simpler assembly (omits magnetic transformer).

Appendix Q (Continued)

Qualification Report For Model Type: MCA1 Ref: MCA-50H, D4-QR-DZ-1 see Appendix P			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to MCA)**
Initial Electrical	Electrical Test		101/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	101/0
	Electrical Test		101/0
Mechanical	Vibration	2.1.2	38/0
	Mechanical Shock	2.1.3	38/0
	Electrical Test		38/0
Life	Life Test	2.1.4 LO Power=17 dBm, Freq= 1 GHz	20/0
	Electrical Test		20/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles 90 Cycles	 38/0 26/0
	Electrical Test		All Pass
Humidity	Humidity Steady State	2.1.8	12/0
	Electrical Test		12/0
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	12/0
	Solderability after Steam aging	2.1.10	12/0
	Resistance to solvents	2.1.11	5/0
	Lead Integrity Terminal Strength	2.1.12	5/0
	Electrical over full operating temperature		5/0 (MCA1-XX)

Appendix R
Model Type: MAX

(Under qualification)

Appendix S

Model Type: DBTC Model Tested: SBTC-2-10

For Qualification Test Flowchart, see Appendix B

Justification for qualification by similarity to SBTC:
Same size LTCC, same assembly method using magnetic transformer.

Appendix S (Continued)

Qualification Report For Model Type: DBTC Ref: SBTC-2-10, D4-QR-AT-2 see Appendix B			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to SBTC-2-10)**
Initial Electrical	Electrical Test		139/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	128/0
	Electrical Test		146/0
Mechanical	Vibration	2.1.2	38/0
	Mechanical Shock	2.1.3	38/0
	Electrical Test		38/0
Life	Life Test	2.1.4 2W DC across resistors	10/0
	Electrical Test	Appendix B1	38/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles +90 cycles	38/0 26/0
	Electrical Test		26/0
Humidity	Humidity Steady State	2.1.8	12/0
	Electrical Test	Appendix B1	All Pass
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	10/0
	Solderability after Steam aging	2.1.10	10/0
	Resistance to solvents	2.1.11	N/A
	Lead Integrity Terminal Strength	2.1.12	N/A
	Electrical over full operating temperature		12/0

Appendix T

Appendix T
Model Type: BDCA

Models Tested:

SBB-2-18 (for Lead Integrity)
MCA-50H (for remainder)

Justification for qualification by similarity to:

SBB-2-18: Same leads.

MCA-50H: Same size LTCC. BDCA is simpler.

Appendix T (Continued)

Qualification Report For Model Type: BDCA Ref: SBB-2-18 see Appendix C MCA-50H see Appendix P			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to MCA-50H)**
Initial Electrical	Electrical Test		128/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	128/0
	Electrical Test		128/0
Mechanical	Vibration	2.1.2	38/0
	Mechanical Shock	2.1.3	38/0
	Electrical Test		38/0
Life	Life Test	2.1.4 Across resistor, ½ Watt	38/0
	Electrical Test		38/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles	38/0 26/0
	Electrical Test		All Pass
Humidity	HAST	2.1.6	
	and/or Autoclave	2.1.7	
	or Humidity Steady State	2.1.8	12/0
	Electrical Test		12/0
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	10/0
	Solderability after Steam aging	2.1.10	12/0
	Resistance to solvents	2.1.11	5/0
	Lead Integrity Terminal Strength	2.1.12	(Similar to SBB-2-18)
	Electrical over full operating temperature		12/0

Appendix U

Model Type: BDCA1 Model Tested: MCA-50H

For Qualification Test Flowchart, see Appendix P

Justification for qualification by similarity to MCA:
Same size LTCC, same leads. BDCA1 is simpler.

Appendix U (Continued)

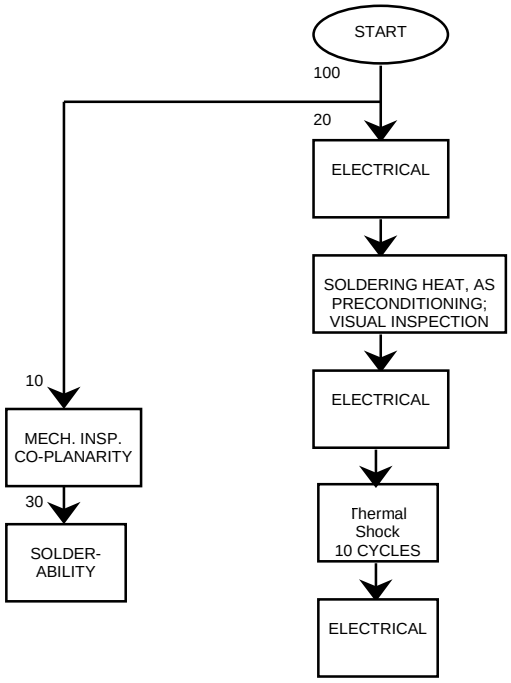
Qualification Report For Model Type: BDCA1 Ref: MCA-50H, D4-QR-DZ-1 see Appendix P			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to MCA)**
Initial Electrical	Electrical Test		101/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	101/0
	Electrical Test		101/0
Mechanical	Vibration	2.1.2	38/0
	Mechanical Shock	2.1.3	38/0
	Electrical Test		38/0
Life	Life Test	2.1.4 LO Power=17 dBm, Freq= 1 GHz	20/0
	Electrical Test		20/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles 90 Cycles	 38/0 26/0
	Electrical Test		All Pass
Humidity	Humidity Steady State	2.1.8	12/0
	Electrical Test		12/0
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	12/0
	Solderability after Steam aging	2.1.10	12/0
	Resistance to solvents	2.1.11	5/0
	Lead Integrity Terminal Strength	2.1.12	5/0
	Electrical over full operating temperature	C.L., L-R and L-I Isolation	5/0

Appendix V

Model Type: LFCN and HFCN Model Tested: LFCN-800

For Qualification Test Flowchart of SCL, similar to LRPS-2-980A, see Appendix A.

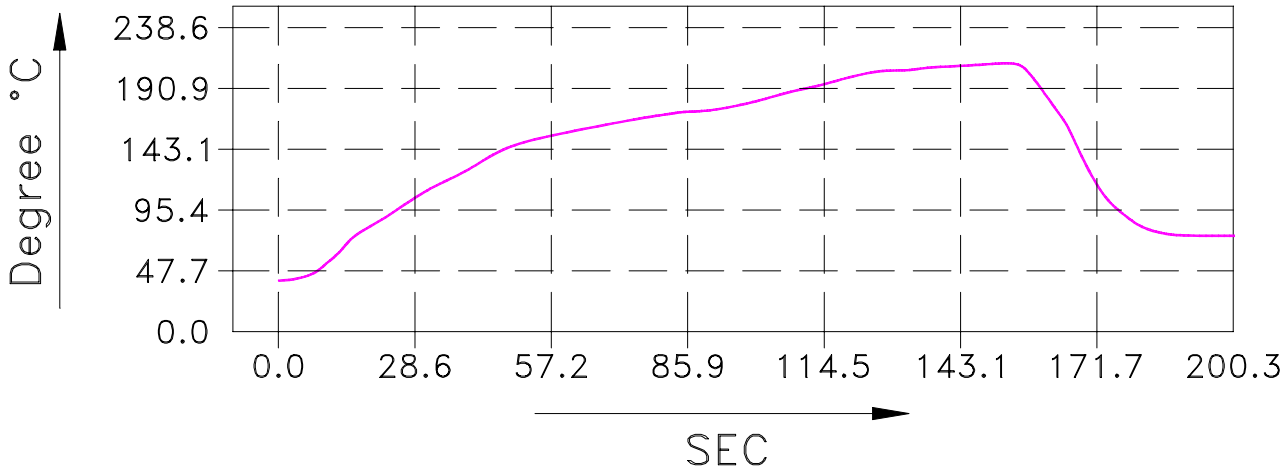
Justification for qualification by similarity to LRPS for Vibration, Mechanical Shock, Life and Humidity tests:
Same kind of LTCC substrate material. LFCN and HFCN are smaller.



Appendix V (Continued)

Qualification Report For Model Type: LFCN and HFCN Ref: LFCN-800, (D4-QR-FV-1) Ref: ED-9913			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail**
Initial Electrical	Electrical Test	Appendix V1	100/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	20/0
	Electrical Test	Appendix V1	20/0
Mechanical	Vibration	2.1.2	Similar to SCL
	Mechanical Shock	2.1.3	Similar to SCL
	Electrical Test		Similar to SCL
Life	Life Test	2.1.4	Similar to SCL
	Electrical Test		Similar to SCL
Thermal Shock	Thermal Shock	2.1.5 10 Cycles	20/0
	Electrical Test		20/0
Humidity	HAST	2.1.6	Similar to SCL
	Autoclave	2.1.7	Similar to SCL
	Electrical Test		Similar to SCL
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	10/0
	Solderability after Steam aging	2.1.10	30/0
	Resistance to solvents	2.1.11	N/A
	Lead Integrity Terminal Strength	2.1.12	N/A
	Electrical over full operating temperature	Appendix V1	1/0

Appendix V1
Test Conditions



Peak Temperature	Total Time above 184 °C, Sec.
212	69.9

Electrical Test Conditions

1.0 PASSBAND INSERTION LOSS

Test Conditions

Freq. (MHz)	Power (dBm)	
1.1	10	-10
1.2	800	-10

2.0 STOP BAND INSERTION LOSS

Test Conditions

Freq. (MHz)	Power (dBm)	
2.1	1400	-10
2.2	4500	-10

3.0 RETURN LOSS

Test Conditions

Freq. (MHz)	Power (dBm)	
3.1	10-800	-10
3.2	1400-4500	-10

Appendix H

Appendix W

Model Type: LFTC AND HFTC Model Tested: SBTC-2-10

For Qualification Test Flowchart, see Appendix B

Justification for qualification by similarity to SBTC:
Same size LTCC, leadless. LFTC and HFTC are simpler.

Appendix W (Continued)

Qualification Report For Model Type: LFTC AND HFTC Ref: SBTC-2-10, D4-QR-AT-2 see Appendix B			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to SBTC-2-10)**
Initial Electrical	Electrical Test		139/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	128/0
	Electrical Test		146/0
Mechanical	Vibration	2.1.2	38/0
	Mechanical Shock	2.1.3	38/0
	Electrical Test		38/0
Life	Life Test	2.1.4 2W DC across resistors	10/0
	Electrical Test		38/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles +90 cycles	38/0 26/0
	Electrical Test		26/0
Humidity	Humidity Steady State	2.1.8	12/0
	Electrical Test		All Pass
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	10/0
	Solderability after Steam aging	2.1.10	10/0
	Resistance to solvents	2.1.11	N/A
	Lead Integrity Terminal Strength	2.1.12	N/A
	Electrical over full operating temperature		12/0

Appendix Y

Model Type: LPCH Model Tested: LPCH-(TBD) **and JY4PS-1-1**

Justification for similarity to JY4PS-1-1 for Vibration and Mechanical Shock: Similar LTCC and leads. LPCH is simpler.

Qualification Test Flowchart of LPCH

(Under qualification)

Appendix Y (Continued)

Qualification Report For Model Type: LPCH Ref: JY4PS-1-1, EQ-9027			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to)**
Initial Electrical	Electrical Test		5/0 (JY4PS-1-1)
Mechanical	Vibration	2.1.2	5/0 (JY4PS-1-1)
	Mechanical Shock	2.1.3	
	Electrical Test		
Life	Life Test	2.1.4	Under Qualification
	Electrical Test		Under Qualification
Thermal Shock	Thermal Shock	2.1.5 10 Cycles 90 Cycles	Under Qualification
	Electrical Test		Under Qualification
Humidity	Humidity Steady State	2.1.8	Under Qualification
	Electrical Test		Under Qualification
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	Under Qualification
	Solderability after Steam aging	2.1.10	Under Qualification
	Resistance to solvents	2.1.11	Under Qualification
	Lead Integrity Terminal Strength	2.1.12	Under Qualification
	Electrical over full operating temperature		Under Qualification

Appendix Z

Model Type: TCC Model Tested: SBTC-2-10

For Qualification Test Flowchart, see Appendix B

Justification for qualification by similarity to SBTC:
Leadless LTCC. TCC is smaller and simpler.

Appendix Z (Continued)

Qualification Report For Model Type: TCC Ref: SBTC-2-10, D4-QR-AT-2 see Appendix B			
Sequence	**Test**	**Conditions: Refer to Para**	**Pass/Fail (Similar to)**
Initial Electrical	Electrical Test		139/0
Pre-conditioning	Resistance to Solder Heat	2.1.1	128/0
	Electrical Test		146/0
Mechanical	Vibration	2.1.2	38/0
	Mechanical Shock	2.1.3	38/0
	Electrical Test		38/0
Life	Life Test	2.1.4 2W DC across resistors	10/0
	Electrical Test		38/0
Thermal Shock	Thermal Shock	2.1.5 10 Cycles +90 cycles	38/0 26/0
	Electrical Test		26/0
Humidity	Humidity Steady State	2.1.8	12/0
	Electrical Test		All Pass
Additional Tests	Mechanical Inspection with co-planarity	2.1.9	10/0
	Solderability after Steam aging	2.1.10	10/0
	Resistance to solvents	2.1.11	N/A
	Lead Integrity Terminal Strength	2.1.12	N/A
	Electrical over full operating temperature		12/0

Appendix AA
Model Type: Transformer, 0805

(Under qualification)