Interface Masters
TECHNOLOGIES
Innovative Network Solutions

RELIABILITY REPORT

FOR THE

Niagara N2924_N4224

Prepared by

Interface Masters

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1.0 INTRODUCTION AND SUMMARY

This document presents the Interface Masters Reliability Prediction Report performed on the Niagara. It was analyzed for Mean Time Between Failure (MTBF) in accordance with Task 203 of MIL-STD-785B; paragraph 2.4 of Task 100 of MIL-STD-756B; and the Telcordia Method I, “Reliability Prediction Procedure for Electronic Equipment”, Telcordia Technologies Special Report, SR-332, Issue 2.

The Niagara was found to have a Mean Time Between Failure (MTBF) of 149,621.44 hours of operation. This statement is fully supported by the reliability mathematical model presented in Section 3.0, the Table 1 Failure Rate Data Summary and the detailed reliability parts count failure rate data tables presented in the Appendix A of this report.

1.1 Scope

This report reflects the Niagara reliability design analysis performed from project inception through the issue date of this document. This report is limited to electronic parts.

1.2 Objectives

Through this report, Interface Masters seeks to provide a prediction of the Niagara MTBF, to evaluate it's current and potential reliability, to provide information in order to assist in directing and planning for reliability and related program efforts and to identify design features which are critical to reliability.

2.0 APPLICABLE DOCUMENTS

2.1 Military Specification Documents

MIL-STD-756B, N1, 31 August 1982	Reliability Modeling and Prediction
MIL-STD-785B, 15 September 1980	Reliability Program for Systems and Equipment Development and Production

MIL-HDBK-217F(N1/2), 10 July 1992/28 February 1995	Reliability Prediction of Electronic Equipment

2.2 Commercial/Telcordia Documents

SR-332, Issue 2, September 2006	Telcordia, “Reliability Prediction Procedure for Electronic Equipment”, Telcordia Technologies Special Report

2.3 Interface Masters Documents

Niagara	Parts Lists and Engineering Drawings

3.0 RELIABILITY ANALYSIS

3.1 Reliability Analysis Methodology

The parts count method of reliability prediction used in this analysis is Commercial/Telcordia Method I, “Reliability Prediction Procedure for Electronic Equipment”, Telcordia Technologies Special Report.

3.2 Reliability Mathematical Model

The Reliability model MTBF reflects the reliability of all electrical parts in the equipment. Their failure rates are summarized in Table 1, by assembly, and presented in the appendix tables by part type.

The Mathematical Model used in determining the Niagara reliability is known as the series model. This model is based on the equation:

$$R(t) = e^{-\lambda t}$$

Where:

$R(t) =$ Reliability of the Niagara

$t =$ Elapsed operation time, in hours

RELIABILITY PARTS COUNT FAILURE RATE DATA SUMMARY

Table 1, Niagara

Assembly/ Parts List	Quantity	Failure Rate in FITS, Parts Per Billion Hours	
		Total	Quantity x Total
Niagara N2924_N4224/ NiagaraN2924_N4224_Rev13.xls	1	6,683.534	6,683.534

Total System Failure Rate = 6,683.534 **Parts Per Billion Hours.**

Total System Mean Time Between Failure (MTBF) = 149,621.44 **Hours.**

$\lambda =$ Niagara failure rate, in parts per billion hours (FITS)

The assumption is that if any part fails during operation, the Niagara is considered to have failed as a whole, and maintenance is required. The reliability of the Niagara, $R(t)$, is the combined probability of the individual parts reliability, where the unit contains quantity n parts:

$$R(t) = \prod_{i=1}^{n} R(t)_i$$

Where: $R(t)_i =$ reliability of part, i, over time, $t, e^{-\lambda_i t}$

The summation of all Niagara part failure rates provides the system failure rate, see Table 1. Thus, the system MTBF is determined by taking the reciprocal of the summation of the failure rates of all the Niagara parts:

$$MTBF = \int_{\circ}^{\infty} R(t)dt = 1/\sum_{i=1}^{n} \lambda_i$$

The analysis presented in this report contains no redundancy. Thus, the total Niagara MTBF is 149,621.44 hours of operation.

The parts count reliability prediction method reflects the generic part types, quantities and qualities used, and considers the operational and environmental impact. These factors are combined in the following mathematical model:

$$\lambda_{PC} = \pi_E \sum_{i=1}^{n} N_i (\lambda_G \pi_Q \pi_S \pi_T)_i$$

where:

$\lambda_{PC} =$ total failure rate (parts per billion hours) of the Niagara.

$\pi_E =$ environment factor for a given environment of an assembly.

$\lambda_G =$ generic failure rate for the ith generic part of an assembly.

$\pi_Q =$ quality factor for the ith generic part of an assembly.

$\pi_S =$ electrical stress factor for the ith generic part of an assembly.

$\pi_T =$ temperature factor for the ith generic part of an assembly.

$N_i =$ quantity of the ith generic part of an assembly.

$n =$ number of different generic part categories.

The failure rate model modifiers, quantity, environment factor, quality factor, electrical stress factor, temperature factor and generic failure rate are listed under their respective columns in the appendix tables. The modifiers are numerical multipliers for the individual generic parts failure rate.

3.3 Environmental Conditions

The total failure rate, λ_{PC}, includes the effects of the environment factor. The appropriate environment designation for the Niagara is Ground Fixed Controlled (G_B). This environment designation is presented in the heading of the appendix tables on a line labeled “Environment:”. The environment factor, π_E, is listed in the appendix tables under the Environment Factor column for each part.

3.4 Quality Factors

Interface Masters' use of commercial parts throughout the Niagara is reflected in the quality factors, presented in the appendix tables. The exact quality level is presented under the Specification/Quality Level column for each part. The quality factor, π_Q, is listed in the appendix tables under the Quality Factor column for each part.

3.5 Electrical Stress Factors

Interface Masters' conservative electrical and thermal design practices are reflected in the electrical stress factors, presented in the appendix tables. The electrical stress factors are based on the percentage of electrical stress applied to a part in a given circuit.

The parts count reliability prediction method used in this report reflects the 50% ratio of the applied electrical stress divided by the rated electrical stress for all parts in the Niagara design. The electrical stress factor, π_S, is listed in the appendix tables under the Electrical Stress Factor column for each part.

3.6 Temperature Factors

The parts count reliability prediction method uses a temperature factor for each generic part type based on a worst case part ambient temperature, T_A, of 55 degrees Celsius within the Niagara enclosure. The temperature factor, π_T, is listed in the appendix tables under the Temperature Factor column for each part.

3.7 Parts Count Failure Rate Calculations

The parts count reliability prediction procedure conducted on the Niagara provides the data upon which part failure rates are assigned for reliability prediction. The failure rate model of each component was determined and the associated failure rates were calculated and listed in the data tabulation sheets of the appendix, using the generic reliability failure rates determined per Commercial/Telcordia Method I, “Reliability Prediction Procedure for Electronic Equipment”.

The various failure rate model modifiers are listed in the appendix on detailed Failure Rate Data tables under "π" columns for each factor. The generic part type quantities, "π" factors and generic failure rates, λ_G, are numerical multipliers that determine the total part failure rate.

APPENDIX A

Reliability Parts Count Failure Rate Data Tabulation
For The
Niagara

RELIABILITY PARTS COUNT FAILURE RATE DATA

System:
Page 1 Niagara

Assembly: N28xx and N42xx

Parts List: Niagara **N2924_N4224**_REV13

Environment: Ground, Fixed, Controlled (GB); Part Ambient Temperature: 55 Degrees C.

Description/ Generic Part Type	Specification/ Quality Level	Quantity	Environment Factor (Pi E)	Quality Factor (Pi Q)	Electrical Stress Factor (Pi S)	Temperature Factor (Pi T)	Failure Rate in FITS, Parts Per Billion Hours Generic	Total
Capacitor/ Fixed Ceramic	Commercial/ II	2085	1	1	1	1.1	0.2	458.70000
Capacitor/ Fixed Aluminum, Chassis Mounted 400 - 12000uF	Commercial/ II	2	1	1	1	2	39	156.00000
Resistor/ Film (Carbon, Oxide, Metal) <= 1 Mohm	Commercial/ II	1013	1	1	1	1.3	0.51	671.61900
Resistor Network/ Discrete Elements	Commercial/ II	40	1	1	1	1.8	0.51	36.72000
Connector/ General Purpose, Power, 6 - 10 Pins	Commercial/ II	2	1	1	1	2	22	88.00000
Connector/ Multi-Pin, 1 - 20 Pins	Commercial/ II	27	1	1	1	2	2	108.00000
Connector/ SFP Multi-Pin, 20 - 100 Pins	Commercial/ II	24	1	1	1	2	2.4	115.20000

Connector/ Multi-Pin, 200- 300 Pins	Commercial/ II	1	1	1	1	2	2.9	5.80000
Connector/ Printed Board, Edge, 1 - 20 Pins	Commercial/ II	5	1	1	1	2	2.6	26.00000
Diode/ Silicon General Purpose <= 20 Amps.	Commercial/ II	29	1	1	1	1.5	1.7	73.95000
Transformer/ Pulse Low Level	Commercial/ II	1	1	1	1	1.3	3	3.90000
Coil/ Ferrite Bead Load Coil	Commercial/ II	65	1	1	1	1.3	0.9	76.05000
Coil/ Power Filter	Commercial/ II	2	1	1	1	1.3	2.3	5.98000
Integrated Circuit/ Digital CMOS Realy Driver	Commercial/ II	8	1	1	1	2.1	3.9	65.52000
Integrated Circuit/ Digital CMOS 1 - 20 Gates (15 Nominal)	Commercial/ II	13	1	1	1	2.1	4.1	111.93000
Integrated Circuit/ Digital CMOS 21 - 50 Gates (40 Nominal)	Commercial/ II	9	1	1	1	2.1	4.4	83.16000
Integrated Circuit/ Digital CMOS 10,001 - 15,000 Gates (13,000 Nominal)	Commercial/ II	1	1	1	1	2.1	7.2	15.12000
Integrated Circuit/ Digital CMOS 30,001 - 50,000 Gates (40,000 Nominal)	Commercial/ II	1	1	1	1	2.1	8.1	17.01000

Integrated Circuit/ Digital CMOS 50,001 - 100,000 Gates (80,000 Nominal)	Commercial/ II	2	1	1	1	2.1	8.7	36.54000
Integrated Circuit/ Digital CMOS 500,001 - 1,000,000 Gates (80,000 Nominal)	Commercial/ II	16	1	1	1	2.1	21	705.60000
Integrated Circuit/ ROM CMOS 100,001 - 600,000 Bits (0.5M Nominal)	Commercial/ II	29	1	1	1	3.3	12	1,148.40000
Integrated Circuit/ ROM CMOS 600,001 - 1,200,000 Bits (1M Nominal)	Commercial/ II	1	1	1	1	3.3	27	89.10000
Integrated Circuit/ DRAM CMOS 600,001 - 1,200,000 Bits (1MB Nominal)	Commercial/ II	1	1	1	1	3.3	38	125.40000
Integrated Circuit/ CMOS Microprocessor, 32 Bits	Commercial/ II	1	1	1	1	2.1	28	58.80000
Transmit/Receive Elements/ SFP Transceiver	Commercial/ II	8	1	1	1	2	110	1,760.00000
Optical Device/ Single LED/LCD Segment	Commercial/ II	67	1	1	1	3.3	0.89	196.77900
Optical Device/ optical switch Segment	Commercial/ II	4	1	1	1	3.3	12	158.40000
Transistor/ Silicon NPN/PNP <= 0.6 Watts	Commercial/ II	36	1	1	1	1.5	1.7	91.80000
Crystal Oscillator/ Quartz Controlled	Commercial/ II	2	1	1	1	1	14	28.00000
Oscillator/	Commercial/	2	1	1	1	1	16	32.00000

Voltage Controlled	II							
Power Modules/ 5 - 15 Watts	Commercial/ II	7	1	1	1	1	10	70.00000
Power Modules/ 15 - 100 Watts	Commercial/ II	3	1	1	1	1	19	57.00000
Fuse/ 1-10 Amp	Commercial/ II	2	1	1	1	1.8	1.96	7.05600

Total Assembly Quantity of Parts = 3509

Total Assembly Failure Rate = 6,683.53400 **Parts Per Billion Hours**

Total System Mean Time Between Failure (MTBF) = 149,621.44 **Hours**