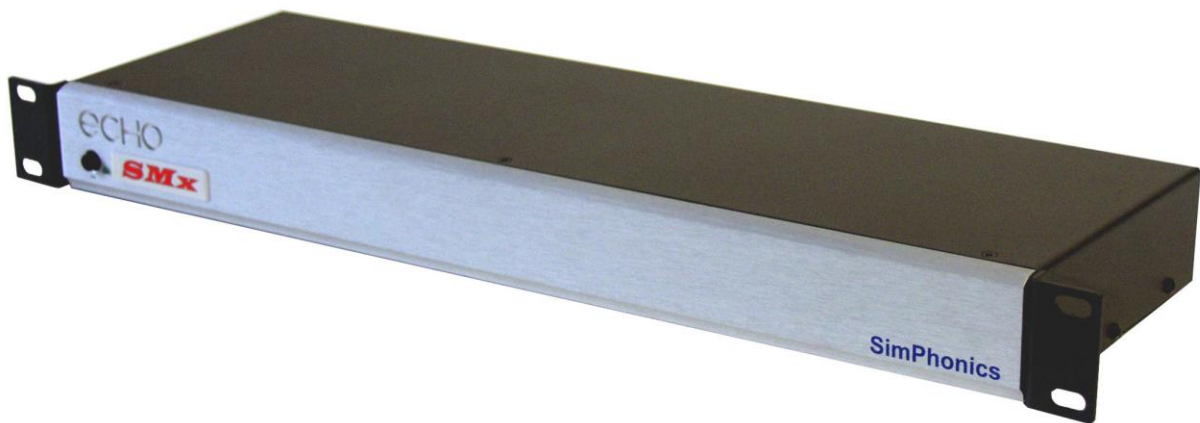


Reliability and Maintainability Predictions for the SMx Audio System Hardware Components



SimPhonics Incorporated

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REVISION HISTORY

Ensure you have the latest release of this document before relying on this information.

Version	Revision	Date
1.0	Initial Release	February 26, 2002
1.1	Updated to current SMx parts list; added worksheets for channels 8-64; updated document format; re-released document.	August 27, 2003
1.2	Updated document per Joe Madore's corrections; re-released document.	August 29, 2003
1.3	Updated document to include worksheet for SMx computer system; re-released document.	March 15, 2005

TABLE OF CONTENTS

Revision History.....	2
1.0 Introduction.....	4
2.0 Applicable Documents.....	5
3.0 Reliability Prediction	6
3.1 Total System Reliability Predictions.....	7
3.1-1 – SMx Computer System Reliability Prediction Worksheet	7
3.1-2 – 8 Channel SMx System Reliability Prediction Worksheet.....	8
3.1-3 – 16 Channel SMx System Reliability Prediction Worksheet.....	8
3.1-4 – 24 Channel SMx System Reliability Prediction Worksheet.....	9
3.1-5 – 32 Channel SMx System Reliability Prediction Worksheet.....	9
3.1-6 – 40 Channel SMx System Reliability Prediction Worksheet.....	10
3.1-7 – 48 Channel SMx System Reliability Prediction Worksheet.....	10
3.1-8 – 56 Channel SMx System Reliability Prediction Worksheet.....	11
3.1-9 – 64 Channel SMx System Reliability Prediction Worksheet.....	11
4.0 Maintainability Predictions	12
4.1 Total System Maintainability Prediction	13

1.0 INTRODUCTION

This prediction report is a structured approach to evaluating the Reliability & Maintainability of the design by assigning probabilities and the resulting effect on the system.

2.0 APPLICABLE DOCUMENTS

Document No.	Document Name
MIL-STD-785B	RELIABILITY PROGRAM
MIL-STD-470A	MAINTAINABILITY PROGRAM
MIL-HDBK-472	MAINTAINABILITY PREDICTION PROGRAM
MIL-HDBK-217F	RELIABILITY PREDICTION OF ELECTRONIC EQUIPMENT
RADC EEMD-1	ELECTRONIC EQUIPMENT MAINTAINABILITY DATA
RADC MRD-18	MICROCIRCUIT DEVICE RELIABILITY
RADC	RADC RELIABILITY ENGINEER'S TOOL-KIT

3.0 RELIABILITY PREDICTION

Sources used to develop the reliability prediction in order of precedence are MIL-HDBK-217, RADC MRD-18 and manufacturers data.

In general, these predictions were performed assuming worst case conditions of stress per derating policy and temperature (40 degrees C). This insures added confidence that the equipment will meet the MTBF goals under all specified conditions while operating in a ground Benign environment.

The prediction method 2004 of MIL-STD-756B was used as guidance. This method assumes the time to failure is exponentially distributed and all systems are modeled in series. Generally the expression for part failure rate is:

$$\lambda = \sum_{i=1}^n n_i (\lambda G Q)_i$$

Where :

Item λ = total failiure rate

G_i = generic failiure rate for the ith generic part

Q_i = quality factor for the ith generic part

n_i = quantity of the ith generic part

n = number of different generic part catagories



3.1 Total System Reliability Predictions

The reliability predictions are depicted within worksheets, 3.1-1 thru 3.1-8. Because the system is a series model with no redundancy, a block diagram is not required. All necessary information is outlined on the worksheets.

3.1-1 – SMx Computer System Reliability Prediction Worksheet

RELIABILITY PREDICTION WORKSHEET
Maintenance Organization Method MIL-HDBK-217F
SMx Computer

Part Number/Name	qty	maintenance		Predicted	Failure rate	Predicted	Predicted MTTR
		repair	replace	MTBF	/million hours	MTTR	x MTTR
Floppy Drive	1		X	10526315.79	0.10	0.10	0.01
Chassis Fan	1		X	591715.98	1.69	0.11	0.19
Hard Drive	1		X	1204819.28	0.83	0.10	0.08
CD R/W	1		X	1461988.30	0.68	0.11	0.08
Motherboard	1		X	2159827.21	0.46	0.12	0.06
Power Supply	1		X	500000.00	2.00	0.12	0.24
Memory	1		X	1538461.54	0.65	0.12	0.08
CPU Fan	1		X	704225.35	1.42	0.12	0.17
CPU	1		X	1351351.35	0.74	0.12	0.09
AC Power Cables	1		X	1000000.00	0.10	0.10	0.01
SYSTEM MTBF				115314	8.67	0.11	0.99



3.1-2 – 8 Channel SMx System Reliability Prediction Worksheet

RELIABILITY PREDICTION WORKSHEET
Maintenance Organization Method MIL-HDBK-217F
8 Channel SMx

Part Number/Name	qty	maintenance		Predicted	Failure rate	Predicted	Predicted MTTR
		repair	replace	MTBF	/million hours	MTTR	x MTTR
SMXB0B-10 Breakout Box	1	X		91407.68	10.94	0.21	2.30
SMXPCI-10 DSP Card	1		X	735294.47	1.36	0.12	0.16
SM4038-15 SMx Serial Cable	1		X	4166666.67	0.12	0.12	0.03
AC Power Cables	1		X	12500000.00	0.08	0.12	0.01
SYSTEM MTBF				86356			

3.1-3 – 16 Channel SMx System Reliability Prediction Worksheet

RELIABILITY PREDICTION WORKSHEET
Maintenance Organization Method MIL-HDBK-217F
16 Channel SMx

Part Number/Name	qty	maintenance		Predicted	Failure rate	Predicted	Predicted MTTR
		repair	replace	MTBF	/million hours	MTTR	x MTTR
SMXB0B-10 Breakout Box	2	X		45703.84	21.88	0.21	4.59
SMXPCI-10 DSP card	1		X	735294.12	1.36	0.12	0.16
SM4038-15 SMx Serial Cable	1		X	8333333.33	0.12	0.12	0.01
SM4F01-2 Fiber Optic Cable	2		X	4166666.67	0.24	0.12	0.03
AC Power Cables	2		X	6250000.00	0.16	0.10	0.02
SYSTEM MTBF				42088			



3.1-4 – 24 Channel SMx System Reliability Prediction Worksheet

RELIABILITY PREDICTION WORKSHEET
Maintenance Organization Method MIL-HDBK-217F
24 Channel SMx

Part Number/Name	qty	maintenance		Predicted	Failure rate	Predicted	Predicted MTTR
		repair	replace	MTBF	/million hours	MTTR	x MTTR
SMXB0B-10 Breakout Box	3	X		30469.23	32.82	0.21	6.89
SMXPCI-10 DSP card	2		X	367647.06	2.72	0.12	0.72
SM4038-15 SMx Serial Cable	2		X	4166666.67	0.24	0.12	0.03
SM4F01-2 Fiber Optic Cable	2		X	4166666.67	0.24	0.12	0.03
SM4039-6 SMx Sync Cable	1		X	8333333.33	0.12	0.12	0.01
AC Power Cables	3		X	4166666.67	0.24	0.10	0.02
SYSTEM MTBF				27487			

3.1-5 – 32 Channel SMx System Reliability Prediction Worksheet

RELIABILITY PREDICTION WORKSHEET
Maintenance Organization Method MIL-HDBK-217F
32 Channel SMx

Part Number/Name	qty	maintenance		Predicted	Failure rate	Predicted	Predicted MTTR
		repair	replace	MTBF	/million hours	MTTR	x MTTR
SMXB0B-10 Breakout Box	4	X		22851.92	43.76	0.21	9.19
SMXPCI-10 DSP card	2		X	367647.06	2.72	0.12	0.72
SM4038-15 SMx Serial Cable	2		X	4166666.67	0.24	0.12	0.03
SM4039-6 SMx Sync Cable	1		X	8333333.33	0.12	0.12	0.01
SM4F01-2 Fiber Optic Cable	4		X	2083333.33	0.48	0.12	0.06
AC Power Cables	4		X	3125000.00	0.32	0.10	0.03
SYSTEM MTBF				20991			



3.1-6 – 40 Channel SMx System Reliability Prediction Worksheet

RELIABILITY PREDICTION WORKSHEET
Maintenance Organization Method MIL-HDBK-217F
40 Channel SMx

Part Number/Name	qty	maintenance		Predicted	Failure rate	Predicted	Predicted MTTR
		repair	replace	MTBF	/million hours	MTTR	x MTTR
SMXB0B-10 Breakout Box	5	X		18281.54	54.70	0.21	11.49
SMXPCI-10 DSP Card	3		X	245098.04	4.08	0.12	1.07
SM4038-15 SMx Serial Cable	3		X	2777777.78	0.36	0.12	0.04
SM4039-6 SMx Sync Cable	2		X	4166666.67	0.24	0.12	0.03
SM4F01-2 Fiber Optic Cable	4		X	2083333.33	0.48	0.12	0.06
AC Power Cables	5		X	2500000.00	0.40	0.10	0.04
SYSTEM MTBF				16595			

3.1-7 – 48 Channel SMx System Reliability Prediction Worksheet

RELIABILITY PREDICTION WORKSHEET
Maintenance Organization Method MIL-HDBK-217F
48 Channel SMx

Part Number/Name	Qty	Maintenance		Predicted	Failure rate	Predicted	Predicted MTTR
		repair	replace	MTBF	/million hours	MTTR	x MTTR
SMXB0B-10 Breakout Box	6	X		1534.61	65.64	0.21	13.78
SMXPCI-10 DSP Card	3		X	245098.04	4.08	0.12	1.07
SM4038-15 SMx Serial Cable	3		X	2777777.78	0.36	0.12	0.04
SM4039-6 SMx Sync Cable	2		X	4166666.67	0.24	0.12	0.03
SM4F01-2 Fiber Optic Cable	6		X	1388888.89	0.72	0.12	0.09
AC Power Cables	6		X	2083333.33	0.48	0.12	0.06
SYSTEM MTBF				13982			



3.1-8 – 56 Channel SMx System Reliability Prediction Worksheet

RELIABILITY PREDICTION WORKSHEET
Maintenance Organization Method MIL-HDBK-217F
56 Channel SMx

Part Number/Name	qty	maintenance		Predicted	Failure rate	Predicted	Predicted MTTR
		repair	replace	MTBF	/million hours	MTTR	x MTTR
SMXB0B-10 Breakout Box	7	X		13058.24	76.58	0.21	16.08
SMXPCI-10 DSP card	4		X	183823.53	5.44	0.12	1.43
SM4038-15 SMx Serial Cable	4		X	2083333.33	0.48	0.12	0.06
SM4039-6 SMx Sync Cable	3		X	2777777.78	0.36	0.12	0.04
SM4F01-2 Fiber Optic Cable	6		X	1388888.89	0.72	0.12	0.09
AC Power Cables	7		X	1785714.29	0.56	0.10	0.06
SYSTEM MTBF				11885			

3.1-9 – 64 Channel SMx System Reliability Prediction Worksheet

RELIABILITY PREDICTION WORKSHEET
Maintenance Organization Method MIL-HDBK-217F
64 Channel SMx

Part Number/Name	qty	maintenance		Predicted	Failure rate	Predicted	Predicted MTTR
		repair	replace	MTBF	/million hours	MTTR	x MTTR
SMXB0B-10 Breakout Box	8	X		11425.96	87.52	0.21	18.38
SMXPCI-10 DSP card	4		X	183823.53	5.44	0.12	0.65
SM4038-15 SMx Serial Cable	4		X	2083333.33	0.48	0.12	0.06
SM4039-6 SMx Sync Cable	3		X	2777777.78	0.36	0.12	0.04
SM4F01-2 Fiber Optic Cable	8		X	1041666.67	0.96	0.12	0.12
AC Power Cables	8		X	1562550.00	0.64	0.10	0.06
SYSTEM MTBF				10482			

4.0 MAINTAINABILITY PREDICTIONS

The maintainability prediction presented herein complies with MIL-STD-470A. Sources used to develop this maintainability prediction in order of precedence are RADC EEMD-1, manufacturers data, and RADC tool-kit.

MTTR values are weight averaged for the system. They are a summation of active repair times during a given period of time, divided by the total number of malfunctions during the same time interval given by the expression.

$$MTTR = \frac{\sum \alpha \lambda R_p}{\sum \alpha \lambda},$$

Where :

α = duty cycle

λ = failure rate of the item

R_p = repair time of item

This maintainability prediction has been prepared for the organizational level of maintenance. It is based on the concept that repair at this level will consist of replacement of the lowest replaceable units of the system.

The prediction has been generated using MIL-HDBK-472 as a guide. All calculations of interchange, disassembly, and reassembly are based on an analysis of the assembly drawings and information obtained from subcontractors. This system is designed to have a maximum corrective maintenance downtime of 90 minutes or less for unscheduled organizational level maintenance.

4.1 Total System Maintainability Prediction

The elemental maintenance tasks included in the MTTR requirement were fault location, fault isolation, disassembly, interchange, align and checkout. The Maintainability worksheet Figure 4.1-1 outlines the maintainability times of the major cards of the system.

Table 4.1-1 - Maintainability Prediction Worksheet

Part Number/Name	Fail Rate	Qty	Total Fail Rate	Loc	ISO	Dis-Assy	Intr-Chg	Re-Assy	Align/Checkout	Repair Time RP	Fail Rate X Rp	Rp in Hours
SMXB0B-10 Breakout Box	10.94	1	10.94	2.00	2.00	1.50	2.00	2.00	3.00	12.50	137.38	0.21
SM4038-15 SMx Serial Cable	0.12	1	0.12	2.00	1.00	1.00	1.00	1.00	1.00	7.00	1.68	0.12
SM4039-6 SMx Sync Cable	0.12	1	0.12	2.00	1.00	1.00	1.00	1.00	1.00	7.00	1.68	0.12
SMXPCI-10 DSP card	1.36	1	1.36	2.00	1.00	1.00	1.00	1.00	1.00	7.00	9.52	0.12
SM4F01-2 Fiber Optic Cable	0.12	2	0.24	2.00	1.00	1.00	1.00	1.00	1.00	7.00	1.68	0.12
AC Power Cables	0.08	2	0.16	2.00	1.00	1.00	0.50	0.50	1.00	6.00	0.96	0.12
SYSTEM MTTR 11.76 Min = 0.20 Hour												