

**Date: December 3, 2002**

**Document: MTBF Calculation for Video Processor**

### **Introduction**

Radiant Incorporated developed a low cost Video Processor containing a Digital Signal Processor (DSP), Video Decoder, Fifo and support circuits. The first units manufactured were tested for 48 hours during an extended temperature burn-in. Seventy two of the units that passed the extended temperature test were shipped to the first installation and have been in continuous service for 2 years. During that time two of the Video Processors have failed. When they failed, the system was being serviced and a backplane failed simultaneously. Since that time over 400 units have shipped worldwide. Approximately 4 units have been returned due to infant mortality. To increase the information available regarding the reliability of the Video Processor we submit the following reliability calculations.

### **MTBF Model**

We used the MIL-HDBK-217 reliability model. A description is at [www.t-cubed.com/faq\\_217.htm](http://www.t-cubed.com/faq_217.htm) and at <http://www.relexsoftware.com/reliability/predictionmodels.asp>. The alternative model is the Telcordia model, which we did not elect to use, but is available.

### **Circuit Description**

The circuit consists of 68 parts in 14 groups each with a package type, thermal model and complexity. Similar parts are grouped together. The complexity of the DSP and Video Decoder were modeled at 60,000 gates, the limit of the software. Each component group is represented in a datafile. This data file contains the information about each circuit element in a format that is native to the Windows based reliability software from T-Cubed.

### **Software**

This document was prepared using a demo version of Relcalc for Windows. This software is available from the T-Cubed website at [www.t-cubed.com](http://www.t-cubed.com). The version used for this documentation was RelCalc for Windows Version 5.0-217F2 Demo.



**MTBF Distribution**

The MTBF of each component group is presented below. The %FR column shows the contribution of each subgroup to the overall Failure Rate.

The highest reliability parts are always the resistors. With 34 parts contributing 2.47% of the total, each resistor is <.07% of the total. That is approximately the same reliability as the PCB.

The lowest reliability parts are the more complex parts like the DSP, Fifo and Video Decoder. The reliability of these parts are to be contrasted with the EEPROM which contains the most gates of any of the devices. The large difference may be due to the assumptions of the 60,000-gate model for the larger parts.

Short List Report		Page 1 of 1	SortBy: PartType/PN/RefDes	Date: 12/3/2002 7:18 AM	
Software: RelCalc for Windows, Version 5.0-217F2 (Release 2002.01)					
Handbook: MIL-HDBK-217F, Notice 2					
Company: Radiant Inc.					
DOC: VIDEO PROCESSOR.CIR RECORDS: 14					
DESCRIPTION: Video Processor					
ENV: GB TEMP: 70.00 C CF: 1.00000 MODEL: Serial					
FR= 8.81067 fpmh MTBF= 113498.6848 hrs. Parts= 68 (FRSMT=0.000000 [0.00%])					
MissionTime= 8760.0000 hrs. MissionMTBF= *NOCALC* hrs. MissionR= *NOCALC* BasicR= 0.925722					
PartNumber	PartType	Qty	RefDes	TotalFR	%FR
DECODER	IC, Logic	1		1.88076	21.35
DSP	IC, Logic	1		2.38858	27.11
FIFO	IC, Logic	1		1.81612	20.61
LOGIC	IC, Logic	3		0.428656	4.87
EEPROM	IC, PROM	1		0.331292	3.76
ANALOG	IC, Linear	4		1.13385	12.87
VREG	IC, Linear	1		0.283463	3.22
DIODES AND TVS	Diode	17		0.028637	0.33
RESISTORS	Resistor	34		0.217285	2.47
DIN20	Connector	1		0.163581	1.86
PCB	CircuitBoard	1		0.006833	0.08
CRYSTAL 24.576MHZ	QuartzCrystal	1		0.057014	0.65
CRYSTAL 32KHZ	QuartzCrystal	1		0.012369	0.14
CRYSTAL 36MHZ	QuartzCrystal	1		0.062246	0.71

**Thermal Model**

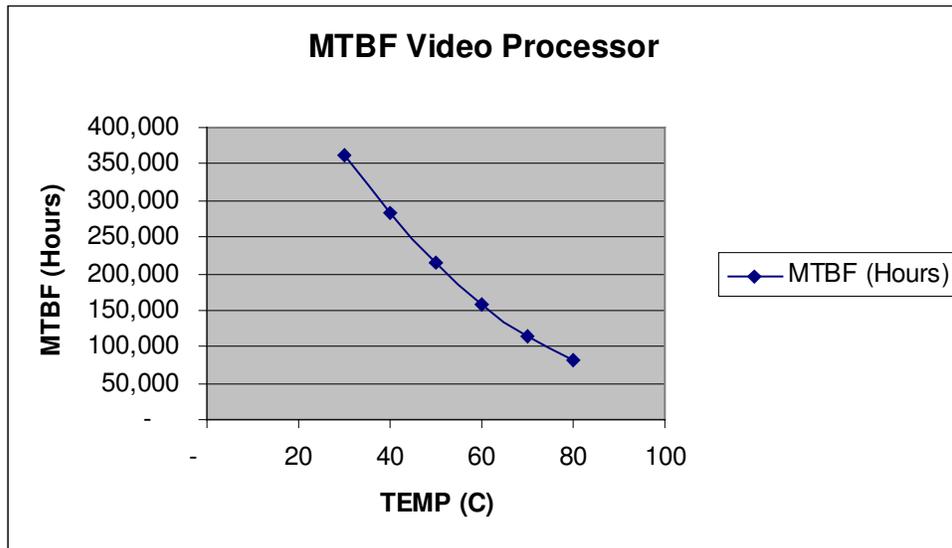
Each part was modeled using the appropriate thermal resistance for the IC package type. An estimated power level was assigned to each part based on the estimated current and voltage that the part uses. The total power for all of the components totals 1 watt, the measured power of the Video Processor.

### MTBF Versus Temperature

A simple temperature model was used that relies on the thermal resistivity of the package types and the power dissipated in each package. The MTBF was calculated at a variety of temperatures yielding the following results:

Temp (C)	MTBF (Hours)
80	80,700
70	113,500
60	157,400
50	213,800
40	282,700
30	361,400

As expected, higher operating temperature decreases MTBF as shown in the following curve.



### MTBF versus Temperature

#### Conclusions

Users should reduce the temperature of the Video Processor by attaching the metal extrusion to a heat sink, using forced-air cooling or turning the power off at extended temperature. The MTBF that was calculated for 60 degree C is 150,000 hours. This corresponds to over 15 years of continuous service.