MEAN TIME BETWEEN FAILURE CALCULATIONS (MTBF)

FOR

FIAR

ON

AGH-0910-DDSF

DIGITAL/LINEARIZED ATTENUATOR

P/N BB685119 REV. 1
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• CONTENTS</td>
<td>2</td>
</tr>
<tr>
<td>• SYNOPSIS</td>
<td>3</td>
</tr>
<tr>
<td>• MTBF Calculations on AGH-0910-60DDSFPIN DIODE ATTENUATOR</td>
<td>4-12</td>
</tr>
<tr>
<td>P/N BB685119 REV. 1</td>
<td></td>
</tr>
<tr>
<td>• MTBF SUMMARY</td>
<td>13</td>
</tr>
</tbody>
</table>
SYNOPSIS

AGH-0910-DDSF DIGITAL/LINEARIZED ATTENUATOR

MTBF = 27.678 HOURS
MTBF calculations for
AGH-0910-DDSF Attenuator
Fiar P/N: BB 685119 Rev. 1

ENVIRONMENT: UNINHABITED AIRBORNE FIGHTER

AMBIENT TEMPERATURE: +71°C

P 5.1.2 MICROELECTRONICS:

\[ \lambda_p = \pi_Q \pi_T \pi_V + C_2 \pi_E \pi_L \] FAILURE/10^6 HOURS

\[
\begin{align*}
\pi_Q &= 2.0 \\
\pi_L &= 1.0 \\
\pi_E &= 9.0 \\
\pi_T &= 0.80 (@ +71°C) \\
\pi_V &= 1.0 \\
C_2 &= 0.010 \text{ HERMETIC FLATPACK} \\
C_1 &= 0.01
\end{align*}
\]

\[ \lambda_p = 1.96 \times 10^{-1} \]

\[ N = 1 \]

TOTAL \[ \lambda_p = 1.96 \times 10^{-1} \]

P 5.1.2 MICROELECTRONICS: VOLTAGE REGULATORS, MIL-STD-883, CLASS B SCREENING

\[ \lambda_p = \pi_Q \pi_T \pi_V + C_2 \pi_E \pi_L \]

\[
\begin{align*}
\pi_Q &= 2.0 \\
\pi_L &= 1.0 \\
\pi_E &= 9.0 \\
\pi_T &= 2.9 (@ +71°C) \\
\pi_V &= 1.0 \\
C_1 &= 0.010 \text{ HERMETIC DEVICE} \\
C_2 &= .0003
\end{align*}
\]

\[ \lambda_p = 6.34 \times 10^2 \]

\[ N = 1 \]

TOTAL \[ \lambda_p = 6.34 \times 10^2 \]
P 5.1.2 MICROELECTRONICS: VOLTAGE REGULATORS, MIL-STD-883, CLASS B SCREENING

\[ \lambda_p = \pi_Q (C_1 \pi_T \pi_V + C_2 \pi_E) \pi_L \]

\( \pi_Q = 2.0 \)
\( \pi_L = 1.0 \)
\( \pi_E = 9.0 \)
\( \pi_T = 2.9 \text{ @} +71^\circ\text{C} \)
\( \pi_V = 1.0 \)
\( C_1 = 0.010 \) HERMETIC DEVICE
\( C_2 = .0003 \)

\[ \lambda_p = 6.34 \times 10^{-2} \]
\( N = 3 \)

TOTAL \( \lambda_p = 1.902 \times 10^{-4} \)

P 5.1.2 MICROELECTRONICS: DIGITAL TO ANALOG CONVERTER

\[ \lambda_p = \pi_Q \pi_A (C_1 \pi_T \pi_V + C_2 \pi_E) \pi_L \]

\( \pi_Q = 2.0 \)
\( \pi_A = 1.24 \)
\( \pi_E = 9.0 \)
\( \pi_T = 1.8 \text{ @} +71^\circ\text{C} \)
\( \pi_V = 1.0 \)
\( \pi_L = 1.0 \)
\( C_1 = 0.06 \)
\( C_2 = .0059 \) HERMETIC DEVICE

\[ \lambda_p = 3.9953 \times 10^{-4} \]
\( N = 1 \)

TOTAL \( \lambda_p = 3.9953 \times 10^{-4} \)

5
P 5.1.3 ZENER DIODE

\[ \lambda_p = \lambda_B (\pi_E \times \pi_A \times \pi_Q) \]

\[ \pi_E = 70 \]
\[ \pi_A = 1.0 \]
\[ \pi_Q = 0.6 \text{ (JANTX SCREENED)} \]
\[ \lambda_B = 0.0015 \text{ (70°C AT .5 POWER STRESS)} \]

\[ \lambda_p = 6.30 \times 10^{-2} \]

\[ N = 6 \]

TOTAL \( \lambda_p = 37.8 \times 10^{-2} \)

P 5.1.6 RESISTORS (CHIP) THICK FILM CHIP RESISTOR, MIL-R-55342, FAILURE RATE "R", 100mW

\[ \lambda_p = \lambda_B (\pi_E \times \pi_R \times \pi_Q) \]

\[ \lambda_B = 0.0017 \text{ (70°C AMBIENT, 0.5 DERATED)} \]
\[ \pi_E = 20 \]
\[ \pi_R = 1.0 \text{ (RESISTANCE UP TO 100K)} \]
\[ \pi_Q = 0.1 \text{ ('R' FAILURE RATED)} \]

\[ \lambda_p = 2.8 \times 10^{-3} \]

\[ N = 40 \text{ (RF AND DC)} \]

TOTAL \( \lambda_p = 1.12 \times 10^{-1} \)
P 5.1.6 THERMISTORS, MIL-T-23648 FAILURE RATE "R"

\[ \lambda_p = \lambda_b \times \pi_E \times \pi_Q \]

\[ \lambda_b = 0.065 \]
\[ \pi_E = 59 \]
\[ \pi_Q = 1.0 \]

\[ \lambda_p = 3.835 \]
\[ N = 1 \]
\[ \lambda_p = 3.835 \]

P 5.1.7 CAPACITORS, CERAMIC CHIP, MIL-C-55681, 20% TOLERANCE, FAILURE RATE 'R', 100 VOLT BREAKDOWN

\[ \lambda_p = \lambda_b(\pi_E \times \pi_Q \times \pi_{CV}) \]

\[ \lambda_b = .013 \text{ (70°C AMBIENT TEMP, 0.5 DERATED)} \]
\[ \pi_E = 45 \]
\[ \pi_Q = 0.1 \text{ (R FAILURE)} \]
\[ \pi_{CV} = 1.0 \text{ (81 pF CAPACITORS AND LOWER)} \]
\[ \pi_{CV} = 1.3 \text{ (720 pF CAPACITORS AND LOWER)} \]
\[ \pi_{CV} = 2.2 \text{ (.058 uf CAPACITORS AND LOWER)} \]

81 pF CAPACITORS AND LOWER

\[ \lambda_p = 5.85 \times 10^{-2} \]
\[ N = 6 \]

TOTAL \[ \lambda_p = 3.51 \times 10^{-1} \]
720 pf CAPACITORS AND LOWER
\[ \lambda_p = 7.605 \times 10^{-2} \]
\[ N = 8 \]
\[ \text{TOTAL } \lambda_p = 6.084 \times 10^{-1} \]

.058 pf CAPACITORS AND LOWER
\[ \lambda_p = 1.287 \times 10^{-1} \]
\[ N = 9 \]
\[ \text{TOTAL } \lambda_p = 1.1583 \]

P 5.1.7 DC: CAPACITORS, SOLID TANTALUM, 10% TOLERANCE, FAILURE RATE '
R'

\[ \lambda_p = \lambda_B (\pi_E \times \pi_{SR} \times \pi_Q \times \pi_{CV}) \]

\( \lambda_B = 0.022 \) (50°C AMBIENT TEMP, 0.5 DERATED)
\( \pi_E = 30 \)
\( \pi_{SR} = 0.33 \)
\( \pi_Q = 0.1 \) (R FAILURE)
\( \pi_{CV} = 1.0 \) (1 uf CAPACITORS AND LOWER)
\( \pi_{CV} = 1.3 \) (8.9 uf CAPACITORS AND LOWER)

1 uf CAPACITORS AND LOWER
\[ \lambda_p = 6.534 \times 10^{-1} \]
\[ N = 2 \]
\[ \text{TOTAL } \lambda_p = 1.3068 \]
8.9 uf CAPACITORS AND LOWER

\[ \lambda_p = 2.8314 \times 10^{-1} \]

\[ N = 4 \]

TOTAL \( \lambda_p = 1.1326 \times 10^{-1} \)

P 5.2.1.9 RF HYBRID

RF HYBRID \( \pi_p = \left( \Sigma N_C \lambda_C \pi_G + [N_R \lambda_R + \Sigma N_I \lambda_I + \lambda_S] \pi_F \pi_E \right) \pi_Q \pi_D \)

P 5.1.2.9.1 \( \Sigma N_C \lambda_C \pi_G \) ACTIVE COMPONENTS AND CAPACITORS

N_C = NUMBER OF EACH PARTICULAR PART

\( \lambda_C = \) FAILURE CONTRIBUTION OF EACH PART

\( \lambda_C = \) DIE AND CAPACITOR CORRECTION FACTORS

CHIP DIODES (SAMPLE CALCULATION):

P 5.1.3 DISCRETE SEMICONDUCTORS, PIN DIODES

\[ \lambda_p = \lambda_B \times \pi_E \times \pi_Q \times \pi_R \times \pi_A \text{ FAIL/10}^6 \text{ HRS} \]

GROUP VIII

\( \lambda_B = 0.085 \) (70°C TEMP, 0.5 POWER STRESS)

\( \pi_E = 70 \)

\( \pi_Q = 0.5 \) (JANTXV SCREENED)

\( \pi_R = 0.5 \) (P < 10 WATTS)

\( \pi_A = 1.0 \)

\[ \lambda_p = 1.4875 \]
CHIP DIODES

\[ \lambda_C = 1.4875 \]
\[ N_C = 6 \]
\[ \pi_G = 0.2 \]

RF CAPACITORS

\[ \lambda_C = 5.85 \times 10^{-2} \]
\[ N_C = 6 \]
\[ \pi_G = 0.8 \]

\[ \Sigma N_C \lambda_C \pi_G = 2.0658 \]

P 5.1.2.9.2 CHIP AND SUBSTRATE RESISTORS

\[ \lambda_R = 2.8 \times 10^{-3} \]
\[ N_R = 2 \]

P 5.1.2.9.3 INTERCONNECTIONS

\[ N_I = 36 \]
\[ \lambda_I = 0.00162 \]

P 5.1.2.9-7 PACKAGE FAILURE RATE

\[ S = 6.94" \]
\[ \lambda_S = .4753 \ (70^\circ C) \]
ENVIRONMENTAL $\pi_E$

$\pi_E = 4.0$

QUALITY $\pi_Q$

$\pi_Q = 1.0$  (B-1 SCREENED MIL-STD-883 METHOD 5008)

DENSITY FACTOR $\pi_D$

$\pi_D = 1.70$

RF HYBRID $\lambda_P = 26.18272$

5.1.12.2 PRINTED CIRCUIT BOARD MULTI-PIN CONNECTOR AND MATING CONNECTOR, MIL-E-38999

$\lambda_P = \lambda_B \times \pi_E \times \pi_P \times \pi_K$

$\lambda_B = 0.01022$ (70°F)

$\pi_E = 15$

$\pi_P = 2.86$ (14 PIN MULTI PIN)

$\pi_K = 1.0$

TOTAL $\lambda_P = 4.38 \times 10^{-1}$
P 5.1.2.9.3 INTERCONNECTIONS IN DC

\[ \lambda_p = N_i \times \lambda_i \]

\[ \lambda_i = 0.00162 \]
\[ N_i = 118 \]

\[ \lambda_p = 1.9116 \times 10^{-1} \]
\[ N = 1 \]

TOTAL \[ \lambda_p = 7.67 \times 10^{-2} \]

P 5.1.12 COAXIAL RF CONNECTORS

\[ \lambda_p = \lambda_B (\pi_E \times \pi_p \times \pi_k) \]

\[ \lambda_B = 0.0202 \text{ (70°C TEMPERATURE)} \]
\[ \pi_E = 15 \]
\[ \pi_p = 1.0 \]
\[ \pi_k = 1.0 \]

\[ \lambda_p = 3.03 \times 10^{-1} \]
\[ N = 2 \]

TOTAL \[ \lambda_p = 6.06 \times 10^{-1} \]
SUMMARY

\[ \lambda_{TOTAL} = \Sigma_{TOTAL} \ \lambda_p = 36.0153 \ \text{FAILURES/MILLION HOURS} \]

\[ \text{MTBF} = \frac{\lambda_{TOTAL}}{1 \times 10^6} = 36.12977/1 \times 10^6 \]

27,678 HOURS BETWEEN FAILURES