AMERICAN MICROWAVE CORPORATION

MEAN TIME BETWEEN FAILURE CALCULATIONS (MTBF)

FOR

FIAR

ON

AGH-0910-DDSF

DIGITAL/LINEARIZED ATTENUATOR

P/N BB685119 REV. 1

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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:

$$\lambda_p = \pi_Q(C_1\pi_T\pi_V + C_2\pi_E)\pi_L \text{ FAILURE}/10^6 \text{ HOURS}$$

$\pi_Q = 2.0$
$\pi_L = 1$
$\pi_E = 9.0$
$\pi_T = 0.80$ (@ +71°C)
$\pi_V = 1.0$
$C_2 = 0.010$ HERMETIC FLATPACK
$C_1 = 0.01$

$$\lambda_P = 1.96X10^{-1}$$

$$N = 1$$

$$\text{TOTAL } \lambda_P = 1.96X10^{-1}$$

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

$$\lambda_p = \pi_Q(C_1 X \pi_T X \pi_V + C_2 X \pi_E)\pi_L$$

$\pi_Q = 2.0$
$\pi_L = 1.0$
$\pi_E = 9.0$
$\pi_T = 2.9$ (@ +71°C)
$\pi_V = 1.0$
$C_1 = 0.010$ HERMETIC DEVICE
$C_2 = .0003$

$$\lambda_P = 6.34X10^{-2}$$

$$N = 1$$

$$\text{TOTAL } \lambda_P = 6.34X10^{-2}$$

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

$$\lambda_p = \pi_Q(C_1 x \pi_T x \pi_V + C_2 \pi_E)\pi_L$$

$\pi_Q = 2.0$
$\pi_L = 1.0$
$\pi_E = 9.0$
$\pi_T = 2.9$ (@ +71°C)
$\pi_V = 1.0$
$C_1 = 0.010$ HERMETIC DEVICE
$C_2 = .0003$

$$\lambda_P = 6.34X10^{-2}$$

$$N = 3$$

$$\text{TOTAL } \lambda_P = 1.902X10^{-1}$$

P 5.1.2 MICROELECTRONICS: DIGITAL TO ANALOG CONVERTER

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

$\pi_Q = 2.0$
$\pi_A = 1.24$
$\pi_E = 9.0$
$\pi_T = 1.8$ (@ +71°C)
$\pi_V = 1.0$
$\pi_L = 1.0$
$C_1 = 0.06$
$C_2 = .0059$ HERMETIC DEVICE

$$\lambda_P = 3.9953X10^{-1}$$

$$N = 1$$

$$\text{TOTAL } \lambda_P = 3.9953X10^{-1}$$

P 5.1.3 ZENER DIODE

$$\lambda_P = \lambda_B(\pi_E \text{ X } \pi_A \text{ X } \pi_a)$$

$\pi_E = 70$
$\pi_A = 1.0$
$\pi_Q = 0.6$ (JANTX SCREENED)
$\lambda_B = .0015$ (70°C AT .5 POWER STRESS)

$$\lambda_P = 6.30X10^{-2}$$

$$N = 6$$

$$\text{TOTAL } \lambda_P = 37.8X10^{-2}$$

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

$$\lambda_P = \lambda_B(\pi_E \text{ X } \pi_R \text{ X } \pi_Q)$$

$\lambda_B = .0017$ (70°C AMBIENT, 0.5 DERATED)
$\pi_E = 20$
$\pi_R = 1.0$ (RESISTANCE UP TO 100K)
$\pi_Q = 0.1$ ('R' FAILURE RATED)

$$\lambda_P = 2.8X10^{-3}$$

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

$$\text{TOTAL } \lambda_P = 1.12X10^{-1}$$

P 5.1.6 THERMISTORS, MIL-T-23648 FAILURE RATE "R"

$$\lambda_P = \lambda_B \text{ X } \pi_E \text{ X } \pi_Q$$

$\lambda_B = 0.065$
$\pi_E = 59$
$\pi_Q = 1.0$

$$\lambda_P = 3.835$$

$$N = 1$$

$$\lambda_P = 3.835$$

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

$$\lambda_P = \lambda_B(\pi_E \text{ X } \pi_Q \text{ X } \pi_{CV})$$

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

81 pf CAPACITORS AND LOWER

$$\lambda_P = 5.85X10^{-2}$$

$$N = 6$$

$$\text{TOTAL } \lambda_P = 3.51X10^{-1}$$

720 pf CAPACITORS AND LOWER

$\lambda_P = 7.605X10^{-2}$

N = 8

TOTAL $\lambda_P = 6.084X10^{-1}$

.058 pf CAPACITORS AND LOWER

$\lambda_P = 1.287X10^{-1}$

N = 9

TOTAL $\lambda_P = 1.1583$

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

$$\lambda_P = \lambda_B(\pi_E \text{ X } \pi_{SR} \text{ X } \pi_Q \text{ X } \pi_{CV})$$

λ_B = .022 (50°C AMBIENT TEMP, 0.5 DERATED)
π_E = 30
π_{SR} = .33
π_Q = 0.1 (R FAILURE)
π_{CV} = 1.0 (1 uf CAPACITORS AND LOWER)
π_{CV} = 1.3 (8.9 uf CAPACITORS AND LOWER)

1 uf CAPACITORS AND LOWER

$\lambda_P = 6.534X10^{-1}$

N = 2

TOTAL $\lambda_P = 1.3068$

8.9 uf CAPACITORS AND LOWER

$\lambda_P = 2.8314X10^{-1}$

N = 4

TOTAL $\lambda_P = 1.1326X10^{-1}$

P 5.2.1.9 RF HYBRID

$$\text{RF HYBRID } \pi_P = \{\Sigma N_C \lambda_C \pi_G + [N_R \lambda_R + \Sigma N_I \lambda_I + \lambda_S] \pi_F \pi_E\} \pi_Q \pi_D$$

P 5.1.2.9.1 $\Sigma N_C \lambda_C \pi_G$ ACTIVE COMPONENTS AND CAPACITORS

N_C = NUMBER OF EACH PARTICULAR PART
λ_C = FAILURE CONTRIBUTION OF EACH PART
Λ_G = DIE AND CAPACITOR CORRECTION FACTORS

CHIP DIODES (SAMPLE CALCULATION):

P 5.1.3 DISCRETE SEMICONDUCTORS, PIN DIODES

$$\lambda_P = \lambda_B \text{ X } \pi_E \text{ X } \pi_Q \text{ X } \pi_R \text{ X } \pi_A \text{ FAIL/}10^6 \text{ HRS}$$

GROUP VIII

λ_B = .085 (70°C TEMP, 0.5 POWER STRESS)
π_E = 70
π_Q = 0.5 (JANTXV SCREENED)
π_R = 0.5 (P < 10 WATTS)
π_A = 1.0

$\lambda_P = 1.4875$

CHIP DIODES

$\lambda_C = 1.4875$
$N_C = 6$
$\pi_G = 0.2$

RF CAPACITORS

$\lambda_C = 5.85X10^{-2}$
$N_C = 6$
$\pi_G = 0.8$

$$\Sigma N_C \lambda_C \pi G = 2.0658$$

P 5.1.2.9.2 CHIP AND SUBSTRATE RESISTORS

$\lambda_R = 2.8X10^{-3}$
$N_R = 2$

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°C)

ENVIRONMENTAL π_E

$\pi_E = 4.0$

QUALITY π_Q

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

DENSITY FACTOR π_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

$$\lambda_P = \lambda_B (\pi_E \text{ X } \pi_P \text{ X } \pi_K)$$

$\lambda_B = 0.01022$ (70°C)
$\pi_E = 15$
$\pi_P = 2.86$ (14 PIN MULTI PIN)
$\pi_K = 1.0$

TOTAL $\lambda_P = 4.38X10^{-1}$

P 5.1.2.9.3 INTERCONNECTIONS IN DC

$$\lambda_P = N_I \text{ X } \lambda_I$$

$\lambda_I = .00162$
$N_I = 118$

$$\lambda_P = 1.9116X10^{-1}$$

$$N = 1$$

$$\text{TOTAL } \lambda_P = 7.67X10^{-2}$$

P 5.1.12 COAXIAL RF CONNECTORS

$$\lambda_P = \lambda_B(\pi_E \text{ X } \pi_P \text{ X } \pi_K)$$

$\lambda_B = 0.0202$ (70°C TEMPERATURE)
$\pi_E = 15$
$\pi_P = 1.0$
$\pi_K = 1.0$

$$\lambda_P = 3.03X10^{-1}$$

$$N = 2$$

$$\text{TOTAL } \lambda_P = 6.06X10^{-1}$$

SUMMARY

$\lambda_{TOTAL} = \Sigma TOTAL\ \lambda_P = 36.0153$ FAILURES/MILLION HOURS

MTBF $= \lambda_{TOTAL}/1X10^6 = 36.12977/1X10^6$

27,678 HOURS BETWEEN FAILURES