

## MTBF (Mean time between failure)

A statistical figure that gives the number of units that will fail over time for a population of system or components. It is statistics and calculated based on the number and type of components and individual stress of the components in the designed system/component.

### MTBF Example 1:

Power supply with calculated MTBF of 200.000 hours.  
One year is 8760 hours  
You deliver 1000 units to a customer and all of them are powered up day one. After one year the power supplies have a total operating time of 1000 units x 8760h = 8760000 hours.  
In theory the number of units that will fail during one year is  $8760000/200000 = 43,8$  units  
An alternative MTBF is so called field based MTBF. It is when the above calculation is made in reverse.

### Field based MTBF Example 2:

If 2000 power supplies operates during one year they have a total operating time of  $2000 \times 8760 = 17520000$  hours. If then 25 are reported to fail the field based MTBF is  $17520000/25 = 700800$  hours

## Lifetime

A lifetime prediction defines the time until one single unit is worn-out. As the weakest components in power supplies in most cases are the capacitors it is a common rule to base lifetime predictions on the weakest capacitor that runs at the highest temperature and that has an important role in the function of the power supply.

### Lifetime example 1:

Capacitor A1 is defined as the most important capacitor in this power supply. It operates at an average temperature of 75 degrees C. Capacitor A1 is specified to a lifetime of 8000 hours at 105 degrees C. A common rule is that every 10 degrees decrease in temperature makes the lifetime double or vice versa.  
Calculation from 105 degrees C to 75 makes three 10 degrees steps. 8000 at 105 degrees is equal to 16000 hours at 95 degrees, 32000 hours at 85 degrees, and 64000 hours at 75 degrees.  
In this example the lifetime of the complete power supply is equal to the lifetime of capacitor A1, which is 64 000 hours or 7,3 years.  
It is common that MTBF figures are about 10 times as many hours compared to the estimated lifetime.

Component name	Description	Number of components at stress fact			Failure rate at stress fact			N*Lamda 0,000000001
		20%	50%	80%	20%	50%	80%	
<b>Resistors</b>	41+4							
	Metal low pow.	38	4	0	1,5	2	3	65
	Metal high pow		3	0	8	10	13	30
Fixed Wire	Precision				3,5	5	8	0
	Power				8	15	30	0
Variable Wire	Precision				320	400	440	0
	Power		0		170	210	275	0
Trim	Cermet		0		5	6	7	0
<b>Capacitors</b>	6+25+6							
Elco	Solid	0			45	75	175	0
	Wet Mini				25	55	135	0
	Wet Small		4	2	8,6	14,4	36,5	130,6
	Wet Large		0		12,9	21,9	54	0
X - Y		3	2		0,6	2	4	5,8
Film			0		0,5	0,9	7,5	0
Ceramic		25	6		0,6	2,5	9	30
<b>Semiconductors</b>								
Diodes	8+8+1+2Z+7Z	15	9	2	3	6	17	133
Transistors	1+4	5	0	0	1,3	2,5	9	6,5
Rectifiers					20	35	80	0
Triacs/Thyristors					15	25	60	0
Power Mos/IGBT		1	2	0	0,5	2	4	4,5

Component name	Description	Number of components at stress fact			Failure rate at stress fact			N*Lamda 0,000000001
		20%	50%	80%	20%	50%	80%	
<b>IC</b>	4							
Linear	Bipolar Small	2			6	12	18	12
	Bipolar Medium				20	40	60	0
	Bipolar Large				35	70	100	0
	MOS Small	1	1		12	25	35	37
	MOS Medium				45	85	125	0
	MOS Large				75	150	225	0
Digital	Bipolar Small				5	10	15	0
	Bipolar Medium				15	30	45	0
	Bipolar Large				30	55	80	0
	MOS Small				8	15	25	0
	MOS Medium				18	35	50	0
	MOS Large				25	55	80	0
<b>General</b>								
Coils	Fixed	2	4		0,3	0,5	1	2,6
	Variable				0,6	1	2	0
Transformer	High power pulse			1	50	60	120	120
	Low power pulse				8	10	20	0
Relays	Reed				7	10	20	0
	Inductive				20	30	55	0
Switches	Push				20	30	55	0
	Micro Contact				280	400	720	0
	Rotary Contact				85	120	210	0
Connectors	Panel				1	1	1	0
	Power		1		24	24	24	24
	Coaxial				15	15	15	0
	Pcb				2	2	2	0
Connections	Hand.sold.				3	3	3	0
	Mach.sold.		400		0,29	0,5	0,5	200
	Wire				0,003	0,003	0,003	0
	Crimp				0,3	0,3	0,3	0
Crystal	Quartz				200	200	200	0
Fuse		1			100	100	100	100
Lamps	Gas				200	200	200	0
	Filament				1000	1000	1000	0
PCB	Plat.through/dm2		2		0,06	0,06	0,06	0,12
Meters					10000	10000	10000	0
Opto	LED	1			20	35	80	20
	Opto-coupler	4			20	35	80	80
<b>Total failure rate</b>								<b>1001,12</b>

**Factor for ambient temperature**

Kt=	0,8 for	15	Kt=1,2
	1 for	30	
	1,2 for	45	
	1,5 for	55	
	2 for	70	

**Factor for environment**

K3=	1 for	gnd benign	K3=	1
	3 for	gnd fixed		
	9 for	gnd mobile		
N*L*Kt*K3= 1201,344				
<b>M.T.B.F 832401,0442</b>				