Failure Rate and MTBF (Mean Time Between Failures)

1. Assumptions

Under the assumption, that the failure rate ◊ is constant over the time, the MTBF is calculated as the reciprocal value of the failure rate (◊ indicated in fit = failures in time = number of failures expected during 10^9 hours):

$$MTBF = 1/◊$$

Since the instruments do not have a preferred direction of failure, the failure rate for an instrument is calculated by summing up the individual failure rates of the built-in components.

Under the assumption that premature ageing has occurred during burn-in, further early failures have not to be considered any more.

2. References

Standard SIEMENS SN 29500/7.81 Parts 1 ... 10	Failure Rates of Components, expected Values

3. Conditions for the Analysis

Ambient Temperature:	+40 °C
Power Supply:	nominal voltage
Self Heating:	delta Temp. = + 5 °C

If the customer needs a detailed analysis, we can provide the component list with the individual component's failure rates.

1 year	=	8'760 hours
10^9 hours	=	114'155 years

4. Analyzed Products

Instrument:	Failure Rate ◊	MTBF:
FTW 113	2‘776 fit	41,1 years
FTF 123	2‘278 fit	50.1 years
FTFW 1422 UC2/UC3:	7'280 fit	15,6 years
FTFW 1424 UC2/UC3:	7'355 fit	15,5 years
FTW 1613 AC230 Ex	4'122 fit	27.7 years
FTF 1623 AC230 Ex	2'738 fit	41.7 years
FTW 1613 AC230	1'336 fit	30.7 years
FTF 1623 AC230	2'476 fit	46.1 years
FTW 1613 DC24	13'121 fit	8.7 years
FTF 1623 DC24	7'610 fit	15.0 years
FTW 1713 AC230	3'718 fit	30.7 years
FTF 1723 AC230	2'482 fit	46.0 years
FTW 1713 DC24	13'121 fit	8.7 years
FTF 1723 DC24	7'610 fit	15.0 years
FTF 2024	7'681 fit	14,8 years
without Light Emitting Diodes:	3'181 fit	35,8 years
FTFW 2022	10‘579 fit	10,8 years
without Light Emitting Diodes:	6‘079 fit	18,7 years
FTD 2040	11‘417 fit	10,0 years
without Light Emitting Diodes:	8‘417 fit	13,5 years
FTU2041	16‘105 fit	7,0 years
without Light Emitting Diodes:	10‘605fit	10,7 years
FTU 2045	2‘909 fit	39,2 years
without Light Emitting Diodes:	1‘909 fit	59,8 years
FTV 2090	372 fit	306,8 years
FTZ 2061/2062	508 fit	141,2 years
without Light Emitting Diodes:	308 fit	370,6 years
FTZ 2065	7'692 fit	14,8 years
without Light Emitting Diodes:	7‘192 fit	15,8 years
FTFU 3024-01	19‘007 fit	6,0 years
without Light Emitting Diodes:	13‘507 fit	8,4 years
FTFU 3024-01 avec FTV 3090	21‘994 fit	5,2 years
without Light Emitting Diodes:	14‘494 fit	7,8 years
FTFU 3024-01 avec FTW 3013	23‘244 fit	4,9 years
without Light Emitting Diodes:	17‘744 fit	6,4 years
FTFU 3024-01 avec FTW 3013 et FTV 3090	26'231 fit	4,3 years
without Light Emitting Diodes:	18‘731 fit	6,1 years
FTZ 3061/3062	814 fit	140,2 years
without Light Emitting Diodes:	314 fit	363,5 years
FTZ 3065	7'692 fit	14,8 years
without Light Emitting Diodes:	7‘192 fit	15,8 years

5. Failure Rate and MTBF (Mean Time Between Failures)

Important customers and regulations (e.g. KTA 3505, section 4.2 with respect to sensors and transducers in reactor safety systems) require the type tests to display data about the instruments reliability.

The failure rate of newly developed instruments can not be determined by experience.

Since our instruments do not have a preferred direction of failure, the failure rate for an instrument is calculated by summing up the failure rates of the individual modules or components. Under the assumption that premature ageing has occurred during thermal curing of potted components or during burn-in and before final testing, further early failures are not considered any more.

Under the assumption, that the failure rates of the installed components are constant over the time, the MTBF of the instruments are calculated as the reciprocal value of the sum of the failure rates ◊ of all the built-in components.

Example 2v3:
For systems with multiple channels and with a 2 out of 3 selection, the MTBF is improved, if failures are continuously detected and repaired. In this case the Mean Down Time (MDT) of the redundant channel determines the MTBF of the complete system according to the following formula:

$$\text{MTBF(hr) total} = \frac{\text{MTBF(hr)}^2}{6 * \text{MDT(hr)}}$$

(atp, 33. Jahrgang, Heft 6/1991)

Under the assumption, that the down time for every failure is 100 hours (4 days), the total MTBF for a FT 3000 system with 2 out of 3 selection for three modules of type FTFU 3024-01 is 526 years, corresponding to a failure rate of 217 fit.

Example 2v4:
For systems with multiple channels and with a 2 out of 4 selection, the MTBF is improved, if failures are continuously detected and repaired. In this case the Mean Down Time (MDT) of the redundant channel determines the MTBF of the complete system according to the following formula:

$$\text{MTBF(hr) total} = \frac{\text{MTBF(hr)}^3}{12 * \text{MDT(hr)}^2}$$

(atp, 33. Jahrgang, Heft 6/1991)

Under the assumption, that the down time for every failure is 100 hours (4 days), the total MTBF for a FT 3000 system with 2 out of 4 selection for four modules of type FTFU 3024-01 is 1‘213 years, corresponding to a failure rate of 94 fit.