# Application Note #3

## Reliability of Electromechanical Relays

The term **M**ean **T**ime **B**etween **F**ailure (MTBF) was established to judge the reliability of devices, where the degradation mechanism is basically time dependent, such as for semiconductors. This term has only limited validity for electromechanical relays. Two different mechanisms have to be taken into consideration, in order to judge the reliability of electromechanical telecom and signal relays from AXICOM. In order to judge the reliability of relays correctly, it must be distinguished between seldom and frequently operated relays.

### 1) Seldom or never actuated electromechanical relays

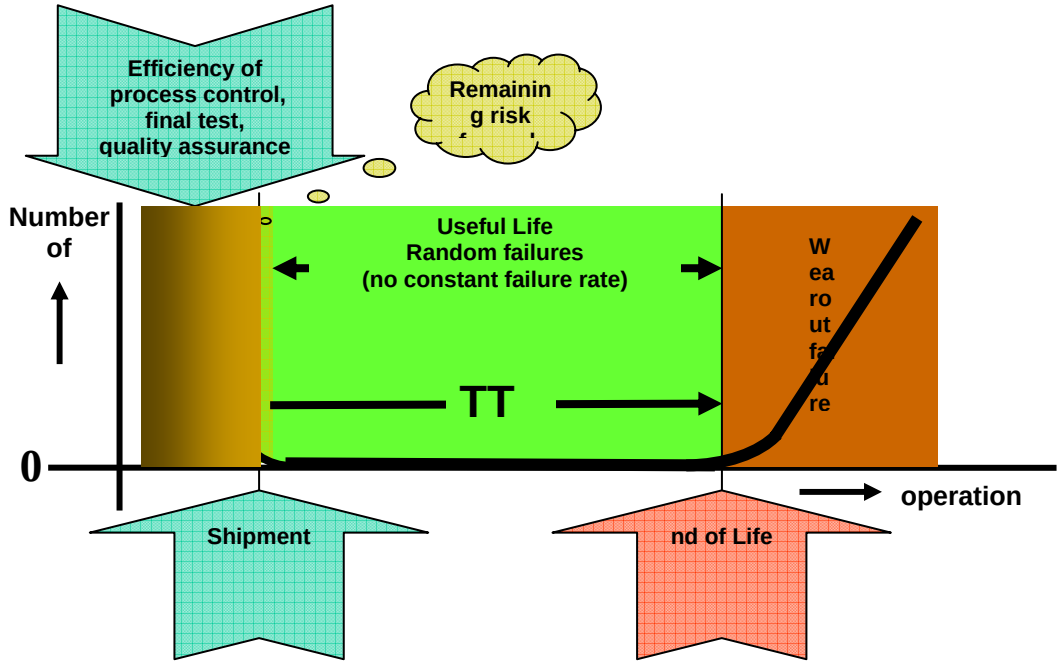
Seldom means, that the relays are not activated for several month or even years and do by far not reach the specified number of operations. In this case the reliability is time dependent.
In this case the reliability of relays is defined by the materials used in manufacturing and the protection the relay housing provides to the electromechanical system and e.g. to the contacts. In all AXCIOM relays gold platted contacts used and the housings provide a protection which is are at least RT III* - washtight (P2, HF3, FP2 P1, MT2, D2n) or even RT V – hermetically sealed (IM, FX2, FT HDV). RT III or even better RT V* efficiently protect the relays from environmental impact as long used according specification, such as defined temperature range, humidity etc. In this case a MTBF value can be given as follows:

**Relays RT III:** P2, HF3, FP2, FT2, FU2 P1, MT2, D2n → **MTBF > 30'000 years**
**Relays RT V:** IM, FX2, FT2 HDV → **MTBF > 50'000 years**

*IEC61810-7: RT III wash tight relay - relay capable of being automatically soldered and subsequently undergoing a washing process to remove flux residues without allowing the ingress of flux or washing solvents.
*IEC61810-7: RT V hermetically sealed relay - sealed relay having an enhanced level of sealing, assuring a time constant better than $2 \times 10^6$ s (see IEC 60068-2-1).

## 2) Frequently operated electromechanical relays

When electromechanical relays are frequently operated, the reliability is not depending on the time, but on the number of operations in time. The expected performance of electromechanical relays is often given by the bathtub curve, given in the figure below.




There are several points to mention:

- **Early failure:** early failure can efficiently eliminated by proper process control in manufacturing, by the 100 percent final test and additional quality assurance measurements. Usually the outgoing quality level, which describes the failing relays after soldering is less than 25 ppm and might reach values as low as less than 1 ppm. When the relays passed the soldering process and the following in circuit test, relays very seldom show failures. The early failure period can efficiently eliminate.
- **Period of random failures:** Electromechanical relays do not have a period of constant failure rate, but during this period random failure might be possible. For telecom, signal and RF relays the random failures can be neglected.
- **Wearout:** The end of a relay is defined by wear out, whether from the mechanical system or in case arcing load is switched by the contacts - by contact erosion.
  In case no load or a minimum load is switched, the end of the life might be defined when the contact resistance is exceeding a certain value, e.g. 1 or 10 Ohm, or contacts do not open or close anymore.
  Generally for all AXCIOM relays the guaranteed number of operations for typical loads are given and all relays reach this number of operations.
  - o No load
  - o Cable load
  - o Maximum power @ maximum current
  - o Maximum power @ maximum voltage
- Based on these figures given in the datasheets and detail specifications, and the number of operations per time known, the expected time to failure can be calculated.

The details of calculation are given in IEC 61810-2 where the test conditions and evaluation methods are described how to obtain relevant reliability measures for electromechanical relays. The life of relays as non repairable itmes is primarily determined by the number of operations. For this reason the reliability is expressed in terms of MCTF (mean cycles to failure).

Commonly, equipment reliability is calculated from MTTF (mean time to failure) figures. With the knowledge of the requency of operation (cycling rate) of the relay within an equipment it is possible to calculate an effective MTTF value for the relay in that application.

Such calculated MTTF values for relays can be used to calculate respective reliability, probability of failure and availability (e.g. MTBF (mean time between failure)) values for equipment into which these relays are incorporated