RELAY END OF LIFE

Data sheets for switching quote the number of operations that a relay can perform, but the definition of end of life is not a precise term and is open to different interpretations. This page will explore some of the issues.

Accelerated Life Testing

The relays we install in our switching products have been life tested, in general we back up manufacturers life test data with our own life tests. Typically two main tests are conducted, one with the relay having virtually no load, one (or more) with the relay having a maximum load.

Both tests are generally accelerated life tests, the relay is operated at as rapid a rate as we can permit and checks are made that the relay makes and breaks contact. The test may also include a contact resistance (CR) test to see how the relay contact resistance changes through its working life.

Mechanical life can be limited by mechanical part failure (springs, coils, part friction) or by mechanical contact wear that exposes contact base metals that in turn leads to erratic contact resistance.

Loaded life is much more likely to be limited by relay heating and contact erosion by the signal current creating minute electric arc's that move metal around the switch contacts. The arc can also encourage the addition of other materials in the contact area, especially on non hermetic relays such as EMR's. Accelerated load testing can even lead to the signal arc heating the relay and causing plastic parts to soften in a way they do not when operated less frequently.

There have even been instances of resonances being excited which cause mechanical failures that do not occur in more representative test conditions.

Reed relays fair very well in the mechanical load tests since there are few moving parts and the contacts are sealed in a hermetic glass envelope.

User operating conditions seldom emulate this accelerated life testing, so their life in an application may differ from data sheet stated numbers. The accelerated testing also tends not to show other effects such as the the build up of contaminants on EMR contacts due to the environment (oxides and sulphides for example). Contamination can result in a minimum switch capacity appearing or time varying behavior of contact resistance. Damage from inrush currents caused by capacitive loading or arc's generated by inductive loading is not replicated by the accelerated life test.

Catastrophic failures are much easier to predict, for example the time to the first welded contact (whether this is temporary or permanent in a test application is usually irrelevant, the first weld is a test run failure on the system) or the first failure to close a contact.

Accelerated life testing gives a good indication of expected life but is best relied upon as a comparison process rather than an exact prediction.

So When is a Relay at End Of Life?

It is very clear when a relay reaches a point where a contact has welded or fails to close because of a contact failure. What is much less clear is when a relay is still functioning but whose performance is degrading. Different users may have different perceptions.

In general for most switching systems the switch assembly has two principal sources of path resistance, the relay contact resistance and the connection to the relay from the user connector (often a PCB track, sometimes mainly a wire). The distribution of this resistance is rather variable from module to module but a typical example on a PCB tracked design might be that the relay represents 30% of the total path resistance. On a data sheet we represent this as the "Initial Path Resistance", it is the maximum allowed resistance of a closed path, usually stated at maximum operating temperature (it generally increases by 0.4% per C) at the point the switching system is manufactured. We measure every path covered in the data sheet in a cold switch test at an appropriate current for the relay.

Once in use the path resistance is stable with time, it may even drop as the contacts "bed in" to each other with use. Eventually the resistance begins to be less stable and generally starts to increase. The problem then is what is the end of life point?. As a rough guide we will typically start to ask questions about a relay if the path it is in has increased so the Initial Path resistance has doubled. Taking a typical design where 30% of the path is relay resistance then given the PCB tracks or wires are unlikely to have changed the relay contact resistance will have increased by almost a factor of 6.

In some cases users would agree that this is a reasonable end of life (certainly our life tests on an individual relay would have started to indicate it is end of life), others might believe that the relay resistance is too high to be of use, others might believe that this resistance of no consequence (for example in series with a DMM or scope input). For these latter users as long as the contact is made they do not care so they will not meet end of life for many more operations.

It also has to be remembered that contact resistance is often not a constant parameter, it can be time dependent and more importantly it can be dependent on the signal level applied through it. The resistance might be higher for low signals (for example measured by a DMM) than for a high current signal. This is particularly true for high signal power relays where the passing of high current signal tends to burn of contaminants from a contact area while contacts which have not carried high current might exhibit non linear resistance behaviour after the gold flash on the contacts has eroded. Some relays can be temporarily "cleaned" by applying high signal levels on a hot switch operation which subsequently improves the path resistance at low currents.

Our guidance remains though that relays in paths that have doubled the Initial Path resistance specification on the data sheet should be considered to be nearing the end of life, but in reality may have considerable life left. The only absolute end of life is a failure to open or a failure to close, anything else may be application dependent.

Whenever we repair switching modules for users we always check not just the defective relay but the working relays and as a precautionary measure take the opportunity to change any that we suspect are showing signs of degradation so that an early repeat failure in a different relay is unlikely.

Source : http://wiki.pickeringtest.net/Relays+End+Of+Life