The International Standard on Electromechanical Relays (IEC 61810-1 Ed. 3)

Critical Review

V. Gurevich, Ph. D.,

Israel Electric Corporation

1. Terms and Definitions.

In section “Terms and Definitions” (items 3.7.1 and 3.7.2) two terms: “Functional Insulation” and “Basic Insulation” are defined and are further used throughout the standard. According to IEC 61810-1 "Functional Insulation" is the insulation necessary only for the proper functioning of the relay and the insulation protected from the electric shock is defined as "Basic Insulation". As an explanation of the difference between these two kinds of insulation, in remarks to tables 10 (h) and 11(e) an instance of "functional" insulation is given as the insulation between contacts of the relay, necessary (as affirmed in the standard) only for the proper functioning of the relay. It is impossible to agree with this assertion, for it is abundantly clear that the same insulation can be “basic” or “functional” depending on the application of the relay. For example, if contacts of the relay make switching in the electric circuits inaccessible to a contact by the person, the insulation between contacts of the relay really is clearly functional, but if contacts of the relay disconnect a voltage source of a part of the electrical installation to which there is an access of a person (direct or mediated, through other electric circuits) this is already “basic” insulation. On the other hand, the relay is often used for galvanic decoupling circuits with the different potential in the equipment, thus insulation between the coil and contacts of the relay has no relation to safety of the person and is cleanly functional, whereas in other cases of relay application it is “basic”. Thus, it can be asked how can the insulation marking in the relay be generally defined, that is, without a connecting it to the concrete application? To establish various demands to electric strength of insulation of the relay only by these definitions determined in advance is impossible. So what is the necessity for defining these terms in general?

2. Rated Values of Currents and Voltages

Sections 5.1 and 5.7 of IEC 61810-1 provide the ranges of rated values of a coil voltage:
1.5; 3; 4.5; 5; 9; 12; 24; 28; 48; 60; 110; 125; 220; 250; 440; 500 Volt DC;
and 6; 12; 24; 48; 100 / 3; 110 / 3; 120 / 3; 100; 110; 115; 120; 127; 200; 230; 277; 400; 480; 500 Volt AC;

and, accordingly, for contacts of the relays working on a resistive load:
4.5; 5; 12; 24; 36; 42; 48; 110; 125; 230; 250; 440; 500 Volt DC or AC.

In tables 16 and 17 different ranges of rated values of voltage are given:
10; 12.5; 16; 20; 25; 32; 40; 50; 63; 80; 100; 125; 160; 200; 250; 320; 400; 500; 630

and:

12.5; 24; 25; 30; 32; 42; 48; 50; 60; 63; 100; 110; 120; 125; 127; 150; 160; 200; 208; 220; 230; 240; 250; 277; 300; 320; 380; 400; 440; 480; 500; 575; 600; 630

First, for a correct designation of the value of an AC voltage it needs to be specified about which value is being spoken (amplitude, average, r.m.s.), the standard does not say.

Secondly, there is bewilderment in the essential differences in the ranges of rating values of voltage. In our opinion, it is absolutely unjustified and it is not logical, as a rule, both contacts and coils of the relay join in electric circuits of the same equipments having a certain range of rating values of voltage. Why these ranges should be different for circuits of contacts, circuits of coils and internal voltage sources in the same equipments is not clear.

Thirdly, ranges of currents and voltages for contacts of the relay in the given standard mismatch classes of the contacts loading, determined in standard IEC 61810-7 Electromechanical elementary relays - Part 7: Test and measurement procedures.

In section 5.7 as minimal value of a load for contacts of the relay is specified as 4.5 V and 0.1 A. At the same time, as is well known, electronic circuits voltages much below 4.5 V (0.5 – 1 V) are used, and currents much less than 0.1A (0.005 - 0.01 A). The micro-electromechanical relays with the bifurcated gilt contacts are widely used for switching such loads. What to do with such relays which really are present in the market, are widely used, but mismatch standard IEC 61810-1? On the other hand, the current range 100 A, specified as the maximal value of rated contacts current, is more characteristic for powerful contactors than for the relay.

The maximal values of rated voltages 400 - 440 V are not correct, in our opinion, as they do not reflect an existing reality. On the one hand, there are standard voltages 660V and 1140V, widely used in the industry, on the other hand, many companies make the small-size open electromechanical relays for voltages 4 - 5 kV (Hehgsler-Ka Co., Italiana Rele, SPS Electronic GmbH, Magnecraft), and also gas filled and vacuum relays for voltages 70 kV and above (Kilovac, Gigavac, Jennings Technologies). Many companies also manufacture high-voltage reed switch relays for voltages 10 - 20 kV [1]. Low-current relays with insulation between the coil and contacts up to 120 kV [2] have been developed already many years ago. Such relays are widely used in the powerful electrical-physical, radio-electronic and medical equipment, test systems, and so forth. In view of this, we can see that in the market there is really a large group of electromechanical relays that have been not embraced by the existing over-all standard in spite of the fact that applicability of this standard is all-embracing as is affirmed in the first section of the standard, and it does not divide the electromechanical relays into the relay low and a high voltage. A logical solution to this situation would be change of the name of this standard (for example, **"**Low-voltage electromechanical elementary relays**"** and restrict the area of its application only to the low voltage relays with rated voltage up to 1000 V).

In the section 5.7b of IEC 61810-1 it is noted that rated values of currents and voltages for inductive loads should match those given in Annex B. However, in the Annex B there are no rated values of currents and voltages. In this annex provisions for the testing of relays with respect to making and breaking capacity and electrical endurance for inductive contact loads are specified.

Actually, the load kinds AC-15 and DC-13 are so-called «utilization categories» specified in table B which characterize loadings as the coils of the switching electromagnetic apparatus: the relays, contactors and starters. The rated current level for these kinds of loads are shares- fraction of amperes, while IEC 61810-1 concerns itself with current levels in tens amperes (up to 100). Actually, standard IEC 61810-1 does not determine commutating ability of the relay for an inductive load, and only confuses the situation as the classes AC-15 and DC-13 are not suitable for currents in tens amperes.

3. The Documentation and Marking

According to IEC 61810-1 the major parameters of the circuit breaking type provided by contacts of the relay should be reflected in the catalogue or the service manual. According to N 3g in the table 4 (item 7.1) one following types of a circuit breaking should be specified: “micro-interruption” (3.5.16), “micro-disconnection” (3.5.17) or “full disconnection” (3.5.18). As follows from section «Terms and Definitions», differences between these types of circuit breakers consist in the size of the contact gap, that is, in the final reckoning, in a dielectric strength of a contact gap. Why was it required to invent special terms, poorly clear to users of the relays and to incorporate it into the engineering specifications on the relays rather than specify the dielectric strength for a contact gap?

Another obligatory parameter that should be reflected in the technical specifications, according to table 4, is the type of insulation, including functional or basic is underlined. There and then in remarks that follow it is noted that it depends on concrete relay application (how, we already have shown above). But if it depends on concrete application of the relay and in advance cannot be ascertained, then should it be specified in the specification?

Alongside with the extremely doubtful in the informative and definiteness in parameters which standard IEC 61810-1 demands to be specified in the technical specifications, there are major parameters of the relay not mentioned at all, parameters such as operating time and release time, contact bouncing time, contact resistance, time constant of the operating coil (R/L), the minimal values of switching voltage and current, etc.

Other problematic areas include the way of designating the contact loads (in item 7.1 (table 4, N 3a) by means of the instructions for contact type, current and voltage without any elaboration of what is offered: maximum or rated.

In item 7.4 (table 6) instances of marking the switching ability of relay contacts, supposing a designation only rated values of switching current and voltage are brought in the form of: 16A 230B (or 16/230), even without the instructions of type of loading (power factor an AC or time constant L/R - on DC). It is necessary to note that such designation does not give to user the information about true switching capability of the relay contacts and is capable of only confusion.

First, without an obligatory marking designation of loads it is simply impossible to size up switching ability of the relay because it strongly depends on the kind of load. For example, for the power relay G7Z type (Omron) the admissible switching current is 40A at cleanly active (resistance) loads of up to 22A at the mixed load with PF = 0.3.

Table 1. Switching parameters of contacts of some types of electro-mechanical relays of wide application

Relay type and manufacturer	Maximal switching current	Maximal switching voltage	Maximal switching power	Production of the current and voltage
750-523 (Wago)	16A AC	440V AC	5000 VA	7040 VA
J114FL (CIT Relays)	16 A	440V AC 125V DC	4000 VA 480 W	7040 VA 2000 W
CT (NAiS)	8 A AC	380V AC	2000 VA	3040 VA
G2RL (Omron)	12A AC	440 V AC	3000 VA	5280 VA

Secondly, in item 7.1 a switching current and a voltage are spoken of, and in item 7.4 about *rated values* of a switching current and a voltage, and it can be all the same, according to an explanation of item 3.3.16 of the standard, the rated value is determined as the value matching specially stipulated conditions. That is, “the rated switching current” is a current under certain, stipulated conditions. Such conditions can be a voltage across the contacts, frequency, a load kind, etc. However, in standard IEC 61810-1 there are no explanations for the terms: “the rated switching current” or “the rated switching voltage” that makes impossible for all practical purposes the correct use of these terms and the values connected with them. For example, what is “a rated switching current 16A”? Is it a current at a voltage across contacts 250V or no more than 125V? Is it a current only for pure a resistive loads, or also for mixed loads? And so on.

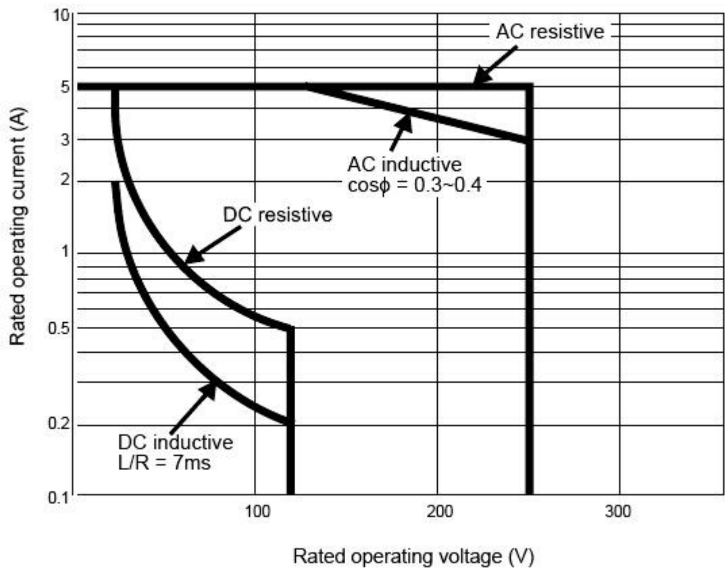

Fig. 1. Typical curve loading of contacts of the relay.

Thirdly, as the concept “rated” (or nominal) in the standard is not stipulated, a designation in the case of the relay the switching ability of contacts in the form of: “16A 230V” in all cases designates that the relay contacts can switch a current 16A at a voltage 230V.

In many cases, there is mention of values of a current and the voltage, which relay producers characterize in the technical specifications as “the maximum values” (for purposes of advertisement). Thus the maximum switching voltage and the maximum current of the switches is often marked. As a rule, the maximum switching power is not equal to product of the maximum current and the maximum voltage, see Table 1. This is because the value of the admissible switching current, as much as possible, to a large extent depends on the value of a voltage on the contacts, especially in connection with direct current, and from a kind of loads, Figure 1.

Unfortunately, in IEC 61810-1 such "subtleties" are not mentioned at all, and this essentially complicates its practical use.

4. Test Procedure

In item 8.2 (e, f) of the standard it is emphasized that test of the relay for heating is made at the powered coil (coils) of the relay and loading by a current of *all contacts*. In practice it is impossible to realize this requirement because if in the relay there are available both normally open and normally closed contacts as it is impossible to load a current simultaneously on both contacts, (how is this reconciled with the standard).

In p.10.3 procedure for dielectric strength is presented. Thus as a one-minute test voltage it is recommended applying a variable sine wave voltage with a frequency of either 50 or 60 Hz or a DC voltage having a value selected from Table 10 or 11. Comparing the two tables it can be seen that the values of voltage presented in them are absolutely identical for the same kinds of connections in the circuit diagram. But, in fact, in one table it is refers to r.m.s. values of the AC voltage, and in other DC voltages! As is known, 1000 V r.m.s. voltage affects insulation quite differently than 1000 VDC. From the point of view of the affect on insulation, even in the most elementary case, even neglecting the known physical effects connected with affect of frequency of an alternating voltage on insulation, it is necessary to inject, at least, factor 1.41 as a relationship between these voltages. IEC 61810-1 makes no mention of this.

For tests of electrical endurance (p. 11) as criterion of an estimation of the condition of the relay the standard uses such concepts as “make malfunctions” or “break malfunction” in contacts. And “malfunction” is defined (3.5.21) as a single event where an item does not perform a required function. The certain quantity and sequence of malfunctions during tests characterize serviceability or failure of the relay. Alongside with this criterion for an estimation of serviceability of the relay its duplicate test of dielectric strength is applied. However, as is well known, many cycles of wear under the maximum current can essentially change not only dielectric strength of insulation inside of the relay, but also contact resistance (owing to erosion of contact surfaces). It is also known that the use of contacts of relays in low-current circuits of the electronic equipment, the essential increment of resistance of contacts is one of the frequent reasons of failure of the electronic equipment. In this case it is possible to ascertain that the relay is not in any condition to carry out its functions (that is to connect circuits) and to it we shall apply the term "failure". Hence, contact resistance is a major criterion for estimating the serviceability of the relay and should be applied as one more criterion during tests of the relay for electrical endurance.

5. Conclusion

The analysis has shown that the most current edition of the IEC 61810-1 standard contains a many inaccuracies and even mistakes in some major sections. Therefore for practical use of this standard it is necessary to exercise care. By development or revising national standards that are based the given international standard, it is necessary to consider the detected inaccuracies and mistakes. We are recommend returning this standard to TC94 committee of IEC for revision and edition.