INSTRUMENT TRANSFORMERS

II. GENERAL CHARACTERISTICS

A. CURRENT TRANSFORMERS

A.1. Measuring and protection current transformers

The devices that suppose the charge of the transformers have different purposes depending on whether they are protection or measurement. Imagine that a current transformer supplies measurement device and that a short-circuit current circulates tens of times higher than the nominal one in the primary of the transformer. This current can damage the measuring device. On the contrary, a transformer that supplies a protection relay needs the secondary current to be a reliable reproduction of the primary one so that the relay can act with accuracy.

Therefore, it is necessary to differentiate between transformers intended to power measurement or protection devices:

- **Measuring devices**, are devices designed to measure normal currents without, before abnormal values, have to provoke corrective responses.
- **Protection devices,** these devices with abnormal values of the magnitude must give a warning or correction response.

Due to their nature, measuring devices do not usually withstand very large values of current or measure abnormally large magnitudes. Therefore, the transformer that feeds them with abnormally large current values in the primary must be able to increase the relation error, that the current in the secondary does not increase in the same proportion as the primary, Kcc << Kn. This is achieved with a saturable magnetic core.

Therefore, in the protection current transformers we want FS (safety factor) to be as large as possible.

Instead, protection devices need at all times a reliable value of the magnitude to be able to act at all times according to convenience. The transformation ratio must always be constant regardless of the primary current. This is achieved with a magnetic core that is not saturable.

Therefore, in the measurement current transformers we want FS (safety factor) to be as small as possible.
The foregoing makes it advisable not to gather measuring and protection devices in the same secondary of a current transformer. The right thing to do is to use two transformers or a dual-core current transformer, each with the right construction characteristics.

A.2. Inadmissibility of the open secondary

The open secondary is equivalent to having a current in the secondary null, that is to say the entire current of the primary is excitation current of the transformer. Therefore, the voltage that is induced in terminals of the secondary is proportional to NpIp, can become of very high values. The saturation of the magnetic core can help the voltage induced in the secondary is not so high.

A.3. Consume of the amperimetric coils of the powered devices

They are consumptions that should be considered at indicative level of the amperimetric coils in VA for electromagnetic type devices. Electronic devices tend to have much lower consume.

Device or instrument	Consumptions in VA
Indicator ammeter	1-2
Recording ammeters	2-5
Precision ammeters	0.2-0.5
Wattmeter indicators	2-4
Wattmeter's recorders	2-8
Precision Wattmeter's	1-2
Active and reactive power counters	1-1.5
Phase meters indicators	5-15
Phase meters recorders	8-20
Overcurrent relays, instant	2-10
Overcurrent relays, independent relay	3-20
Overcurrent relays, thermal	3-7
Timing relays	2-5
Differential relays	2-10
Distance relays	5-20
Electronic relays do not usually consume more than 5 VA	

It must not be forgotten that the conductors, which connect the secondary terminals of the transformer, have their own consumption, which must be added to the previous ones.

We attach, in the following table, the consumes in VA, per meter of copper conductor (length to be considered, plus return).

Section (mm^2)	Consumption in VA per m de CU conductor	
	Isn 5A	Isn 1A
2.5	0.18	0.007
4	0.11	0.0044
6	0.07	0.0029
10	0.044	0.00175

When the total length of the conductors is large it is advisable to use Isn = 1A.

A.4. Uses of current transformers, according to accuracy classes

Measurement transformers	
Accuracy class	More general uses
0.1	Precision measurements (laboratory)
0.2	Precision counters, especially for high powers (high voltages). Cases that are to predict low power factors. Laboratory measurements Portable patterns.
0.5	Normal counters. Measuring devices, and regulators, sensitive.
1	Ammeters, wattmeter's and phasemeter's.

Protection transformers	
Accuracy class	More general uses
5P	Differential, distance, directional, earth-ground and other precision relays. In general, all those that affect the angle error.
10P	Ordinary protection relays and others. In general, those who are not affected by the angle error.

B. VOLTAGE TRANSFORMERS

B.1. Voltage factors

It is the value by which one has to multiply the nominal voltage and obtain the maximum value of voltage to which the transformer must comply with the heating and precision prescriptions.

The normal values of the voltage factor are: 1.2 -1.5 -1.9.

This voltage factor is determined by the maximum operating voltage, which in turn depends on the network and the grounding conditions of the primary winding of the transformer.

The normal values of appropriate nominal voltage factor in the different grounding conditions of the network are indicated in table I, simultaneously with the permissible duration of the maximum operating voltage (that is, nominal duration).

Rated voltage factor	Nominal duration	Mode of connection of the primary winding and conditions of grounding of the network
1.2	continuous	- Between phases of any network - Between the neutral point of the transformers in star and earth, in any network.
1.2	continuous	- Between phase and earth, in a network with neutral effectively grounded
1.5	30 s	
1.2	continuous	- Between phase and earth, in a network with neutral not effectively grounded with automatic ground fault elimination
1.9	30 s	
1.2	continuous	- Between phase and earth, in a network with isolated neutral without automatic elimination of the ground fault, or in a network with neutral grounded through an extinction coil without automatic elimination of ground fault.
1.9	8 h	

Table I. *Normal values of the nominal voltage factor*

B.2. Consumes of the voltmetric coils of the powered devices

They are consumptions that should be considered at indicative level of the voltmetric coils in VA for electromagnetic type devices. Electronic devices tend to have much lower consume.

Device or instrument	Consumption in VA
Indicator voltmeter	3-10
Recording voltmeters	0.3-20
Wattmeter indicators	0.3-10
Wattmeter's recorders	1-15
Active and reactive power counters	2.5-5
Precision Wattmeter's	1-2
Phase meters	1-15
Frequency meters	1-10
Synchro scopes	5-20
Null voltmeters	5-30
Low voltage relays	5-15
High voltage relays	5-15
Directional relays	5-30
Ground contact relays	10-30
Distance relays	10-30
Regulators	30-70

B.3. Uses of voltage transformers, according to accuracy classes

Measurement transformers	
Accuracy class	More general uses
0.1	Precision measurements (laboratory)
0.2	Precision counters, especially for high powers (high voltages). Cases that are to predict low power factors. Laboratory measurements Portable patterns.
0.5	Normal counters. Measuring devices, and regulators, sensitive.
1	Voltmeters, wattmeter's and frame phase meters. Industrial counters. Ordinary regulators.
3	Devices of great consume, without great requirements. Devices of low precision or those that do not affect the concrete value of the voltage. Cases in which angle errors do not matter.

Protection transformers	
Accuracy class	More general uses
3P	Relays that require a certain precision and not excessive angle error (directional and distance)
6P	Relays of overvoltage or of minimum tension, without special requirements to what angle of error