# Choosing a Current Transformer

### DETERMINING THE TRANSFORMER RATIO IP/IS

- For the transformer primary current, choose the standard value immediately higher than the current to be measured;
  e.g. current to be measured 1124 A; take Ip = 1250 A
- For the secondary current, choose1A or 5A depending on the instrument or relay, and on the distance between the transformer and the instrument it is feeding:
  - 5 A secondary is used when instruments or relays are close to the transformer, less than 10m;
  - 1 A secondary is preferred when the distance separating the current transformer and the instrument or the relay is above 10m. Losses due to the wire resistance are 25 times higher at 5 A than at 1 A.

### DETERMINING THE TRANSFORMER OUTPUT

- In order to define the transformer output in VA, add the lead burden (table 2) to the burden of the instruments connected to the transformer (table 1).
- We recommend that you choose the output rating as close as possible to, but higher than, the calculated burden since the characteristics regarding accuracy and security factor might otherwise be modified.

### DEFINING THE ACCURACY CLASS

| | |
|---|---|
| Standards | Class 0.1 or 0.2 |
| Tariff metering | Class 0.5 or 0.2 |
| Industrial division metering | Class 1 |
| Measurement display | Class 1 or 3 |
| Protection | Class 5P or 10P |

- Remember that instrument errors add to the errors of the transformers feeding them. This applies also when several transformers are mounted in tandem.
- In the case of class 5P or 10P choose the accuracy limit factor, generally 5, 10, 15 or 20.

### DEFINING THE TYPE OF TRANSFORMER

- When the primary current is very low, a few amps or even some tens of amps, a wound primary transformer is generally used.
- Window type transformers, where the primary conductor is a cable or a bar passing through the transformer, are used when the currents to be measured are higher than 150 A. Their performance is reduced when the primary current is not particularly high (between 40 and 150 A). It is neither practical nor economic to use them below 40 A. The choice of model depends on the type of primary conductor, cable or busbar, and on its cross-section.

# Choosing a Voltage Transformer

### DEFINING THE ACCURACY CLASS

| | |
|---|---|
| Standards | Class 0.1 or 0.2 |
| Tariff metering | Class 0.5 or 0.2 |
| Divisional industrial metering | Class 1 |
| Measurement display | Class 1 or 3 |
| Protection | Class 3P or 6P |

### DEFINING THE VOLTAGE FACTOR

- The voltage factor is determined by the maximum operating voltage, which depends on the neutral system, and the voltage transformer primary winding earthing conditions.
- When the voltage transformer is connected between two phases, the voltage factor is 1.2 Un continuously.
- When the voltage transformer is connected between phase and earth, the voltage factor depends on the neutral system:
  - 1.5 Un for 30s in an effectively earthed neutral system
  - 1.9 Un for 30 s in a non-effectively earthed neutral system with automatic earth-fault tripping
  - 1.9 Un for 8 h in an isolated neutral system, or in a resonant earthed system, without earth-fault tripping.

# Important warning

- Never leave the secondary circuit of a current transformer open when voltage is applied to the transformer. High voltages may appear at the secondary circuit terminals which can be dangerous to personnel and may result in the destruction of the current transformer.
- Never short-circuit the secondary circuit of a voltage transformer when it is operating since this would destroy it in a few seconds.

# Selection - Tables

### TABLE 1 - INSTRUMENT BURDEN

| Instrument | Burden | | |
|---|---|---|---|
| Ammeters | 0.5 | to | 4 VA |
| Voltmeters | 2 | to | 5 VA |
| Frequency meters | 1 | to | 5 VA |
| Phase angle meters | 0.5 | to | 5 VA |
| Wattmeters - VARmeters | 1 | to | 5 VA |
| Electromechanical counters | 2 | to | 5 VA |
| Electronic counters | 0.5 | to | 2 VA |
| Transducers | 0.5 | to | 1 VA |
| Recorders | 5 | to | 20 VA |
| Protection relays | 0.2 | to | 30 VA |

### TABLE 2 - LEAD BURDEN

Burden in VA - Loop lengths in m.

| Is=5A | 1m | 2m | 3m | 4m | 5m | 6m | 7m | 8m | 9m | 10m |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.5mm² | 0.60 | 1.19 | 1.79 | 2.38 | 2.98 | 3.57 | 4.17 | 4.76 | 5.36 | 5.95 |
| 2.5mm² | 0.36 | 0.71 | 1.07 | 1.43 | 1.78 | 2.14 | 2.50 | 2.86 | 3.21 | 3.57 |
| 4mm² | 0.22 | 0.45 | 0.67 | 0.89 | 1.12 | 1.34 | 1.56 | 1.79 | 2.01 | 2.24 |
| 6mm² | 0.15 | 0.30 | 0.45 | 0.60 | 0.74 | 0.89 | 1.04 | 1.19 | 1.34 | 1.49 |
| 10mm² | 0.09 | 0.18 | 0.27 | 0.36 | 0.44 | 0.54 | 0.63 | 0.71 | 0.80 | 0.89 |

| Is=1A | 10m | 20m | 30m | 40m | 50m | 60m | 70m | 80m | 90m | 100m |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.5mm² | 0.24 | 0.48 | 0.72 | 0.96 | 1.19 | 1.43 | 1.67 | 1.91 | 2.15 | 2.38 |
| 2.5mm² | 0.14 | 0.29 | 0.43 | 0.57 | 0.72 | 0.86 | 1.00 | 1.14 | 1.29 | 1.43 |
| 4mm² | 0.09 | 0.18 | 0.27 | 0.36 | 0.45 | 0.54 | 0.63 | 0.71 | 0.8 | 0.89 |
| 6mm² | 0.06 | 0.12 | 0.18 | 0.24 | 0.30 | 0.36 | 0.42 | 0.48 | 0.54 | 0.60 |
| 10mm² | 0.04 | 0.07 | 0.11 | 0.14 | 0.18 | 0.21 | 0.25 | 0.29 | 0.32 | 0.36 |

### TABLE 3 - PERMISSIBLE CURRENT IN A BUSBAR

Ambient temperature = 30°C
Maximum busbar temperature rise = 40°C
Bars on edge
Busbar spacing equal to the thickness of a bar
Permissible current in Amps

| Bar Dimensions | Copper | | | | Aluminium | | | |
|---|---|---|---|---|---|---|---|---|
| | *1 bar* | *2 bars* | *3 bars* | *4 bars* | *1 bar* | *2 bars* | *3 bars* | *4 bars* |
| 20 x 5 | 320 | 570 | 730 | 940 | 190 | 340 | 430 | 570 |
| 30 x 5 | 460 | 820 | 1050 | 1380 | 360 | 640 | 820 | 1080 |
| 40 x 5 | 550 | 990 | 1260 | 1650 | 430 | 770 | 980 | 1290 |
| 50 x 5 | 650 | 1170 | 1490 | 1950 | 510 | 910 | 1170 | 1530 |
| 60 x 5 | 840 | 1510 | 1930 | 2520 | 660 | 1180 | 1510 | 1980 |
| 80 x 5 | 1000 | 1800 | 2300 | 3000 | 780 | 1400 | 1790 | 2340 |
| 100 x 5 | 1200 | 2160 | 2760 | 3600 | 940 | 1690 | 2160 | 2820 |
| 160 x 5 | 1800 | 3240 | 4140 | 5400 | 1410 | 2530 | 3240 | 4230 |

# Selection - Tables

## LIMITS OF ERRORS AND PHASE DISPLACEMENT FOR INSTRUMENT TRANSFORMERS

### Current transformers

IEC 60044-1 standard

| Accuracy class | Ratio error | | | | | Phase displacement | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *0.05In* | *0.2In* | *0.5In* | *In* | *1.2In* | *0.05In* | *0.2In* | *In* | *1.2In* |
| 0.2 | ± 0.75% | ± 0.35% | - | ± 0.2% | ± 0.2% | ± 30′ | ± 15′ | ± 10′ | ± 10′ |
| 0.5 | ± 1.5% | ± 0.75% | - | ± 0.5% | ± 0.5% | ± 90′ | ± 45′ | ± 30′ | ± 30′ |
| 1 | ± 3% | ± 1.5 % | - | ± 1% | ± 1% | ± 180′ | ± 90′ | ± 60′ | ± 60 ′ |
| 3 | - | - | ± 3% | - | ± 3% | - | - | - | - |

| Accuracy class | Ratio error | | | | | Phase displacement | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *0.01In* | *0.05In* | *0.2In* | *In* | *1.2In* | *0.01In* | *0.05In* | *0,2In* | *In* | *1.2In* |
| 0.2S | ± 0.75% | ± 0.35% | ± 0.2% | ± 0.2% | ± 0.2% | ± 30′ | ± 15′ | ± 10′ | ± 10′ | ± 10′ |
| 0.5S | ± 1.5% | ± 0.75% | ± 0.5% | ± 0.5% | ± 0.5% | ± 90′ | ± 45′ | ± 30′ | ± 30′ | ± 30′ |

| Accuracy class | Ratio error *In* | Phase displacement *In* | Composite error *At rated accuracy limit current* |
|---|---|---|---|
| 5P | ± 1% | ± 60′ | ± 5% |
| 10P | ± 3% | - | ± 10% |

### Voltage transformers

IEC 60044-2 standard

| Accuracy class | Ratio error *0.8Un…1.2Un* | Phase displacement *0.8Un…1.2Un* |
|---|---|---|
| 0.2 | ± 0.2% | ± 10′ |
| 0.5 | ± 0.5% | ± 20′ |
| 1 | ± 1% | ± 40′ |
| 3 | ± 3% | - |

| Accuracy class | Ratio error *0.05Un…Voltage factor x Un* | Phase displacement *0.05Un…Voltage factor x Un* |
|---|---|---|
| 3P | ± 3% | ± 120′ |
| 6P | ± 6% | ± 240′ |