MTE Meter Test Equipment

Testing of three-phase meters with closed I-P links using current isolation transformers

With ever increasing frequency, meter manufacturers and meter operators are producing and using meters that do not allow the links between the current and voltage measuring circuits (I-P links) to be opened for test or calibration purposes. There are several reasons for this but the most important for manufacturers is the lower manufacturing cost of single-phase meters using resistive shunts for current measurement. To provide the facility to isolate the current and voltage paths of these meters would result in a significantly higher manufacturing cost. During normal operation, this isolation would not even be technically feasible. A second reason for not supplying meters with removable I-P links is that the presence of these links makes the possibility of fraud by customers more likely.

The same consideration also applies to non-CT operated three-phase meters. (Whole current meters).

These meters are therefore sometimes also manufactured with I-P links which cannot be disconnected from outside the sealed meter case. In this case, again, the meter is less expensive to manufacture than if accessible disconnection links are provided inside the terminal cover.

For meters designed for use with external transformers, the terminal block provides access to all current and voltage terminals in order to be able to connect the required transformers.

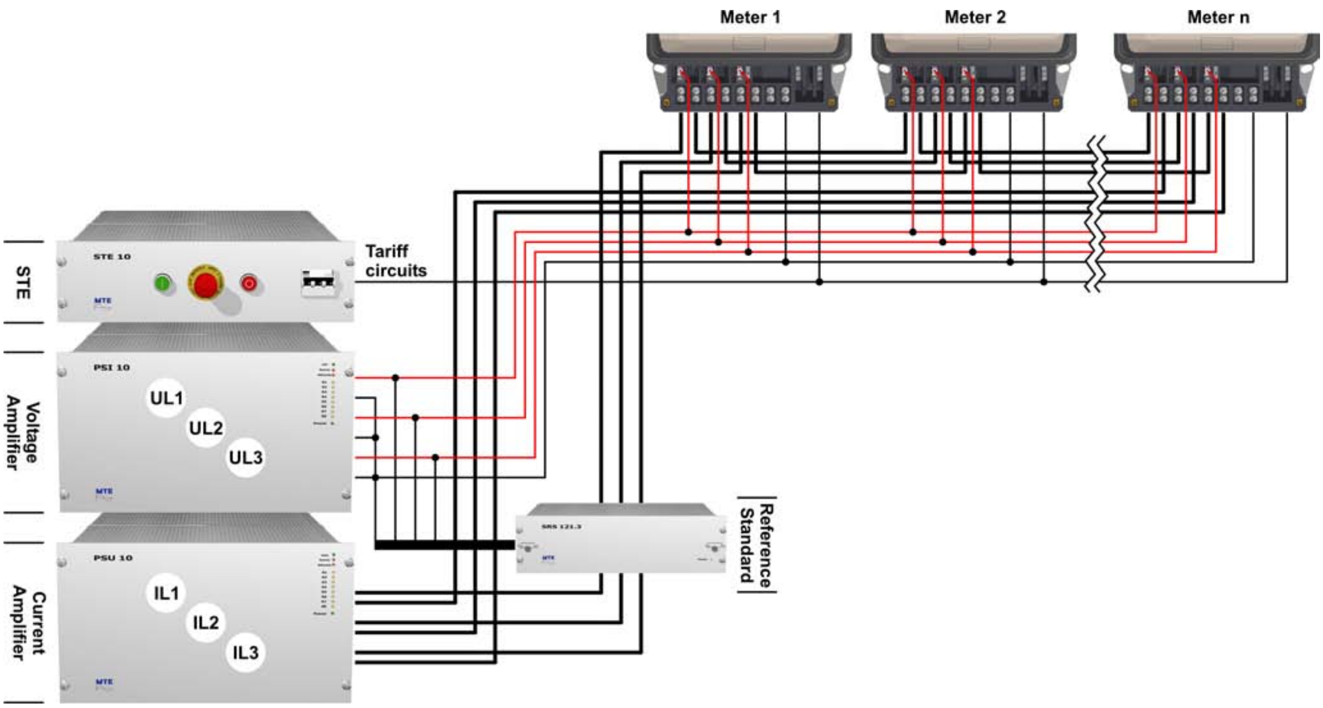
The above reasons support the concept of providing whole current meters with closed I-P connections for both domestic and commercial use. This approach allows cost reduction in production and also reduces the likelihood of energy theft.

There are however, some important implications in this approach, for the specification of meter test equipment.

Basic arrangement of a meter test installation

During meter testing, an electronic source is normally used as a phantom load to provide test currents and voltages applied to both the meters under test and the reference meter. The term “phantom load” means that the current measuring element is supplied with the required current and the voltage element is supplied separately with the required test voltage.

Modern electronic meter test installations configured in this way allow for automatic testing of the meters over their full working range. The current and voltage measurement circuits at each meter can be disconnected via links in the terminal block (I-P links). Thus it is possible to connect any number of meters with voltage in parallel and current in series for efficient testing of large numbers of meters. The same currents and voltages are applied to all of the meters under test.



Test requirements with closed I-P links

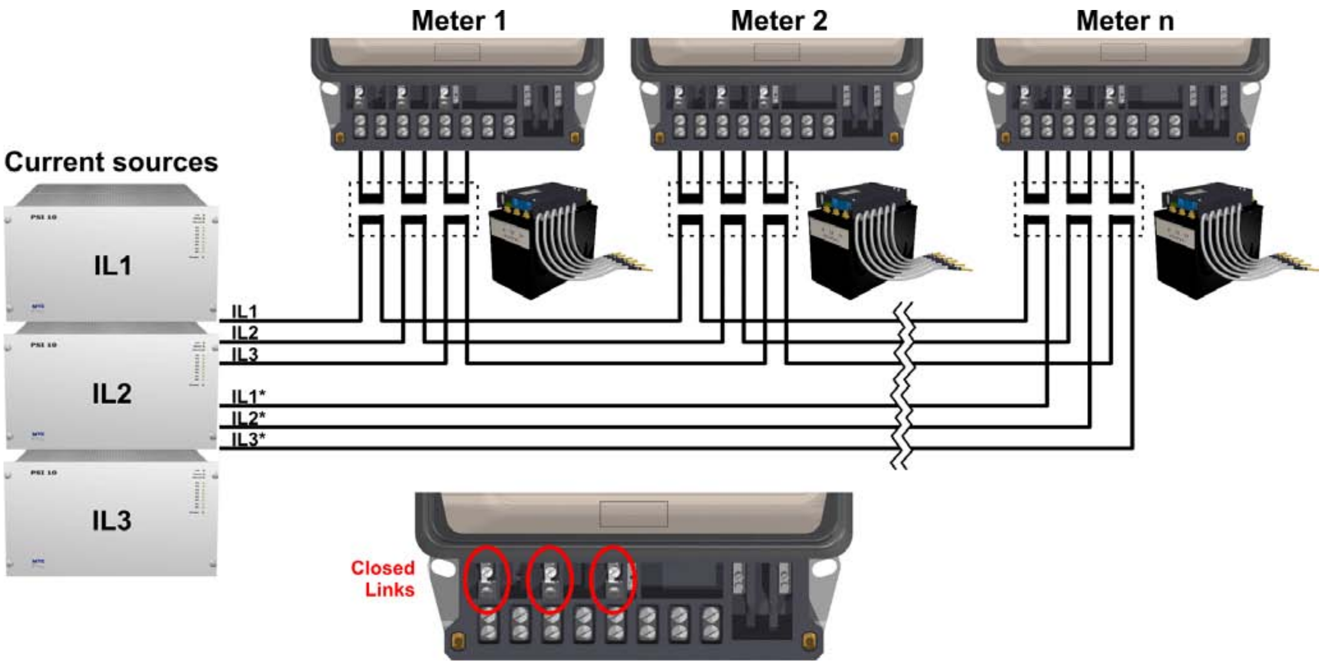
If the meters under test do not allow for opening of the I-P links, then there is an unwanted connection between voltage and current path at every meter position.

Because of these connections the line (input) and load (output) of each current measurement element are forced to be at the same potential, an effective short-circuit path exists across the current measuring circuit of every meter under test, causing a large measurement error. It is therefore not possible to test multiple meters with closed I-P connections on a conventional meter test installation without additional facilities. To be able to test these types of meters, galvanic isolation must be provided between the current and voltage circuits of each meter under test. This isolation must ensure that the closed I-P links in the meters do not cause these unwanted short-circuits and the resultant measurement errors. With single phase meters, galvanic isolation can theoretically be carried out using either voltage or current isolation transformers. In this case, a connected I-P link does not cause a short-circuit, as this connection is now made on the secondary side of the transformer, thus avoiding any direct connection with the other meters in the circuit.

Potential disconnection during the testing of multi-phase meters

Multi-phase meters for direct connection are also manufactured with closed I-P links. On the other hand, CT or PT connected meters in general do not have a connection between voltage and current circuits. Thus, meters intended for transformer connection can be tested on conventional test systems without additional isolation being necessary.

Whereas with single phase meters, the problem caused by closed I-P links can be solved relatively easily by using a voltage transformer with several galvanically isolated secondary windings (MSIVT), for parallel testing of more than one three-phase meter with closed I-P links on a conventional meter test installation, it is not possible to simply utilise three voltage transformers with separated secondary windings. In this case the voltage circuits would be connected to each other via the common neutral connection, therefore complete galvanic isolation cannot be achieved in this way. The required isolation therefore must be achieved by using transformers in the current circuits and in order to do this the test installation, must be fitted with one current transformer per phase for each test position. In this way, each meter under test is supplied with isolated test currents via these current transformers, which normally (but not necessarily) have a current ratio of 1:1 and a phase error over the required current range small enough as not to introduce significant additional errors.



As the current isolation transformers provide an additional load to the current amplifier, the power output of the current source needs to be approximately twice as high as would be necessary without the current transformers.

Also because of the non-linearity inherent in these transformers, the overall accuracy of the system is limited at lower currents.

Typically, achievable accuracy lies at 0.05 % without incurring excessive transformer manufacturing costs.

The increased complexity of a test installation including current isolation leads to costs up to 30 % higher than a conventional bench (dependent on the number of test positions). The additional expense for the measurement technology could therefore easily negate the cost reduction achieved by purchasing three-phase meters with fixed I-P links, and should be a consideration when buying meters.

ICT 1.3 Three-phase Isolation Current Transformer

The ICT 1.3 three-phase Isolation Current Transformer is used on multi position test benches for testing three-phase meters with closed links between the current and voltage measuring circuits (C-P links). Meter of this type are produced and used with increasing frequency.
While testing meters with fix closed C-P links, unwanted connections between voltage and current path at each test position will cause significant accuracy reduction.
In this case transformers in the current circuit are required to decouple the voltage from the current path.
To achieve complete decoupling the test installation must be fitted with one current transformer per phase for each test position. In this way each meter under test is supplied with isolated test currents via these toroidal-core current transformers, which normally have a current ratio of 1:1 and a phase error over the required current range small enough not to introduce significant additional errors.

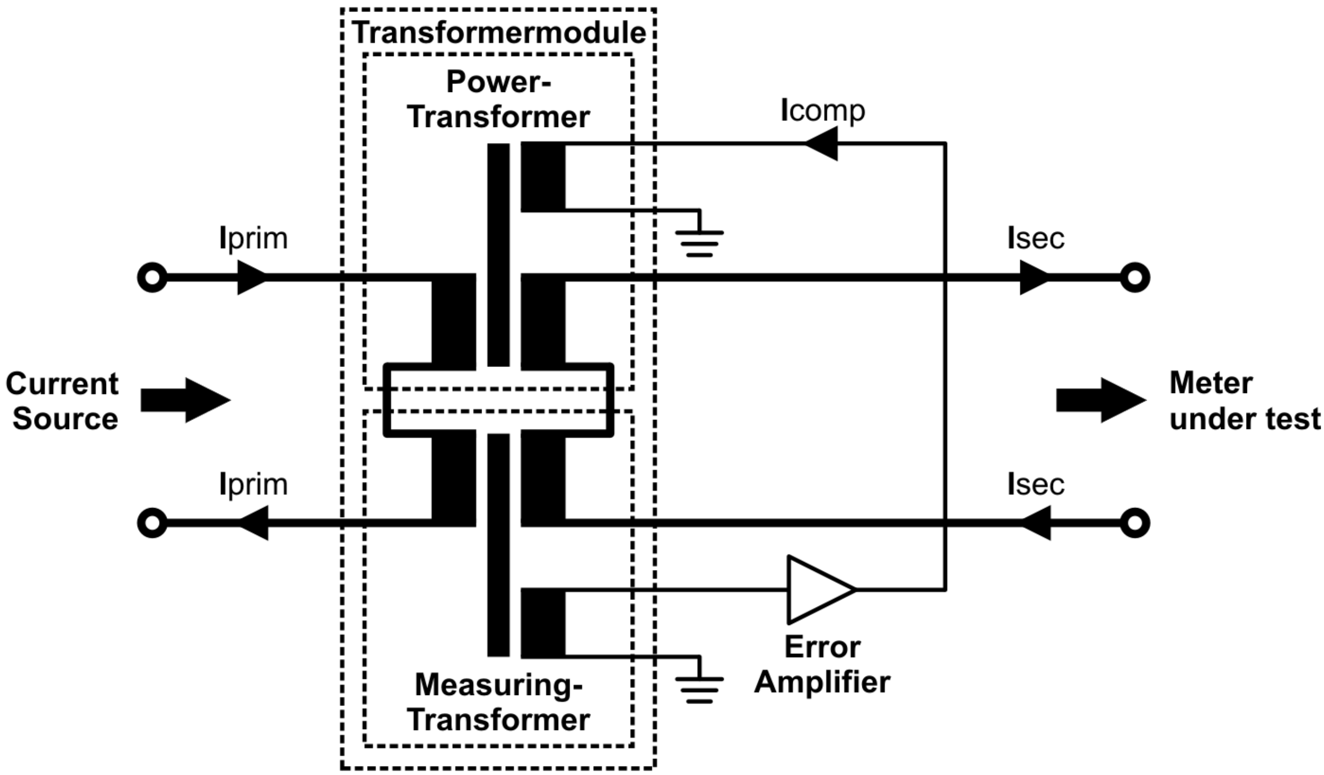
Advantages

- Wide current range from 25 mA up to 120 A
- Output power max. 60 VA
- High accuracy class 0.05 by electronic error compensation
- Overload protected

Application

- Multi position test systems for meters with closed current-voltage links
- Module for modernisation of older test systems

Block diagram



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ICT 2.3

Three-phase Isolation Current Transformer

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Technical Data ICT 2.3

General characteristics

Auxiliary supply:	85 VAC_{min} … 265 VAC_{max} / 47 Hz … 63 Hz
Power consumption:	max. 15 VA
Housing:	Hard plastic
Dimensions:	W 152 x D 238 x H 262 mm
Operation temperature:	- 10°C … +50°C
Storage temperature:	- 20°C … +60°C
Weight:	approx. 17 kg
Temperature coefficient:	≤0.003 %/°C (+0°C ... +15°C / +25°C ... +40°C) ≤0.005 %/°C (-10°C ... +0°C / +40°C ... +50°C)

Transformer characteristics

Nominal frequency fn:	50 Hz (45 … 55 Hz) or 60 Hz (54 … 66 Hz)
Ratio:	1:1 (primary current = secondary current)
Current range:	10 mA ... 120 A
Class:	0.05 (100 mA … 120 A)

Output power (per phase)							
Current range:	120 A	100 A	80 A	60 A	10 A	1 A	100 mA
Output power max.:	60 VA	50 VA	40 VA	30 VA	5 VA	50 mVA	0.5 mVA
Primary loss max.:	5 VA	3.5 VA	2.2 VA	1.3 VA	insignificant		
Input burden:	0.35 mΩ (Calculated with primary cable length / ICT 2.3: 0.5 m and cable section 25 mm^2)						

Output burden (per phase)	**1 A … 120 A**					**100 mA … 1 A**	
Current range:	120 A	100 A	80 A	60 A	10 A	1 A	100 mA
Output burden max.:	4.2 mΩ	5.0 mΩ	6.3 mΩ	8.3 mΩ	50 mΩ	50 mΩ	50 mΩ
Output burden voltage:	0.5 V					50 mΩ / I	

Error			
Current range:	100 mA … 120 A (whole output burden range)	25 mA … 100 mA (whole output burden range)	10 mA … 25 mA (whole output burden range)
Ratio error:	≤ ± 0.02 % (typical) ≤ ± 0.05 % (max.)	≤ ± 0.10 % (typical) ≤ ± 0.20 % (max.)	≤ ± 0.50 % (typical)
Angle error:	≤ ± 0.8 min	≤ ± 1.5 min	≤ ± 3 min
Range: Typical (max.) error of meter test system with ICT 2.3	cos = 1 cos = 0.5c ... 1 ... 0.5i	cos = 1 cos = 0.5c ... 1 ... 0.5i	cos = 1 cos = 0.5c ... 1 ... 0.5i
ICT 2.3 + SRS 400.3 (Class 0.02)	≤ ± 0.03 % (0.07 %) ≤ ± 0.05 % (0.14 %)	≤ ± 0.05 % (0.12 %) ≤ ± 0.10 % (0.24 %)	≤ ± 0.15 % (0.22 %) ≤ ± 0.50 % (1.00 %)
ICT 2.3 + SRS 121.3 (Class 0.05)	≤ ± 0.05 % (0.10 %) ≤ ± 0.10 % (0.20 %)	≤ ± 0.10 % (0.15 %) ≤ ± 0.15 % (0.30 %)	≤ ± 0.15 % (0.25 %) ≤ ± 0.50 % (1.00 %)

Control elements and connections

Green LED´s: Normal operation conditions. The isolation current transformer ICT 2.3 is switched on		**Red LED´s:** General error message, e.g. overload or the ICT 2.3 is out of order			
SHORT: With this button the ICT 2.3 is short-circuited (all LED´s on)		**RESET:** With this button the ICT 2.3 is reset	**Supply voltage connection:** To supply the ICT 2.3 with the operation voltage	**Supply voltage connection:** For transmission of the operation voltage to the next ICT 2.3	**Remote control** SHORT RESET **Status indication** OK and OVL