

Current transformer testing by C300B & CP11B calibrators

Application Note No36

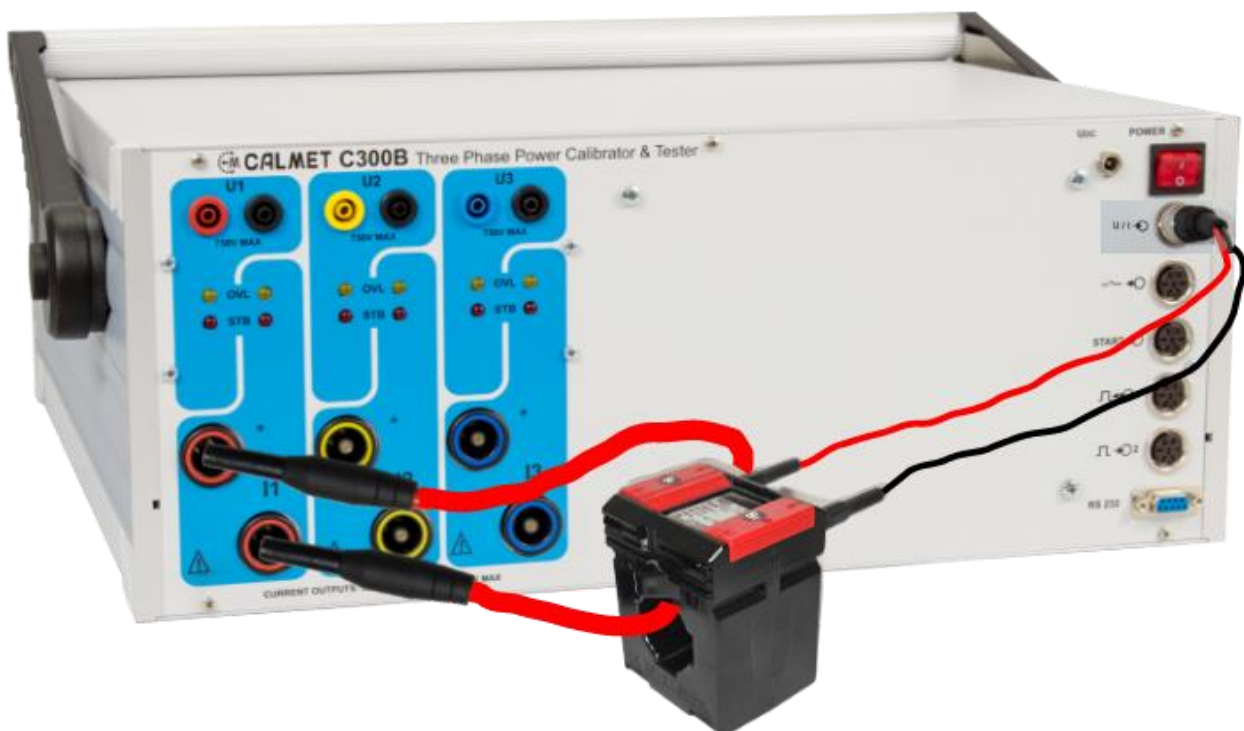
Current transformers for measurements are an important part of the energy measurement installation and have an influence on the accuracy of the whole measurement system. The accuracy class is defined in the standard IEC 60044-1 (Instrument Transformers Part 1 - Current Transformers) and each class of accuracy index requires that the CT ratio error is within the limits and the phase shift error is within the limits defined in the above-mentioned standard - see Table 11 (like in standard) below:

Table 11 – Limits of current error and phase displacement for measuring current transformers (classes from 0.1 to 1)

Accuracy class	± Percentage current (ratio) error at percentage of rated current shown below				± Phase displacement at percentage of rated current shown below							
					Minutes				Centiradians			
	5	20	100	120	5	20	100	120	5	20	100	120
0.1	0,4	0,2	0,1	0,1	15	8	5	5	0,45	0,24	0,15	0,15
0.2	0,75	0,35	0,2	0,2	30	15	10	10	0,9	0,45	0,3	0,3
0.5	1,5	0,75	0,5	0,5	90	45	30	30	2,7	1,35	0,9	0,9
1.0	3,0	1,5	1,0	1,0	180	90	60	60	5,4	2,7	1,8	1,8

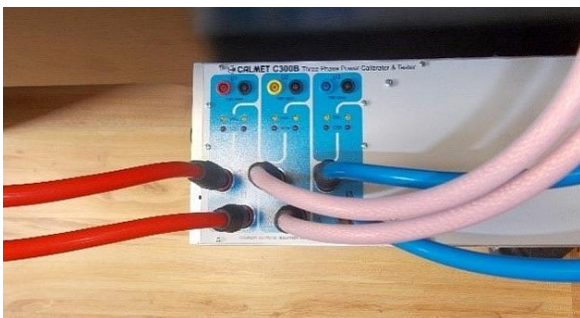
The classic method of CT testing requires a current source for the primary current and a current and phase meter for the secondary current. The source and meter can be the C300B 3-phase power calibrator with a maximum output current (three phases combined) of up to 360A or the CP11B single-phase power calibrator with an output current of up to 120A. Both calibrators have a built-in AC current and phase shift meter for current up to 6A and an uncertainty at the level of 0.05% and an uncertainty of 0.1° (6 minutes) for phase shift measurement. The meter is used to measure secondary current.

The CT under test connection to the C300B calibrator is shown below. For primary current requirements up to 360A, the cables from each of three phases should be split together. The secondary current is connected to the meter input (Pin5&6-signal, Pin 4&7-GND) by means of Amphenol C091A plug (delivered with calibrator) or additional connection box AD300 (see pictures below).





U/I		measurement inputs of DC and AC voltage and currents	
Pin	Signal	Description	
1	±24mA DC 16mA AC	DC current input -24...0...+20mA ($R_{IN}=200\Omega$) AC current input ...0...16mA ($R_{IN}=200\Omega$)	
2	±14V DC 10V AC	DC voltage input -14...0...+14V ($R_{IN}=30k\Omega$) AC voltage input 0...10V ($R_{IN}=30k\Omega$)	
3	200mA AC	AC current input 0...200mA ($R_{IN}=3.2\Omega$)	
4, 7	GND	Ground of the voltage and current input	
5, 6	6A AC	AC current input 0...6A ($R_{IN}=0.02\Omega$)	



Testing CT by C300B and CP11B calibrators by means of Calpro300 PC Soft requires to set the: “Current transformer TYPE” with general accuracy class and primary current.

- U | Phi | P | Q | S
- Symmetric
- Asymmetric
- Waveform
- Power Quality
- Test system
- Electricity meter
- Relay
- Current transformer
 - Type
 - Procedure
 - Auto Test
 - Result

Current transformer name

Nominal parameters

I_{pn} - primary current <input type="text" value="100.0"/> A	I_{sn} - secondary current <input type="text" value="5"/> A	I_{pn} / I_{sn} <input type="text" value="20.000"/>	f - frequency <input type="text" value="50.0"/> Hz
Class of accuracy <input type="text" value="0.2"/> %	S Power <input type="text" value="2.5"/> VA	Phase error <input type="text" value="0.2"/> °	Secondary current range <input type="text" value="6Aac"/>

This menu is used to set the value of the rated primary current I_{pn} [A], the value of the rated secondary current I_{sn} [A], the accuracy class [%], the rated power S [VA], the phase shift error in [°] degrees and the frequency. The I_{pn}/I_{sn} ratio is calculated automatically. It is also possible to select the measuring range in the C300B (CP11B) meter: 6A, 200mA or 16mA. Then the set type is saved under the name: CT100A-5A in the data base. The type example is for CT 100A/5A class 0.2 and nominal power of 2.5VA (see below).



CT testing with the C300B and CP11B calibrators requires that the "PROCEDURE" of testing, which consists of primary current points set as % of CT nominal current, ratio error limit and phase error limit according to the above class requirements in Table 11. The PROCEDURE can be prepared for any CT class, with as many test points as required by the customer. Then the set PROCEDURE is saved under the name: CT100A-5A in the data base.

No	Point Name	I	f [Hz]	Coil	Waveform	Measurement:	Error limit	Phase error
1	1A	1 %Ipn	50.0	No	-	5	2.0	1.0
2	5A	5 %Ipn	50.0	No	-	5	0.75	0.5
3	10A	10 %Ipn	50.0	No	-	5	0.5	0.3
4	20A	20 %Ipn	50.0	No	-	5	0.35	0.25
5	50A	50 %Ipn	50.0	No	-	5	0.3	0.2
6	80A	80 %Ipn	50.0	No	-	5	0.25	0.2
7	100A	100 %Ipn	50.0	No	-	5	0.2	0.17
8	120A	120 %Ipn	50.0	No	-	5	0.2	0.17

Then we can start „AUTO TEST” by selecting the “Procedure name” (eg. CT100A-5A) and “Current transformer name” (Type eg. CT100A-5A). We can select individual load currents or select all load points for full CT characteristics. Just after “Start” we get programmed number of results (5 in this example): ε - average value of CT ratio error, φ - average value of phase shift error and standard deviation of both quantities. In case that result is within limits it is displayed in **green** color, in opposite case in **red**.

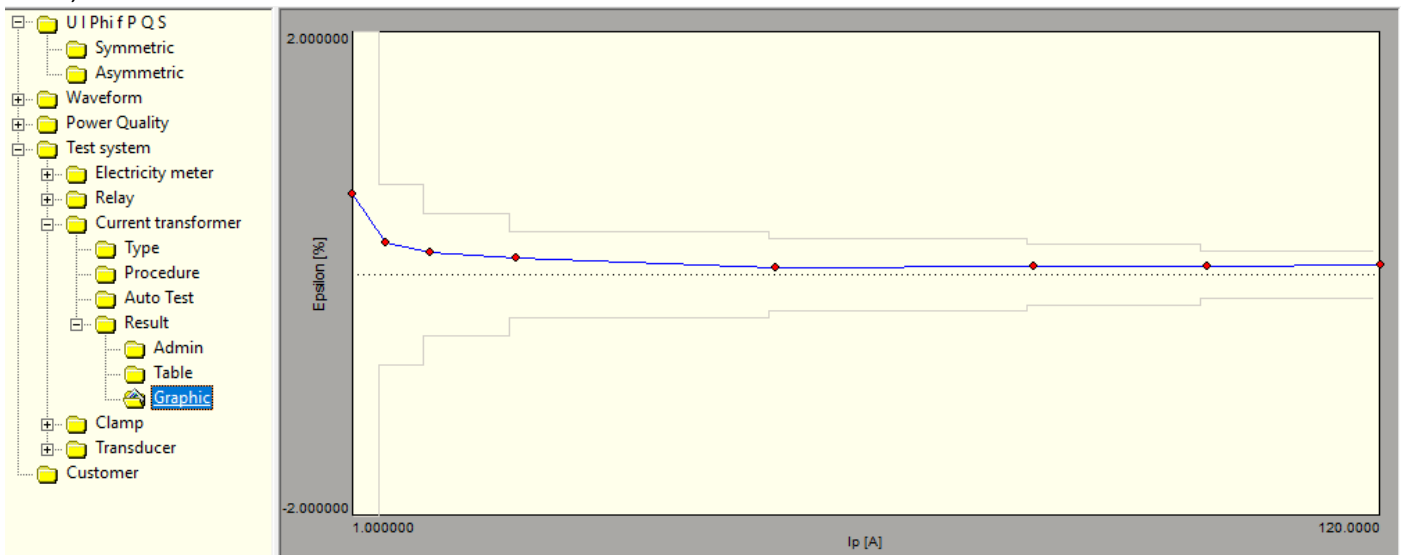
No	Is [A]	ε [%]	φ [°]
1	5.99510	0.082	-0.084
2	5.99506	0.082	-0.083
3	5.99503	0.083	-0.083
4	5.99502	0.083	-0.083
5	5.99503	0.083	-0.082

\bar{I}_s [A]	5.99505
\bar{I}_p / I_s	20.017
$\bar{\varepsilon}$ [%]	0.083
ε_s [%]	0.001
$\varepsilon_{ I=I_p}$	0.200
$\bar{\varphi}$ [°]	-0.083
φ_{ε} [°]	0.001

The set of results consists of measured ratio error in [%] in green when it is in limits or red when it is out of limits, plus the phase displacement error in [°] in green when it is in limits or red when it is out of limits.

No	Date	Time	I _p [A]	f [Hz]	I _s [A]	I _s (I _p) [A]	I _p /I _s	Coil	Limit [%]	ε [%]	ε _s [%]	φ _{lim} [°]	φ [°]	OK
1	2024-03-05	09:13:22	1.00000	50.000	0.049670	0.050000	20.133	No	2.000	0.661	0.000	1.000	-0.563	✓
2	2024-03-05	09:13:48	5.00000	50.000	0.249335	0.250000	20.053	No	0.750	0.266	0.000	0.500	-0.260	✓
3	2024-03-05	09:14:15	10.0000	50.000	0.499056	0.500000	20.038	No	0.500	0.189	0.000	0.300	-0.199	✓
4	2024-03-05	09:14:42	20.0000	50.000	0.99866	1.00000	20.027	No	0.350	0.134	0.000	0.250	-0.145	✓
5	2024-03-05	09:15:09	50.0000	50.000	2.49864	2.50000	20.011	No	0.300	0.054	0.000	0.200	-0.112	✓
6	2024-03-05	09:15:35	80.0000	50.000	3.99716	4.00000	20.014	No	0.250	0.071	0.000	0.200	-0.068	✓
7	2024-03-05	09:16:02	100.000	50.000	4.99653	5.00000	20.014	No	0.200	0.069	0.000	0.170	-0.073	✓
8	2024-03-05	09:16:29	120.000	50.000	5.99505	6.00000	20.017	No	0.200	0.083	0.001	0.170	-0.083	✓

The result can be also presented in form of diagram with value of current in X axis and value of ratio error in Y axis,



In this way we get an automatic classification of whether the CT is in class (all results are green) or out of class (even one result is red). We also know for which current value we are out of class. Finally, the results can be printed in the form of a test report.

CALMET Automatic Measuring Center
 Customer info: Name: Calmet, Address: 01-011 Warsaw, Poland, Contact: info@calmet.com.pl
 Date info: Name: Calmet, Address: 01-011 Warsaw, Poland, Contact: info@calmet.com.pl
 Current transformer info: Transformer name: CT1000A, Serial number: 01-011, Year: 2024, Weight: 20.000g
 Test results table (Table 1):

No	Date	Time	I _p [A]	f [Hz]	I _s [A]	I _s (I _p) [A]	I _p /I _s	Coil	Limit [%]	ε [%]	ε _s [%]	φ _{lim} [°]	φ [°]	OK
1	2024-03-05	09:13:22	1.0000	50.000	0.049670	0.050000	20.133	No	2.000	0.661	0.000	1.000	-0.563	✓
2	2024-03-05	09:13:48	5.0000	50.000	0.249335	0.250000	20.053	No	0.750	0.266	0.000	0.500	-0.260	✓
3	2024-03-05	09:14:15	10.0000	50.000	0.499056	0.500000	20.038	No	0.500	0.189	0.000	0.300	-0.199	✓
4	2024-03-05	09:14:42	20.0000	50.000	0.99866	1.00000	20.027	No	0.350	0.134	0.000	0.250	-0.145	✓
5	2024-03-05	09:15:09	50.0000	50.000	2.49864	2.50000	20.011	No	0.300	0.054	0.000	0.200	-0.112	✓
6	2024-03-05	09:15:35	80.0000	50.000	3.99716	4.00000	20.014	No	0.250	0.071	0.000	0.200	-0.068	✓
7	2024-03-05	09:16:02	100.000	50.000	4.99653	5.00000	20.014	No	0.200	0.069	0.000	0.170	-0.073	✓
8	2024-03-05	09:16:29	120.000	50.000	5.99505	6.00000	20.017	No	0.200	0.083	0.001	0.170	-0.083	✓

Page 1/2

Test results table (Table 2):

Page 2/2