



70570064-HVL

06-1071

2006-04-21

Test on CT Analyzer for OMICRON, Austria.

TEST REPORT

Report no. 70570064-HVL 06-1071
Client OMICRON electronics GmbH,
Klaus, Austria

Reference

Concerning test
Date April and October 2005
Place High-Voltage Laboratory of KEMA
Nederland B.V., Arnhem, the Netherlands
Object CT Analyzer
Type BB 174 U
Manufacturer OMICRON

REQUIREMENTS

The requirements as specified in the following standards:

- IEC 60044-1 (1996) + amendment 1 (2000) + amendment 2 (2002)
- IEC 60044-6 (2002)
- ANSI C57.13 (1993)

TEST PROGRAMME

The programme was specified by the client and was as follows:

- 1 Verification checks of the analyzer test function for determination of winding resistance
- 2 Verification checks of the analyzer test function for the determination of current transformer transformation errors
- 3 Verification checks of the analyzer test function for the determination of magnetization curves of current transformers
- 4 Verification checks of the some additional analyzer test functions

SUMMARY AND CONCLUSION

The results obtained relate only to the work ordered and to the material tested.
For the summary and conclusion, reference is made to page 4 of this report.

Author R.C.A.M. Koevoets

KEMA Nederland B.V.

A blue ink signature, likely of P.G.A. Bus, consisting of a large, stylized capital 'B' with a horizontal line extending to the right.

This report consists of:
24 pages
4 appendixes

P.G.A. Bus
KEMA T&D Testing Services
Managing Director

Arnhem, 21 April 2006

MATERIAL DATA

Test were carried out on the apparatus as under:

CT Analyser

Manufacturer	OMICRON, Klaus, Austria
Serial No.	BB 174 U
Option	not applicable
Input	110-240 V/50/60 Hz/6A
Output	1 x 130 V/5 A/350 VA
Sampling procedure	by the Manufacturer

For the purpose of the tests the following current transformers were utilized:

CT OMICRON 1: KSO1811

- Manufacturer: Ritz
- CT 2000/5A and 2000/1A
- Class 0,02% at 2,5 VA, Class 0,1% at 15 VA
- Core Type: Non gapped, measurement CT
- Omicron Ser. No.: 05 – 305
- Ser. No.: 05/596717

CT OMICRON 2: KSO1812

- Manufacturer: Ritz
- CT 1000/1A
- Class 0,2% at 1 VA
- Core Type: Non gapped, measurement CT
- Omicron Ser. No.: 02 – 195
- Ser. No.: 05/560150

CT OMICRON 3: Special class TPY

- Manufacturer: Koncar (Zagreb)
- CT 1000/1A
- Class TPY at $R_b = 1,5 \text{ Ohm}$
- Core Type: gapped, protection CT
- Omicron Ser. No.: 05 – 319

CT OMICRON 4: Special class TPZ

- Manufacturer: Pfiffner (CH)
- CT 1200/1A
- Class TPZ
- Core Type: gapped, protection CT
- Ser. No.: Omicron 05 - 313

CT OMICRON 5: KSO1811

- Manufacturer: Ritz
- CT 2000/5A and 2000/1A
- Class 0,02% at 2,5 VA
- Core Type: Non gapped, measurement CT
- Ser. No.: 03/582927

CT KEMA 01:

- Manufacturer: Ritz
- NTRO 320, CT 5000/5 or CT 10000/5
- Class 0,01% at 10 VA
- Core Type: Non gapped, measurement CT
- KEMA HSL No 12.09 ORS 075392
- Ser. No.: 83/440308

CT KEMA 02:

- Manufacturer: Ritz
- NTTS
- Class 0,01% at 1 VA
- Core Type: Non gapped, measurement CT
- KEMA HSL No 12.07
- Ser. No.: 540 627

PERSONS ATTENDING THE TEST

Mr F. Süß

OMICRON, Hardware Development

THE TEST WAS CARRIED OUT BY

Mr R.C.A.M. Koevoets

KEMA Nederland B.V.

Mr J. Mijnen

KEMA Nederland B.V.

PURPOSE OF THE TEST

Purpose of the test was to verify whether the material complies with the specified requirements.

SUMMARY AND CONCLUSION

SUMMARY

- General

The functional operation and applicability of the OMICRON CT ANALYZER for testing of current transformers was verified by checks during determination of main characteristics of several current transformers. The OMICRON CT ANALYZER was under operation and control by the manufacturer, under supervision of KEMA. The results are valid only for the checks carried out together with the selected testing modes and should not be treated as results of type tests, routine tests, acceptance tests, or similar.

- Verification checks of the analyzer test function for determination of winding resistance

The functional operation during determination of winding resistance using the OMICRON CT ANALYZER did not give rise to remarks.

The numerical evaluation, during measuring of KEMA shunt resistor resistance values, showed differences of 0,1% or less, when compared with the calibration certificate values of the shunts.

- Verification checks of the analyzer test function for the determination of current transformer transformation errors

The functional operation during determination of current transformation errors using the OMICRON CT ANALYZER did not give rise to remarks. Tests were carried out in both selection modes, respectively for measurement CT's with non-gapped cores and for protection CT's with gapped cores.

- Verification checks of the analyzer test function for the determination of magnetization curves of current transformers

The functional operation during determination of current transformation magnetization curves using the OMICRON CT ANALYZER did not give rise to remarks.

- Verification checks of the some additional analyzer test functions

Since, as a result of the automatic and integrated operation of the OMICRON CT ANALYZER, several additional test functions came into operation during the checks and verifications performed, these functions resulted in output parameter values such as for FS, Ts, knee-point data, etc. In particular the determination of the knee-point data was verified. The results do not give rise to remarks.

CONCLUSION

From the tests, verifications and measurements it has become obvious that the OMICRON CT-ANALYZER does a very accurate current ratio measurement on continuous ring cores (non gapped) (better than 0.02%/0.5min) and an adequate accurate current ratio measurement on gapped cores (TPY better than 0,2%/3min; TPZ better than 1%/5min).

Furthermore, the OMICRON CT-ANALYZER is able to determine in a fast and accurate way the magnetization curves and the related parameters.

DESCRIPTION AND RESULTS OF THE TEST

MEASUREMENT UNCERTAINTY

The last page of this report contains a table with measurement uncertainties. Unless otherwise indicated in the report, the measurement uncertainties of the results presented are as indicated in this table.

INTRODUCTION

The applicability and output results of the OMICRON CT ANALYZER with its functions for testing of current transformers were compared with requirements and results of testing on the same current transformers however using other test equipment, that is applied normally by KEMA for the tests to be carried out on current transformers.

Based on the results of the comparison, conclusions may be drawn as to the applicability of the OMICRON CT ANALYZER for the tests on current transformers.

Although the OMICRON CT ANALYZER has capabilities for many other testing functions, the tests and checks, described in this report are related to the functions given in the test program only.

The testing activities (tests, checks, comparison and or verifications) cannot be considered as type tests or routine tests or acceptance tests or calibration tests. The results may serve as an important impression as to the applicability of several functions and results of the OMICRON CT ANALYZER for testing of current transformers.

1 VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF WINDING RESISTANCE

First in April 2005 and in October 2005 several checks were carried out in order to verify whether the OMICRON CT ANALYZER was able to perform its function: determination of winding resistance.

For the purpose of this verification some resistance values were determined in two ways: using the OMICRON CT ANALYZER and using a KEMA laboratory instrument.

Initially this verification was performed in a functional way on several current transformers, during resistance measurements of windings of some available current transformers. The results were compared with results obtained using other instruments at KEMA. It was not the intention to carry out accurate tests. The results of these checks are presented in appendix 1 page 1 of this report. From the results it was concluded that the OMICRON CT ANALYZER did not cause any functional problem during the checks.

Subsequently, in order to gather more information as to the accuracy of the measurements, this verification was performed on two standard resistors, used as standard shunt in the KEMA laboratory. Since the calibration results of these shunts are available, a better check of this function of the OMICRON CT ANALYZER could be made. For this purpose the (known) resistance values of these shunts were determined using the OMICRON CT ANALYZER.

The results are presented in appendix 1 page 2 of this report.

From the results it can be concluded that the deviation between the results of the tests carried out using the analyzer and those carried out using other instruments is small. Although the checks are not systematically covering the full range of the possibilities of the analyzer for the determination of winding resistance, it can be concluded that the results that were produced by the OMICRON CT ANALYZER were correct and precise for those resistance values that were determined.

2 VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR THE DETERMINATION OF CURRENT TRANSFORMER TRANSFORMATION ERRORS

First in April 2005 and in October 2005 several checks were carried out in order to verify whether the OMICRON CT ANALYZER was able to perform its function: determination of current transformer transformation errors.

For this purpose accuracy tests were carried out in two ways: using the OMICRON CT ANALYZER and using a KEMA laboratory accuracy measuring bridge. The accuracy tests were carried out on several current transformers of various design and ratings. For the presentation and results four examples were selected from the many tests carried out.

The transformation errors of four current transformers were measured using 1) the KEMA transformation error measuring bridge and 2) the OMICRON CT ANALYZER.

The transformation errors of the current transformers generally were determined at 50 Hz.

2.1 Determination of transformation errors for measuring purposes on CT OMICRON 05

The current error (%) and the phase displacement (min) were determined at rated current (2000 A) and respectively with burdens of 2,5 VA, $\cos(\beta) = 1,0$ and of 1,25 VA, $\cos(\beta) = 1,0$. In this case the measurements were carried out at both 50 Hz and 60 Hz.

2.2 Determination of transformation errors for measuring purposes on CT OMICRON 01

The current error (%) and the phase displacement (min) were determined at rated current (2000 A) and respectively with burdens of 2,58 VA, $\cos(\beta) = 1$ and of 15,25 VA, $\cos(\beta) = 0,8$ (15 VA is rated burden). The measurements were carried out at 50 Hz.

2.3 Determination of transformation errors for measuring purposes on CT OMICRON 02

The current error (%) and the phase displacement (min) were determined at rated current (1000 A) and respectively with burdens of 1,29 VA, $\cos(\beta) = 1$ and of 14,9 VA, $\cos(\beta) = 0,8$ (1 VA is rated burden). The measurements were carried out at 50 Hz.

2.4 Determination of transformation errors for measuring purposes on CT OMICRON 03 (with air gap)

The current error (%) and the phase displacement (min) were determined at rated current (1000 A) and respectively with burdens of 1,28 VA, $\cos(\beta) = 1$ and of 14,8 VA, $\cos(\beta) = 0,8$ (1,5 VA is rated burden). The measurements were carried out at 50 Hz.

2.5 Determination of transformation errors for measuring purposes on CT OMICRON 04 (with air gap)

The current error (%) and the phase displacement (min) were determined at rated current (1200 A) and respectively with burdens of 5,16 VA, $\cos(\beta) = 0,8$ and of 7,50 VA, $\cos(\beta) = 0,8$ and of 9,86 VA, $\cos(\beta) = 0,8$ (5 VA is rated burden). The measurements were carried out at 50 Hz.

The results are presented in appendix 2 pages 1, 2 and 3 of this report.

From the results the following conclusions were drawn:

- The results of the determination of transformation errors, as carried out, on the current transformers and for the values of current and burden as indicated in this report, and measured using the OMICRON CT ANALYZER, do not differ significantly from those determined by the KEMA measuring bridge and instrumentation.
- Further reference is given in the appendixes A, B, C, D.

3 VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR THE DETERMINATION OF CURRENT TRANSFORMER EXCITATION CURVES

In October 2005 several checks were carried out in order to verify whether the OMICRON CT ANALYZER was able to perform its function: determination of current transformer excitation curves.

For this purpose curves measuring tests were carried out in two ways: using the OMICRON CT ANALYZER and using a KEMA laboratory instruments. The measurements were carried out on several current transformers of various design and ratings. For the presentation and results four examples were selected from the many tests carried out.

The excitation curves of four current transformers were measured using 1) the KEMA laboratory instruments and 2) the OMICRON CT ANALYZER.

The excitation curves of the current transformers were determined at the rated frequency 50 Hz.

The results are presented in appendix 3 pages 1-8 of this report.

It has to be noted that the accuracy of the measurements by KEMA may have been affected by noise coming from neighboring tests. This, together with the nature of the selected instrumentation for measurement of voltage and current may have resulted in a higher level of uncertainty than normal.

It has to be noted too that the values in the tables, for the excitation current were taken at the voltage levels selected by KEMA. From the OMICRON CT ANALYZER the excitation currents at these voltage levels could be taken only after interpolation between other voltage levels, as selected by the OMICRON CT ANALYZER, within the appropriate range.

From the results the following conclusions were drawn:

- The results of the determination of excitation curves, as carried out, on the current transformers and for the values of voltage as indicated in this report, and measured using the OMICRON CT ANALYZER, do not differ significantly from those determined by the KEMA measuring instruments.
- Some differences, in individual numbers of current and voltage, in several cases, are mostly related to saturation effects that are visible in the curves and do not affect the overall curve and still allow the correct derivation of further quantities from these curves.
- Further reference is given in the appendixes A, B, C, D.

4 VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR THE DETERMINATION OF SOME ADDITIONAL ANALYZER TEST FUNCTIONS

In April and in October 2005 several checks were carried out in order to verify whether the OMICRON CT ANALYZER was able to perform other test functions, additional to those mentioned in paragraphs 1, 2 and 3 of this report.

Since, as a result of the automatic and integrated operation of the OMICRON CT ANALYZER, several additional test functions came into operation during the checks and verifications performed, these functions resulted in output parameter values such as for F_s , T_s , knee-point data, etc.

The presentation of the results by the OMICRON CT ANALYZER seems trustworthy; however not all results were verified or checked by KEMA.

Since the magnetization curves had been determined for several current transformers, by KEMA and by the OMICRON CT ANALYZER as well, a comparison could be made for the resulting knee-point data.

The results are presented in appendix 4 page 1.

It has to be noted that the accuracy of the measurements by KEMA may have been affected by noise coming from neighboring tests. This, together with the nature of the selected instrumentation for measurement of voltage and current may have resulted in a higher level of uncertainty than normal.

Nevertheless, from the results can be concluded:

- that the knee-point data, determined by the OMICRON CT-ANALYZER, are quite similar to or better than those following from the measurements carried out by KEMA
- Further reference is given in the appendixes A, B, C, D.

Client OMICRON, Klaus, Austria
 Test object CT Analyzer, manufactured by the client
 Requirements Functional impression only
 Test date 27 October 2005

1 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF WINDING RESISTANCE

Atmospheric conditions

Ambient temperature 20 °C Ambient air pressure 1018 hPa
 Object temperature 20 °C Humidity 14 g/m³

object tested	resistance measured using KEMA-laboratory ohm-meter (Ω)	resistance measured using OMICRON CT-ANALYZER (Ω)	deviation (%)	notes
CT OMICRON 01 winding 2000/1	8,90	8,847	-0,6	These values were measured in order to have an initial functional check only.
CT OMICRON 01 winding 2000/5	0,428	0,423	-1,2	
CT OMICRON 02 winding 1000/1	3,68	3,636	-1,2	
CT OMICRON 03 winding 1000/1	2,72	2,681	-1,4	
CT OMICRON 04 winding 1200/1	2,12	2,083	-1,7	
CT OMICRON 05 winding 2000/1	10,17	10,16	-0,1	No functional problems occurred during the functional determination of winding resistance values.
CT KEMA 01 winding 5000/5	1,30	1,281	- 1,46	
CT KEMA 01 winding 10000/5	2,81	2,767	- 1,53	
CT KEMA 02 winding 5000/5	1,96	1,969	+ 0,46	
CT KEMA 02 winding 10000/5	4,75	4,726	- 0,50	

Client OMICRON, Klaus, Austria
 Test object CT Analyzer, manufactured by the client
 Requirements Precise resistance measurement
 Test date 29 October 2005

1 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF WINDING RESISTANCE (continued)

Atmospheric conditions

Ambient temperature 20 °C Ambient air pressure 1015 hPa
 Object temperature 20 °C Humidity 14 g/m³

object tested	resistance measured as per KEMA-calibration certificate (mΩ)	resistance * measured using OMICRON CT- ANALYZER (mΩ)	deviation (%)	notes
KEMA shunt ORS 105412	10,00048	10,01	0,1	see below
KEMA shunt ORS 105398	99,9974	100,0	< 0,1	

* These values represent the average values of ten individual measurements. All ten individual results were equal to the average.

Client OMICRON, Klaus, Austria
 Test object CT Analyzer, manufactured by the client
 Requirements IEC 60044-1(1996) + amendment 1(2000) + amendment 2(2002)
 Test date 5 April 2005

2 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF CURRENT TRANSFORMER TRANSFORMATION ERRORS

Atmospheric conditions

Ambient temperature 20 °C Ambient air pressure 1014 hPa
 Object temperature 20 °C Humidity 12 g/m³

2.1 Transformation errors for measuring purposes on CT OMICRON 05 at 50 Hz

CT OMICRON 05 ratio 2000/1 at 2000 A		measured with KEMA measuring bridge		measured with OMICRON CT ANALYZER	
burden		ratio error	phase displacement	ratio error	phase displacement
(VA)	COS(β)	(%)	(min)	(%)	(min)
2,5	1,0	- 0,015	+ 0,5	- 0,004	+ 0,3
1,25	1,0	- 0,015	+ 0,5	- 0,003	+ 0,2

2.2 Transformation errors for measuring purposes on CT OMICRON 05 at 60 Hz

CT OMICRON 05 ratio 2000/1 at 2000 A		measured with KEMA measuring bridge		measured with OMICRON CT ANALYZER	
burden		ratio error	phase displacement	ratio error	phase displacement
(VA)	COS(β)	(%)	(min)	(%)	(min)
2,5	1,0	- 0,015	+ 0,5	- 0,002	+ 0,2
1,25	1,0	- 0,015	+ 0,5	- 0,001	+ 0,2

Client OMICRON, Klaus, Austria
 Test object CT Analyzer, manufactured by the client
 Requirements IEC 60044-1(1996) + amendment 1(2000) + amendment 2(2002)
 Test date 27 October 2005

2 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF CURRENT TRANSFORMER TRANSFORMATION ERRORS (Continued)

Atmospheric conditions

Ambient temperature 20 °C Ambient air pressure 1018 hPa
 Object temperature 20 °C Humidity 14 g/m³

2.3 Transformation errors for measuring purposes on CT OMICRON 01 at 50 Hz

CT OMICRON 01 ratio 2000/1 at 2000 A		measured with KEMA measuring bridge		measured with OMICRON CT ANALYZER	
burden		ratio error	phase displacement	ratio error	phase displacement
(VA)	COS(β)	(%)	(min)	(%)	(min)
15,25	0,8	- 0,024	+ 0,1	- 0,022	+ 0,05
2,58	1,0	- 0,01	+ 0,3	- 0,01	+ 0,27

2.4 Transformation errors for measuring purposes on CT OMICRON 02 at 50 Hz

CT OMICRON 01 ratio 1000/1 at 1000 A		measured with KEMA measuring bridge		measured with OMICRON CT ANALYZER	
burden		ratio error	phase displacement	ratio error	phase displacement
(VA)	COS(β)	(%)	(min)	(%)	(min)
14,9	0,8	- 0,07	+ 0,4	- 0,05	+ 0,17
1,29	1,0	- 0,02	+ 0,9	- 0,017	+ 0,53

Client OMICRON, Klaus, Austria
 Test object CT Analyzer, manufactured by the client
 Requirements IEC 60044-1(1996) + amendment 1(2000) + amendment 2(2002)
 Test date 27 October 2005

2 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF CURRENT TRANSFORMER TRANSFORMATION ERRORS (continued)

Atmospheric conditions

Ambient temperature 20 °C Ambient air pressure 1018 hPa
 Object temperature 20 °C Humidity 14 g/m³

2.5 Transformation errors for measuring purposes on CT OMICRON 03 at 50 Hz

CT OMICRON 01 ratio 1000/1 at 1000 A		measured with KEMA measuring bridge		measured with OMICRON CT ANALYZER	
burden		ratio error	phase displacement	ratio error	phase displacement
(VA)	COS(β)	(%)	(min)	(%)	(min)
14,75	0,8	- 0,97	+ 58,6	- 1,060	+ 57,58
1,28	1,0	+ 0,16	+ 16,9	+ 0,030	+ 16,89

2.5 Transformation errors for measuring purposes on CT OMICRON 04 at 50 Hz

CT OMICRON 01 ratio 1200/1 at 1200 A		measured with KEMA measuring bridge		measured with OMICRON CT ANALYZER	
burden		ratio error	phase displacement	ratio error	phase displacement
(VA)	COS(β)	(%)	(min)	(%)	(min)
9,86	0,8	- 4,13	+ 218	- 3,59	+ 222
7,50	0,8	- 3,00	+ 179	+ 2,62	+ 182
5,16	0,8	- 1,94	+ 138	- 1,658	+ 142

Client OMICRON, Klaus, Austria
 Test object CT Analyzer, manufactured by the client
 Requirements IEC 60044-1(1996) + amendment 1(2000) + amendment 2(2002)
 Test date 28 October 2005

3 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF CURRENT TRANSFORMER EXCITATION CURVES

Atmospheric conditions

Ambient temperature	20 °C	Ambient air pressure	1016 hPa
Object temperature	20 °C	Humidity	13 g/m ³

3.1 Excitation curve measured on CT OMICRON 01

	measured with KEMA instruments	measured with OMICRON CT ANALYZER
voltage across terminals (V)	excitation current (A)	excitation current (A)
92,02	1,982	2,0806
85,9	1,047	1,08686
82,95	0,5432	0,58272
81,42	0,2657	0,31688
80,56	0,1082	0,16880
79,78	0,016	0,05315
(V)	(mA)	(mA)
76,9	4,31	4,41936
70,07	1,57	1,59109
60,26	0,625	0,64075
50,22	0,454	0,42985
39,89	0,368	0,33294
29,89	0,280	0,25201
20,38	0,208	0,18633
10,35	0,129	0,11375

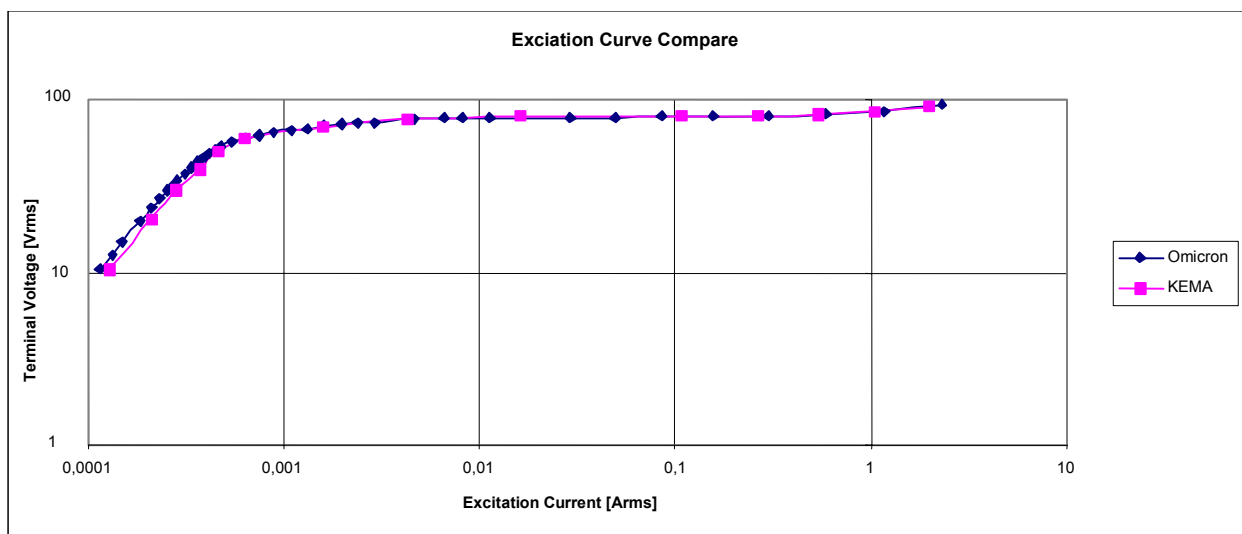
Client	OMICRON, Klaus, Austria
Test object	CT Analyzer, manufactured by the client
Requirements	IEC 60044-1 (1996) + amendment 1 (2000) + amendment 2 (2002)
Test date	28 October 2005

3 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF CURRENT TRANSFORMER EXCITATION CURVES

Atmospheric conditions

Ambient temperature	20 °C	Ambient air pressure	1016 hPa
Object temperature	20 °C	Humidity	13 g/m ³

3.1 Excitation curve measured on CT OMICRON 01



Client OMICRON, Klaus, Austria
 Test object CT Analyzer, manufactured by the client
 Requirements IEC 60044-1 (1996) + amendment 1 (2000) + amendment 2 (2002)
 Test date 28 October 2005

3 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF CURRENT TRANSFORMER EXCITATION CURVES (continued)

Atmospheric conditions

Ambient temperature	20 °C	Ambient air pressure	1016 hPa
Object temperature	20 °C	Humidity	13 g/m ³

3.2 Excitation curve measured on CT OMICRON 02

	measured with KEMA instruments	measured with OMICRON CT ANALYZER
voltage across terminals (V)	excitation current (A)	excitation current (A)
160	2,377	2,656
154	0,218	0,343
(V)	(mA)	(mA)
152,7	30,6	61,2
148,2	7,10	7,45
138,9	3,04	3,516
125,8	2,246	2,473
96,24	1,650	1,653
55,33	1,068	1,010
28,11	0,659	0,616
11,92	0,378	0,346
4,247	0,191	0,179
2,734	0,143	0,134

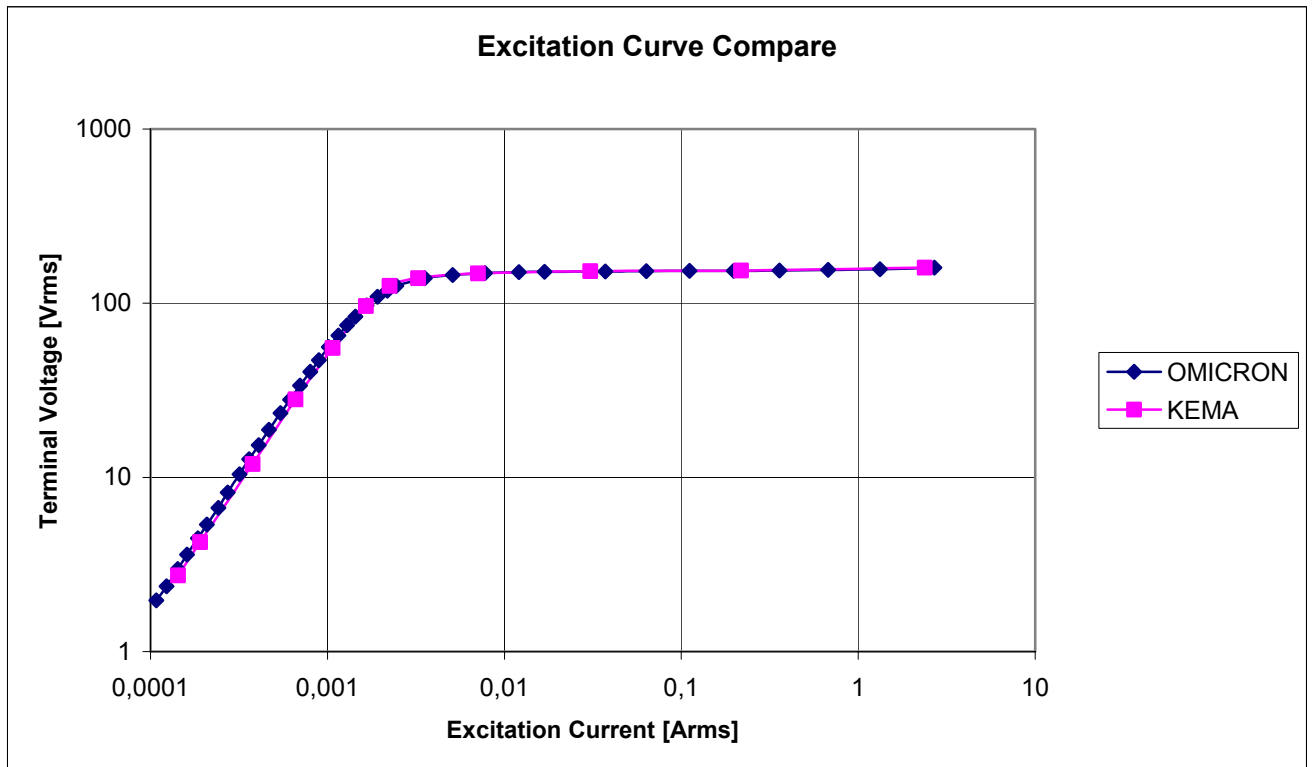
Client	OMICRON, Klaus, Austria
Test object	CT Analyzer, manufactured by the client
Requirements	IEC 60044-1 (1996) + amendment 1 (2000) + amendment 2 (2002)
Test date	28 October 2005

3 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF CURRENT TRANSFORMER EXCITATION CURVES (continued)

Atmospheric conditions

Ambient temperature	20 °C	Ambient air pressure	1016 hPa
Object temperature	20 °C	Humidity	13 g/m ³

3.2 Excitation curve measured on CT OMICRON 02



Client OMICRON, Klaus, Austria
 Test object CT Analyzer, manufactured by the client
 Requirements IEC 60044-1 (1996) + amendment 1 (2000) + amendment 2 (2002)
 Test date 28 October 2005

3 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF CURRENT TRANSFORMER EXCITATION CURVES (continued)

Atmospheric conditions

Ambient temperature	20 °C	Ambient air pressure	1016 hPa
Object temperature	20 °C	Humidity	13 g/m ³

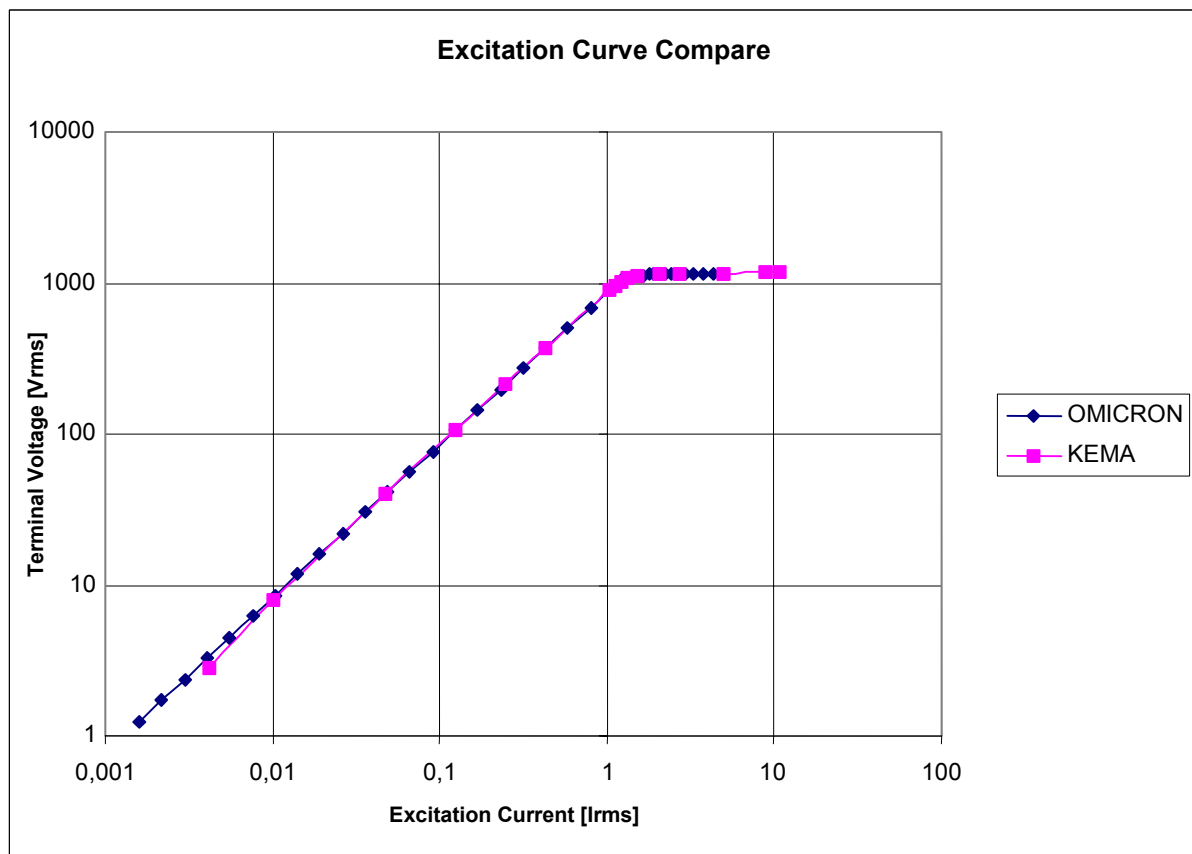
3.3 Excitation curve measured on CT OMICRON 03

	measured with KEMA instruments	measured with OMICRON CT ANALYZER
Voltage across terminals (V)	Excitation current (A)	Excitation current (A)
1149	2,739	2,526
1140	2,054	2,019
1113	1,506	1,519
1079	1,323	1,331
1027	1,210	1,215
964	1,124	1,126
886	1,028	1,031
(V)	(mA)	(mA)
368	426	426
213	248	248
105	124	124
40,0	47,8	47,5
7,98	10,0	9,67
2,82	4,20	3,51

Client	OMICRON, Klaus, Austria
Test object	CT Analyzer, manufactured by the client
Requirements	IEC 60044-1 (1996) + amendment 1 (2000) + amendment 2 (2002)
Test date	28 October 2005

3 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF CURRENT TRANSFORMER EXCITATION CURVES (continued)

3.3 Excitation curve measured on CT OMICRON 03



Client OMICRON, Klaus, Austria
 Test object CT Analyzer, manufactured by the client
 Requirements IEC 60044-1 (1996) + amendment 1 (2000) + amendment 2 (2002)
 Test date 28 October 2005

3 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF CURRENT TRANSFORMER EXCITATION CURVES (continued)

Atmospheric conditions

Ambient temperature	20 °C	Ambient air pressure	1016 hPa
Object temperature	20 °C	Humidity	13 g/m ³

3.4 Excitation curve measured on CT OMICRON 04

	measured with KEMA instrument	measured with OMICRON CT ANALYZER
Voltage across terminals (V)	Excitation current (A)	Excitation current (A)
997	6,70	6,515
713	4,80	4,810
327	2,20	2,202
169	1,13	1,14
(V)	(mA)	(mA)
55,1	374	372
13,7	89,7	89,1
2,82	19,5	19,2

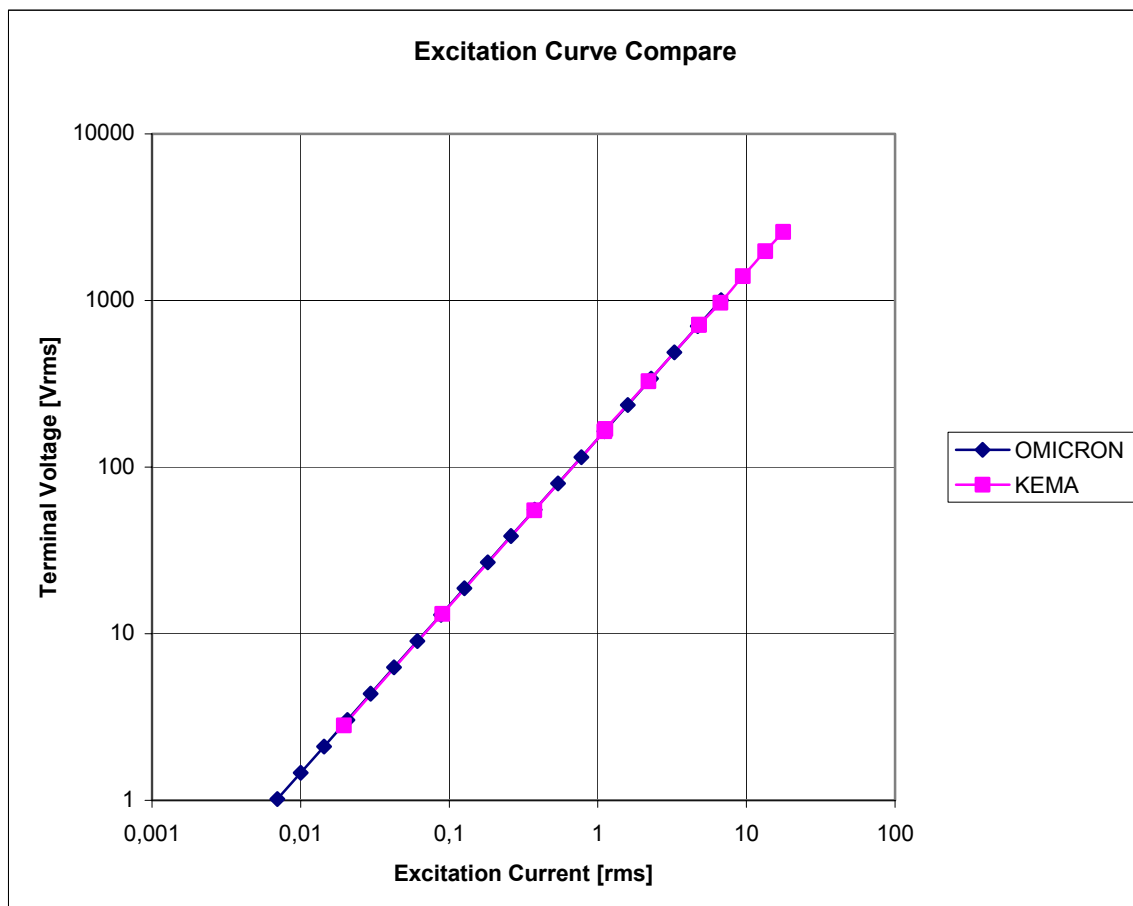
Client	OMICRON, Klaus, Austria
Test object	CT Analyzer, manufactured by the client
Requirements	IEC 60044-1 (1996) + amendment 1 (2000) + amendment 2 (2002)
Test date	28 October 2005

3 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF CURRENT TRANSFORMER EXCITATION CURVES (continued)

Atmospheric conditions

Ambient temperature	20 °C	Ambient air pressure	1016 hPa
Object temperature	20 °C	Humidity	13 g/m ³

3.4 Excitation curve measured on CT OMICRON 04



The measurement uncertainties in the results presented are as specified below unless otherwise indicated.

measurement	measurement uncertainty
dielectric tests and impulse current tests	peak value: $\leq 3\%$ time parameters: $\leq 10\%$
capacitance measurement	0,3%
$\tan \delta$ measurement	$\pm 0,5\% \pm 5 \times 10^{-5}$
partial discharge measurement	$< 10 \text{ pC} : 2 \text{ pC}$ $10 - 100 \text{ pC} : 5 \text{ pC}$ $> 100 \text{ pC} : 20 \%$
measurement of impedance ac-resistance measurement	$\leq 1\%$
measurement of losses	$\leq 1\%$
measurement of insulation resistance	$\leq 10\%$
measurement of dc resistance	$1 \mu\Omega - 5 \mu\Omega : 1\%$ $5 \mu\Omega - 10 \mu\Omega : 0,5\%$ $10 \mu\Omega - 200 \mu\Omega : 0,2\%$
radio interference test	2 dB
calibration of current transformers	$2,2 \times 10^{-4} \text{ li/lu}$ and $290 \mu\text{rad}$
calibration of voltage transformers	$1,6 \times 10^{-4} \text{ Ui/Uu}$ en $510 \mu\text{rad}$
measurement of conductivity	5%
measurement of temperature	$-50^\circ\text{C} - -40^\circ\text{C} : 3 \text{ K}$ $-40^\circ\text{C} - 125^\circ\text{C} : 2 \text{ K}$ $125^\circ\text{C} - 150^\circ\text{C} : 3 \text{ K}$
tensile test	1%
sound level measurement	type 1 meter as per IEC 651 and ANSI S1.4.1971
measurement of voltage ratio	0,1%

Client OMICRON, Klaus, Austria
 Test object CT Analyzer, manufactured by the client
 Requirements IEC 60044-1 (1996) + amendment 1 (2000) + amendment 2 (2002)
 Test date 28 October 2005

4 RESULTS OF THE VERIFICATION CHECKS OF THE ANALYZER TEST FUNCTION FOR DETERMINATION OF KNEE-POINT DATA

Atmospheric conditions

Ambient temperature 20 °C Ambient air pressure 1016 hPa
 Object temperature 20 °C Humidity 13 g/m³

CT	knee point found by OMICRON CT-ANALYZER	knee point found by KEMA measurement	result
OMICRON 1 KSO1811	59,26V / 574µA	between 50V-60V between 454µA – 625µA	the knee-point found by the OMICRON CT-ANALYZER is between the values found by KEMA measurement
OMICRON 2 KSO1812	128,81V / 2,68mA	between 125,8V – 138,9V between 2,25mA – 3,25mA	the knee-point found by the OMICRON CT-ANALYZER is between the values found by KEMA measurement
OMICRON 3 TPY	1031,5V / 1,222A	between 1079V – 1113V between 1,323A – 1,506A	the knee-point found by the OMICRON CT-ANALYZER is close to the values found by KEMA measurement
OMICRON 4 TPZ	not reached	not reached	The OMICRON CT-ANALYZER correctly found that the knee-point criteria were not met

APPENDIX A

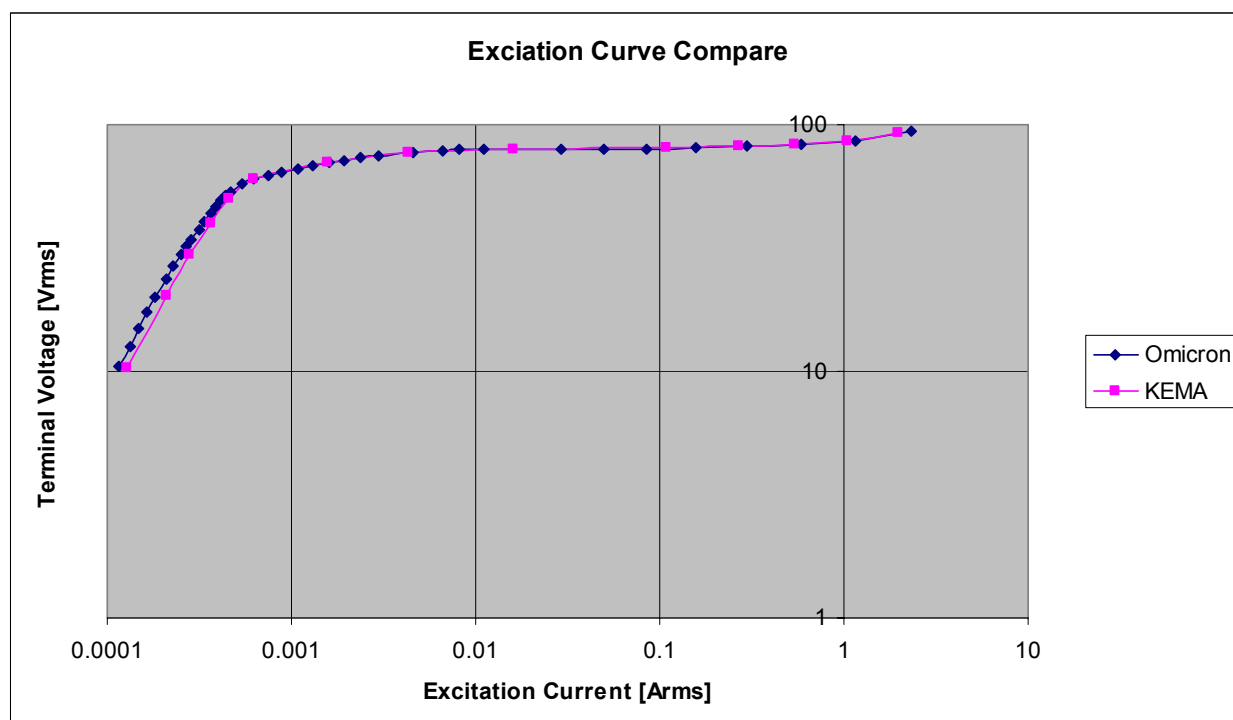
FURTHER ASSESMENT INFORMATION AS PRESENTED BY THE MANUFACTURER

(4 pages)

Tested CT (Current Transformer): **CT OMICRON 1** (see Material Data)

Excitation Curve Comparison between measurement from Omicron and KEMA

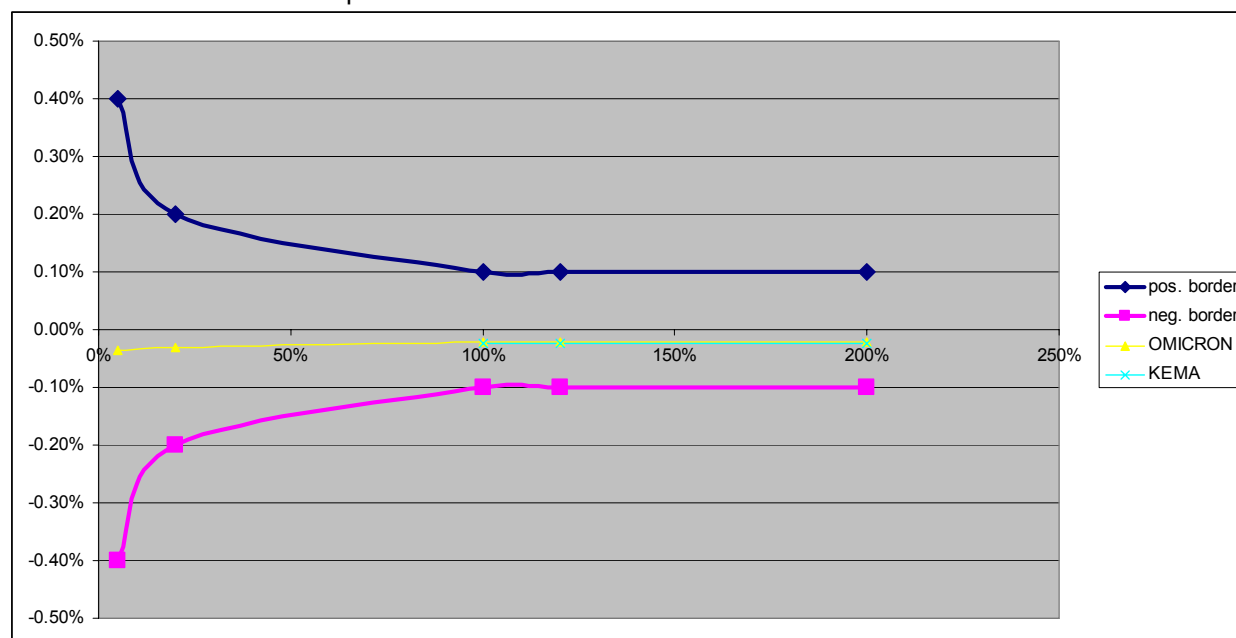
The graph below shows the excitation curve taken with KEMA equipment (pink) and the OMICRON CT Analyzer.



Comparison of Current Errors in IEC Borders

The graph below shows the difference of the current error calculated from the excitation graph between the excitation measurement from KEMA and the excitation measurement with OMICRON CT-Analyzer.

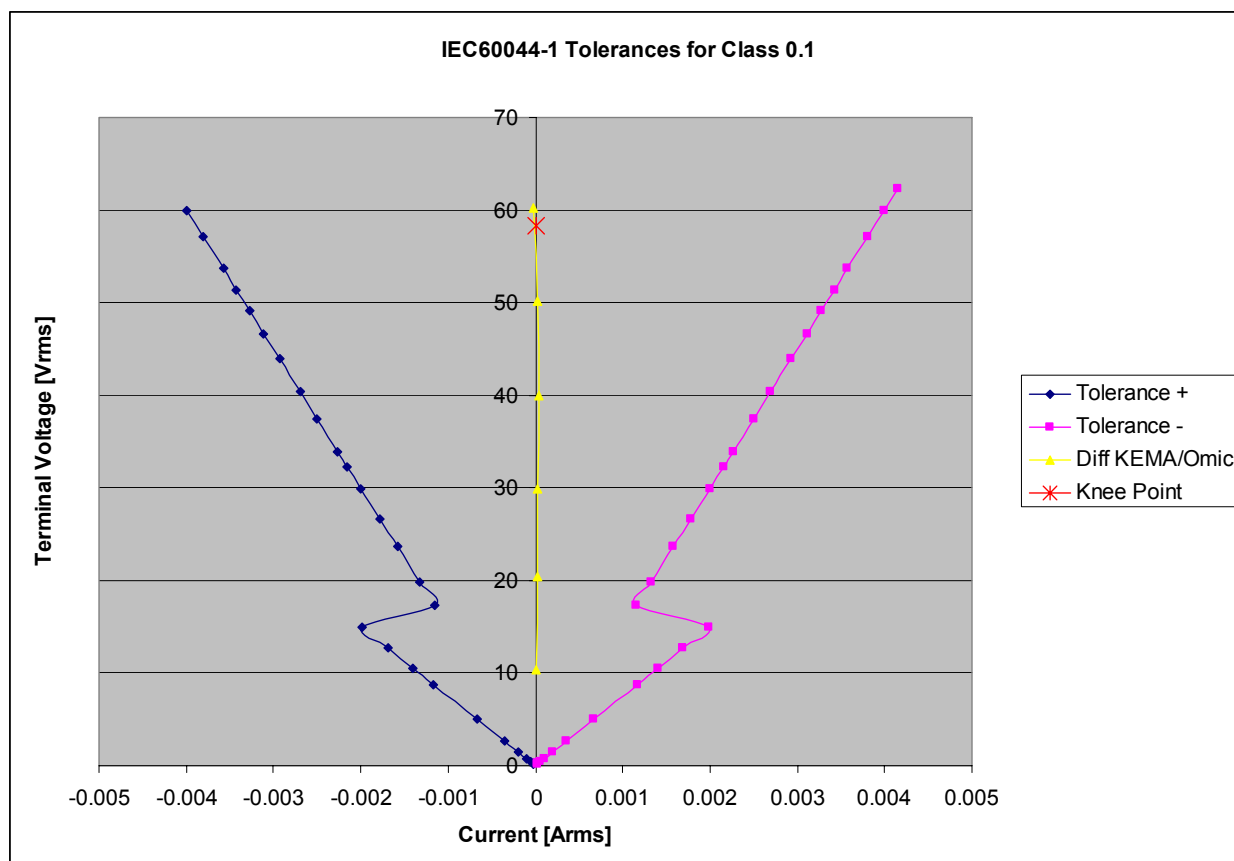
The used burden was 15VA, $I_{nom} = 1A$. This graph shall show the influence of the measurement error of the excitation measurement and not the absolute error. It can be seen that a small error in the excitation measurement has practical no influence to the absolute error.



Comparison of Current deviation up to Knee Point:

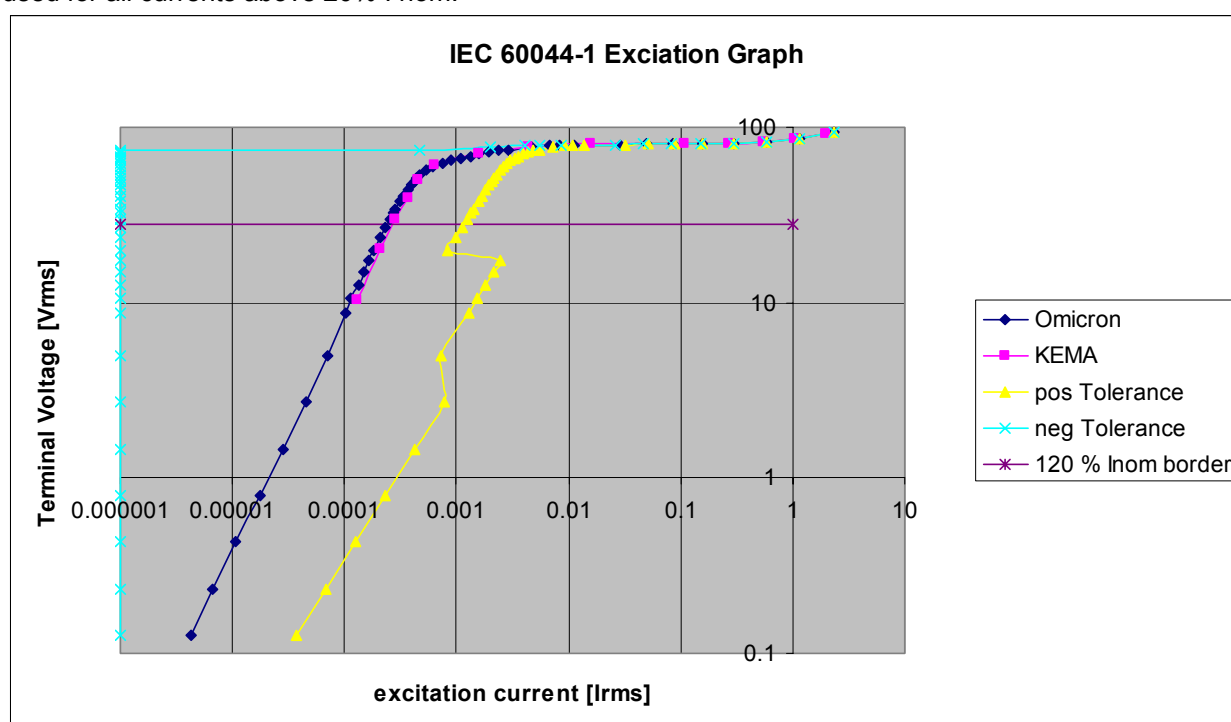
The graph below shows the maximum current tolerance to keep the current error within 0,1% and shows the deviation (not absolute values) of current between the measurement with KEMA equipment and the OMICRON CT-Analyzer.

The graphs are only shown up to the knee point. Above the knee point the deviation between the two curves can no more be calculated properly because of the steep current rise. In this area a small deviation in voltage would result in a large current deviation.



Excitation Curves and Maximum Tolerance Curves

The graph below shows the positive tolerance border (yellow) and the negative tolerance border for IEC 60044-1 as also the two measured excitation curves. The logarithmic scale does not allow the negative tolerance border properly therefore the negative value was limited to $1\mu\text{A}$. The IEC60044-1 has defined the tolerances only up to 120% of nominal current in this graph the 0.1% tolerance was used for all currents above 20% I_{nom} .



APPENDIX B

FURTHER ASSESMENT INFORMATION AS PRESENTED BY THE MANUFACTURER

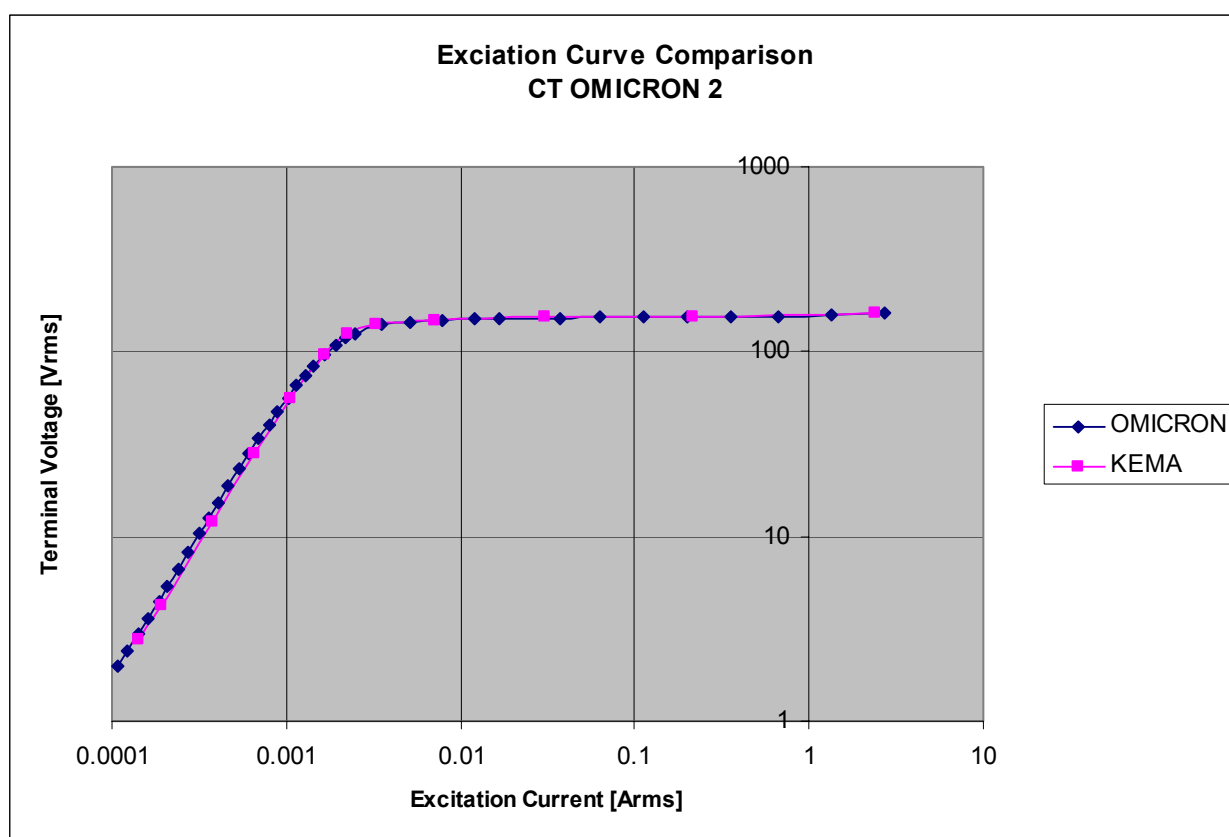
(4 pages)

Tested CT (Current Transformer): **CT OMICRON 2** (see Material Data)

Excitation Curve - Comparison between Measurement by Omicron and KEMA

Tested CT (Current Transformer):

Name: CT OMICRON 2 (see Material Data)
Type: Measurement core with continuous ring core
Class: 0.02%
Burden: 14.9VA/CosPhi 0.8



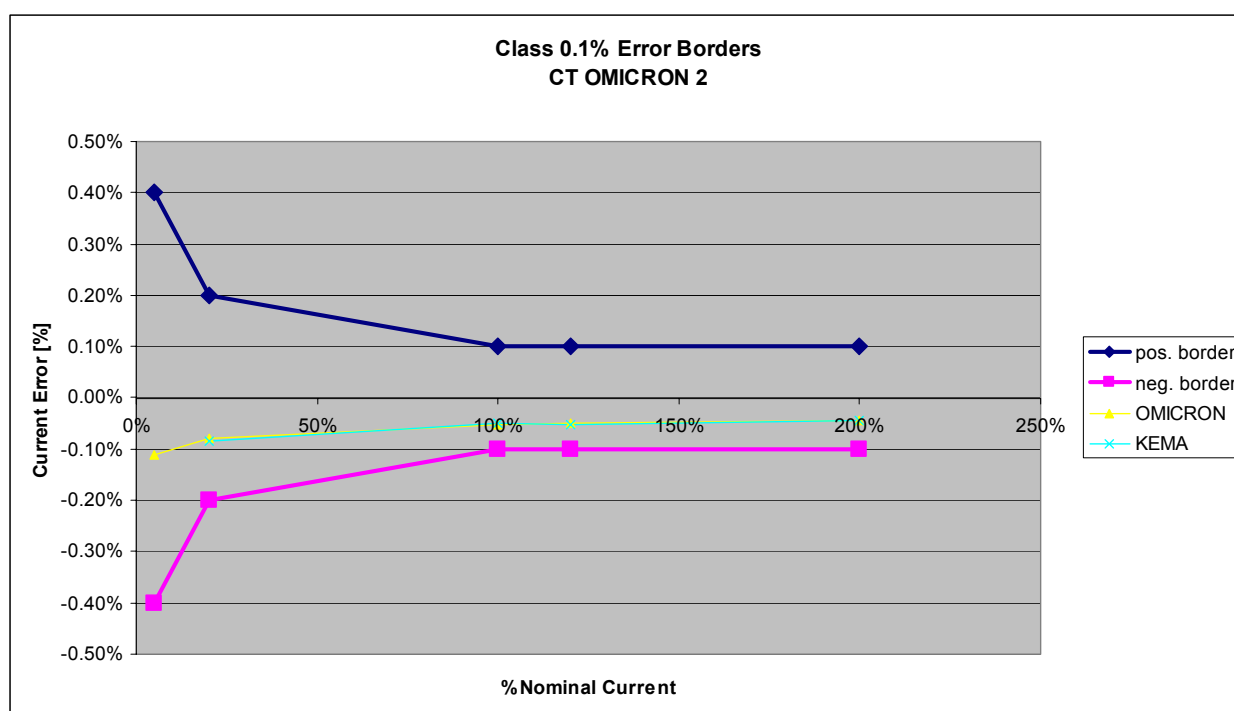
Blue line: Measurement with Omicron CT-Analyzer.

Pink line: Measurement with KEMA equipment.

Comparison of Current Errors in Tolerance Borders acc. to IEC 60044-1

The graph below shows the current error within the class 0.1 % tolerance borders according to IEC 60044-1. It shows the difference of the current error calculated from the excitation graph measured with the OMICRON *CT Analyzer* and the KEMA test equipment. The calculation was done under the assumption only the excitation current would influence the ratio error, therefore, no excitation current would result in a ratio error of zero.

The used burden was 15 VA, $I_{nom} = 1$ A. The graph is supposed to show the influence of the measurement error of the excitation measurement and not the absolute ratio error.

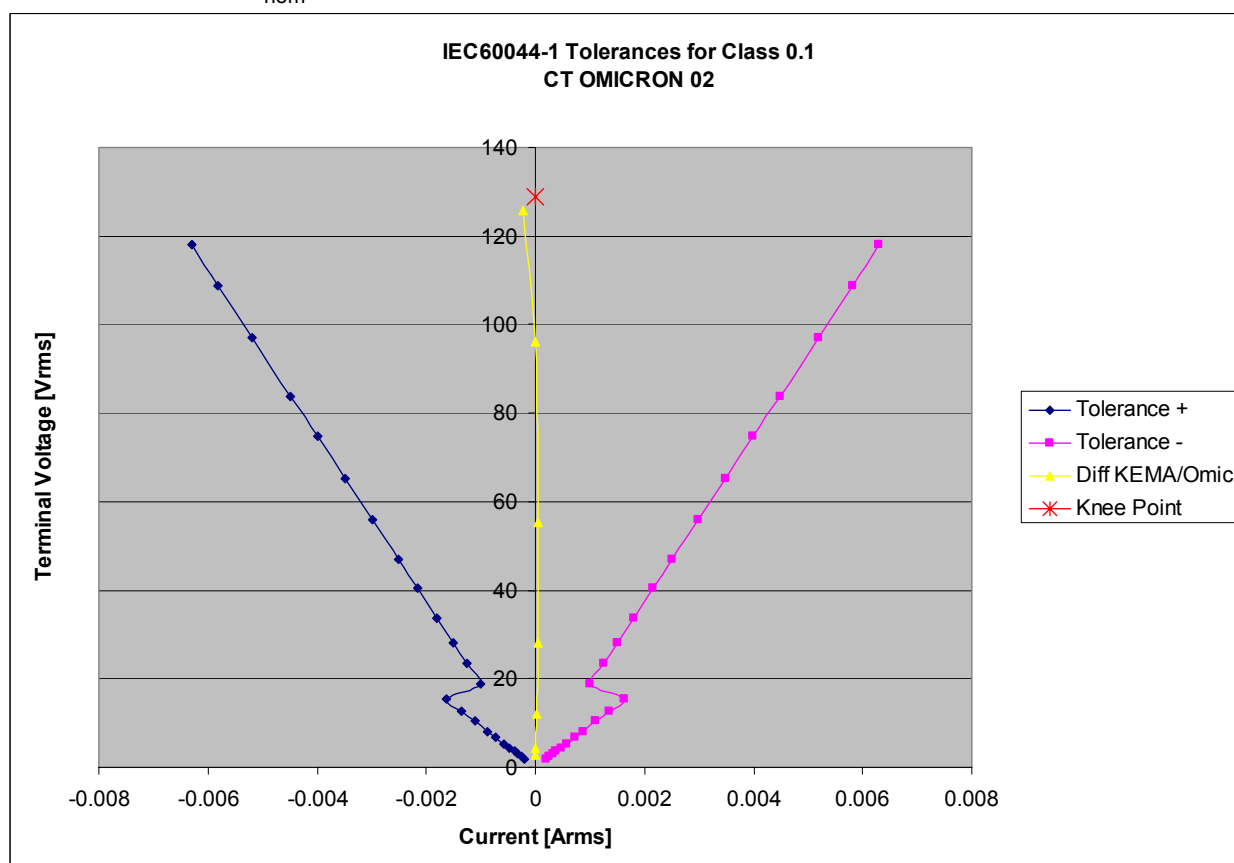


Comparison of Current Deviation up to Knee Point:

The graph below shows the maximum current tolerance to keep the current error within class 0.1 %. It furthermore shows the deviation (not the absolute values) of current between the measurement with the KEMA equipment and the OMICRON *CT Analyzer* (measurements from KEMA would be 0 A_{rms}).

The graphs are shown up to the knee point only. Above the knee point, the deviation between the two curves cannot be calculated properly anymore because of the steep current rise. In this area, a small deviation in voltage would result in a large deviation in current.

Only two tolerance borders were used: a tolerance of 0.2 % below 20 % of I_{nom} , and a tolerance of 0.1 % above 20 % of I_{nom} .



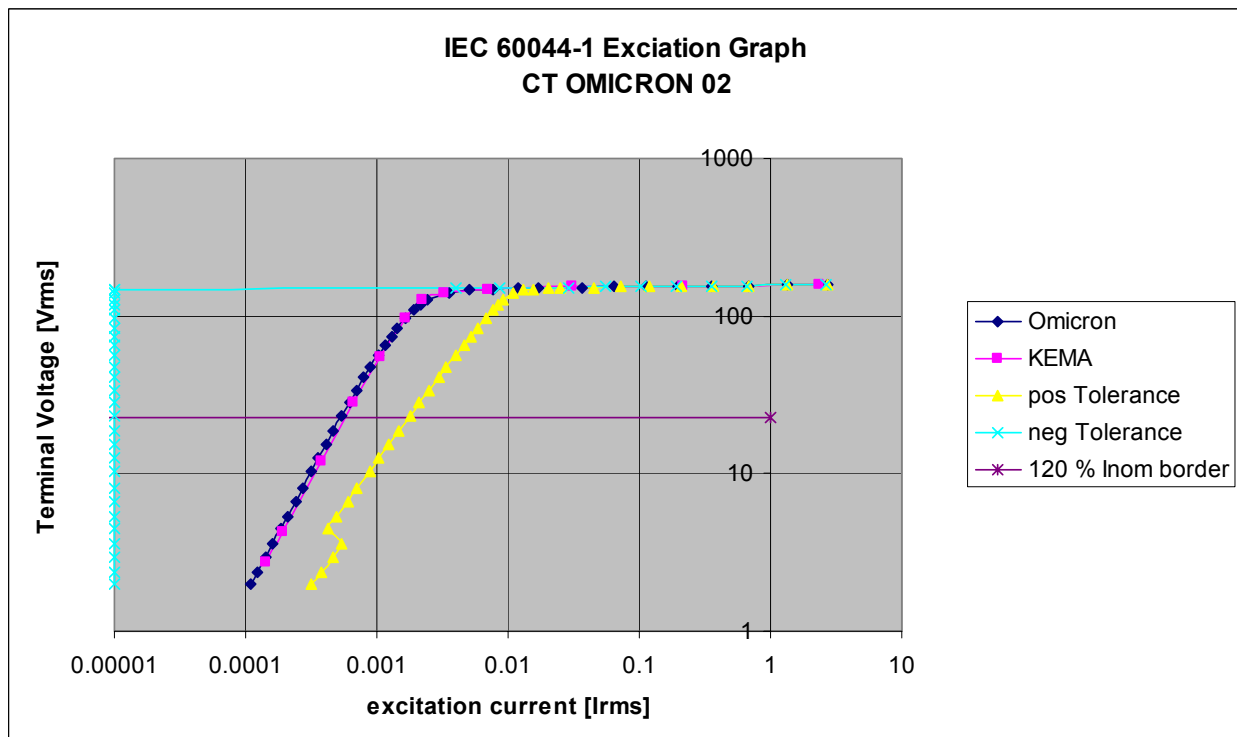
Excitation Curves and Maximum Tolerance Curves

The graph below shows the positive tolerance border (yellow) and the negative tolerance border as defined in IEC 60044-1 for class 0.1 as well as the two measured excitation curves. The logarithmic scale does not allow the negative tolerance border to be shown properly, therefore the negative values were limited to 10µA. IEC60044-1 only defines the tolerances up to 120% of nominal current. The 0.1% tolerance was used for all currents above 20% Inom with a burden of 15 Ohm.

The output current was calculated by
$$I_s = \frac{U_{Terminal}}{R_{CT} + R_{Burden}}$$

The error border was calculated as in the following example with 100% Inom.

$$I_{posTolerance} = I_s + I_s * 0.001$$



APPENDIX C

FURTHER ASSESMENT INFORMATION AS PRESENTED BY THE MANUFACTURER

(5 pages)

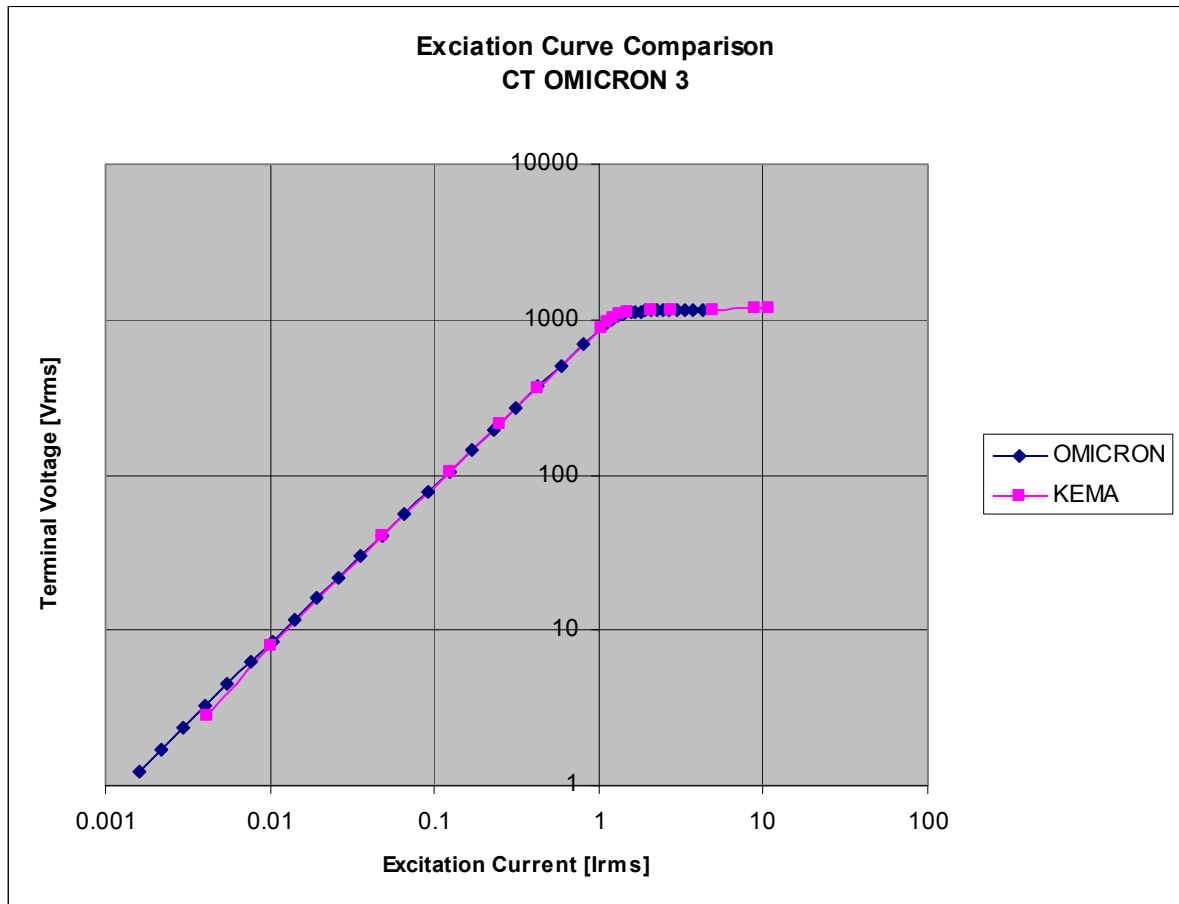
Tested CT (Current Transformer): **CT OMICRON 3** (see Material Data)

Excitation Curve - Comparison between Measurement by Omicron and KEMA

Tested CT (Current Transformer):

Name: CT OMICRON 3 (see Material Data)
 Type: Protection core with gapped ring core
 Class: TPY
 Burden: 14.75VA/CosPhi 0.8

Comment: The OMICRON CT-Analyzer does only guarantee high accuracy for non gapped cores but the measurement results below show that also on gapped protection cores reasonable results can be reached.



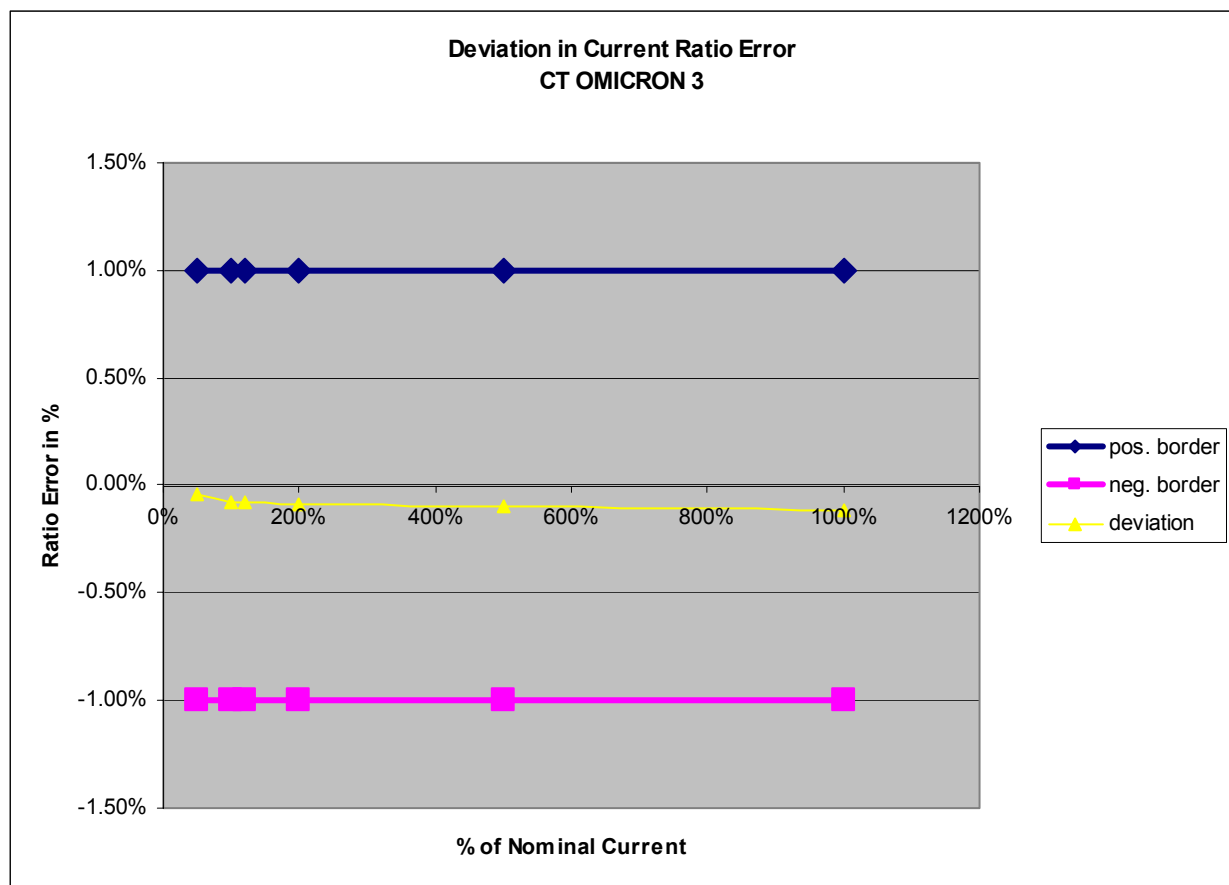
Blue line: Measurement with Omicron CT-Analyzer.
 Pink line: Measurement with KEMA equipment.

Comparison of Current Errors within 1% Tolerance Borders

The graph below shows the current error within 1 % tolerance. It shows the relative current error calculated from the excitation graph measured with the OMICRON *CT Analyzer* and the KEMA test equipment. The calculation was done under the assumption that only the difference of the two excitation curves would influence the deviation, therefore, no difference of the two excitation curves would result in a deviation of zero.

The ratio error measured by KEMA was -0,97% the ratio error measured from CT-Analyzer was - 1,076% (difference 0.106%). The used burden was 14,75VA, $I_{nom} = 1 \text{ A}$.

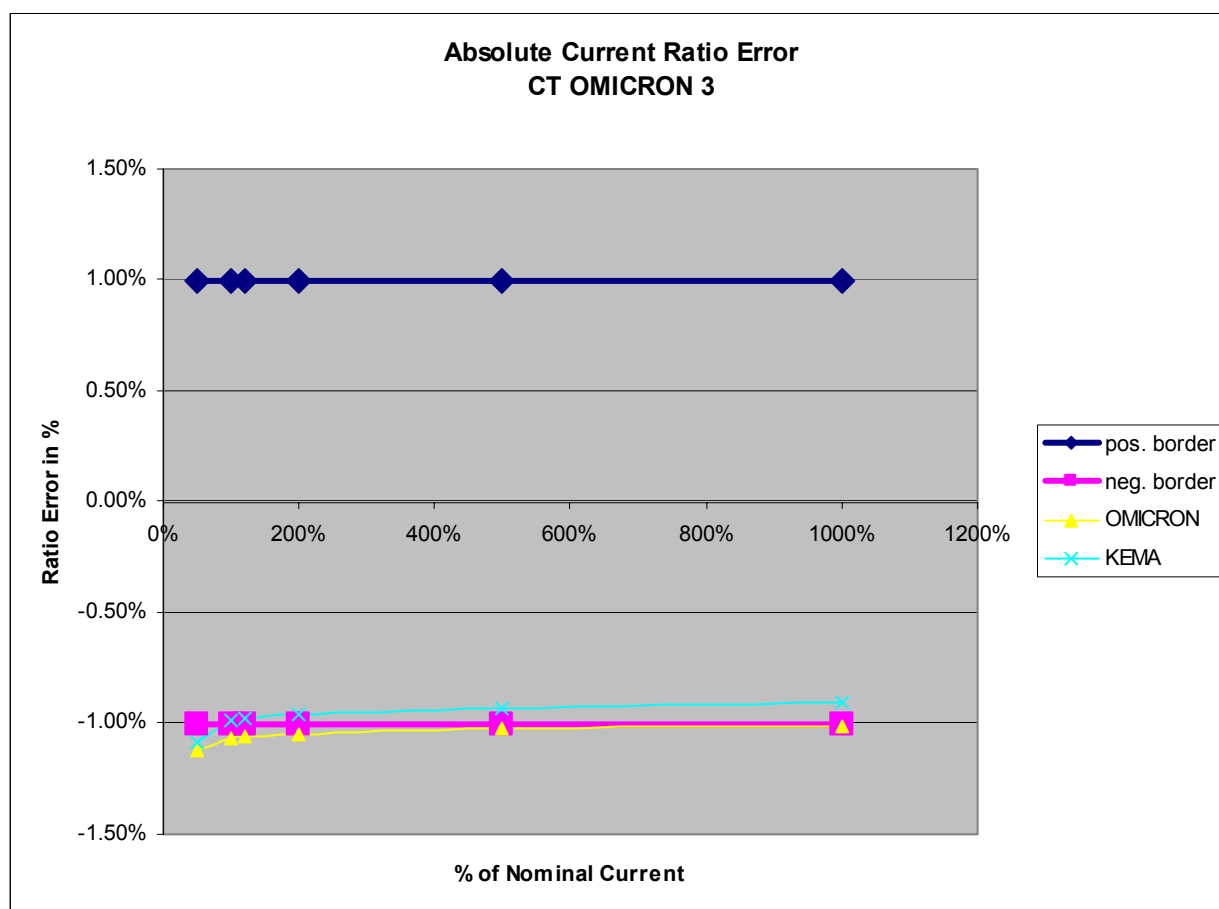
The graph is supposed to show the influence of the measurement error of the excitation measurement and not the absolute ratio error.



Dark blue line: +1% error border
 Pink line: -1% error border
 Yellow line: Deviation between the measurement from KEMA and the measurement with OMICRON CT-Analyzer.

Comparison of Absolute Current Errors in 1% Tolerance Borders

The graph below shows the absolute current ratio error calculated from the excitation graph and the ratio measurement with both the equipment from KEMA and the OMICRON CT-Analyzer. The used burden was 14,75VA, $I_{nom} = 1A$.



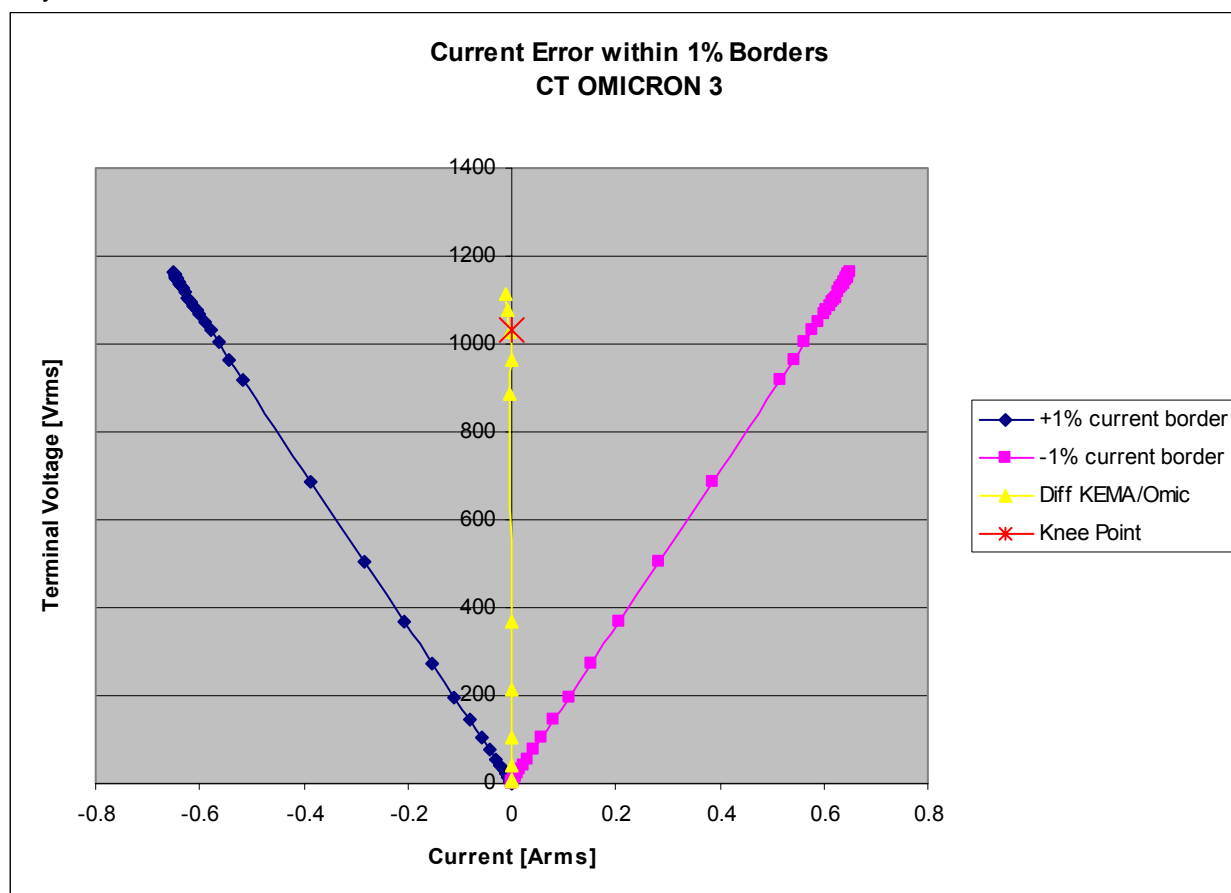
Dark blue line: +1% error border
 Pink line: -1% error border
 Yellow: ratio error with OMICRON CT-Analyzer
 Light blue: ratio error measured with KEMA equipment

Comparison of Current Deviation up to the Knee Point:

The graph below shows the maximum current tolerance to keep the current error within 1 %. It furthermore shows the deviation (not the absolute values) of current between the measurement with the KEMA equipment and the OMICRON *CT Analyzer* (measurements from KEMA would be 0 A_{rms}).

The graph is shown up to the knee point only. Above the knee point, the deviation between the two curves cannot be calculated properly anymore because of the steep current rise. In this area, a small deviation in voltage would result in a large deviation in current.

Only the 1% tolerance borders were used.



Yellow line: Deviation of the output current measured with KEMA equipment and OMICRON CT-Analyzer. No ratio error is considered.

Dark blue line: +1% error border

Pink line: -1% error border

Excitation Curves in 1% Tolerance Borders

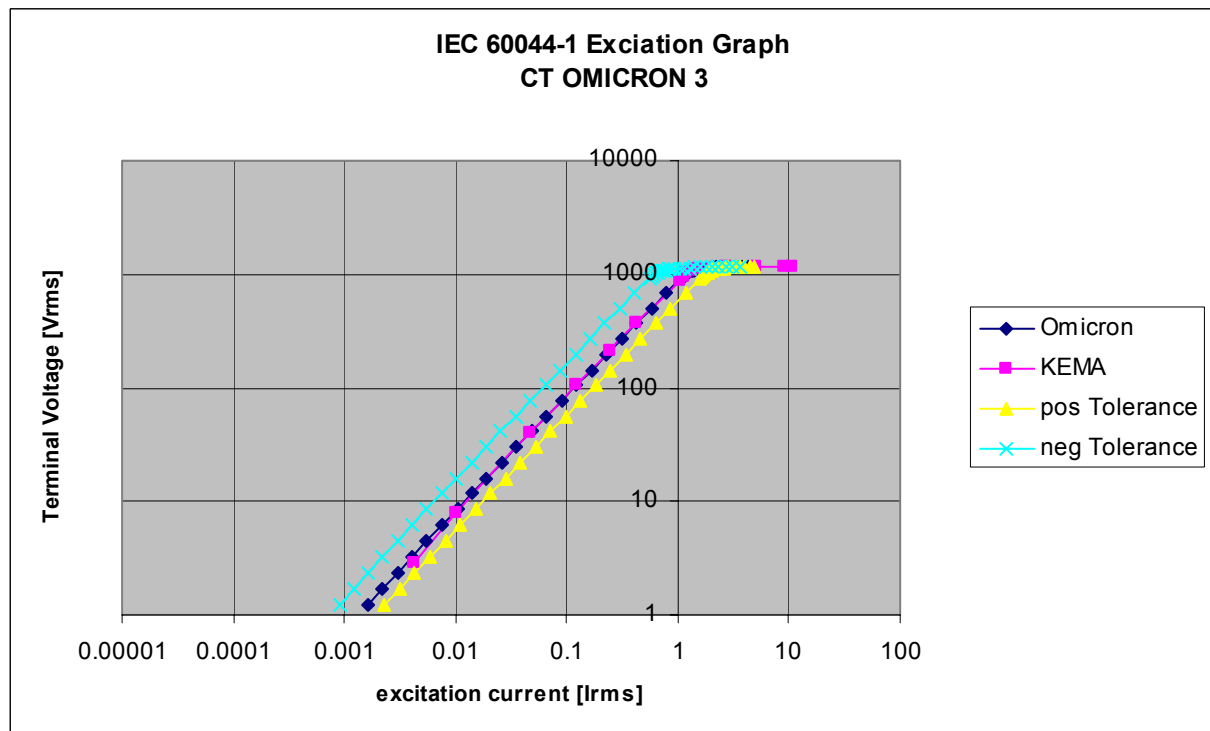
The graph below shows the positive tolerance border (yellow) and the negative tolerance border that would represent a ratio error of 1% as well as the two measured excitation curves.

The burden to calculate the 1% tolerance borders was 15 Ohm.

The output current was calculated by
$$I_s = \frac{U_{emf}}{R_{CT} + R_{Burden}}$$

The error border was calculated as in the following example with 100% I_{nom} .

$$I_{posTolerance} = I_s + I_s * 0.01$$



APPENDIX D

FURTHER ASSESMENT INFORMATION AS PRESENTED BY THE MANUFACTURER

(5 pages)

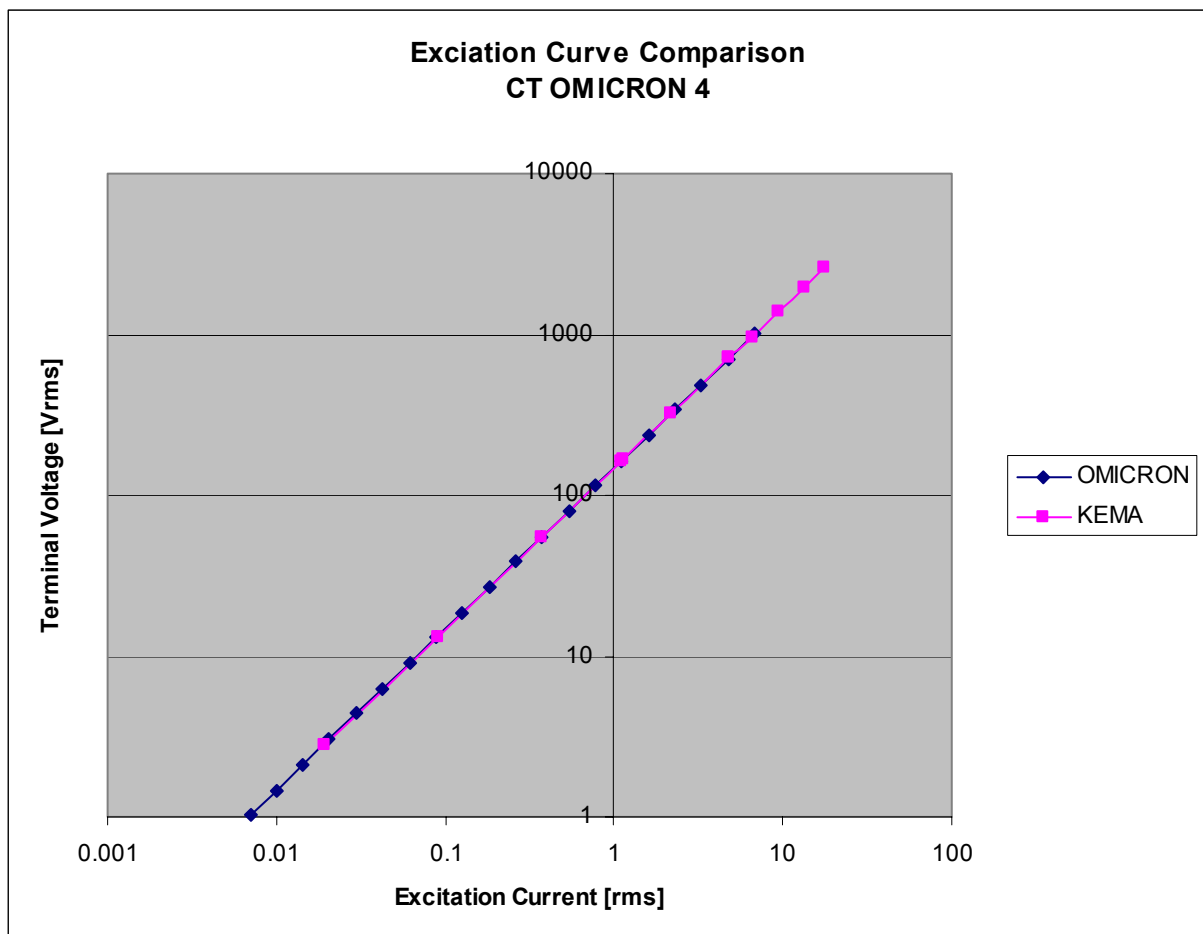
Tested CT (Current Transformer): **CT OMICRON 4** (see Material Data)

Excitation Curve - Comparison between Measurement by Omicron and KEMA

Tested CT (Current Transformer):

Name: CT OMICRON 4 (see Material Data)
 Type: Protection core with gapped ring core
 Class: TPZ
 Burden: 5.16VA/CosPhi 0.799

Comment: The ratio measurement of the TPZ core was done according IEC 60044-1 to get comparable results between the KEMA equipment and the CT-Analyzer. The OMICRON CT-Analyzer does only guarantee high accuracy for non gapped cores but the measurement results below show that also on gapped protection cores reasonable results can be reached.



Blue line: Measurement with Omicron CT-Analyzer.

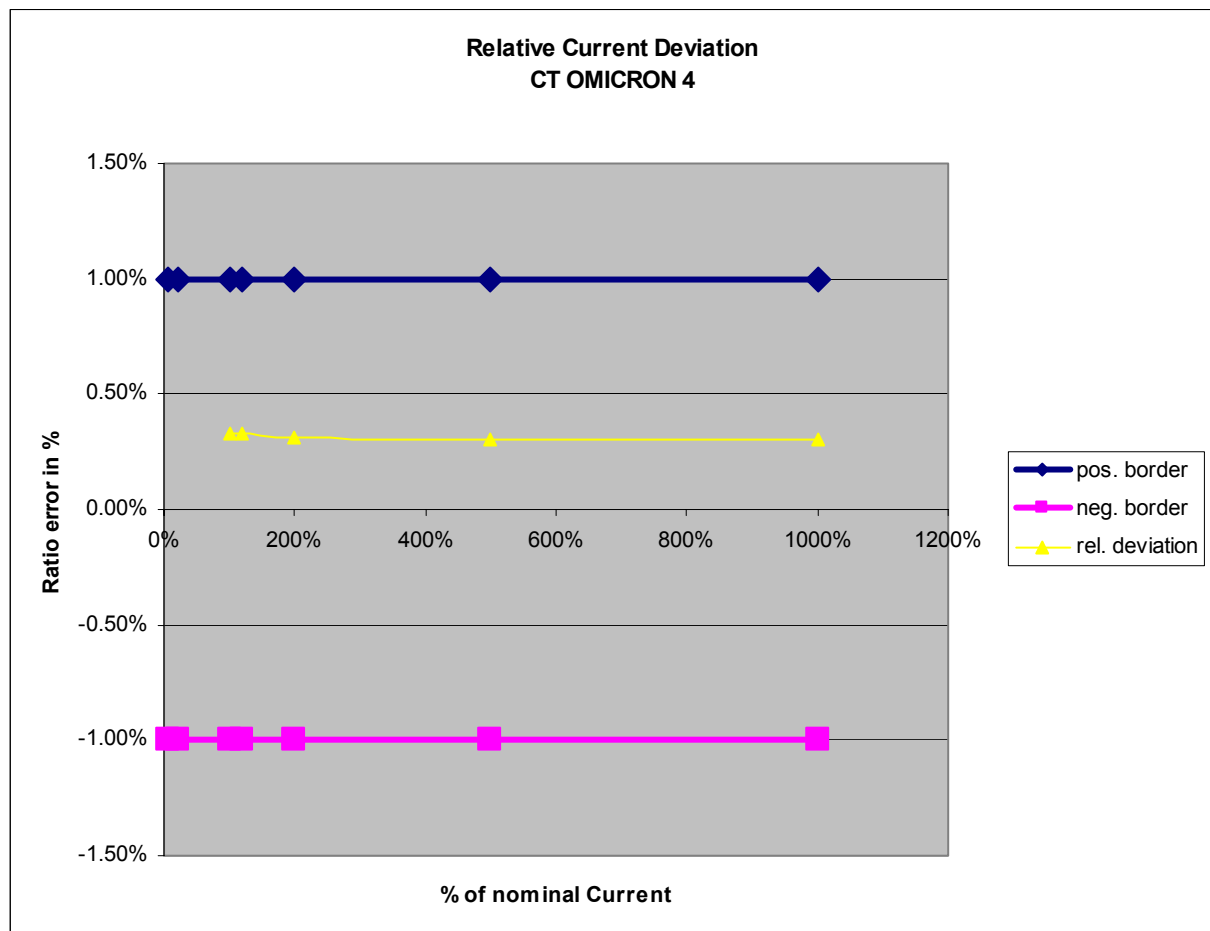
Pink line: Measurement with KEMA equipment.

Comparison of Current Errors within 1% Tolerance Borders

The graph below shows the current error within 1 % tolerance. It shows the relative current error calculated from the excitation graph measured with the OMICRON *CT Analyzer* and the KEMA test equipment. The calculation was done under the assumption that only the difference of the two excitation curves would influence the deviation, therefore, no difference of the two excitation curves would result in a deviation of zero.

The ratio error measured by KEMA was -1,94% the ratio error measured from CT-Analyzer was -1,658% (difference 0.28%). The used burden was 5,16VA, $I_{nom} = 1A$.

The graph is supposed to show the influence of the measurement error of the excitation measurement and not the absolute ratio error.



Dark blue line: +1% error border

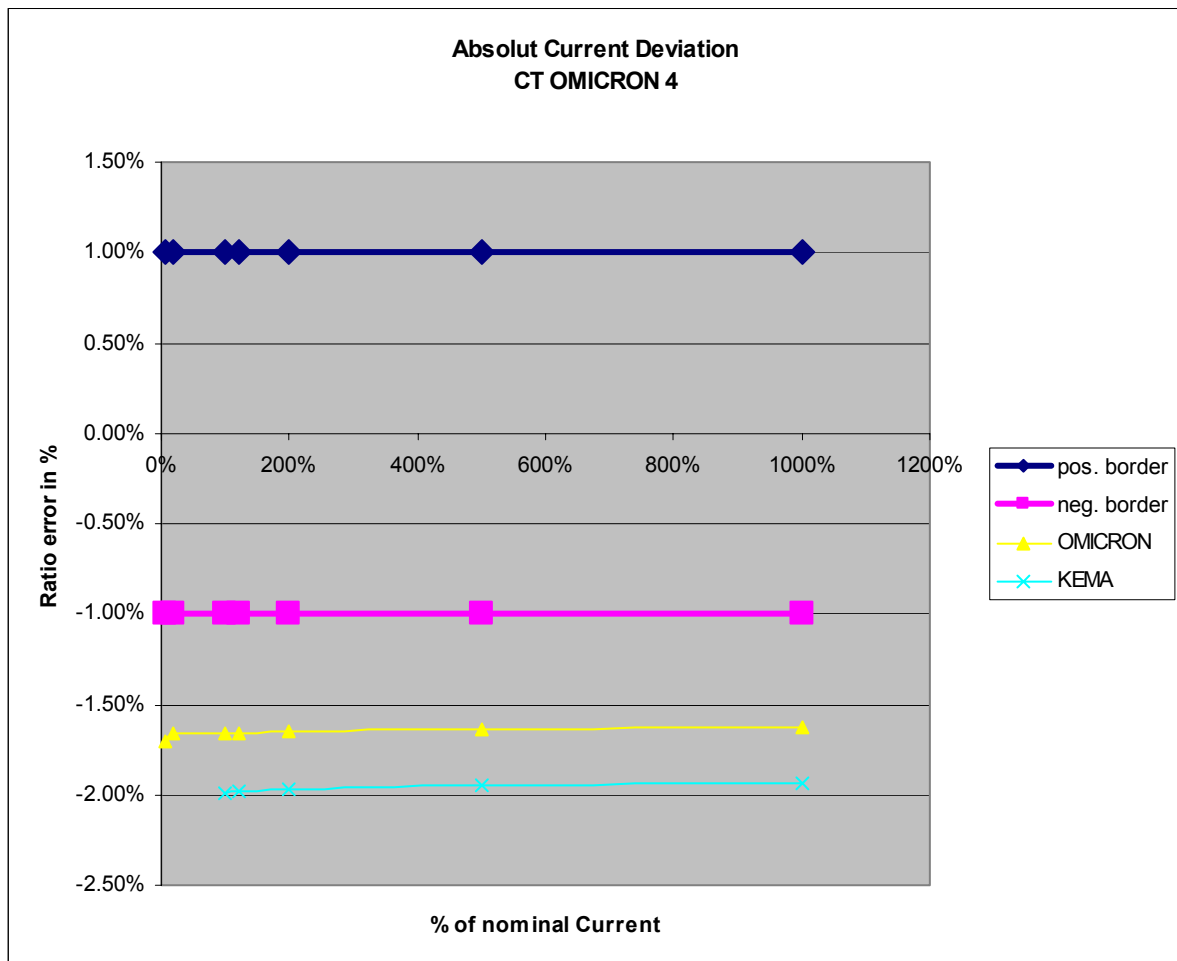
Pink line: -1% error border

Yellow line: Deviation between the measurement from KEMA and the measurement with OMICRON CT-Analyzer.

Comparison of Absolute Current Errors in 1% Tolerance Borders

The graph below shows the absolute current ratio error calculated from the excitation graph and the ratio measurement with both the equipment from KEMA and the OMICRON CT-Analyzer. The used burden was 5,16VA, $I_{nom} = 1A$.

The ratio error measured by KEMA was -1,94% the ratio error measured from CT-Analyzer was -1,658% (difference 0.28%). The used burden was 5,16VA, $I_{nom} = 1A$.

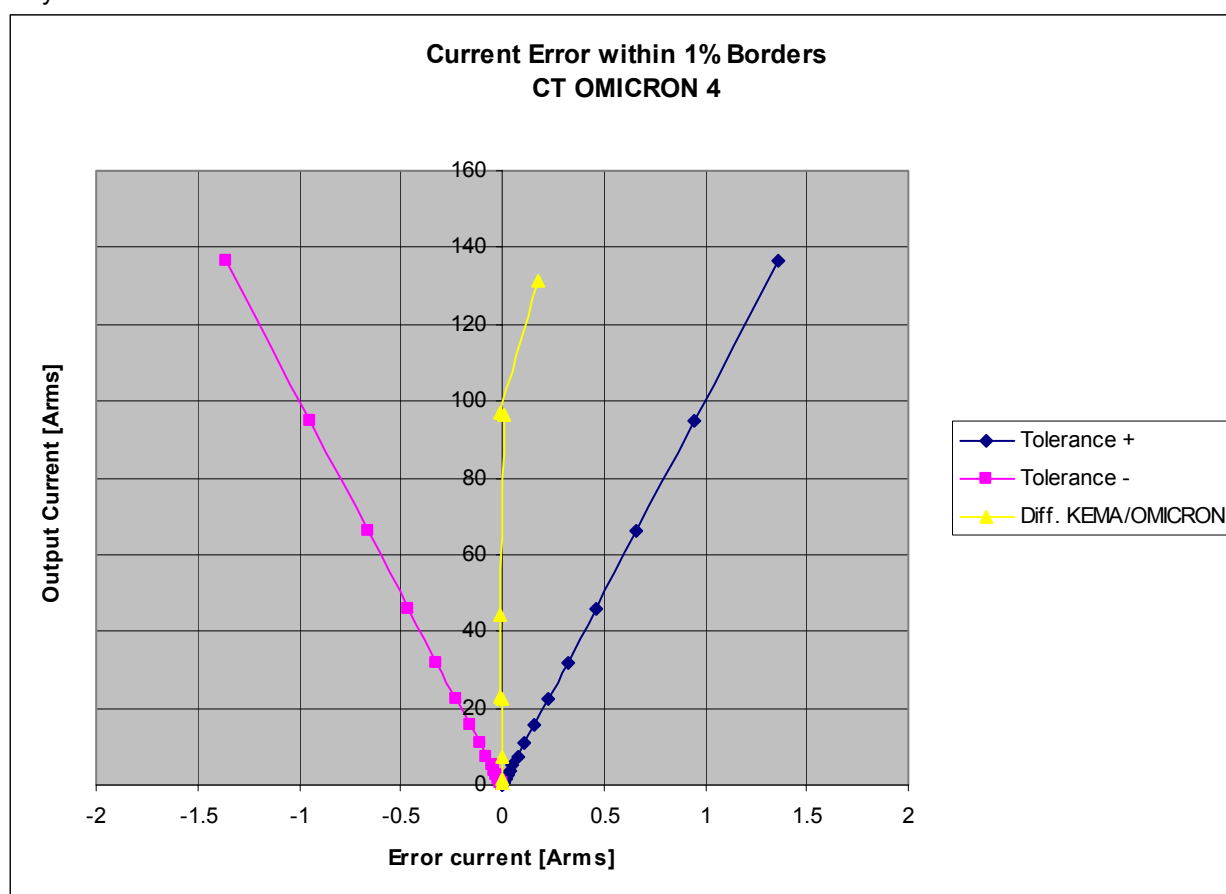


Dark blue line: +1% error border
 Pink line: -1% error border
 Yellow: ratio error with OMICRON CT-Analyzer
 Light blue: ratio error measured with KEMA equipment

Comparison of Current Deviation up to the Knee Point:

The graph below shows the maximum current tolerance to keep the current error within 1 %. It furthermore shows the deviation (not the absolute values) of current between the measurement with the KEMA equipment and the OMICRON *CT Analyzer* (measurements from KEMA would be 0 A_{rms}).

Only the 1% tolerance borders were used.



Yellow line: Deviation of the output current measured with KEMA equipment and OMICRON CT-Analyzer. No ratio error considered.

Dark blue line: +1% error border

Pink line: -1% error border

Excitation Curves in 1% Tolerance Borders

The graph below shows the positive tolerance border (yellow) and the negative tolerance border that would represent a ratio error of 1% as well as the two measured excitation curves. The burden to calculate the 1% tolerance borders was 5,16 Ohm.

The output current was calculated by
$$I_s = \frac{U_{emf}}{R_{CT} + R_{Burden}}$$

The error border was calculated as in the following example with 100% I_{nom} .

$$I_{posTolerance} = I_s + I_s * 0.01$$

