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TF Instrument Transformer Accuracy

Fall 2021 Meeting

Virtual Meeting

Nov. 16th

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TF Instrument Transformer Accuracy

Agenda:

- Start of meeting and introductions.
- Quorum-verification
- Patent-Claims Statement
- IEEE SA Copyright Policy
- Approval of Agenda
- Approval of minutes of the spring 2021 virtual meeting
- Report and conclusions from Sub TF Meeting on investigation of burdens at amperage other than 5 amps
- Presentation of the initial variant of Annex A regarding calculation of VT RCF and phase error from measured values at different PF and burdens – to be held by **T. Sizemore**
- Presentation of the application of the method on different high-voltage units – to be held by **I. Ziger**
- Discussion on the topic
- New business
- Date and Place of next Meeting (Denver, Colorado USA, March 27-31, 2022)
- Adjournment

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Patent statement:

"If anyone in this meeting is aware of any patent claims that are potentially essential to implementation of the document under consideration by this WG, that fact should be made known to the WG and recorded in the meeting minutes"

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- Distribution of Draft Standards (see 6.1.3 of the *IEEE SA Standards Board Operations Manual*)
  - https://standards.ieee.org/about/policies/opman/sect6.html

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Quorum verification

- 36 members
- 18 needed for quorum

If you would like to apply for membership, please contact one of the chairs:

igor.ziger@koncar-mjt.hr

dkkumaria@gmail.com

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Lee Bigham	Randy Brannen	Huan Dinh	David Ellis	Eric Euvrard	Ferras Fattal
Jose Antonio Gonzalez Ceballos	Kurt Kaineder	Vladimir Khalin	Ivan Konta	Marek Kornowski	Deepak Kumaria
Colby Lovins	Nigel Macdonald	Scott McCloskey	Ross McTaggart	Robert Middleton	Slobodan Misur
Frank Neder	Rudolf Ogajanov	Dipakkumar Patel	Caroline Peterson	Sylvain Plante	Adnan Rashid
Pierre Riffon	Zoltan Roman	Thomas Sizemore	William Solano	Brian Sonnenberg	Dervis Tekin
Risto Trifunoski	Kiran Vedante	Deniss Villagran	David Wallace	Mana Yazdani	Igor Ziger

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Spring 2021 virtual meeting minutes approval

- Spring 2021 Meeting Minutes

- Minutes were sent out on May 10 and Nov 12
- No objections were recieved

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Report of sub WG – Investigation of burdens at at amperage other than 5A

- 2 meetings were held (July 14th and July 28th)
- 21 volunteers signed up for the task, 19 actively particiapted in the meetings

No.	Name	Meeting 1	Meeting 2	Meeting 3
1	Binzhan Chen	X	X	
2	Brian Sonnenberg	X	-	
3	Frank Neder	-	X	
4	Hossein Nabi Bidhendi	X	X	
5	Huan Dinh	X	X	
6	Igor Ziger	X	X	
7	Jonas Oliveira	X	-	
8	Mana Yazdani	X	X	
9	Marek Kornovski	X	X	
10	Pierre Riffon	X	-	
11	Randy Mullikin	X	X	Not Held
12	Risto Trifunovski	X	X	
13	Ross McTaggart	X	X	
14	Rudy Ogajanov	X	X	
15	Ryan Hogg	-	-	
16	Scott McCloskey	X	X	
17	Steven Ashcraft	X	-	
18	Thomas Sizemore	X	X	
19	Vladimir Khalin	X	-	
20	William Solano	-	-	
21	Zoltan Roman	X	X	

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Report of sub WG – Investigation of burdens at at amperage other than 5A

- Minutes of meeting 1 (July 14th)
- Minutes of meeting 2 (July 28th)
- Official Answer to IEC
- Proposed changes to the existing text

All materials will be posted on the IEEE website

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Presentation of the initial variant of Annex A regarding calculation of VT RCF and phase error from measured values at different PF and burdens

to be held by **T. Sizemore**

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TF Instrument Transformer Accuracy

Discussion.

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TF Instrument Transformer Accuracy

Presentation of the application of the method on different high-voltage units

to be held by **I. Ziger**

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TF Instrument Transformer Accuracy

The method was applied to a total of 7 units:

- 5 VTs (72,5 – 550 kV)
- 2 Combination units (123 – 145 kV)

All units were evalated „retroactively" and all were measured according to IEEE C57.13 -2016 (nothing was done at unity PF)

2 approaches were used:

- Measurement at 0 and Max VA (i.e. Z or ZZ burden)
- Measurement at two largest burdens (i.e. Z and ZZ burden)

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TF Instrument Transformer Accuracy

Voltage class	BIL [kV]	Ratios	Accuarcy at large ratio	Accuracy at small ratio
72,5 kV VT	350	350 / 600 : 1	0.3 WXYZ ZZ	0.3 WXYZ ZZ
145 kV VT	650	700 / 1200 : 1	0.3 WXYZ ZZ	0.3 WXYZ ZZ
170 kV VT	750	800 / 1400 : 1	0.15 WXYZ	0.15 WXYZ
362 kV VT	1300	1800 / 3000 : 1	0.3 WXYZ ZZ	0.3 WXYZ ZZ
550 kV VT	1800	2511 / 4350 : 1	0.3 WXYZ ZZ	0.3 WXYZ ZZ
123 kV CTVT	550	460 / 765 : 1	0.3 WXYZ ZZ	0.15 WXYZ ZZ
145 kV CTVT	650	700 / 1200 : 1	0.3 WXYZ ZZ	0.15 WXYZ ZZ

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TF Instrument Transformer Accuracy

145 kV Combination unit 0.3 WXYZ ZZ @ 1200:1

DETERMINATION OF ERRORS OF THE VOLTAGE TRANSFORMER				
U / Un	Y2 – Y3 (67.08 V)			
	S (VA)	p (%)	RCF	δ (min)
1.0	0	+0.16	0.9984	+1.5
1.0	12.5	+0.15	0.9985	+1.9
1.0	25	+0.13	0.9987	+1.8
1.0	75	+0.09	0.9991	+1.8
1.0	200	-0.01	1.0001	+2.2
1.0	400	-0.17	1.0017	+2.6

170 kV VT 0.15 WXYZ @ 800:1

U / Un	X1 – X3 (800:1)			
	S (VA)	p (%)	RCF	δ (min)
1.0	0	+0.12	0.9988	-0.2
1.0	12.5	+0.11	0.9989	-0.3
1.0	25	+0.10	0.9990	-0.6
1.0	35	+0.10	0.9990	-0.1
1.0	75	+0.06	0.9994	-1.2
1.0	200	-0.02	1.0002	-2.5

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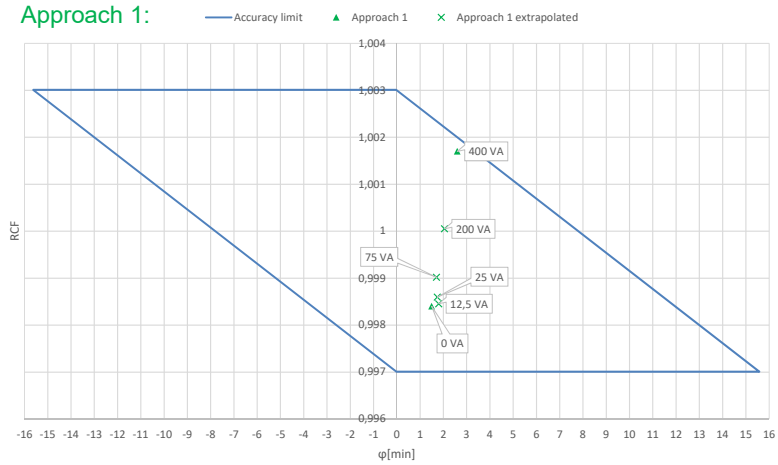
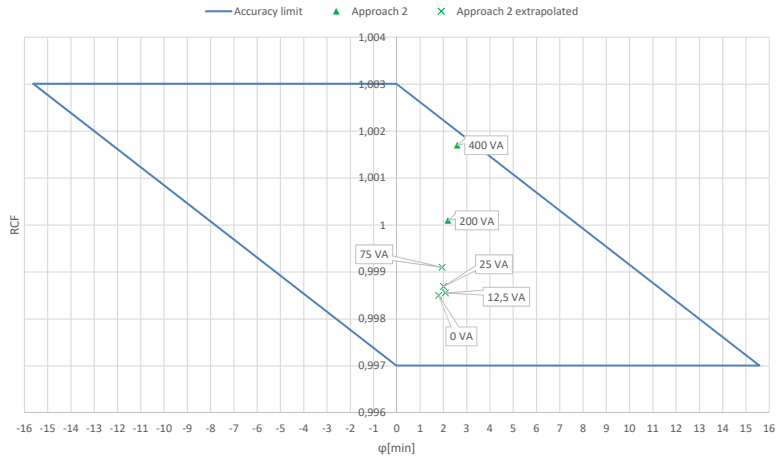
TF Instrument Transformer Accuracy

Approach 1:



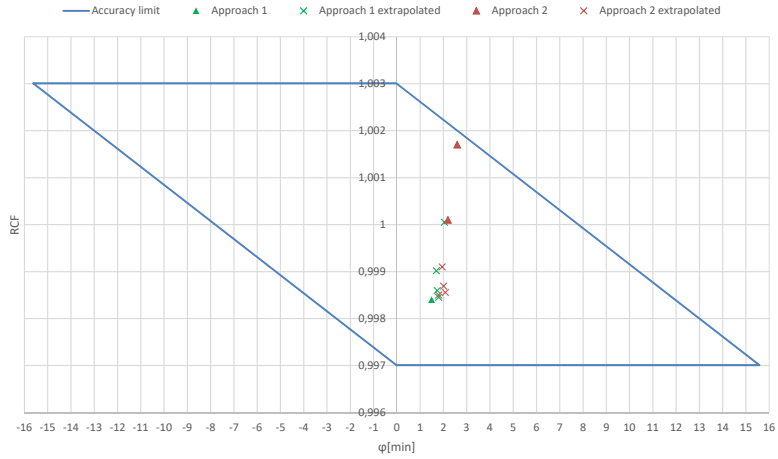
TF Instrument Transformer Accuracy

Approach 2:



TF Instrument Transformer Accuracy

Overlap of 1 and 2



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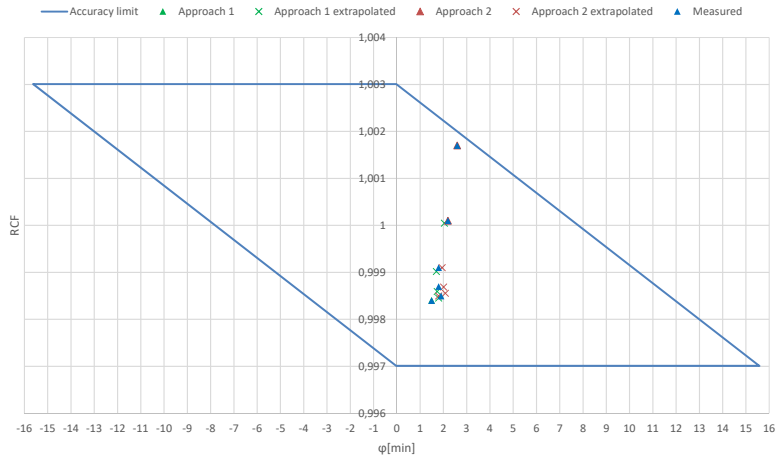
TF Instrument Transformer Accuracy

Overlap of 1 and 2



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TF Instrument Transformer Accuracy

	Burden	RCF diff.	RCF diff. [%]	Phase diff. [min]	Phase diff. [%]
APPROACH 1	0 VA	-	-	-	-
	12,5 VA	4,51E-05	0,005	0,098	5,43
	25 VA	1,04E-04	0,010	0,064	3,70
	75 VA	8,13E-05	0,008	0,094	5,49
	200 VA	5,00E-05	0,005	0,150	7,32
	400 VA	-	-	-	-
APPROACH 2	0 VA	-1,00E-04	-0,010	-0,300	-16,67
	12,5 VA	-5,51E-05	-0,006	-0,188	-9,00
	25 VA	9,23E-06	0,001	-0,212	-10,55
	75 VA	0,00E+00	0,000	-0,150	-7,69
	200 VA	-	-	-	-
	400 VA	-	-	-	-

TF Instrument Transformer Accuracy

145 kV Combination unit 0.3 WXYZ
ZZ @ 1200:1

DETERMINATION OF ERRORS OF THE VOLTAGE TRANSFORMER				
U / Un	Y2 – Y3 (67.08 V)			
	S (VA)	p (%)	RCF	δ (min)
1.0	0	+0.16	0.9984	+1.5
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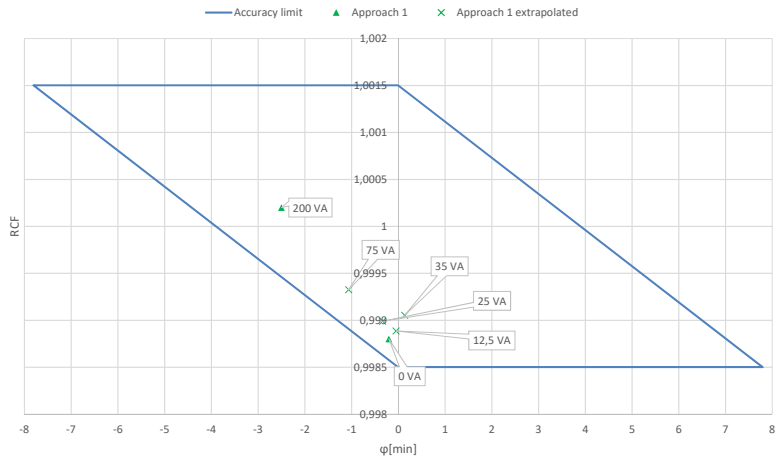
1.0	25	+0.13	0.9987	+1.8
1.0	75	+0.09	0.9991	+1.8
1.0	200	-0.01	1.0001	+2.2
1.0	400	-0.17	1.0017	+2.6

170 kV VT 0.15 WXYZ
@ 800:1

U / Un	X1 – X3 (800:1)			
	S (VA)	p (%)	RCF	δ (min)
1.0	0	+0.12	0.9988	-0.2
1.0	12.5	+0.11	0.9989	-0.3
1.0	25	+0.10	0.9990	-0.6
1.0	35	+0.10	0.9990	-0.1
1.0	75	+0.06	0.9994	-1.2
1.0	200	-0.02	1.0002	-2.5

TF Instrument Transformer Accuracy

Approach 1:



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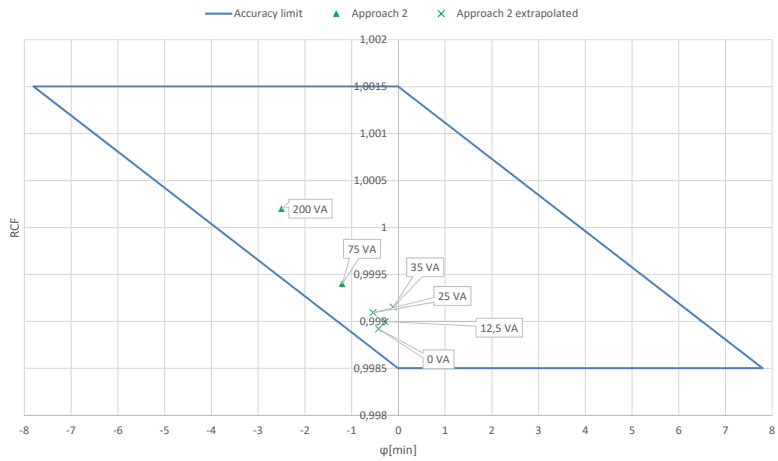
Approach 2:



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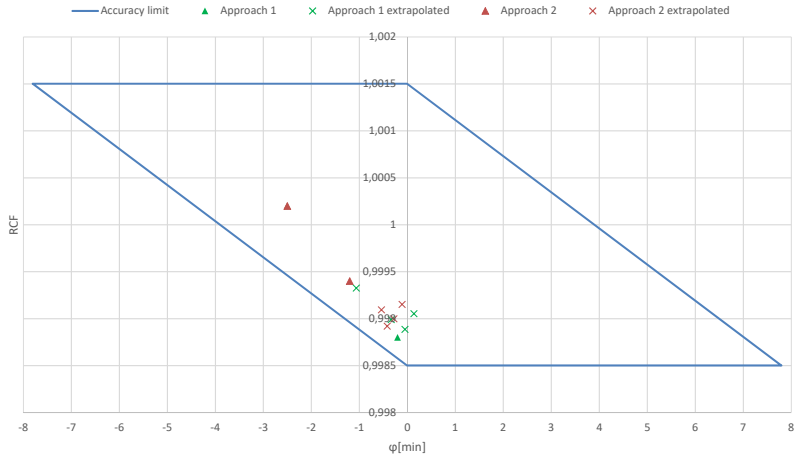
TF Instrument Transformer Accuracy

Overlap of 1 and 2



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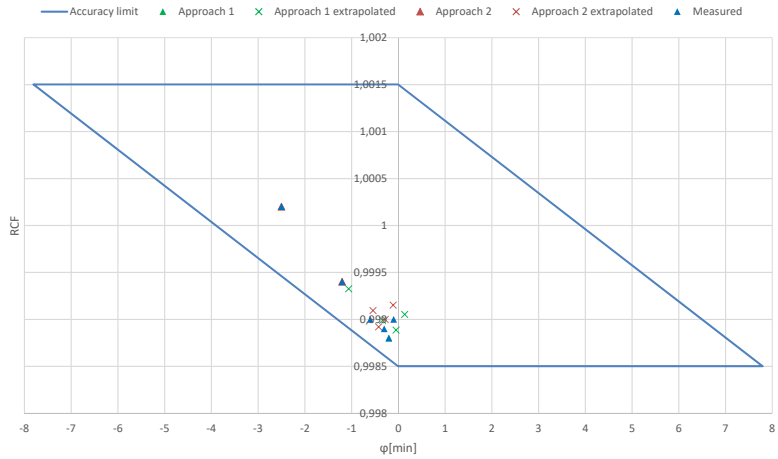
Overlap of 1 and 2



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TF Instrument Transformer Accuracy

	Burden	RCF diff.	RCF diff. [%]	Phase diff. [min]	Phase diff. [%]
APPROACH 1	0 VA	-	-	-	-
	12,5 VA	1,4E-05	0,001	-0,25	512,35
	25 VA	1,0E-05	0,001	-0,26	78,64
	35 VA	-5,3E-05	-0,005	-0,24	-173,21
	75 VA	7,5E-05	0,008	-0,14	12,94
	200 VA	-	-	-	-
APPROACH 2	0 VA	-0,0001	-0,012	0,22	-52,38
	12,5 VA	-0,0001	-0,010	-0,02	6,74
	25 VA	-0,0001	-0,009	-0,06	10,82
	35 VA	-0,0002	-0,015	0,01	-8,69
	75 VA	-	-	-	-
	200 VA	-	-	-	-

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TF Instrument Transformer Accuracy

	Approach 1				Approach 2			
	Max Δ_{RCF}	Min Δ_{RCF}	Max $\Delta\varphi_{[min]}$	Min $\Delta\varphi_{[min]}$	Max Δ_{RCF}	Min Δ_{RCF}	Max $\Delta\varphi_{[min]}$	Min $\Delta\varphi_{[min]}$
72,5 kV VT	5,0E-05	-2,2E-05	0,128	0,012	-8,5E-05	-1,2E-04	0,170	0,000
145 kV VT	1,1E-04	0,0E+00	0,056	-0,050	1,1E-04	0,0E+00	0,137	0,100
170 kV VT	7,5E-05	-5,3E-05	-0,138	-0,264	-9,3E-05	-1,5E-04	0,220	-0,059
362 kV VT	3,4E-05	0,0E+00	0,050	-0,031	3,3E-05	-5,3E-07	-0,050	-0,125
550 kV VT	1,6E-06	-1,7E-05	0,100	-0,074	1,6E-07	-1,8E-05	-0,087	-0,270
123 kV CTVT	9,4E-05	3,6E-05	0,000	-0,038	1,3E-05	-1,0E-04	0,000	-0,033
145 kV CTVT	1,0E-04	4,5E-05	0,150	0,064	9,2E-06	-1,0E-04	-0,150	-0,300
Max / Min	0,0001	-0,0001	0,15	-0,26	0,0001	-0,0002	0,22	-0,30

Uncertanties: ±0.0002 RCF / ±0.3 min phase error

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TF Instrument Transformer Accuracy

Conclusions:

- Both approaches are comparble in accuracy
- The unertainty introduced by the method is comparable or even better than the measurement uncerainty of the test setup
- Valid for all voltages and accuracy classes

Future actions:

- Evaluate accuracy for burdens beyond the maximal burden
- Evaluate accuracy for high burdens with different PF

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Discussion.

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TF Instrument Transformer Accuracy

New business ?

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TF Instrument Transformer Accuracy

New business: Extended Range CT

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Extended Range CT

The term “Extended Range CT” is “widely” requested within the industry, without it being explicitly defined.

Different customers specify it in different ways.

Some examples are:

- 0,15 Extended Range (without saying up to which current)
- 0,15S from 1% to RF
- 0,15 from 0,5% to RF (does that mean that higher errors are allowed at 0,5 %)
- 0,15ER from 0,05% to RF (same as above)

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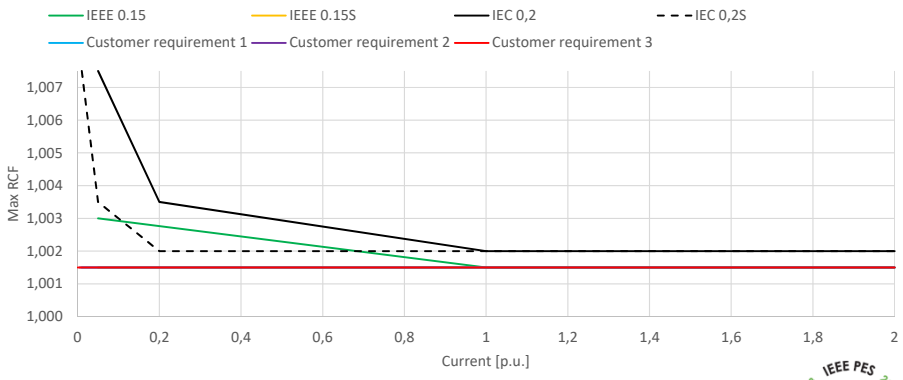
Extended Range CT

Comparison of different requirements



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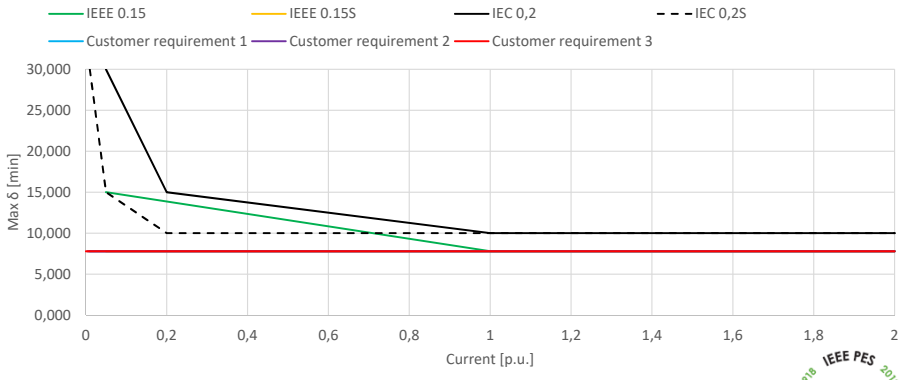
Extended Range CT

Comparison of different requirements



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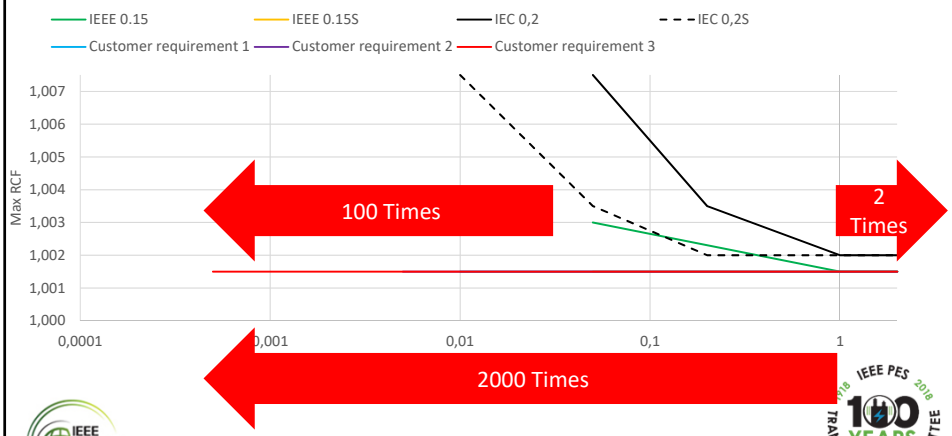
Extended Range CT

Comparison of different requirements



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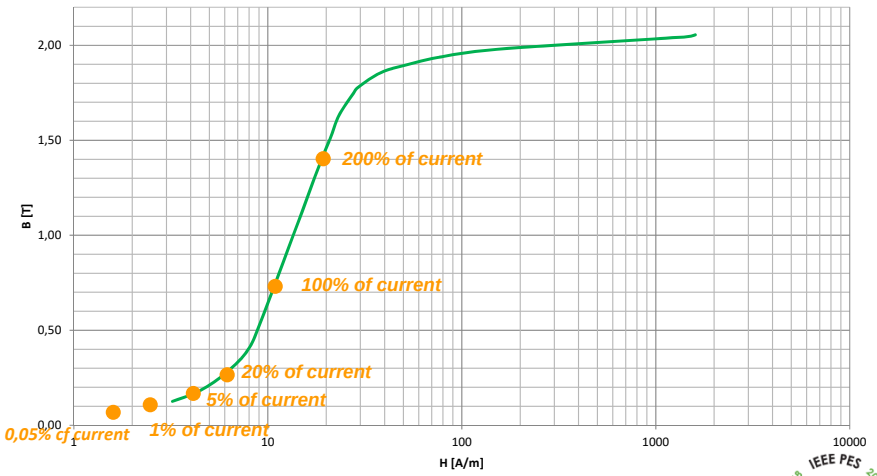
Extended Range CT



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Extended Range CT

What is the proposal ?

- To define the term “Extended Range”
- To define what is the default current range that term covers (e.g. 0,5% to RF or 1% to RF or 2,5% to RF...)
- To add appropriate language for those requirements that go beyond that.

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Discussion.

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TF Instrument Transformer Accuracy

Proposal – To set up a dedicated meeting (call) between meetings to address this issue and conclude why this change was made and if possible determine the approach to be taken in the future

- If you would like to be a part of the dedicated discussion please add your preferred email in the session chat
- Or contact one of the chairs:

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