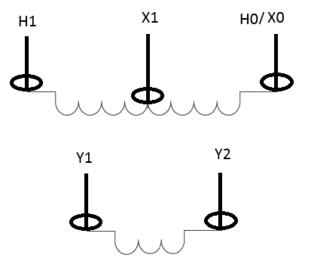


Testing bushing CTs in a high noise substation

Objective: This application note demonstrates how to hook up leads and perform the test with MRCT test equipment on bushings CTs of an auto transformer in a high voltage substation with extreme noise and interference.

Test object: Single phase auto transformer



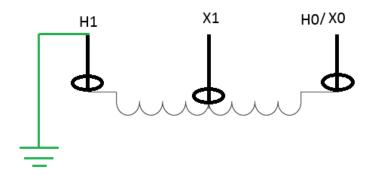
Single phase auto transformer with bushing CTs

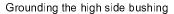
Test Equipment: MRCT

Test connections:

Ground the H1 bushing and leave it grounded for the whole duration of testing all CTs as shown

below:





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Testing bushing CTs in a high noise substation

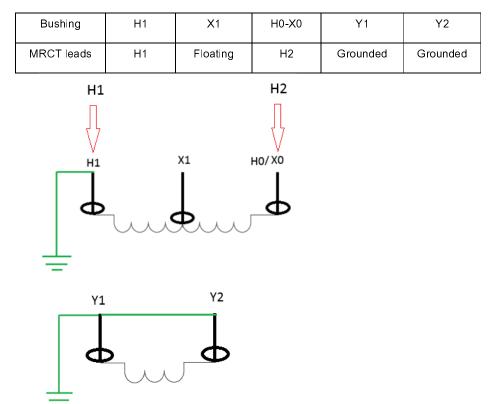
Grounding is performed to reduce any induced voltage from overhead energized lines

Testing CTs on H side bushing

MRCT unit has H and X test leads

a) Connection of H leads

Make following connections for H1 and H2 test leads

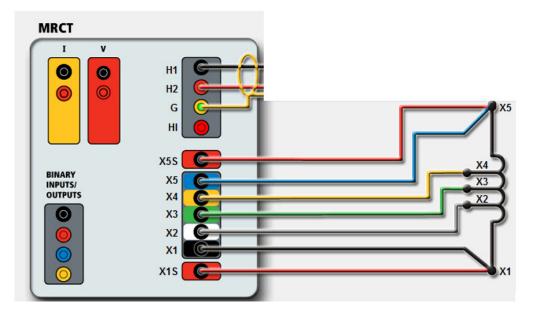


b) Connection of X leads

Connect MRCT secondary leads marked X1S, X1, X2, X3, X4, X5 and X5S to the secondary of the CT under test as per the diagram shown below.

Megger.

Testing bushing CTs in a high noise substation

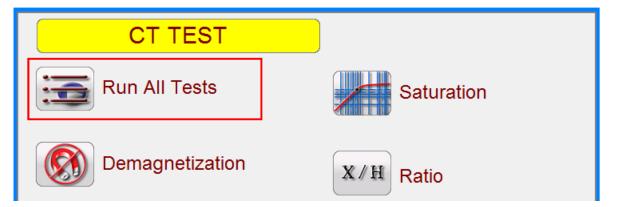


Before proceeding to start the test, please make sure that communication button at the top left side

of the software screen is green. This indicates that software is communicating with the test box.



From home screen of the MRCT software select Run All Tests



In the Test selection screen, check all saturation, all ratio and all winding resistance test. Ratio test includes polarity test.



Testing bushing CTs in a high noise substation

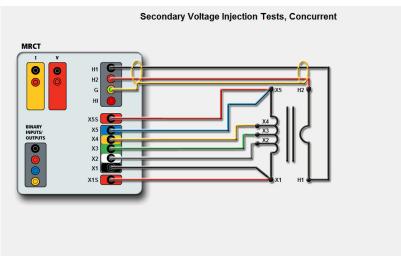
# Taps 5	Saturation Test	Ratio Test	Winding Resistance	Insulation Resistance
X1-X2	\checkmark	\checkmark	\checkmark	Primary To Secondary 🗾 1KV
X1-X3	N		N	
X1-X4			N	Primary To Ground
X1-X5	$\overline{\checkmark}$	N	$\overline{\checkmark}$	Secondary To Ground 🚺 1KV
X2-X3	\checkmark	\checkmark	\checkmark	All Ranges
X2-X4		$\overline{\mathbf{\nabla}}$		
X2-X5	$\overline{}$	\checkmark	\checkmark	
X3-X4	N	N	N	
X3-X5	\checkmark	\checkmark	\checkmark	
X4-X5	$\overline{\checkmark}$	$\overline{\checkmark}$	V	
Saturation/Ratio X1 to Xn Only		All Ratio Tests	All Winding Tests	
Concurrent				

It is important to NOT check insulation resistance test as high side is intentionally shorted to ground to eliminate the interference. User would have to perform the insulation resistance separately. Hit the play button to run the test

Following diagram will show up. Hit the play button again to confirm and unit will initiate the test.



Testing bushing CTs in a high noise substation





The tests will be performed in following order:

- DC winding resistance of CT secondary
- Demagnetization
- Saturation or Excitation Test
- Ratio and Polarity test

At the end of the test, a report similar to below will show up:



Testing bushing CTs in a high noise substation

MAN	NUFACTURER		-	SE	RIAL NO.	5226t3a00	1		PHASE		
			ACCURACY CLASS SATURATION STD ANSI 45								
						°		SATURA		0140	
BUR	RDEN				VA						
Se	condary Vol	tage Injectio									
	Тар	X1-X2	X1-X3	X1-X4	X1-X5	X2-X3	X2-X4	X2-X5	X3-X4	X3-X5	X4-X5
2	Nameplate	1000:5	2200:5	2500:5	3000:5	1200:5	1500:5	2000:5	300:5	800:5	500:5
	Measured	1000.291:5	2200.464:5	2500.626:5	3000.644:5	1200.172:5	1500.335:5	2000.353:5	300.163:5	800.18:5	500.018:5
b	% Error	0.029	0.021	0.025	0.021	0.014	0.022	0.018	0.054	0.023	0.004
L	Test V (V)	99.866	219.68	249.65	299.57	119.82	149.79	199.71	29.967	79.888	49.920
L	Test I (A)	0.1674	0.0761	0.0670	0.0558	0.1395	0.1116	0.0837	0.5579	0.2093	0.3349
	Prim V (V)	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992
Ph	nase Dev.	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'
	Polarity	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct
Knee		196.23	431.30	490.20	589.27	235.07	293.96	393.05	58.893	157.93	99.016
	Cur.(A)	0.2643	0.1203	0.1058	0.0882	0.2209	0.1765	0.1324	0.8801	0.3306	0.5292
	10						***		x1-x2 x1-x3 x1-x4 x1-x5 x2-x3 x2-x4 x2-x5 x3-x4 x3-x5		
	22		0.01	Cum	ent	0.1	Displ	1	n Test Data	_	

Hit the save button to save the file by giving it a file name.

FILE HOME TOOLS	HELP	
	Import ▼ Import ▼ Import ▼ Import ▼ Import ▼	🔌 🗵 🔰 🗊 🐼
New Open Save Print	K Cut Select Instrume	
File	Edit Data Instru	ument Settings Test Controls

Testing CTs on X1 bushing

Before testing X1 bushing, follow the below steps to enable a specific setting in MRCT software:

Click on the nameplate icon on the home screen of the software as shown below:



Testing bushing CTs in a high noise substation



In the nameplate screen, click on the area shown in the blue circle:

Nameplate		
CT1X CT2X CT3X CT4X CT5X CT6X CT7X CT83	X CT9X CT10X CT11X CT12X	
No. of CTs 12 No. of Cores 1	No. of Taps 5	CT Label X Name CT1
Manufacturer]	Meter Protection
Serial No. 5226t3a001	Accuracy Class	
Asset ID	VA	
Phase	Burden	
		Buried CT in Delta Connection
Ratios X1-X2 1,000 : 5 X1-X3 2,200 : 5	X1-X4 2,500 : 5 X1-X5	3,000 : 5
User Descriptions and Values		
Description	Value	Сору

This will pop up a window asking to enter a password. Enter password vapower (case sensitive)



Hit green OK button

This will enable a new selection check box on nameplate screen: "H2 connected to shroud" as

shown below:



Testing bushing CTs in a high noise substation

Nameplate	
CT1X CT2X CT3X CT4X CT5X CT6X CT7X CT8	3X CT9X CT10X CT11X CT12X
No. of CTs 12 No. of Cores 1	No. of Taps 5 CT Label X Name CT1
Manufacturer	Meter Protection
Serial No. 5226t3a001	Accuracy Class
Asset ID	VA
Phase	Burden
H2 Connected to Shroud	Buried CT in Delta Connection
Ratios X1-X2 1,000 : 5 X1-X3 2,200 : 5	X1-X4 2,500 : 5 X1-X5 3,000 : 5
User Descriptions and Values	
Description	Value Copy

Please note that user does not have to perform these steps every time. It is performed just one time

and can be saved as default settings by following the steps below:

		Save As Default
92. 😚 🚍 → 🤇	Default Settings Options	Restore Default
		Restore Factory

MRCT unit has H and X test leads

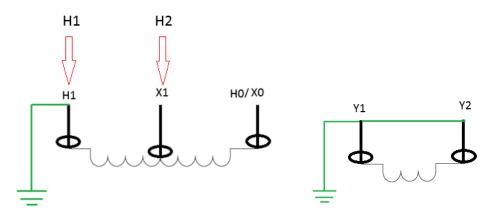
a) Connection of H leads

Make following connections for H1 and H2 test leads

Bushing	H1	X1	H0- Xo	Y1	Y2
MRCT leads	H1	H2	Floating	Grounded	Grounded

Megger.

Testing bushing CTs in a high noise substation



Please note that by connecting H1 and H2 test leads as shown above will generate incorrect polarity

but that will be taken care of in section below.

In the nameplate screen check the box "H2 connected to Shroud"



This will take care of incorrect polarity issue.

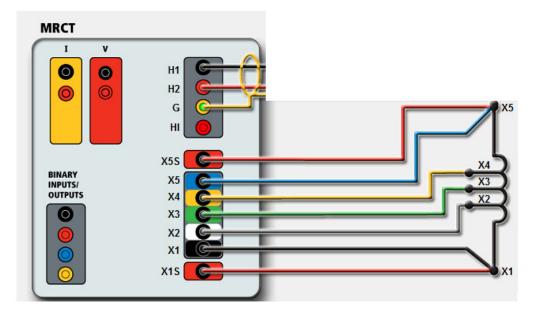
b) Connection of X leads

Connect MRCT secondary leads marked X1S, X1, X2, X3, X4, X5 and X5S to the secondary of the

CT under test as per the diagram shown below.



Testing bushing CTs in a high noise substation



From home screen of the MRCT software select Run All Tests

CT TEST	
Run All Tests	Saturation
Demagnetization	X/H Ratio

In the Test selection screen, check all saturation, all ratio and all winding resistance test. Ratio test includes polarity test.



Testing bushing CTs in a high noise substation

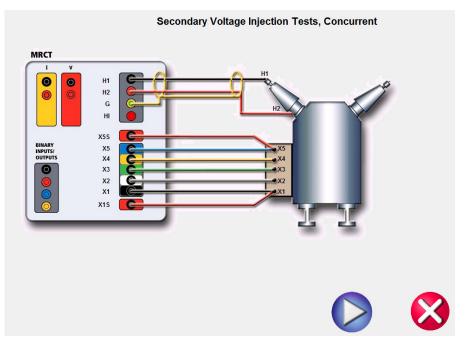
# Taps 5	Saturation Test	Ratio Test	Winding Resistance	Insulation Resistance
X1-X2	\checkmark	\checkmark		Primary To Secondary 🗾 1KV
X1-X3	N		N	
X1-X4			N	Primary To Ground
X1-X5	$\overline{\checkmark}$	N	$\overline{\checkmark}$	Secondary To Ground 🚺 1KV
X2-X3	\checkmark	\checkmark	\checkmark	All Ranges
X2-X4		$\overline{\mathbf{\nabla}}$		
X2-X5	$\overline{}$	\checkmark	\checkmark	
X3-X4	N	N	N	
X3-X5	\checkmark	\checkmark	\checkmark	
X4-X5	$\overline{\checkmark}$	$\overline{\checkmark}$	V	
Saturation/Ratio X1 to Xn Only		All Ratio Tests	All Winding Tests	
Concurrent				

It is important to NOT check insulation resistance test as high side is intentionally shorted to ground to eliminate the interference. User would have to perform the insulation resistance separately. Hit the play button to run the test

Following diagram will show up. Hit the play button again to confirm and unit will initiate the test.



Testing bushing CTs in a high noise substation



The tests will be performed in following order:

- DC winding resistance of CT secondary
- Demagnetization
- Saturation or Excitation Test
- Ratio and Polarity test

At the end of the test, a report similar to below will show up:



Testing bushing CTs in a high noise substation

МА	NUFACTURER	Ł		SE	RIAL NO.	5226t3a00	1		PHASE		
AS	SET ID				CURACY CLAS	s		SATURA		ISI 45	
BU	RDEN			_	VA						
				_							
56	econdary Vol Tap	X1-X2	n X1-X3	X1-X4	X1-X5	X2-X3	X2-X4	X2-X5	X3-X4	X3-X5	X4-X5
٤T	Nameplate	1000:5	2200:5	2500:5	3000:5	1200:5	1500:5	2000:5	300:5	800:5	500:5
	Measured	1000.291:5	2200.464:5	2500.626:5	3000.644:5	1200.172:5	1500.335:5	2000.353:5	300.163:5	800.18:5	500.018:
ŀ	% Error	0.029	0.021	0.025	0.021	0.014	0.022	0.018	0.054	0.023	0.004
۲ŀ	Test V (V)	99.866	219.68	249.65	299.57	119.82	149.79	199.71	29.967	79.888	49.920
ŀ	Test I (A)	0.1674	0.0761	0.0670	0.0558	0.1395	0.1116	0.0837	0.5579	0.2093	0.3349
ŀ	Prim V (V)	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992
P	hase Dev.	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'
	Polarity	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct
Kne	e Volt.(V)	196.23	431.30	490.20	589.27	235.07	293.96	393.05	58.893	157.93	99.016
	Cur.(A)	0.2643	0.1203	0.1058	0.0882	0.2209	0.1765	0.1324	0.8801	0.3306	0.5292
Voltage L Z							***		X1-X3 X1-X4 X1-X5 X2-X4 X2-X4 X3-X4 X3-X4 X3-X5		
	5 2 0,001	<i>A</i>	0.01	Curr		0.1	Disp	1	n Test Data	_	

Hit the save button to save the file by giving it a file name.

FILE HOME TOOLS	HELP							
New Open Save Print	Cut	🕞 Import 🔹 🋃 Export 🔹	Select Instrument	Setup	9 Initialize	Simulation Mode	Simulate Contact	Abort Test
File	Edit	Data	Instrum	ent Sett	ings	Tes	t Controls	

Testing CTs on X0 bushing

MRCT unit has H and X test leads

a) Connection of H leads

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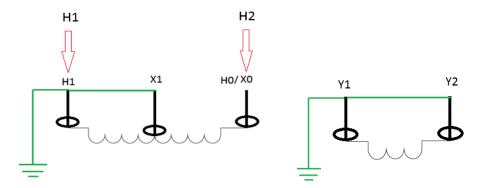
Testing bushing CTs in a high noise substation

Make following connections for H1 and H2 test leads

Bushing	H1	X1	H0- Xo	Y1	Y2
MRCT leads	H1	Grounded	H2	Grounded	Grounded

Please note that by connecting H1 and H2 test leads as shown above will generate incorrect polarity

but that will be taken care of in section below.



In the nameplate screen check the box "H2 connected to Shroud"



This will take care of incorrect polarity issue.

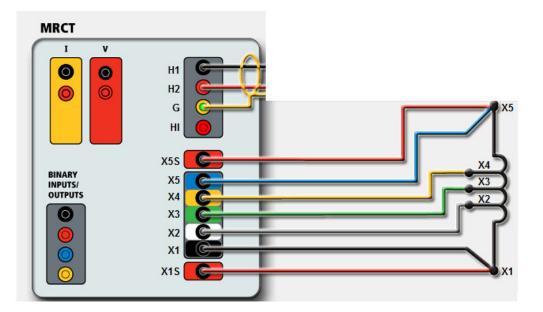
b) Connection of X leads

Connect MRCT secondary leads marked X1S, X1, X2, X3, X4, X5 and X5S to the secondary of the

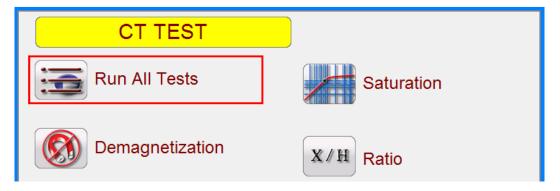
CT under test as per the diagram shown below.



Testing bushing CTs in a high noise substation



From home screen of the MRCT software select Run All Tests



In the Test selection screen, check all saturation, all ratio and all winding resistance test. Ratio test includes polarity test.



Testing bushing CTs in a high noise substation

# Taps 5	Saturation Test	Ratio Test	Winding Resistance	Insulation Resistance
X1-X2	\checkmark	\checkmark		Primary To Secondary 🗾 1KV
X1-X3	V	N	N	
X1-X4				Primary To Ground
X1-X5				Secondary To Ground 1KV
X2-X3	\checkmark	\checkmark		All Ranges
X2-X4		$\overline{\mathbf{\nabla}}$		Air Nairges
X2-X5	$\overline{}$	\checkmark	$\overline{\mathbf{\nabla}}$	
X3-X4	N	$\overline{\mathbf{v}}$	N	
X3-X5	$\overline{}$	\checkmark	$\overline{\mathbf{v}}$	
X4-X5	\checkmark	$\overline{\checkmark}$	N	
Saturation/Ratio X1 to Xn Only		All Ratio Tests	All Winding Tests	
Concurrent				

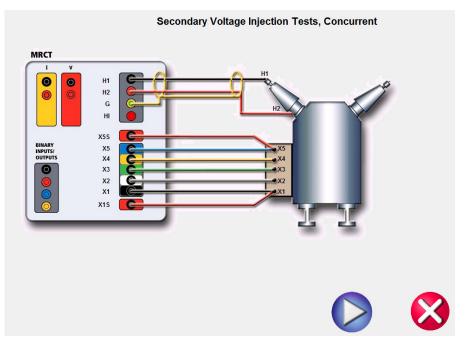
It is important to NOT check insulation resistance test as high side is intentionally shorted to ground to eliminate the interference. User would have to perform the insulation resistance separately.

Hit the play button to run the test

Following diagram will show up. Hit the play button again to confirm and unit will initiate the test.



Testing bushing CTs in a high noise substation



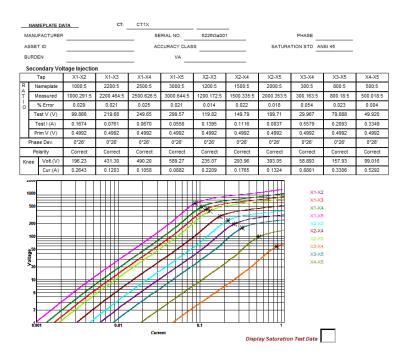
The tests will be performed in following order:

- DC winding resistance of CT secondary
- Demagnetization
- Saturation or Excitation Test
- Ratio and Polarity test

At the end of the test, a report similar to below will show up:



Testing bushing CTs in a high noise substation



Hit the save button to save the file by giving it a file name.



Testing CTs on Y1 bushing

If the tertiary winding has only single tap, user can change the no. of taps to two by going to

nameplate screen:



Testing bushing CTs in a high noise substation

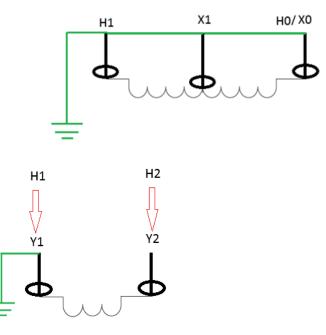
Nameplate			
Numeplate			
No. of CTs	1 No. of Cores 1	No. of Taps 2	CT Label X Name CT1
Manufacturer			Meter Protection
Serial No.		Accuracy Class	
Asset ID		VA (
Phase		Burden	
	H2 Connected to Shroud		Buried CT in Delta Connection

MRCT unit has H and X test leads

a) Connection of H leads

Make following connections for H1 and H2 test leads

Bushing	H1	X1	H0- Xo	Y1	Y2
MRCT leads	Grounded	Grounded	Grounded	H1 and Grounded	H2



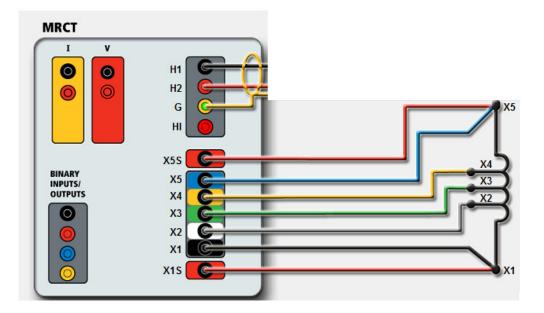


Testing bushing CTs in a high noise substation

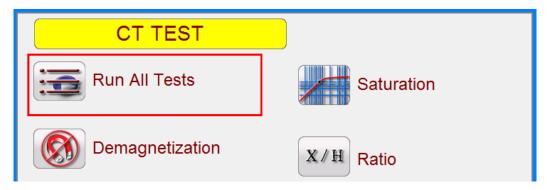
b) Connection of X leads

Connect MRCT secondary leads marked X1S, X1, X2, X3, X4, X5 and X5S to the secondary of the

CT under test as per the diagram shown below.



From home screen of the MRCT software select Run All Tests



In the Test selection screen, check all saturation, all ratio and all winding resistance test. Ratio test includes polarity test.



Testing bushing CTs in a high noise substation

# Taps 5	Saturation Test	Ratio Test	Winding Resistance	Insulation Resistance
X1-X2	\checkmark	\checkmark		Primary To Secondary 🗾 1KV
X1-X3	$\overline{}$	$\overline{\mathbf{\nabla}}$		Primary To Ground
X1-X4	\checkmark	\checkmark	\checkmark	Primary To Ground
X1-X5	N	$\overline{\mathbf{\nabla}}$	N	Secondary To Ground1KV
X2-X3	\checkmark	\checkmark	\checkmark	
X2-X4	N	$\overline{\checkmark}$	N	All Ranges
X2-X5	\checkmark	\checkmark	N	
X3-X4	N	\checkmark	N	
X3-X5	\checkmark	\checkmark	$\overline{\mathbf{A}}$	
X4-X5	$\overline{\checkmark}$	$\overline{\checkmark}$	N	
Saturation/Ratio		All Ratio Tests	All Winding Tests	
Concurrent				

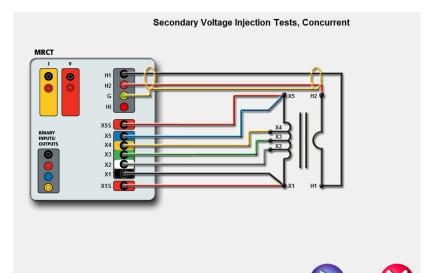
It is important to NOT check insulation resistance test as high side is intentionally shorted to ground to eliminate the interference. User would have to perform the insulation resistance separately.

Hit the play button to run the test

Following diagram will show up. Hit the play button again to confirm and unit will initiate the test.



Testing bushing CTs in a high noise substation



The tests will be performed in following order:

- DC winding resistance of CT secondary
- Demagnetization
- Saturation or Excitation Test
- Ratio and Polarity test

At the end of the test, a report similar to below will show up:

	NAMEPLATE DA	ATA	CT:	CT1X							
м	IANUFACTURER			SE	RIAL NO.	5226t3a00	1		PHASE		
A	SSET ID		ACCURACY CLASS					SATURA	TION STD AN	ISI 45	
в	URDEN		VA								
5	Secondary Vol	tage Injectio	n								
	Тар	X1-X2	X1-X3	X1-X4	X1-X5	X2-X3	X2-X4	X2-X5	X3-X4	X3-X5	X4-X5
R	Nameplate	1000:5	2200:5	2500:5	3000:5	1200:5	1500:5	2000:5	300:5	800:5	500:5
Ŧ	Measured	1000.291:5	2200.464:5	2500.626:5	3000.644:5	1200.172:5	1500.335:5	2000.353:5	300.163:5	800.18:5	500.018:5
0	% Error	0.029	0.021	0.025	0.021	0.014	0.022	0.018	0.054	0.023	0.004
	Test V (V)	99.866	219.68	249.65	299.57	119.82	149.79	199.71	29.967	79.888	49.920
	Test I (A)	0.1674	0.0761	0.0670	0.0558	0.1395	0.1116	0.0837	0.5579	0.2093	0.3349
	Prim V (V)	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992
	Phase Dev.	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'
	Polarity	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct
Kr	Cur.(A)	196.23 0.2643	431.30 0.1203	490.20 0.1058	589.27 0.0882	235.07 0.2209	293.96 0.1765	393.05 0.1324	58.893 0.8801	157.93 0.3306	99.016 0.5292
1			Jan Harrison (Construction of the second sec						X1-32 X1-32 X1-32 X1-32 X2 X2-32 X2 X2-32 X2 X2-32 X2 X2-32 X2 X2-32 X2 X2-32 X2 X2-32 X2	4 5 5 5 5 5	
	Current Display Saturation Test Data										



Testing bushing CTs in a high noise substation

Hit the save button to save the file by giving it a file name.

FILE HOME TOOLS	HELP		
New Open Save Print	Copy Import Paste Export Cut Import	Select Setup Initialize	Simulation Simulate Abort Mode Contact Test
File	Edit Data	Instrument Settings	Test Controls

Testing CTs on Y2 bushing

If the tertiary winding has only single tap, you can change the no. of taps to 2 by going to nameplate

screen:

Nameplate			
No. of CTs	1 No. of Cores 1	No. of Taps 2	CT Label X Name CT1
Manufacturer			Meter Protection
Serial No.		Accuracy Class	
Asset ID		VA	
Phase		Burden	
	H2 Connected to Shroud		Buried CT in Delta Connection

MRCT unit has H and X test leads

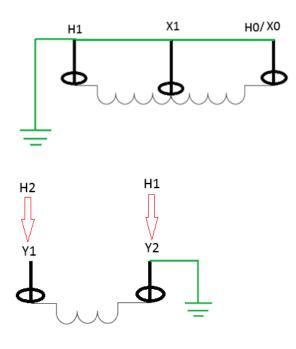
a) Connection of H leads

Make following connections for H1 and H2 test leads

Bushing	H1	X1	H0- Xo	Y1	Y2
MRCT leads	Grounded	Grounded	Grounded	H2	H1 and Grounded



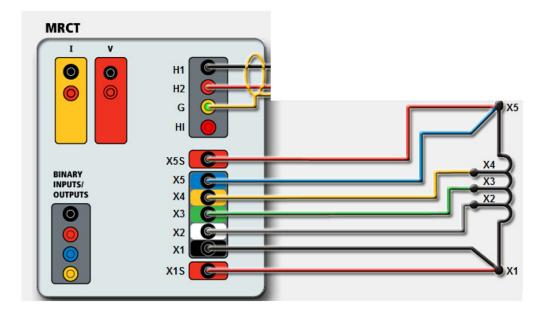
Testing bushing CTs in a high noise substation



b) Connection of X leads

Connect MRCT secondary leads marked X1S, X1, X2, X3, X4, X5 and X5S to the secondary of the

CT under test as per the diagram shown below.

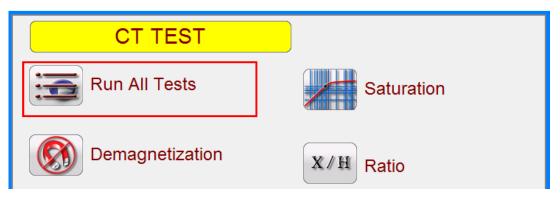


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Testing bushing CTs in a high noise substation

From home screen of the MRCT software select Run All Tests



In the Test selection screen, check all saturation, all ratio and all winding resistance test. Ratio test

includes polarity test.

# Taps 5	Saturation Test	Ratio Test	Winding Resistance	Insulation Resistance
X1-X2	\checkmark		\checkmark	Primary To Secondary 🗾 1KV
X1-X3	$\overline{\mathbf{\nabla}}$	$\overline{\mathbf{\nabla}}$		Primary To Ground
X1-X4	N	N		Primary To Ground
X1-X5	\checkmark		\checkmark	Secondary To Ground 1KV
X2-X3	\checkmark	\checkmark	\checkmark	
X2-X4	$\overline{\checkmark}$	$\overline{\checkmark}$	\checkmark	All Ranges
X2-X5	\checkmark	\checkmark		
X3-X4	$\overline{}$		$\overline{\mathbf{\nabla}}$	
X3-X5	$\overline{}$	\checkmark	\checkmark	
X4-X5	N	V	N	
Saturation/Rati			All Winding	
X1 to Xn Only	/ Tests	V Tests	V Tests	
Concurrent				

It is important to NOT check insulation resistance test as high side is intentionally shorted to ground

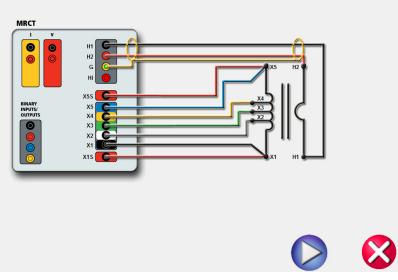
to eliminate the interference. User would have to perform the insulation resistance separately.



Testing bushing CTs in a high noise substation

Hit the play button to run the test

Following diagram will show up. Hit the play button again to confirm and unit will initiate the test.



Secondary Voltage Injection Tests, Concurrent

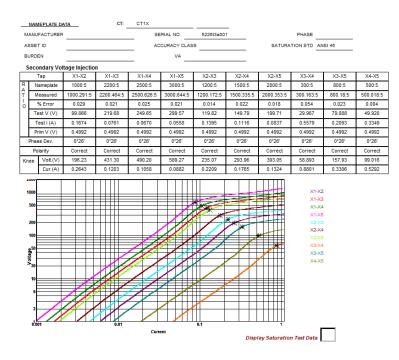
The tests will be performed in following order:

- DC winding resistance of CT secondary
- Demagnetization
- Saturation or Excitation Test
- Ratio and Polarity test

At the end of the test, a report similar to below will show up:



Testing bushing CTs in a high noise substation



Hit the save button to save the file by giving it a file name.

FILE H	OME TOOLS	HELP						
New Oper	Save Print	ि <u>a</u> <u>C</u> opy Copy Cut	ि Import… ▼ Export… ▼	Select Instrument	Setup Initialize	Simulation S Mode	Simulate Contact	Abort Test
	File	Edit	Data	Instrum	nent Settings	Test	Controls	