

## 1. Purpose

The purpose of this commissioning standard is to confirm that transformers are placed into service reliably and safely.

## 2. Description of applicable equipment

All pole type, ground type and indoor type transformers. For kiosk transformers refer to standard CB012.

## 3. Tests required

- Continuity test
- Insulation Resistance test (Megger)
- Voltage test
- Phase sequence test
  - This test shall be carried out in the following situations when dealing with three phase transformers
    - Where the transformer cannot be paralleled with any other three phase transformers, or
    - Where the transformer can be paralleled with another three phase transformer but for specific reasons such as load considerations, the final Phase Out test is not to be carried out at the substation.
- Phase Out test
  - This test shall be carried out in all cases where
    - A three phase transformer can be paralleled with another three phase transformer, or
    - Where a single phase transformer can be paralleled with another single phase transformer by means of LV isolators
- Earth Resistance test
- Tap Changer – Test the mechanism is operational and set correctly
- Ratio Changer for dual HV Voltage (11/6.6kV) transformers to ensure that the mechanism is set to the desired Voltage. Refer CP4726 / 2031 Ratio Testing 6.6/11kV Dual Voltage Transformers Operation Procedure.
- For CitiPower transformers confirm that the vector connection is suitable for the location

## 4. Tools and Equipment

- Audible (Buzz) tester or Insulation Resistance Tester (Megger) set on 500v setting.
- 1.0 kV, 2.5 kV or 5kV Insulation Resistance tester (Megger)
- Voltmeter
- Phase Identification tester
- Earth resistance tester

## 5. Test Procedures

Ensure correct Operational authorities are issued by an authorised operator prior to starting any tests.

### 5.1. Continuity test

- Check continuity from each active to active.
- This test may be carried out in depot prior to delivery to site.

### 5.2. Insulation Resistance test (Set megger for 2.5kV for all tests.)

- Check the HV windings,
- Check the LV windings,
- Check HV–LV windings,
- This test may be carried out in depot prior to delivery to site.

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#### Important:

For SWER and SWER Iso transformers disconnect the earth strap from 'ER' (Earth Return) before testing and reconnect the earth strap to 'ER' immediately after testing.

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### 5.3. Voltage test

Please note that test must be taken at the transformer side of the transformer open LV isolator/fused isolators or fuses.

- Three phase  
Using a voltmeter that has a range from zero to at least 600 volts measure
  - the voltage of each phase to neutral, and
  - each phase to the next phase until all phases have been tested.
- Single phase (including SWER and SWER Iso)  
Using a voltmeter that has a range from zero to at least 600 volts measure
  - actives to neutral, and
  - active to active

### 5.4. Phase sequence test

Using the phase identification tester connect the red, white and blue leads of the instrument and to the respective phases at the transformer LV isolators/fused isolators.

### 5.5. Phase Out test

Using a voltmeter the test is to be conducted between the two live circuits at the transformer LV isolators/fused isolators or, where this is not considered appropriate, at the normal paralleling (open) point and in the following manner:

- Ensure that both circuits are alive by conducting phase to phase voltage checks on each circuit separately.
- Carry out a test from one circuit to the other across the open point

**5.6. Earth Resistance test**

Conduct earth resistance test as per current earthing test procedures.

**Warning:**

Ensure that transformer is isolated and earthed prior to testing SWER HV earth.

**5.7. Ratio Changer Test**

Refer to CitiPower Operational Procedure CP4723 / 2031.

**5.8. Tap Changer (Confirm tap changer is operational)**

**5.9. Vector Group (Only required within CitiPower)**

A visual inspection of the name plate to confirm the transformer is suitable for the location.

**6. Test Result Pass Criteria**

When recording these values, an accurate measurement must be recorded. Values with ranges (e.g. 55+MΩ) will not be acceptable. The test results will form the baseline for future maintenance purposes.

**6.1. Continuity and Megger tests**

**Three-Phase**

Test type	Test result
<b>HV</b>	
A-B, A-C, B-C	0 Ω *
A to transformer tank/earth	> 1000 MΩ (1GΩ)
<b>LV</b>	
a-b, a-c, b-c, a-n	0 Ω
a to transformer tank/earth	> 10 MΩ
<b>HV-LV</b>	
A-a	> 1000 MΩ (1GΩ)

**Single-Phase**

Test type	Test result
<b>HV</b>	
A <sub>1</sub> -A <sub>2</sub> 0	Ω *
A <sub>1</sub> to transformer tank/earth	> 1000 MΩ (1GΩ)
<b>LV</b>	
a1-a4, a1-neutral	0 Ω

**Single-Phase**

Test type	Test result
a1 to transformer tank/earth	> 1000 MΩ (1GΩ)
<b>HV-LV</b>	
A <sub>1</sub> -a1	> 1000 MΩ (1GΩ)

**SWER**

Test type	Test result
<b>HV</b>	
SW-ER	0 Ω *
SW to transformer tank/earth	> 10 MΩ
<b>LV</b>	
a1-a4, a1-neutral	0 Ω
a1 to transformer tank	> 1000 MΩ (1GΩ)
<b>HV-LV</b>	
SW-a1	> 1000 MΩ (1GΩ)

**SWER Isolator**

Test type	Test result
<b>HV</b>	
A <sub>1</sub> -A <sub>2</sub> 0	Ω *
A <sub>1</sub> to transformer tank	> 1000 MΩ (1GΩ)
A <sub>1</sub> -SW	> 1000 MΩ (1GΩ)
SW-ER	0 Ω *
SW to transformer tank	> 10 MΩ
<b>LV</b>	
a1-a4, a1-neutral	0 Ω
a1 to transformer tank	> 1000 MΩ (1GΩ)
<b>HV-LV</b>	
A <sub>1</sub> -a1	> 1000 MΩ (1GΩ)
SW-a1	> 100 MΩ

\* Test with tap changer in required in-service position.

6.2. Voltage Test

Three-Phase

Test	22kV	6.6/11kV & 11kV
Phase to Neutral	240 – 245	235 – 240
Phase to Phase	415 – 424	407 – 415

Single-Phase (including SWER and SWER Iso)

Test type	Test result
Actives to Neutral	240 – 245V
Active to Active	480 – 490 V

6.3. Phase Sequence Test

The test is considered satisfactory when the tester indicates “correct sequence”.

6.4. Phase Out Test

Test type	Test result
Red to Red	< 10 V
White to White	< 10 V
Blue to Blue	< 10 V

6.5. Earth Resistance Test

The following table outlines the maximum allowable resistance to earth for MEN, IMEN and CMEN earthing systems.

Earthing System	Earthing Arrangement	Max. Resistance of Earth System to Ground (Ohms)			Max. Resistance of Neutral to Ground (Ohms)	Testing Requirements
		HV	LV	Common		
<b>Pole Mounted (except 66kV or SWER), Ground type, Indoor Substation</b>						
CMEN	Common or Bonded HV/LV	N/A	N/A	10	1	Common earth with Neutral Connected
MEN or IMEN	Common or Bonded HV/LV	N/A	N/A	10 (MEN) 1 (IMEN)	1	Common earth with Neutral Connected
	Separate HV/LV	10	10	N/A	10	HV earth LV earth LV earth with

Earthing System	Earthing Arrangement	Max. Resistance of Earth System to Ground (Ohms)			Max. Resistance of Neutral to Ground (Ohms)	Testing Requirements
		HV	LV	Common		
						Neutral connected
<b>Kiosk Substation</b>						
CMEN	Common or Bonded HV/LV	N/A	N/A	10	1	Common earth with Neutral Connected
MEN or IMEN	Common or Bonded HV/LV	N/A	N/A	10	1	Common earth Common earth with Neutral Connected
	Separate HV/LV	10	10	N/A	10	HV earth LV earth LV earth with Neutral connected
<b>Pole Mounted Substations (on 66 kV poles)</b>						
MEN or IMEN	Separate HV/LV	N/A	10	N/A	10	HV earth LV earth LV earth with Neutral connected
<b>Pole Mounted Substations (SWER)</b>						
MEN or IMEN	Separate HV/LV	Isolating substation			30	HV earth LV earth LV earth with Neutral connected
		1 (200kVA) 2 (100kVA) 4 (50kVA) 8 (25kVA)	30	N/A		
MEN or IMEN	Separate HV/LV	Distribution Substation			30	HV earth LV earth LV earth with Neutral connected
		10 ( $\leq$ 25kVA) 4 (50kVA)	30	N/A		

## 7. Supporting documents

### 7.1. Test Report Forms

The commissioning test reports are available in the appendix:

- Transformers – Three Phase Test Report
- Transformers – Single Phase Test Report
- Transformers – SWER Test Report
- Transformers – SWER ISO – Test Report

For CitiPower/Powercor employees the commissioning test reports are to be completed via the ClickMobile application, for further details refer to guideline “Testing Form” (Document No. JEQA4UJ443MT-1864305901-228).

The commissioning standards and test reports can also be found on CitiPower/Powercor’s external website from:

- Home/Industry/Supplier Resources/Forms, Reports and Bulletins/Commissioning Standards and Test Reports.

### 7.2. Standard Works Practices

Related works practices are available from Source:

- SWP High Voltage Underground Cable and Plant Commissioning.

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## Appendix A - Transformers-Three Phase - Test Report

Job Title:

Test Instrument Model		Instrument No.	
Test Instrument Model		Instrument No	
Tested by		Date	

DSM (location) Number	
Make	
Serial Number	
Rating	
Voltage	
Tap Setting	

**NOTE:** When recording values below, an accurate measurement must be recorded. Values with ranges (e.g. 55+MΩ) will not be acceptable. The test results will form the baseline for future maintenance purposes.

CONTINUITY AND INSULATION RESISTANCE TESTS					
Three Phase					
HV		A-B	A-C	B-C	Expected Value
	Service Tap	Ω	Ω	Ω	0Ω
		A	B	C	
	A - transformer tank	MΩ	MΩ	MΩ	>1000 MΩ (1GΩ)
LV	Red-neutral	A-B	A-C	B-C	
		MΩ	MΩ	MΩ	0Ω
		A	B	C	
	a - transformer tank	MΩ	MΩ	MΩ	>10 MΩ
HV-LV	HV - LV	MΩ	MΩ	MΩ	>1000 MΩ (1GΩ)

VOLTAGE TEST	
Three phase	
Red to Neutral	V
White to Neutral	V
Blue to Neutral	V
Red to White	V
White to Blue	V
Blue to Red	V

PHASE IDENTIFICATION TEST	
Phase Checked	

PHASE OUT TEST	
Three Phase	
Red to Red	
White to White	
Blue to Blue	

HV FUSES	
Make/ Number of	
Fuse	PF <input type="checkbox"/> EDO <input type="checkbox"/> BA <input type="checkbox"/> FT <input type="checkbox"/>
Fuse Rating	
Element Type**	K <input type="checkbox"/> E <input type="checkbox"/> T <input type="checkbox"/>

LV FUSES	
Type / Make	
Fuse Unit	
Fuse Rating	
Element Type	

SURGE DIVERTERS	
Make	
Number of	
Class	A(Fire) <input type="checkbox"/> C(Non Fire) <input type="checkbox"/>

**Appendix A - Transformers-Three Phase - Test Report (Continues)**

EARTH RESISTANCE TEST	
Substation Type (tick type applicable)	
Pole mounted	
Ground type	
Indoor type	
Kiosk	

Earthing System (tick system applied)		Earthing arrangement (tick applied arrangement)	
CMEN		Common	
MEN		Bonded HV/LV	
IMEN		Separate HV/LV	

Maximum Resistance			
Earth System to Ground		Allowed (Refer to CB011)	Measured
	HV	Refer to CB011	Ω
	LV	Refer to CB011	Ω
	Common	Refer to CB011	Ω
Neutral to Ground		Refer to CB011	Ω

Ratio Changer Test Passed	
Tap Changer Operational	
Vector Group Correct.	

CHECKLIST		
Items	Checked	Comment (if any)
All required tests satisfactorily completed as per CB011		
HV metalclad switchgear tests satisfactorily completed as per CB021		
Substation and complete installation complies with the work instruction requirements a) Is the transformer the correct polarity? b) Correct Vector Group? c) Correct Rating?		
No visible damage		
Is the correct earthing system installed		
Is the appropriate earth conductor size used		
Fuses appropriate for substation size are correctly installed where applicable		
Have all breather caps been removed as required		
Is the transformer oil level correct		
Signs and Labels		
Ensure all signage and labelling complies with DS411		

**Commissioning Test Passed**    Yes -     No -

**Comments**

**Signed:**

**Date:**

## Appendix B - Transformers-Single Phase - Test Report

Job Title:

Test Instrument Model		Instrument No.	
Test Instrument Model		Instrument No	
Tested by		Date	

DSM (location) Number	
Make	
Serial Number	
Rating	
Voltage	
Tap Setting	

**NOTE:** When recording values below, an accurate measurement must be recorded. Values with ranges (e.g. 55+MΩ) will not be acceptable. The test results will form the baseline for future maintenance purposes.

CONTINUITY AND INSULATION RESISTANCE TESTS			
Single Phase			
HV		A1-A1	Expected Value
	Service Tap	Ω	0Ω
	A1-transformer tank	MΩ	>1000 MΩ (1GΩ)
LV	a1-a4	Ω	0Ω
	a1-neutral	Ω	0Ω
	a1-transformer tank	MΩ	>1000 MΩ (1GΩ)
HV-LV	A1-a1	MΩ	>1000 MΩ (1GΩ)

VOLTAGE TEST	
Single Phase	
Active to Neutral	V
Active to Neutral	V
Active to Active	V

PHASE OUT TEST	
Single Phase	
Active to Active	V
Active to Active	V

HV FUSES	
Make/ Number of	
Fuse	PF <input type="checkbox"/> EDO <input type="checkbox"/> BA <input type="checkbox"/> FT <input type="checkbox"/>
Fuse Rating	
Element Type**	K <input type="checkbox"/> E <input type="checkbox"/> T <input type="checkbox"/>

LV FUSES	
Type / Make	
Fuse Unit	
Fuse Rating	
Element Type	

SURGE DIVERTERS	
Make	
Number of	
Class	A(Fire) <input type="checkbox"/> C(Non Fire) <input type="checkbox"/>

### Appendix B - Transformers-Single Phase - Test Report (Continues)

EARTH RESISTANCE TEST	
Substation Type (tick type applicable)	
Pole mounted	
Ground type	
Indoor type	
Kiosk	

Earthing System (tick system applied)		Earthing arrangement (tick applied arrangement)	
CMEN		Common	
MEN		Bonded HV/LV	
IMEN		Separate HV/LV	

Maximum Resistance			
Earth System to Ground		Allowed (Refer to CB011)	Measured
		HV	Refer to CB011
	LV	Refer to CB011	Ω
	Common	Refer to CB011	Ω
Neutral to Ground		Refer to CB011	Ω

Tap Changer Operational	
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CHECKLIST		
Items	Checked	Comment (if any)
All required tests satisfactorily completed as per CB011		
HV metalclad switchgear tests satisfactorily completed as per CB021		
Substation and complete installation complies with the work instruction requirements a) Is the transformer the correct polarity? b) Correct Vector Group? c) Correct Rating?		
No visible damage		
Is the correct earthing system installed		
Is the appropriate earth conductor size used		
Fuses appropriate for substation size are correctly installed where applicable		
Have all breather caps been removed as required		
Is the transformer oil level correct		
<b>Signs and Labels</b>		
Ensure all signage and labelling complies with DS411		

**Commissioning Test Passed**    Yes -     No -

**Comments**

**Signed:**

**Date:**

## Appendix C - Transformers-SWER - Test Report

Job Title:

Test Instrument Model		Instrument No.	
Test Instrument Model		Instrument No	
Tested by		Date	

DSM (location) Number	
Make	
Serial Number	
Rating	
Voltage	
Tap Setting	

**NOTE: When recording values below, an accurate measurement must be recorded. Values with ranges (e.g. 55+MΩ) will not be acceptable. The test results will form the baseline for future maintenance purposes.**

CONTINUITY AND INSULATION RESISTANCE TESTS			
Single Phase			
HV		SW-ER	Expected Value
	Service Tap	Ω	0Ω
	SW-transformer tank	MΩ	>10 MΩ
LV	a1-a4	Ω	0Ω
	a1-neutral	Ω	0Ω
	a1-transformer tank	MΩ	>1000 MΩ (1GΩ)
HV-LV	SW-a1	MΩ	>1000 MΩ (1GΩ)

VOLTAGE TEST	
SWER	
Active to Neutral	V
Active to Neutral	V
Active to Active	V

PHASE OUT TEST	
SWER	
Active to Active	V
Active to Active	V

HV FUSES	
Make/ Number of	
Fuse	PF <input type="checkbox"/> EDO <input type="checkbox"/> BA <input type="checkbox"/> FT <input type="checkbox"/>
Fuse Rating	
Element Type**	K <input type="checkbox"/> E <input type="checkbox"/> T <input type="checkbox"/>

LV FUSES	
Type / Make	
Fuse Unit	
Fuse Rating	
Element Type	

SURGE DIVERTERS	
Make	
Number of	
Class	A(Fire) <input type="checkbox"/> C(Non Fire) <input type="checkbox"/>

**Appendix C - Transformers-SWER - Test Report (Continues)**

EARTH RESISTANCE TEST	
Substation Type (tick type applicable)	
Pole mounted	
Ground type	
Indoor type	
Kiosk	

Earthing System (tick system applied)		Earthing arrangement (tick applied arrangement)	
CMEN		Common	
MEN		Bonded HV/LV	
IMEN		Separate HV/LV	

Maximum Resistance			
Earth System to Ground		Allowed (Refer to CB011)	Measured
	HV	Refer to CB011	Ω
	LV	Refer to CB011	Ω
	Common	Refer to CB011	Ω
Neutral to Ground		Refer to CB011	Ω

Tap Changer Operational	
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CHECKLIST		
Items	Checked	Comment (if any)
All required tests satisfactorily completed as per CB011		
HV metalclad switchgear tests satisfactorily completed as per CB021		
Substation and complete installation complies with the work instruction requirements a) Is the transformer the correct polarity? b) Correct Vector Group? c) Correct Rating?		
No visible damage		
Is the correct earthing system installed		
Is the appropriate earth conductor size used		
Fuses appropriate for substation size are correctly installed where applicable		
Have all breather caps been removed as required		
Is the transformer oil level correct		
Signs and Labels		
Ensure all signage and labelling complies with DS411		

**Commissioning Test Passed**    Yes -     No -

**Comments**

**Signed:**

**Date:**

## Appendix D - Transformers-SWER Iso - Test Report

**Job Title:**

<b>Test Instrument Model</b>		<b>Instrument No.</b>	
<b>Test Instrument Model</b>		<b>Instrument No</b>	
<b>Tested by</b>		<b>Date</b>	

DSM (location) Number	
Make	
Serial Number	
Rating	
Voltage	
Tap Setting	

**NOTE: When recording values below, an accurate measurement must be recorded. Values with ranges (e.g. 55+MΩ) will not be acceptable. The test results will form the baseline for future maintenance purposes.**

<b>CONTINUITY AND INSULATION RESISTANCE TESTS</b>			
SWER Iso			
HV		<b>A1-A2</b>	<b>Expected Value</b>
	Service Tap	Ω	0Ω
	A1-transformer tank	MΩ	>1000 MΩ (1GΩ)
	A1-SW	MΩ	>1000 MΩ (1GΩ)
	SW-ER	Ω	0Ω
LV	SW-transformer tank	MΩ	>10 MΩ
	a1-a4	Ω	0Ω
	a1-neutral	Ω	0Ω
HV-LV	a1-transformer tank	MΩ	>1000 MΩ (1GΩ)
	A1-a1	MΩ	>1000 MΩ (1GΩ)
	SW-a1	MΩ	>100 MΩ

<b>VOLTAGE TEST</b>	
SWER Iso	
Active to Neutral	V
Active to Neutral	V
Active to Active	V

<b>HV FUSES</b>	
Make/ Number of	
Fuse	PF <input type="checkbox"/> EDO <input type="checkbox"/> BA <input type="checkbox"/> FT <input type="checkbox"/>
Fuse Rating	
Element Type**	K <input type="checkbox"/> E <input type="checkbox"/> T <input type="checkbox"/>

<b>LV FUSES</b>	
Type / Make	
Fuse Unit	
Fuse Rating	
Element Type	

<b>SURGE DIVERTERS</b>	
Make	
Number of	
Class	A(Fire) <input type="checkbox"/> C(Non Fire) <input type="checkbox"/>

**Appendix D - Transformers-SWER Iso - Test Report (Continues)**

EARTH RESISTANCE TEST	
Substation Type (tick type applicable)	
Pole mounted	
Ground type	
Indoor type	
Kiosk	

Earthing System (tick system applied)		Earthing arrangement (tick applied arrangement)	
CMEN		Common	
MEN		Bonded HV/LV	
IMEN		Separate HV/LV	

Maximum Resistance			
Earth System to Ground		Allowed (Refer to CB011)	Measured
	HV	Refer to CB011	Ω
	LV	Refer to CB011	Ω
	Common	Refer to CB011	Ω
Neutral to Ground		Refer to CB011	Ω

CHECKLIST		
Items	Checked	Comment (if any)
All required tests satisfactorily completed as per CB011		
HV metalclad switchgear tests satisfactorily completed as per CB021		
Substation and complete installation complies with the work instruction requirements a) Is the transformer the correct polarity? b) Correct Vector Group? c) Correct Rating?		
No visible damage		
Is the correct earthing system installed		
Is the appropriate earth conductor size used		
Fuses appropriate for substation size are correctly installed where applicable		
Have all breather caps been removed as required		
Is the transformer oil level correct		
Signs and Labels		
Ensure all signage and labelling complies with DS411		

**Commissioning Test Passed**    Yes -     No -

**Comments**

**Signed:**

**Date:**