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Electricity Specification 510

Issue 2 October 2021

Procedure for Commissioning Measurement Transformers Connected to Settlement Metering Equipment

Amendment Summary

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Contents

1 Introduction

This document specifies the procedures for testing and commissioning measurement transformers (CTs and VTs) connected to settlement metering equipment. As such, it implements the requirements of Code of Practice (CP) 510.

Testing and commissioning must be carried out:

- following complete assembly or installation of the equipment, where the measurement transformers or any associated secondary wiring are not intended to be disturbed;
- to appropriate procedures;
- by a competent commissioning engineer, who is a suitably Authorised Person and who meets, as a minimum, the requirements of Authorisation Code 165 and Code 166 in CP 614;
- with the equipment suitably isolated from the electricity system;
- in accordance with Electricity North West Limited's Distribution Safety Rules.

If either the equipment or any secondary wiring is disturbed such that the results of any tests or checks are affected, the affected equipment/secondary wiring circuits must be retested/recommissioned.

The requirements and recommendations of equipment manufacturers must be followed. Any conflict with these procedures must be referred to the Protection Policy Manager.

The tests and commissioning checks in this document must be satisfactorily completed and recorded on the relevant CP 510 commissioning record form before the metering equipment is put into service.

2 Scope

This specification comprises the procedures for testing and commissioning measurement transformers (CTs and VTs) connected to settlement metering equipment.

The scope of this document applies to measurement transformers used for settlement metering installed in the following electricity distribution network (Network) assets owned or to be adopted by Electricity North West Limited.

- HV metering units.
- HV metering switchgear panels.
- LV metering cut-out units.
- LV metered service units.
- LV substation cable distribution boards incorporating metered service ways.
- LV metering moulded case circuit-breakers (MCCBs).

This procedure applies to testing and commissioning carried out by:

- Electricity North West Limited employees.
- Electricity North West Limited delivery partners and/or contractors.
- Independent Connection Providers (ICPs) who commission metering equipment to be adopted by Electricity North West Limited.

This procedure does not apply to:

- commissioning of settlement metering equipment neither owned nor to be adopted by Electricity North West Limited.

3 Definitions

CP	Code of Practice
CT	Current transformer
ES	Electricity Specification
HV	High voltage
ICP	Independent Connection Provider
LV	Low voltage
Measurement transformer	Current transformer or voltage transformer
MPAN	Metering Point Administration Number
SCDB	Substation Cable Distribution Board
Settlement metering	Metering equipment used for settlement purposes in accordance with Balance and Settlement Code requirements
VT	Voltage transformer

4 Equipment

4.1 HV Equipment

HV metering units approved by Electricity North West Limited have the following characteristics.

- Flange or cable box connection to Electricity North West Limited switchgear connections.
- A combined CT/VT arrangement.
- Three-phase 3-limb star connected VT construction.
- Unearthed HV star point.
- VT secondary fuses/links.
- Dual ratio CTs provided in the L1 and L3 phases.
- Discrete CT secondary winding terminals, i.e. not commoned together.
- Terminal blocks with:

- shorting links for CT secondary winding terminals;
- sliding earth link for earthing one side of the CT secondary windings;
- test points for the CT/VT secondary windings.

HV metering units must conform to the requirements in Clause 10 of ES 314.

For combinations of HV switchgear and HV metering units that are prepared and assembled at Electricity North West Limited's stores, it is intended that commissioning of measurement transformers and associated secondary wiring to the equipment secondary terminal blocks, so far as is practicable, will be carried out in conjunction with protection testing prior to dispatch to site.

4.2 LV Equipment

4.2.1 LV Metering Cut-outs

LV metering cut-outs comprise of a traditional fused cut-out either connect to a metering CT chamber or combined with metering CTs. The metering CTs are connected via a multicore cable, to a separate metering cubicle, which houses the test terminal block.

Metering CT chambers/metering CTs that are assembled and connected on site must be commissioned at site following installation by the relevant commissioning party (see Appendix C of CP510).

Background information on LV metering CT/VT arrangements can be found in CP 502.

4.2.2 LV Metered Service Units

LV metered service units comprise of a complete factory assembled and tested unit comprising of a traditional fused cut-out, metering CT chamber, test terminal block and provision to house settlement meters.

Commissioning of measurement transformers and associated secondary wiring contained within LV metered service units will be carried out by the supplier (see ES 503) and subsequent site tests will not be required following installation at site providing the metering CT unit, secondary wiring and test terminal block is not visibly damaged or has not been disturbed.

4.2.3 LV Metered Service Ways

LV metered service ways comprise of a fuse way within a substation cable distribution board (SCDB) with a metering CT arrangement. The metering CTs are connected via a multicore cable, to a separate metering cubicle, which houses the test terminal block.

For LV SCDBs with metered service ways that are prepared and assembled at Electricity North West Limited's stores, it is intended that commissioning of measurement transformers and associated secondary wiring to the equipment secondary terminal blocks, so far as is practicable, will be carried out in conjunction with protection testing prior to dispatch to site.

5 Test Equipment

Typical test equipment/instruments to be used include:

- Insulation resistance tester (1 kV).
- Analogue multimeter (with d.c. mA range).
- Clamp ammeter.
- Current injection test set.
- Voltage injection test set.

The make, type, serial number, description and calibration details of each item of test equipment/instrument must be recorded on the commissioning record form.

Test equipment/instruments to be used must have a valid calibration certificate and must only be used within the calibration expiry date.

6 Common Requirements

6.1 Commissioning Records

The relevant commissioning record from Appendix A of CP510 must be completed.

- A1 – HV Metering Equipment
- A2 – LV Metering Equipment

All fields on the relevant commissioning record must be completed.

Confirm the manufacturer's calibration certificate(s) are attached to the switchgear and in are in accordance with ES 501 by checking the certificates for the following.

- Results match each measurement transformer (by comparing the serial number(s) on the switchgear nameplate with those on the certificate).
- Confirmation of correct phase, polarity and marking.
- Confirmation continuity and insulation resistance of secondary wiring are satisfactory.
- Ratio error results are documented for all available ratios and range of burdens.
- Phase angle error results for all available ratios and range of burdens.

Any missing results/confirmation and/or anomalies must be noted on the commissioning record.

6.2 Customer Information

Record the following.

- Name of the customer (see the XXXX).
- Address of the property, where the measurement transformers are installed.

- MPAN (available from Sharepoint maintained by Data Management).
- If installed in a substation, the name, and where available the number, of the substation (see the nameplate on the substation door).
- Switch panel circuit name, if applicable (see the circuit label on the front of the panel).
- Switchgear serial number(s), if applicable (see the nameplate on the switch panel). NOTE: This is different to the measurement transformer serial number(s).
- Structure Plant Number (SPN) XXXX

6.3 CT/VT Details

Record the physical location of each CT/VT in relation to the Defined Metering Point. The Defined Metering Point is usually the point of connection to Electricity North West Limited's electricity distribution network. Record any disparity between location of the metering CT/VTs and the Defined Metering Point.

NOTE: The metering CT/VTs should be physically and electrically at or close to the Defined Metering Point.

For each CT/VT, check the nameplate and record: the serial number, burden (VA rating), accuracy class (e.g. Class 0.5 is equivalent to 0.5%), make/manufacturer, type, available ratios (e.g. 200/100/5 Amps for CT and 11,000/6,600/110 Volts for VT) and the selected ratio (e.g. 100/5 Amps for CT and 11,000/110 Volts for VT).

NOTE: The selected ratio can be determined by checking the secondary ferruling against the equipment wiring diagram or by checking the connections on the CT nameplate plate.

Record the VT secondary fuse ratings.

6.4 Electrical Safety

Prior to carrying out any electrical tests ensure:

- both primary and secondary connections of the measurement transformers are dead and isolated.
- the metering circuit breaker is open, where applicable.

Equipment that is connected to Electricity North West Limited's electricity distribution network must be made safe for testing in accordance with Electricity North West Limited's Distribution Safety Rules. Testing of HV equipment must be carried out under a Sanction-For-Test.

CT secondary connections must not be open-circuited when the primary circuit is energised.

When energised, open-circuited CT secondary connections can be at high voltages.

6.5 CT/VT Reference Voltage Associations

The correct phase association between each CT and each VT (for HV) or its reference voltage (for LV) must be determined to confirm the current in the L1 phase CT is associated with the voltage in L1 VT or the L1 reference voltage.

Carry out the phase identification checks in 7.2.7 and 8.2.8 and record in the 'CT/VT reference voltage associations' section of the commissioning record.

Where the supply can be energised check the phase sequence is standard at the test terminal block by connecting a phase sequence meter to the reference voltage terminals. The correct phase sequence should be:

L1 Brown (previously Red)

L2 Black (previously Yellow)

L3 Grey (previously Blue)

NOTE: It is not necessary to check the correct phase sequence if the supply cannot be energised as this is the responsibility of the Meter Operator Agent.

7 Voltage Transformers

7.1 Insulation Resistance (3 Limb VT)

7.1.1 Disconnect the VT secondary connections from the metering multicore cable terminals at the test terminal block.

NOTE: This is not required if the metering multicore cable is not installed.

7.1.2 Check all VT fuses and earth links are in place.

7.1.3 Measure the insulation resistance of the VT primary (HV) winding to earth using a 1 kV insulation resistance tester connected between the HV winding and earth.

Acceptance criteria: Insulation resistance > 100 MΩ.

7.1.4 Open the VT secondary earth link.

7.1.5 Where practicable, earth the VT primary winding star point.

7.1.6 Measure the insulation resistance of each VT secondary (LV) winding to earth using a 1 kV insulation resistance tester connected between the LV winding and the secondary earth terminal.

Acceptance criteria: Insulation resistance > 100 MΩ.

7.1.7 Reclose the VT secondary earth link.

7.1.8 Connect an ohmmeter across the terminals of the secondary earth link.

7.1.9 Record the d.c. resistance measured by the ohmmeter.

7.1.10 Confirm the VT primary winding star point is unearthed.

7.2 Phase Identification

7.2.1 For a star-star connected VT the relationship between the HV connections and VT windings should be as follows.

Table 1

HV CONNECTIONS	VT PRIMARY WINDINGS	VT SECONDARY WINDINGS
L1 - L2	U - V	u - v
L2 - L3	V - W	v -w
L3 - L1	W- U	w - u

7.2.2 For the selected ratio connect an a.c. test system between L1 and L2 (L1 – L2) HV connections (which should correspond to phase U and V (U – V) of the VT primary (HV) winding).

7.2.3 Apply a test voltage of 120 V a.c.

7.2.4 Confirm the measured secondary a.c. voltage across phase u and v (u – v) of the VT secondary (LV) windings corresponds to the value in Table 2. This should be the highest voltage measured either between phases or between and phases and neutral.

Table 2

VOLTAGE RATIO	PRIMARY AC TEST VOLTAGE	PRIMARY CONNECTION	SECONDARY AC MEASURED VOLTAGE	SECONDARY CONNECTION
33000/110 V	120 V	L1-L2	0.4 V 0.2 V 0 V	u-v u-n v-n w-n
		L2-L3	0.4 V 0.2 V 0 V	v-w v-n w-n u-n
		L3-L1	0.4 V 0.2 V 0 V	w-u w-n u-n v-n
11000/110 V	120 V	L1-L2	1.2V 0.6 V 0V	u-v u-n v-n w-n
		L2-L3	1.2V 0.6 V 0V	v-w v-n w-n u-n
		L3-L1	1.2V 0.6 V 0V	w-u w-n u-n v-n
6600/110 V	120 V	L1-L2	2 V 1 V 0V	u-v u-n v-n w-n
		L2-L3	2 V 1 V 0V	v-w v-n w-n u-n
		L3-L1	2 V 1 V 0V	w-u w-n u-n v-n

7.2.5 Repeat the tests in 7.2.2 to 7.2.3 and the measurements in 7.2.4 for the following HV connections.

- L2 – L3 (which should correspond to phase V and W of the VT primary (HV) winding and phase v and w of the VT secondary (LV) winding.
- L3 – L2 (which should correspond to phase W and U of the VT primary (HV) winding and phase w and u of the VT secondary (LV) winding).

7.2.6 An alternative magnitude of a.c. test voltage may be used, in which case the expected secondary a.c. measured voltage in Table 2 must be adjusted accordingly.

7.2.7 Following the tests above confirm the relationship between the L1, L2 and L3 phase connections and the VT secondary wiring is correct and the VT secondary wiring ferruling matches the metering scheme wiring diagram.

7.3 Ratio

7.3.1 The ratio of the VT should be confirmed from the ratio of the primary a.c. test voltage applied across the VT primary (HV) windings and the secondary a.c. measured voltage across the corresponding LV secondary (LV) windings as follows.

7.3.2 Calculate the VT ratio using the formula below.

Calculated VT Ratio = Injected Primary Voltage / Measured Secondary Voltage

7.3.3 Confirm the calculated VT ratio compares to the VT ratio on the nameplate.

7.3.4 Repeat test for the L2 and L3 phase VTs, as required.

8 Current Transformers

8.1 Insulation Resistance

8.1.1 Open the CT secondary earth link, if fitted. If an earth link is not fitted, disconnect the CT secondary winding star point connection from earth.

The integrity of the CT star point must not be disturbed.

8.1.2 Measure the insulation resistance of each CT secondary winding to earth using a 1 kV insulation resistance tester connected between the CT star point connection and the secondary earth terminal.

NOTE:

As one end of each CT secondary winding is connected together via the star point a connection between the star point connection and earth will test all CT secondary connections to earth including selected and available ratio connections.

Acceptance criteria: Insulation resistance > 100 MΩ.

8.1.3 Reclose the CT secondary earth link or reconnect the CT secondary star point connection to earth, as appropriate.

8.1.4 Connect an ohmmeter across the terminals of the secondary earth link.

8.1.5 Record the d.c. resistance measured by the ohmmeter.

8.2 Polarity (Flick Test) & Phase Identification

8.2.1 Connect an analogue multimeter, set to the d.c. mA range, across the secondary winding of the L1 phase (phase u) CT with the positive terminal connected to the S1 terminal and the negative terminal connected to S2 terminal.

8.2.2 Connect the negative terminal of a battery (typically a 6 V lantern battery) to P2 side of the CT.

8.2.3 Momentarily connect the positive terminal of the battery to P1 side of the CT, a flick in the positive direction (usually to the right) should be seen on the multimeter.

8.2.4 Connect the negative terminal of the battery to P1 side of the CT.

8.2.5 Momentarily connect the positive terminal of the battery to P2 side of the CT; a flick in the negative direction (usually to the left) should be seen on the multimeter.

8.2.6 If the direction of flick is as expected in 8.2.3 and 8.2.5 then the polarity of the CT is correct and should be duly recorded on the commissioning record. If the direction of flick is opposite to that expected in 8.2.3 and 8.2.5 then the polarity of the CT is incorrect.

8.2.7 Repeat the tests in 8.2.1 to 8.2.6 for the L2 and L3 phase CTs.

8.2.8 Following the tests above confirm the relationship between the L1, L2 and L3 phase CTs and the CT secondary wiring is correct and the CT secondary wiring ferruling matches the metering scheme wiring diagram.

8.3 Ratio

8.3.1 A primary current injection test should be conducted to establish the ratio of each CT. If required, the ratio of any protection CTs fitted may be established using the same primary current injection test. Where multi-ratio CTs are installed, all ratios shall be tested. However, where the supply is already energised and sufficient load exits then a load test may be used to confirm the ratio (see 8.4).

NOTE: The load test will require the primary current to be measured, e.g. using a clamp ammeter.

8.3.2 Connect an ammeter across the secondary test terminals of the L1 phase CT. The connections should prevent the CT becoming open-circuited during the test. Alternatively, ensure the secondary test terminals of the L1 phase CT are short-circuited and connect a clamp ammeter around its secondary wiring.

8.3.3 Connect the current injection test set across the connections to the L1 phase CT (to ensure primary current flows through the CT).

8.3.4 Inject 50 A or 100 A of primary current, as appropriate for the CT ratio.

8.3.5 Record the secondary current in the L1 phase CT measured by the ammeter.

8.3.6 Switch-off the primary current.

8.3.7 Calculate the expected CT secondary current using the formula below and check this is comparable to the current measured by the ammeter.

Measured Secondary Current = Injected Primary Current / Expected CT Ratio

8.3.8 For multi-ratio CTs, repeat the tests and calculation in 9.3.2 to 9.3.7 for the other ratio secondary connections.

8.3.9 Repeat the primary current injection test for the L2 and L3 phase CTs, as required.

8.3.10 On completion of testing, check that the link earthing each CT secondary winding is closed and that links shorting each secondary winding are closed for the selected ratio. If the selected ratio is to be left open then record the explanation on the commissioning record.

Non-selected ratio CT connections on dual ratio CTs must be left open-circuited when the selected ratio connection is in use.

NOTE: Some metering arrangements only measure primary current in two phases (usually L1 and L3) and the secondary terminals of the phase not being measured need to be shorted out in the test terminal block.

8.4 On-Load Test

8.4.1 Measure the primary current flowing in the phase L1 using a suitable clamp ammeter.

8.4.2 Measure the secondary current flowing in the phase L1 using a suitable clamp ammeter.

8.4.3 Calculate the CT ratio using the formula below.

Calculated CT Ratio = Measured Primary Current / Measured Secondary Current

8.4.4 Confirm the calculated CT ratio compares to the CT ratio on the nameplate.

8.4.5 Repeat test for the L2 and L3 phase CTs, as required.

9 Burden Measurements

9.1 For CTs With Load Connected

9.1.1 Where the metering installation is fully complete (with meters and load connections) and the customer is/can be supplied, the burden on each CT can be checked as follows.

9.1.2 Measure the a.c. r.m.s. voltage across the secondary terminals of the L1 phase CT in the switchgear/plant with load current flowing.

9.1.3 Measure the secondary current flowing in the L1 phase CT using a suitable clamp ammeter.

9.1.4 Calculate the burden at the measured secondary current using the following formula:

Measured Burden (Ω) = Measured Secondary Voltage (V) / Measured Secondary Current (A)

9.1.5 Calculate the maximum expected burden using the following formula:

Max. Expected Burden (VA) = Measured Burden (Ω) x Rated Secondary Current (A) ^{2}

9.1.6 Confirm the maximum expected burden is equal to or less than the VA rating of the CT for the selected ratio.

9.1.7 Repeat the measurements and calculations in 9.1.2 to 9.1.6 for the L2 and L3 phase CTs, as required.

9.2 For VTs with Load Connected

9.2.1 Where the metering installation is fully complete (with meters and load connections) and the customer is/can be supplied, the burden on each VT can be checked as follows.

9.2.2 Measure the a.c. r.m.s. voltage across the secondary terminals of the L1 phase VT in the switchgear/plant with load current flowing.

9.2.3 Measure the secondary current flowing in the L1 phase VT circuit using a suitable clamp ammeter.

9.2.4 Calculate the burden at the measured secondary voltage using the following formula:

Measured Burden (VA) = Measured Secondary Voltage (V) x Measured Secondary Current (A)

9.2.5 Calculate the maximum expected burden using the following formula:

Max. Expected Burden (VA) = Measured Burden (VA) x Rated Secondary Voltage (V) / Measured Secondary Voltage (V)

9.2.6 Confirm the maximum expected burden is equal to or less than the VA rating of the VT for the selected ratio.

9.2.7 Repeat the measurements and calculations in 9.2.2 to 9.2.6 for the L2 and L3 phase VTs, as required.

9.3 For CTs/VTs With No Load Connected

9.3.1 Where the metering installation is not fully complete (no meters and load connections) and the customer cannot be supplied, the burden on each CT/VT at the test terminal block, i.e. secondary cable burden, can be determined as follows.

9.3.2 Isolate the L1 phase CT/VT secondary connections from the multicore cable at the switchgear/plant terminals.

9.3.3 Connect an ohmmeter between the multicore cable terminations at the switchgear/plant terminals.

9.3.4 Short the multicore cable terminations at the test terminal block in the meter cabinet.

9.3.5 Record the d.c. resistance measured by the ohmmeter.

9.3.6 Calculate the secondary cable burden at the rated secondary current using the formula below:

$$\textit{Secondary Cable Burden (VA)} = \textit{Rated Secondary Current (A)}^2 \times \textit{Lead Resistance } (\Omega)$$

9.3.7 Confirm the secondary cable burden is less than the rated burden (VA) of the CT/VT.

9.3.8 Remove the short from the multicore cable terminations at the test terminal block in the meter cabinet.

9.3.9 Disconnect the ohmmeter between the multicore cable terminations at the switchgear/plant terminals.

9.3.10 Restore the L1 phase CT/VT secondary connections to the multicore cable at the switchgear/plant terminals.

9.3.11 Repeat the measurements and calculations in 9.3.2 to 9.3.7 for the L2 and L3 phase CTs/VTs, as required.

10 As-Left Checks

On completion of testing and commissioning the following checks shall be carried out.

Where installed, check the multicore cable is connected to the switchgear/metering unit and test terminal block and check the ferruling matches the metering scheme diagram.

Check the shorting links of each CT are closed, unless the secondary circuit is complete ready for energisation.

Check any connections disturbed during testing and commissioning are tight.

Check all VT secondary fuses and links are withdrawn unless the secondary circuit is complete ready for energisation.

Check that all covers have been replaced.

Check all fields of the relevant metering equipment commissioning record (see Appendix A of CP 510) have been completed.

11 Records

The commissioning engineer and/or organisation responsible for commissioning shall email a copy of each completed metering equipment commissioning record shall to the Electricity North West Limited P283 commissioning mailbox P283commissioning@enwl.co.uk.

Any CT/VT calibration certificates attached to the equipment shall be removed and shall be kept with the original testing and commissioning records. The commissioning engineer and/or organisation responsible for commissioning shall email a copy of the CT/VT calibration certificates, where available, to the Electricity North West Limited P283 commissioning mailbox P283commissioning@enwl.co.uk.

NOTE: A scanned copy or digital photograph of the CT/VT calibration certificates is acceptable for email purposes.

The commissioning engineer and/or organisation responsible for commissioning shall retain the original testing and commissioning records to facilitate subsequent checks and auditing.

In addition to the requirements of above, for metering equipment that is part-tested prior to being delivered to site, a paper copy of the part completed metering equipment commissioning record shall be left in the equipment or placed in a weatherproof wallet and attached to the equipment. This is to facilitate recording of any subsequent tests and checks at site by other after the equipment has been installed.

The commissioning engineer and/or organisation responsible for commissioning shall be responsible for promptly addressing any errors or omissions notified by Electricity North West Limited Data Management.

12 Documents Referenced

DOCUMENTS REFERENCED	
CP 502	Distribution Business Information for Meter Operators

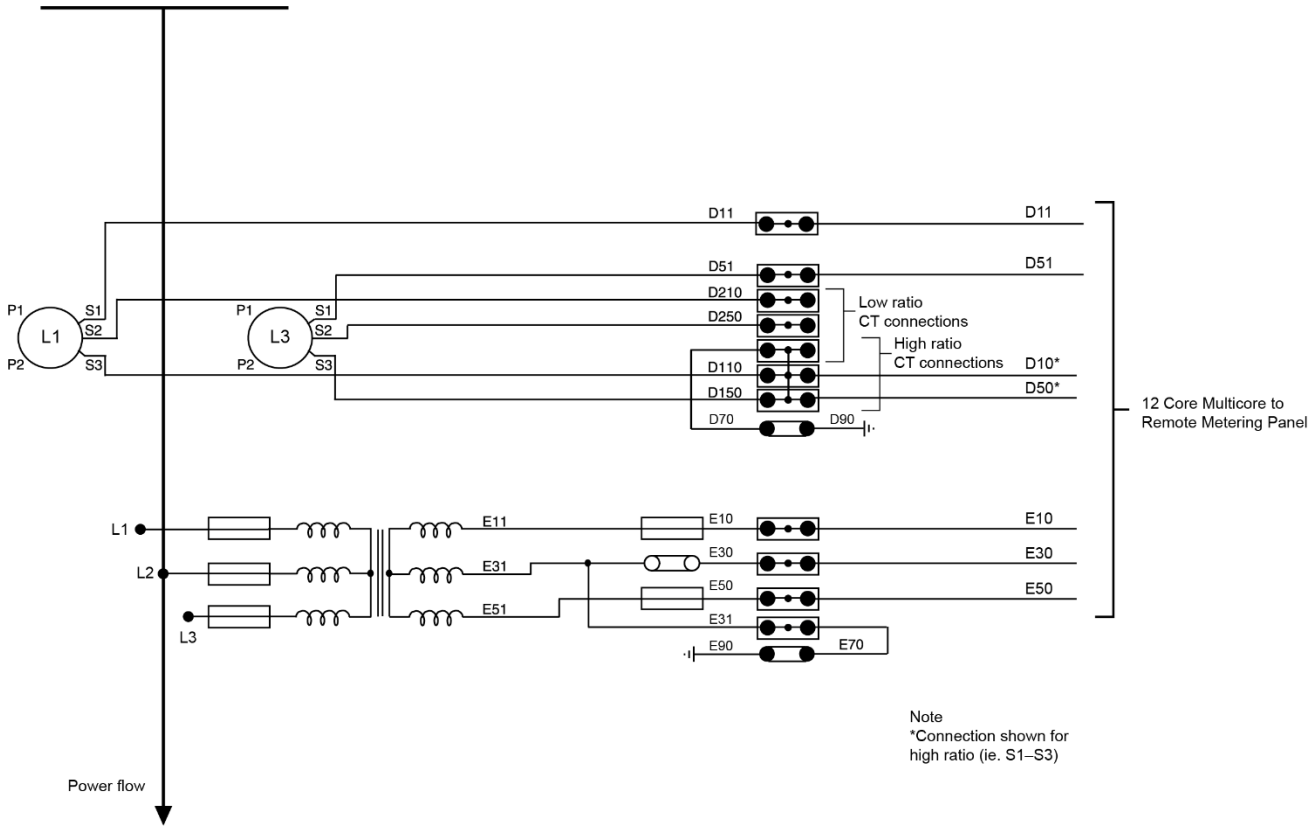
CP510	Commissioning of Measurement Transformers connected to Tariff Metering Equipment
CP 614	Authorisation
ES 501	Metering Current and Voltage Transformers
ES 503	Specification for Metered Service Units
ES 314	12kV and 7.2kV 21.9kA Switchgear for Distribution Substations

13 Keywords

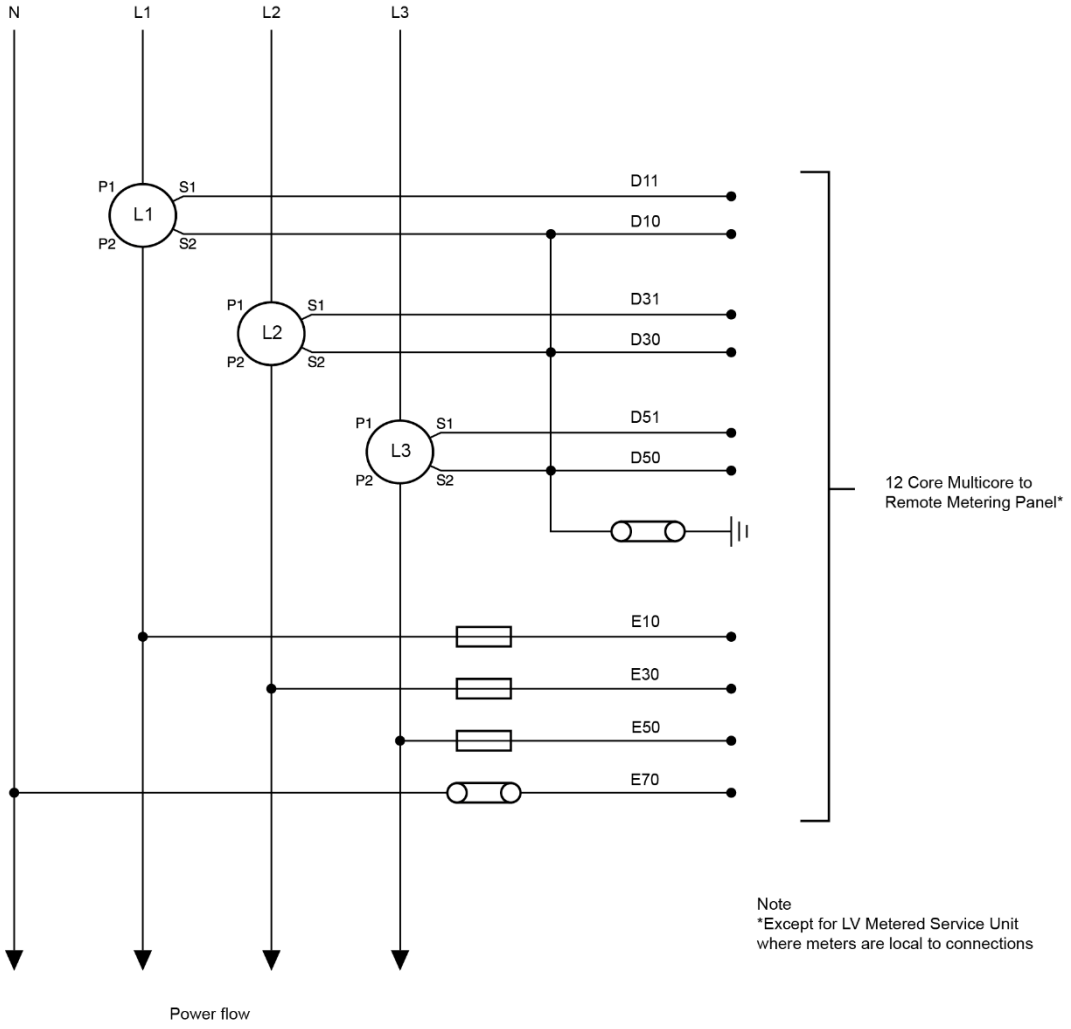
Procedure; Commissioning; Settlement Metering; CT; VT; LV; HV

Appendix A – Wiring Diagrams

A1 HV Metering Unit Wiring Diagram – General



A2 LV Metering Wiring Diagram – General



A3 Multicore Termination Schedules

The following schedules give the standard core allocation and ferruling for the 12 core multicore cable installed between metering class measurement transformers and remote metering panels for both HV and LV metering connections.

HV				LV		
CORE No	**Ferrule**	**Use**		**CORE No**	**Ferrule**	**Use**
1	D11	L1 CT S1		1	D11	L1 CT S1
2	D11	L1 CT S1		2	D10	L1 CT S2
3	D10	L1 CT S2 or S3		3	D31	L2 CT S1
4	D10	L1 CT S2 or S3		4	D30	L2 CT S2
5	D51	L3 CT S1		5	D51	L3 CT S1
6	D51	L3 CT S1		6	D50	L3 CT S2
7	D50	L3 CT S2 or S3		7	E10	L1 Volts
8	D50	L3 CT S2 or S3		8	E30	L2 Volts
9	E10	L1 Volts		9	E50	L3 Volts
10	E30	L2 Volts		10	E70	Neutral
11	E50	L3 Volts		11	90	Earth
12	90	Earth		12	90	Earth

NOTE: For HV, where dual ratio CTs are supplied, S2 is the low ratio connection and S3 is the high ratio connection.