

Capital Delivery Directorate

Design Handbook

**GUIDANCE ON THE PREPARATION
OF SETTINGS FOR NON-UNIT (DISTANCE) PROTECTION
FOR 400 & 275KV FEEDERS**

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Authorised by:



Technical Assurance Manager

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GUIDANCE ON THE PREPARATION OF SETTINGS FOR NON-UNIT (DISTANCE) PROTECTION FOR 400kV and 275kV FEEDERS

Contents

1.	Purpose	5
2.	References	5
3.	Responsibilities	5
3.1	Settings Engineer (Supplier))	5
3.2	Settings Engineer (Assurance)	5
4.	Requirements	5
4.1	Introduction	5
4.2	Two ended Feeders	6
4.3	Two Ended 400/275kV Transformer (Single/Banked Pair) Feeders	7
4.4	Two and Three Ended Supergrid/DNO Transformer (Single/Banked) Feeders	8
4.5	Three Ended Feeder connecting three substations	8
4.6	Three ended feeder with 'teed' SGT with or without HV Circuit Breaker	9
5.	Example: Application to a Three Ended Feeder to comply with NG Policy	10
	PS(T)010 requirements	
5.1	SGT Impedance Data	10
5.2	Circuit Impedance Data	11
5.3	Fault Level Data	11
5.4	Considerations for Blocked Distance Protection Settings	11
5.4.1	Zone 1 Setting	12
5.4.2	Zone 2 Setting Considerations	12
5.4.3	Zone 3 Setting Considerations	13
5.4.4	Zone 2 Setting Criterion	14
5.4.5	Reverse Blocking Zone Criterion	16
5.4.6	Resistive Reach Calculation	17
6.	Authorisation / Revision	21

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1. PURPOSE

This document provides guidance on the application and settings policy of non-unit protection for 400 & 275 kV feeders on the National Grid UK Electricity Transmission System. It is to be used as a guide and does not take any responsibility away from the Supplier.

It should be read in conjunction with settings guidance offered by the suppliers of the protection equipment which is provided as part of the Type Registration of the Standard Bay Solution (SBS).

This document also includes an example for the most onerous non-unit protection application, a three ended feeder with blocked distance protection at all ends.

2. REFERENCES

PS(T) 010: Application and Protection Setting Policy for the National Grid UK Transmission System

DH28: Guidance on the application of system data for protection purposes

Reference should also be made to the settings guidance offered by the suppliers of the protection equipment which is provided as part of the Type Registration of the Standard Bay Solution (SBS).

3. RESPONSIBILITIES

3.1 Settings Engineer (Supplier)

The Settings Engineer (Supplier) has the responsibility for ensuring that any relay settings calculated for a particular project are produced using the guidance within a suitable settings guidance document produced by the equipment supplier.

3.2 Settings Engineer (Assurance)

The Settings Engineer (Assurance) has the responsibility for ensuring that any settings calculated and applied during any construction project are completed in line with an agreed settings guidance document produced as part of the Type Registration.

4. REQUIREMENTS

4.1 Introduction

It is assumed that the non-unit feeder protection provided is based on distance protection and its general theory is known by the reader.

The high level policy for the setting of distance protection is given in PS(T) 010. This document serves to give the high level setting application guidance for different application scenarios.

Different manufacturers may have different zone descriptions for distance protection. National Grid uses the following generic descriptions for different zones.

Zone 1	Instantaneous forward reaching zone protecting the line Set to 80% of the positive sequence impedance Z_1 of the protected feeder
Zone 2	Forward reaching back up zone with a time delay of 0.5s Typically set to 150% of the positive sequence impedance of the protected feeder. It shall allow short term system maximum loading requirements to be met.
Zone 3	Generally an offset characteristic back up protection zone with a time delay of 1s Typically set to $(0.8 Z_1 + 1.5\%)$ where Z_1 is the percentage positive sequence impedance of the protected feeder based on a 100 MVA base. Note Zone 3 offset zone tends to be a separate zone on modern numerical relays. It is usually an

integral part of relays that offer offset MHO characteristics where forward and reverse reaches can be independently set.

Zone 3 when set to $(0.8 Z_I + 1.5\%)$ prevents detection of 132 kV faults for 400/132 kV and/or 275/132kV SGTs connected to the transmission system - assuming that no more than three supergrid/132 kV transformers operate in parallel at the remote end of the feeder.

Note that the above formula is only valid when Z_I is expressed in % on a 100MVA base.

In case there are more than 3 SGTs operating in parallel at the remote end, the following formula should be used.

$Zone3 \leq 0.8(Z_I + 0.7 Z_T)$ where Z_I is the positive sequence impedance of the protected line and Z_T is the parallel impedances of all SGTs that run in parallel at the remote end substation.

Zone 3 reverse Reverse back up protection zone with a time delay of 1s
Typically set to 10% of forward looking Zone 3.

Note that if a separate zone is not available for the Zone 3 offset, then Zone 4 (normally used for blocking) must be used to provide the offset.

Zone 4 Reverse blocking zone.
It can be used in either tripping or non-tripping mode. Where used in tripping mode, it is vital ensure that it does not look through to the LV side either locally or at the remote ends.

In comparison to MHO characteristics, QUAD characteristics provide a better coverage for high resistance earth faults and are, therefore, preferred.

The maximum system loadings for 400kV and 275kV systems are 7600 A and 5200 A respectively. It is important to ensure that the chosen zone settings do not restrict the maximum expected system loading. Further details can be found in PS(T) 010.

Primary to secondary ohms reach conversion is given below by the following formula:

$$\frac{Z_{pri}}{Z_{sec}} = \frac{VT \text{ Ratio}}{CT \text{ Ratio}}$$

For a 400kV distance scheme with a 2000:1 CT ratio and a three phase 396kV/110V voltage transformer, the secondary reach can be obtained by multiplying the primary one by 0.556.

4.2 Two Ended Feeders

A two ended feeder is a feeder circuit with two circuit ends with no inductive plant in the protected zone. An example with two double busbar circuit ends is shown in figure 1. Cables can be included as part of the circuit.

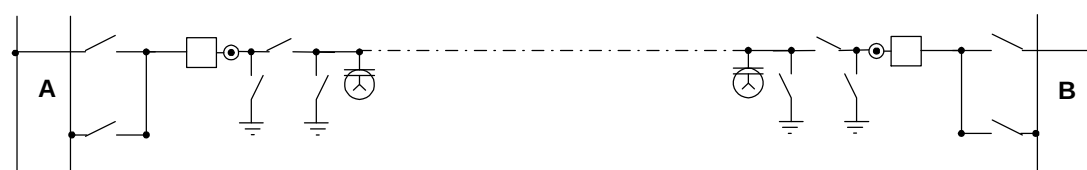


Figure 1- Two ended feeder application

The non-unit protection application for two ended feeders is given in sections 1.2 and 1.2.1 of PS(T) 010.

The setting guidance for plain & blocked scheme application is provided in sections 3.2.2 and 3.2.3 of PS(T) 010 respectively.

4.3 Two Ended 400/275kV Transformer (Single/Banked Pair) Feeders

A two-ended transformer feeder circuit is a feeder circuit connecting two substations with a local circuit breaker at one end and a transformer at the remote substation without a dedicated HV circuit breaker. An example of a transformer feeder is shown below in Figure 2.

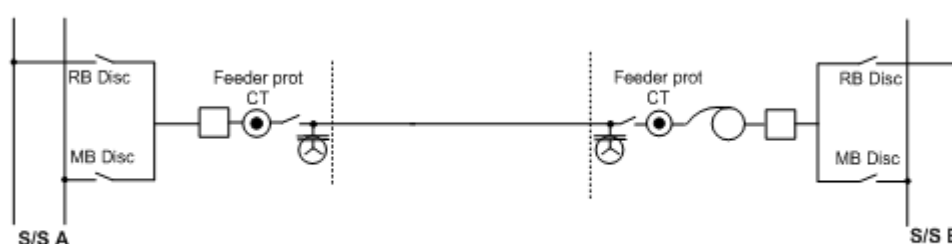


Figure 2 - Transformer feeder application

A two-ended banked pair transformer feeder circuit is a feeder circuit connecting two substations with a local circuit breaker at one end and a banked pair of transformers at the remote substation without their dedicated HV circuit breakers. Figure 3 shows a banked pair transformer feeder.

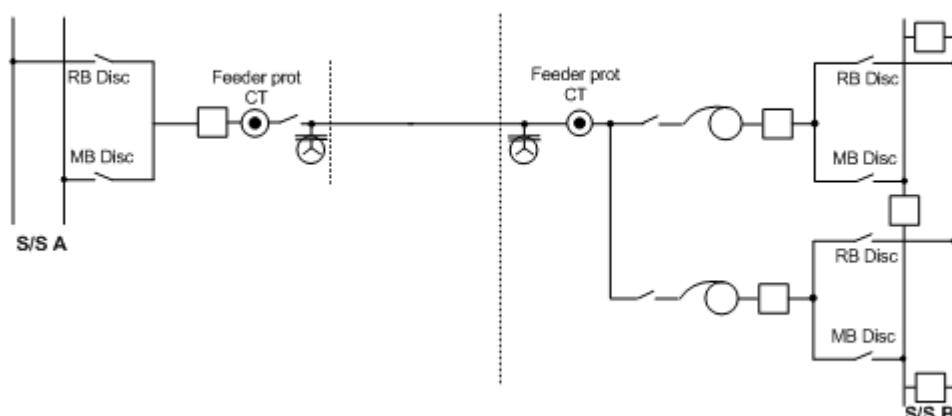


Figure 3- Banked pair transformer feeder application

The setting policy for 400/275kV transformer feeder application is defined in section 3.2.6 of PS(T)010.