MiCOM P746
Setting Guide

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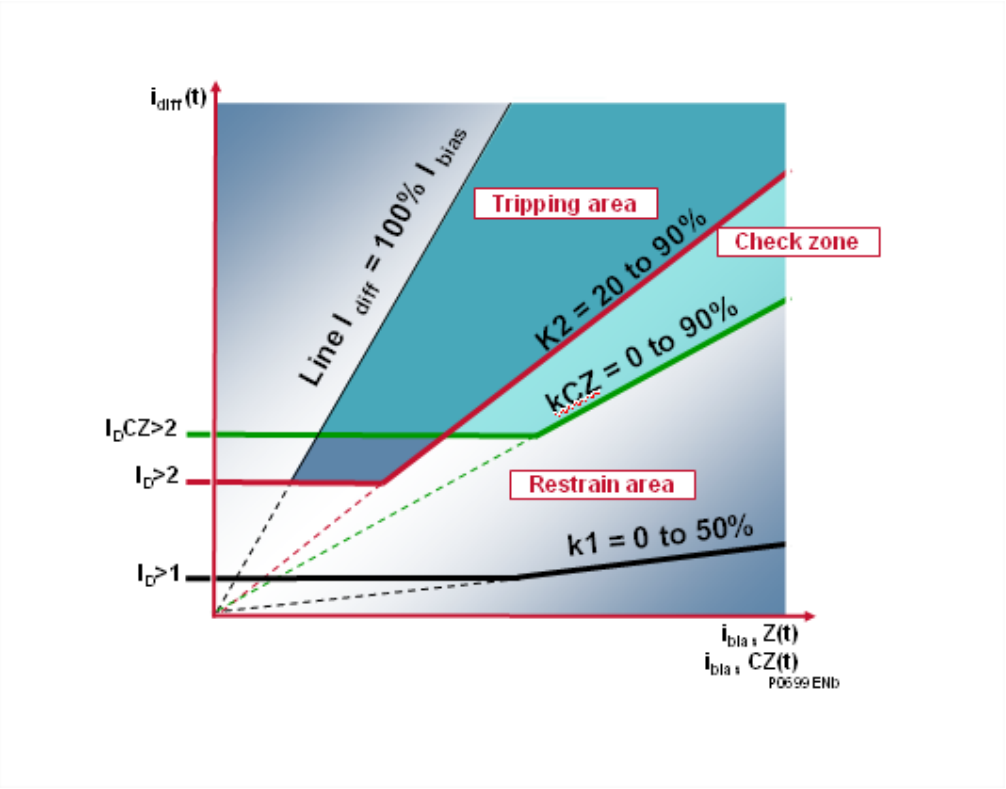
1 INTRODUCTION 87 BB /P

This document is the setting manual to configure the numerical busbar protection.

87 BB /P

For Solid earthed networks:



2 TERMINAL SETTINGS (ALL PROTECTIONS)

For each Terminal (connected to the secondary of a High voltage CT):

2.1 CT Ratios

Only **3 values** have to be known and entered:

1. Phase CT Primary current (from 1 to 30000 A) given by the manufacturer.
2. Phase CT secondary current (1 or 5 A) given by the manufacturer.
3. Polarity (Standard (towards the busbar) or Inverted (opposite to the busbar)

Note: For the busbar protection reference **2 values** have to be entered:

1. Phase reference CT Primary current (from 1 to 30000 A).
2. Phase reference CT secondary current (1 or 5 A).

2.2 VT Ratios

Only **3 values** have to be known and entered:

Phase VT Primary voltage (from 100 to 100 kV) given by the manufacturer.

Phase VT Secondary voltage (80 or 140 V) given by the manufacturer.

3 87BB PHASE SETTINGS (SOLIDLY EARTHED NETWORK SCHEMES)

3.1 Sub-station features

Only **7 values** have to be known:

1. Number of independent busbars
2. Minimum load current in a feeder
3. Maximum load current in a feeder
4. Maximum load current in a busbar
5. Biggest CT primary winding
6. Minimum short-circuit value (phase to phase) in a busbar
7. Voltage used (Yes or No)

3.2 Idiff Ibias Setting calculation spreadsheet

Enter in the Idiff_Ibias spreadsheet the 7 values here above listed and you'll be able to choose the values hereafter listed.

It is important to know that if the minimum internal fault detection is set below the maximum load an additional criterion such as voltage must be used.

3.3 Differential Busbar Protection

1. ID>1 (from 5 A to 500 A (primary value)) as high as possible
2. Slope k1 (ID>1) (from 0% to 50%), recommendation is 10%
3. ID>2 (from 50 A to 50000 A (primary value)) as low as possible
4. Slope k2 (ID>2) (from 20% to 90%), recommendation is 60% (50% for China)
5. IDCZ>2 (from 50 A to 50000 A (primary value)) as low as possible
6. Slope kCZ (IDCZ>2) (from 0% to 90%), recommendation is 30% (25% for China)
7. ID>1 Alarm Timer (from 0 to 100 s) shall be greater than the longest protection time (such as line, overcurrent, etc…)
8. Phase comparison threshold recommendation depends on the number of infeeds

Explanations of the values:

1. ID>1 shall be higher than 2% of the biggest CT to not detect noise coming from it and less than 80% of the minimum load of a feeder to detect the minimum load imbalance in case of a problem in that particular feeder.
2. Slope k1 recommendation is 10% to meet 10Pxx current transformers
3. ID>2 shall be below twice the maximum load for the phase comparison algorithm to pickup the load and if possible below 50% of the minimum fault to be sub-cycle (80% otherwise) and if no voltage criteria is used above 100% (and when possible 120% to allow 20% margin) of the biggest load to not maloperate in case of CT short-circuited or open circuit

Note: voltage criteria can be used for single busbar only in one box mode.
and less than 80% of the minimum fault current to operate sub-cycle for the minimum fault (and 50% when possible to be sure to always operate in 13ms)

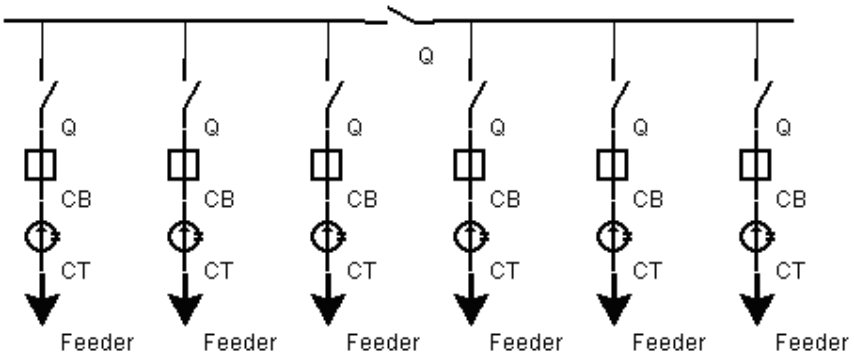
4. Slope k2 (ID>2)
    a. Recommendation is 60%

    To be always stable in the worth CT ratio conditions (between the biggest CT and the smallest CT).
    b. Recommendation is 50% for China

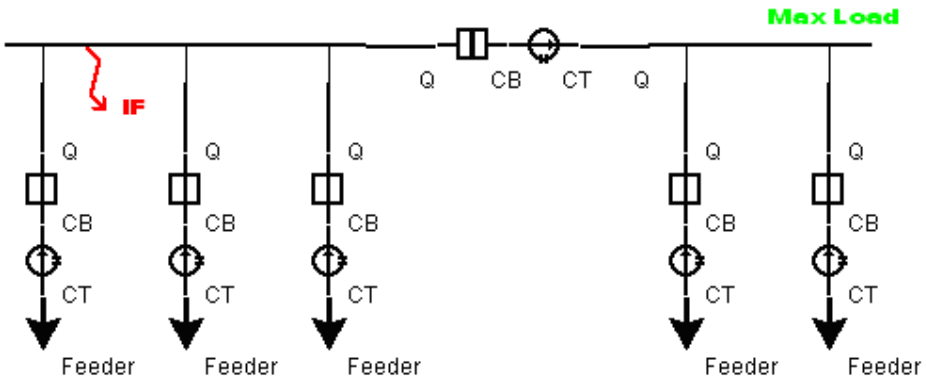
    In China, the requirement is to be able to detect a resistive fault equal to 50% of the bias current.

5. IDCZ>2 same as ID>2
6. Slope kCZ (IDCZ>2)
    a. Recommendation is 30%

    kCZ depends on the number of busbars:
    - n busbars (Independent busbars)
    - A minimum internal short-circuit value (Icc min (1 busbar))
    - A maximum load for a busbar (IloadMax (1 busbar)).



The worst case is:
- when all these buses are independent (bus sectionalizers open)
- the maximum load is on all the buses (biggest bias current)
- The internal short-circuit value is minimum.



During the internal fault:

- the bias current is: Icc min (1 busbar) + (n-1) x IloadMax (1 busbar)
- the differential current is: Icc min (1 busbar)

Thus the biggest slope for the Check Zone to detect the fault is:

$$\frac{\text{Icc min (1 busbar)}}{((\text{Independent busbars} - 1) \times \text{IloadMax (1 busbar)}) + \text{Icc min (1 busbar)}}$$

If for example:

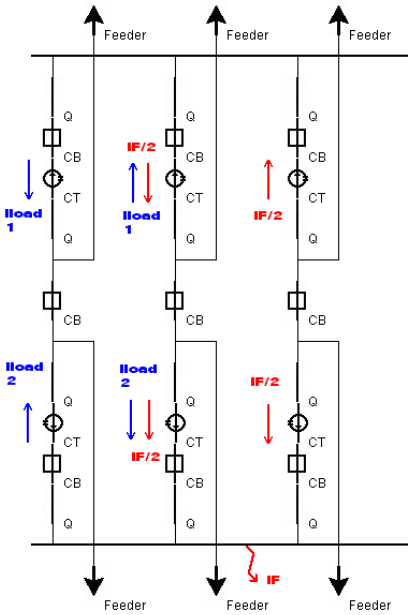
There are 3 buses and Icc min = IloadMax, the slope must be below 33%

Case Half-Breaker Scheme:

P746 has to be able to trip for a fault that is counted twice by the Check Zone (for example one and half circuit breaker substation).

For a one and half breaker scheme there are:

- 2 busbars (Independent busbars)
- A minimum internal short-circuit value (Icc min (1 busbar))
- A maximum load for a busbar (IloadMax (1 busbar)).



The worst case is:

- when the Fault (Icc) is split in 2 and goes as well through the opposite busbar
- the maximum load is on the 2 buses (biggest bias current)
- The internal short-circuit value is minimum.

During the internal fault:

- the CZ bias current is: 2 x Icc min (1 busbar) + 4 x IloadMax (1 busbar)
- the CZ differential current is: Icc min (1 busbar)

Thus the biggest slope for the Check Zone to detect the fault is:

$$\frac{\text{Icc min (1 busbar)}}{(4 \times \text{IloadMax (1 busbar)}) + 2 \times \text{Icc min (1 busbar)}}$$

If for example:

Icc min = IloadMax, the slope must be below 17%

b. Recommendation is 25% for China

In China, the requirement is to be able to trip for a resistive fault that is counted twice by the Check Zone (for example one and half circuit breaker substation).

7. ID>1 Alarm Timer to not operate for an external fault shall be greater than the longest protection time (such as line, overcurrent, etc…)

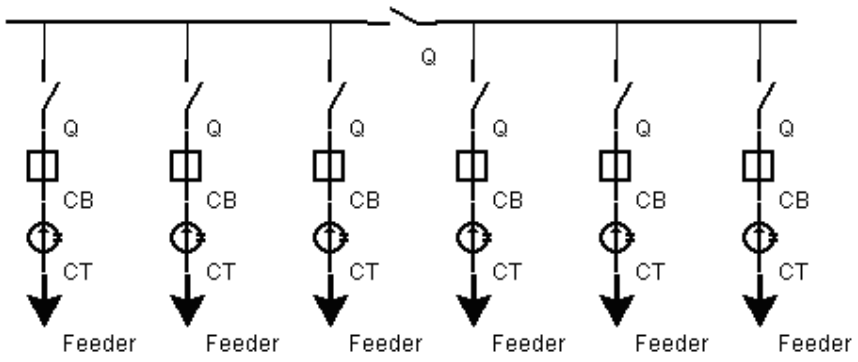
8. Phase comparison

Phase comparison is used to define the minimum current to be included in the phase comparison blocking algorithm. We cannot consider any level of current in phase comparison because even for an internal fault some small currents can flow out (this situation depends on fault impedance).

The requirement for phase comparison minimum threshold is to be able to detect a through fault that is fed by the infeeds;

It depends on :

- The minimum internal short-circuit threshold (ID>2)
- The maximum number of infeeds and their CT primary nominal currents



The worst scenario is when the CT is fully saturated and the differential algorithm picks up on the ID>2 threshold. The phase comparison must block the trip by detecting the incoming currents:

We assume the infeeds will contribute to the ID>2 fault in proportion to their CT primary nominal current (worst situation).

Then we need for each infeed , phase comparison threshold to be lower than :

ID>2 x (In CT / Σ(In CTs infeeds))

And Phase comp.= ID>2 / (In CT / Σ(In CTs infeeds)) / In CT,

So for any infeed, Phase comp. = ID>2 / Σ(In CTs infeeds))

We take 80% of this value so that to keep sufficient margin. Recommended setting is then : :

Phase comp. = 0.8 x ID>2 / Σ(In CTs infeeds)

Phase comp. setting % = 100 x 0.8 x ID>2 / Σ(In CTs infeeds)

4 87BB SETTINGS (COMPENSATED EARTHED NETWORK SCHEMES)

4.1 Sub-station features

Only 4 values have to be known:

1. Maximum load current in a feeder
2. Minimum phase to phase fault current (Ph-Ph min.) in a busbar
3. Maximum single phase steady state faulty current (Ph-N Max.) in a busbar
4. Number of independent busbars
5. Maximum number of infeeds

4.2 Differential Busbar Protection

9 values have to be chosen:

1. ID>1 (from 5 A to 500 A (primary value)), recommendation equal to 1,2 x (Ph-N Max.)
2. Slope k1 (ID>1) (from 0% to 50%), recommendation is 10%.
3. ID>1 Alarm Timer (from 0 to 100 s) shall be greater than the longest Busbar protection time
4. Slope k2 (from 20% to 90%) but recommendation 65%.
5. ID>2 (from 50 A to 50000 A (primary value)), recommendation is:
6. Lower than 0,8 x (Ph-Ph min) and Higher than 1,2 x Iload Max and if possible equal to 6 x (ID>1).
7. Slope kCZ (from 0% to 90%) but recommendation 30%.
8. IDCZ>2 (from 50 A to 50000 A (primary value)), recommendation is:
9. Lower than 0,8 x (Ph-Ph min) and Higher than 1,2 x Iload Max and if possible equal to 6 x (ID>1).
10. Phase comparison recommendation is around or below 50%

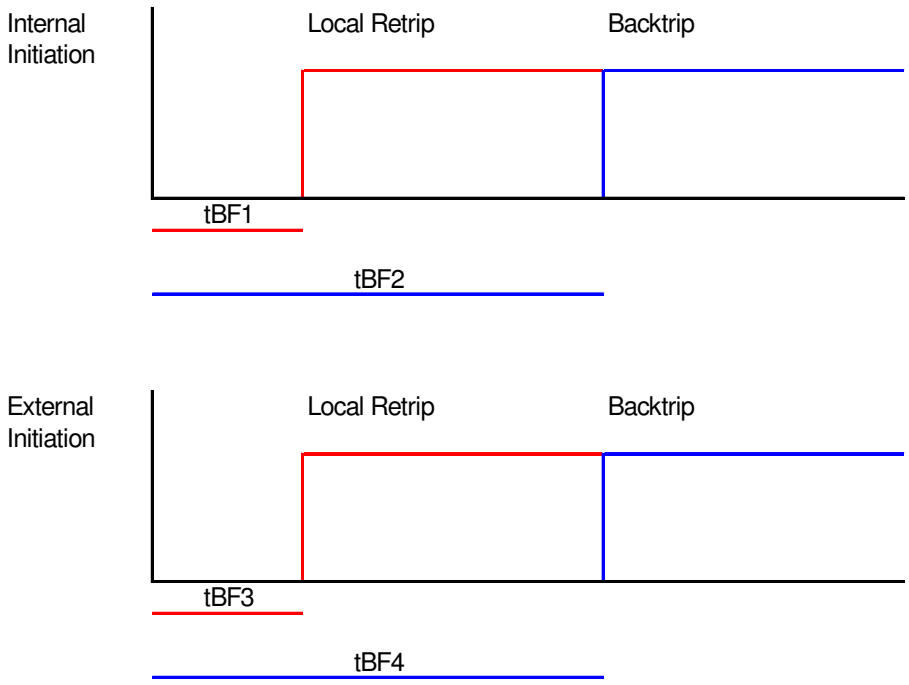
Explanations of the values:

1. ID>1 shall be higher than 120% of the highest phase to neutral fault to not operate in case of phase to neutral fault.
2. Slope k1 recommendation is 10% to meet 10Pxx current transformers
3. ID>1 Alarm Timer to not operate for an external fault shall be greater than the longest protection time (such as line, overcurrent, etc…)
4. Slope k2 (ID>2) recommendation is 65%

   To be always stable in the worth CT ratio conditions (between the biggest CT and the smallest CT). 60% is OK as long as the CT ratio is less than 5.
5. ID>2 shall be lower than 80% of the minimum phase to phase fault current to operate sub-cycle for the minimum fault and higher than 120% Iload Max (120% to allow 20% margin) and if possible equal to 6 x (ID>1) to be insensitive to the worth CT saturation.
6. IDCZ>2 same as ID>2
7. Slope kCZ (IDCZ>2) recommendation is 30%

   The requirement is to be able to trip for a fault that is counted twice by the Check Zone (for example one and half circuit breaker substation).

5 50BF



5.1 Terminal SETTINGS

For each Terminal connected to a Circuit Breaker

Only **4 values** have to be entered:

5.1.1 Reset Criteria

Reset criteria objective is to detect what the CB has opened.

This detection can be based on several types of criteria: either based on the position of the CB, the value of the current flowing through the CT, a logical combination is the position of the CB and the current value.

CBF reset criteria setting range:

- I< : current criteria

- 52a: CB Position

- I< and 52a: Combination of current and CB position.

In case undercurrent is selected as a reset criteria, I< = 5% In is the recommended setting value to detect a pole dead.

!!Warning: There is a mistake in 02 and 03 software models: 'I< and 52a' is implemented as 'I< 'OR '52a' instead of AND.

5.1.2 Internal initiation

1. Local retrip delay tBF1

2. Backtrip delay tBF2

TBF2 should be equal to the maximum opening time + 30 ms*

5.1.3 External initiation

3. Local retrip delay tBF3
4. Bactrip delay tBF4

TBF4 should be equal to the maximum opening time + 30 ms*

*: In case of external relaying, add the relay additional closing time.

Important note: if the external trip command is not longer than TBF4, add a dwell gate set longer than TBF4 in the PSL.

Note: The CB fail alarm is raised as soon as tBF1 or tBF3 are reached.

6 DEAD ZONE

For each Terminal connected to a Feeder Circuit Breaker (but not on the coupling)

6.1 Terminal SETTINGS

For the phase:

I>DZ must be below 80% of the minimum Dead Zone fault (and if possible bigger than the maximum load).

I>DZ Time delay must be at least 50ms if the CB status positions are used (any value otherwise)

For the Neutral (if used):

IN>DZ must be below 80% of the minimum Dead Zone earth fault.

IN>DZ Time delay must be at least 50ms if the CB status positions are used (any value otherwise)

Important note:

When a dead zone fault occurs and the bias current flowing through the busbar is small, there could be a maloperation of the 87BB.

To prevent that, it is recommended to enable an additional criterion such as voltage (voltage criteria can