Protective Relay Settings

Understanding The IEC Based IDMT Settings of Phase Over-current (51) Protection for SEPAM Protective Relay

Introduction

Phase over-current protection is a common and widely used protection scheme that is implemented in high voltage and low voltage networks. As we are more familiar with settings based on how we set the electromechanical relays, this section describes the ways to set the SEPAM relay for phase over-current protection, in close relation to the settings in an electromechanical relay.

IDMT Electromechanical Relay

Inverse Definite Minimum Time (IDMT) is affected by the inverse proportional relationship between the operating time of the relay and the function of current. For the electromechanical relay, there are two adjustments:

1) Plug Setting (P.S)

The plug setting determines the current at which the relay will start to operate. It is seen by adjusting the position of a plug in a plug bridge.

Example:
For a 100/5A CT, if the relay is set to operate at 5A, the plug setting will be:

P.S (%) = (Relay current setting)/5A
= 5A/5A = 100%.
Likewise, for the relay to operate at 2.5A,
P.S (%) = 2.5A/5A = 50%.

2) Time Multiplier Settings (TMS)

The time multiplier setting controls the relay's disc movement. The position of the moving contact is usually adjusted by turning the time multiplier knob, which ranges from 0.1 to 1.0. Hence, the appropriate choice of TMS settings will provide grading of a network protection system.

For both electromechanical and microprocessor - based relays, the IDMT characteristics are derived from a formula that complies with BS142 and IEC 60255 standards. It is generally defined as:

$$T(s) = \frac{K}{\left(\frac{I}{Is}\right)^{\alpha} - 1} \times TMS$$

where
T = operating time in s
TMS = time multiplier setting
I = value of actual secondary current
Is = value of relay current setting
α and K are constants.

However, for an electromechanical relay, it is interesting to note that both I and Is are referring to the secondary current of the CTs. In other words, the ratio of I/Is is equivalent to the multiples of plug setting current.

Figure 1 shows a range of normal inverse, or standard inverse curves at various TMS, which ranges from 0.1 to1.

By varying the α and K values in the same formula, four standard curves, the normal inverse, very inverse, extremely inverse and the long-time inverse are available.

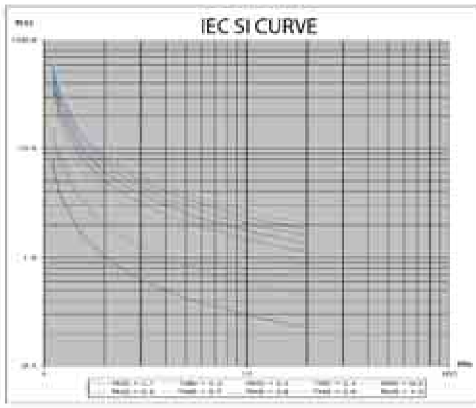

Figure 1. Normal Inverse Curve

Table 1. Values of α and K determine the degree of inverse in the IDMT curves

Type of curve	α	K
Normal Inverse	0.02	0.14
Very Inverse	1.0	13.5
Extremely Inverse	2.0	80.0
Long-time Inverse	1.0	120.0

SEPAM Relay

To set the IDMT characteristic of a SEPAM relay, the following parameters should be considered:

1) Type of current transformer and its rated current

The primary and secondary rated current of the CTs (1A or 5A), will be determined in the general settings of the relay.

2) A/B group settings

The phase over-current functions of a SEPAM relay comprises 4 independent elements which are divided equally into 2 groups (A & B). Having 2 groups (A & B) of settings cater to a changing network configuration.

Example: In a specific network
- *Group A settings are for the network, supplied by the utility*
- *Group B settings are for the network, supplied by a backup generator*

Hence for a network that connects only to the utility, it is normal to use group A settings and to disable group B settings.

3) Threshold current in A or kA

Threshold current refers to the current setting at which the relay starts to operate (Is). This current is based on the primary current and it is not necessary to do a current transformation. This is because the CT ratios have been determined in the general settings of the relay.

Example:
For a CT of 100/5A, if the relay is set to operate at 50A, Is will be set as 50A. This setting is equivalent to a P.S of 50%

4) TMS or 10I/Is settings

In SEPAM, the IDMT characteristic curve is also derived from the formula that complies with the BS142 and IEC 60255 standards. It is mathematically defined as

$$T_d(s) = \frac{K}{\left(\frac{I}{Is}\right)^{\alpha} - 1} \times \left(\frac{T}{\beta}\right)$$

where

T_d = operating time in s

T = operation time at 10Is,

Is = primary threshold current in A or kA

I = primary actual current value in A or kA

α, K and β are constants.

Similarly, by varying the α and K values in the same formula, it leads to four standard curves.

Table 2. Values of α, K and β which determine the degree of inversian of the IDMT curve

Type of curve	α	K	β
Normally inverse	0.02	0.14	2.97
Very Inverse	1.0	13.5	1.5
Extremely Inverse	2.0	80.0	0.808
Long-time Inverse	1.0	120.0	13.33

In comparison with the earlier formula based on TMS, the relationship is **T/ β = TMS**. This is because the time delay T is the operation time of the relay when the current reaches 10Is. Hence, the time delay of the IDMT tripping may be set either by:

- T (s): operation time at 10Is or
- TMS: where **TMS** = T/ β

Example:

For 100/5 CT with P.S at 100%, TMS=0.1, using the standard inverse 3/10 curve, the SEPAM relay will be set based on the following:

Is = 100A

Type of curve =SIT/A

If the setting mode is set as 10I/Is then

T= β *x TMS = 2.97 x 0.1 = 0.297.*

If the setting mode is set as TMS, then TMS will be set at 0.1.

With a primary current of 200A passing through the relay, both modes will provide the same tripping time:

At 10I/Is mode:

$$T_d(s) = \frac{0.14}{(200/100)^{0.02} - 1} \times (0.297/2.97) = 1s$$

At TMS mode:

$$T(s) = \frac{0.14}{(2)^{0.02} - 1} \times 0.1 = 1s$$

The Difference Between Type 1 And Type 1.2 IDMT Curves

It is important to distinguish the difference in the initial pick up of the various types of IDMT curves.

Type of curve	Type
Standard inverse time (SIT)	1.2
Very inverse time (VIT or LTI)	1.2
Extremely inverse time (EIT)	1.2
Ultra inverse time (UIT)	1.2
RI curve	1
IEC standard inverse time SIT/A	1
IEC very inverse time VIT or LTI/B	1
IEC extremely inverse time EIT/C	1
IEEE moderately inverse (IEC/D)	1
IEEE very inverse (IEC/E)	1
IEEE extremely inverse (IEC/F)	1
IAC inverse	1
IAC very inverse	1
IAC extremely inverse	1

The curve equations are given in the chapter entitled "IDMT protection functions"

Figure 2 Type of IDMT curves

Figure 2 shows that there are Type 1 and Type 1.2 characteristic curves in SEPAM. For instance, under the SI curve, there is the SIT, which is based on Type 1.2 characteristic. The other is the SIT/A, which is based on Type 1 characteristic.

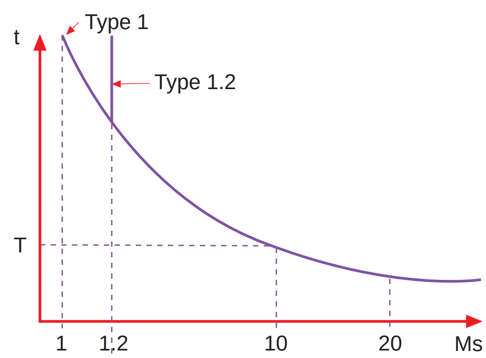

Figure 3. IDMT curves based on Type 1 and Type 1.2

Figure 3 shows that for the Type 1 curve, the relay will activate at 1 x Is, after a certain time delay. However, for Type 1.2 curve, the relay will only activate at 1.2 x Is. The Type 1.2 curve characteristic is in accordance with BS 142 standard, which has considered the nature of the electromechanical relay. With a better understanding of the IDMT curves and the way the SEPAM relay interprets the curves, SEPAM users will better appreciate the flexibility of the settings for phase over-current (51) protections.

Contributed by:
Tong Ween Kai
Assistant Marketing Manager
MV/LV Equipment

REFERENCES

Electrical Network Protection, SEPAM Series 20 User Manual.

Electrical Network Protection, Protection Guide.