Reverse Time During Current Relay Performance to Support the Protection System Practicum

Wahyono [(1)], **F. Gatot S** *[(2)], **Wiwik Purwati W.** [(3)], **Margana** [(4)], **Suwarti** [(5)], **Ajie Pribadi N** [(6)]
[1,2,3,4,5,6] **Program studi Konversi Energi , Teknik Mesin Politeknik Negeri Semarang**

Email address: * fgatots@gmail.com

Abstract—Overcurrent Relay is one of the protection system tools in the electricity network. Overcurrent Relay works based on the increase in fault current that exceeds a certain safety value and a certain period of time. The type of relay that will be used in this test is the IDMT NX203A Overcurrent Relay. The purpose of this test is to get a good practicum module and to prove the inverted time relay characteristic curve according to British Standard BS142. In the test, the tool to be assembled is tested for its work function so that in data collection errors can be avoided while the relay on the module will be given a current setting of 2A; 3A; and 4A with TMS0.05; 0.5; and 1.0 which will be connected to a digital timer so that if the fault current exceeds the setting current, the relay will automatically give a signal and the digital timer will show the time when the current is cut off. The final result is a practicum module where each tool functions under normal working conditions and a graph of time against relay current for setting current 2A, fastest time 0.498s at 9A fault current and 0.05 TMS, longest time 12.991s at 4A TM fault current. . 1.0. Current setting of 3A for the fastest time is 0.572s at fault current of 9A and TM 0.05, for the longest time is 35.854s at fault current of 4A and TM 1.0. Current setting of 4A for the fastest time is 0.708s at fault current of 9A and TM 0.05, for the longest time is 55.979s at fault current of 5A and TM 1.0.

Keywords: Reverse Current Relay Time

I. INTRODUCTION

The protection system has an important role in the operation of the electric power system in the event of a disturbance. These disturbances can come from external disturbances or internal disturbances. External disturbances are disturbances caused by natural phenomena such as weather, floods, earthquakes, and lightning strikes, while internal disturbances are disturbances caused by system damage such as human factors (human error), long component life, abnormal voltages and currents. , overload, and breakdown of the insulator. Relay is a device that secures the electric power system by detecting disturbances that occur in the network. If a disturbance occurs, the relay will give orders to the circuit breaker to cut off the current causing the disturbance. Safety relays can detect disturbances in electrical network equipment by measuring or comparing received quantities such as voltage, current, power, frequency and others. For the purpose of tuning the protective relay, the fault current is calculated not only at the fault point. For this reason, it is necessary to calculate the short-circuit fault current which can immediately assist in the calculation of adjustment and protection [8].

Overcurrent Relay is a relay that works based on an increase in current that exceeds a certain safety value and a certain period of time. Overcurrent Relay is a relay that works against overcurrent, will work when the current flowing exceeds the setting value (Iset). Overcurrent Relays work based on the presence of excess current felt by the relay, either due to a short circuit or overload to then give a trip command to the PMT according to the characteristics of the time.

In this practicum module assembly, the NX203A IDMT overcurrent relay is used. IDMT (Inverse Definite Minimum Time) is a type of protection curve characteristic used in determining protection parameters. The word inverse means that the higher the fault current detected passing through a protected system, the faster the protection relay time to instruct the Circuit Breaker to work to trip the system. The value of the current and trip time on the protection relay varies greatly, according to the characteristics of the load and the network to be protected so that a disturbance at a point in an electric power network will not cause a total disturbance.

The reverse timing relay has 3 types of characteristic curves, namely:

1. Standard Inverse (SI)

The Standard Inverting Curve is a form of the Overcurrent Relay curve with a short inverse time delay.

2. Very Inverted (VI)

https://jurnal.polines.ac.id/index.php/eksergi

ISSN 0216-8685 (print); 2528-6889 (online)

The Very Inverse curve is a form of the Overcurrent Relay curve with a very long inverse time delay when compared to the Standard Inverse.

3. Extreme Inverse (EI)

The Extreme Inverse curve is a form of the Over Current Relay curve with a very, very long inverse delay compared to the Very Inverse and Standard Inverse.

Based on the objectives of this study, the formulation of the problem in the discussion of the results of the assembly of the Overcurrent Relay Relay practicum module and the test results of the Overtime Reverse Time Relay characteristic curve.

In this test, an analysis of the calculation of the magnitude of the fault current is carried out in the following way:

The determination of the magnitude of the fault current given to the system is carried out with the guidelines listed in the IDMTOver Current RelayNX203A manual book.

a. Over-Low Set Current Adjustment (l>)

- This adjustment is to set the minimum overcurrent to trip with a time delay.
- The setting range is from 2A to 6A.
- Setting range is from 1x to 10x overcurrent low setting value.

$$\frac{I}{I>} = a$$

Descriptiom :

I = Fault current (Amperes)

I> = Low setting current (Amperes)

a = nominal current

(1 to 10)

b. Time Multiplier (TM) Adjustment

• Time multiplier to set reverse normal time / current characteristic (IDMT) according to BS142.

The setting range is from 0.05 to 1.0.

II. METHODS

Methods section covers the methodology of the research, including any materials needed.

This research begins with the lack of various types of safety relays used in the protection system practicum at the Energy Conversion Engineering Laboratory, by adding overcurrent relay equipment so that you can use this module as practical material in the Energy Conversion Engineering Laboratory.

1) Literature Search

This method is done by browsing and studying books and looking for information about overcurrent relays through print and online media. The literature search takes into account several aspects including the function of the tool, how the tool works, manufacturing costs, module aesthetics, and various other aspects with valid and correct data sources.

2) Module Design

The process of making the module is preceded by planning the shape of the module made with the software inventor, while the parts that are designed are the module box, the support box, the layout of the tool to be assembled. The design of the wiring diagram is made with Microsoft Visio software.

3) Module Assembly

The assembly process is the process of uniting all the tools to become one system with a specific purpose. This stage begins with the preparation of tools and materials to be used such as Over current relay, digital timer, voltmeter, ammeter, MCB, and acrylic. The next process is the manufacture of the box, which begins with measuring the length, width, and height required according to the design, the support for the box is made according to the design. The next stage is to connect all the tools and materials into one system unit.

4) Module Testing

The testing procedure is carried out by testing the results of the module assembly first so that it works according to its function. The next test is testing the characteristics of the relay by setting the relay at a certain setting current then in the test circuit a fault current is given which exceeds the setting current. This test is carried out with several variations setting current, fault current, and time multiple setting. Parameters measured in this test include setting current (amperes), fault current (amperes), trip time (seconds), voltage (volts) and relay state.

III. RESULTS AND DISCUSSION

Based on the results of the practicum module testing carried out, all the assembled tools can work well so it can be concluded that the

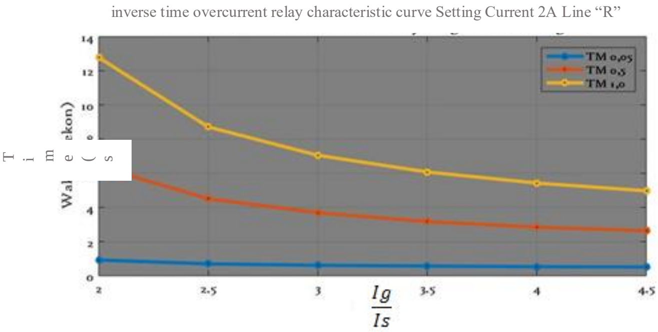
https://jurnal.polines.ac.id/index.php/eksergi

ISSN 0216-8685 (print); 2528-6889 (online)

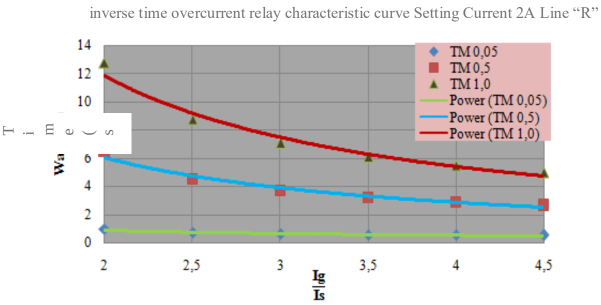
practicum module can be used according to its work function.

I. Graph of Testing Characteristics of Inverse Time Over current relay

1. Inverse time over current relay characteristic curve with setting current 2A



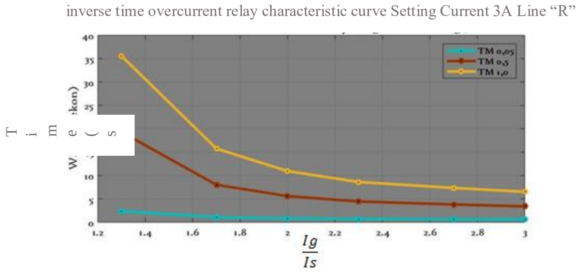
Picture 4.1 inverse time overcurrent relay characteristic curve Setting Current 2A Line "R"



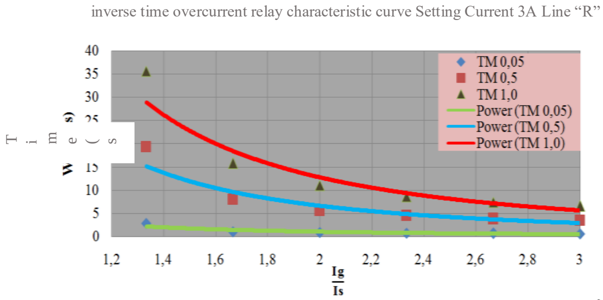
Picture 4.2 inverse time overcurrent relay characteristic curve Setting Current 2A Line "R" with trendline

Based on the graph that has been described, it appears that the greater the value of the fault current, the faster the relay tripping time. It can also be seen that if given the same fault current but the time setting is greater, the tripping time will be slower. The trendline line depicted shows that the experimental data line and the trendline are almost the same, so the graph in theory can be proven by the experimental data graph. For setting the TM time of 0.05s the curve is very gentle and the time is close to zero, this is a characteristic of the relay inverse timeover current with the Standard Inverse curve. Furthermore, the setting time value is increased to 0.5s so that the relay tripping time is a bit slower than the setting time of 0.05s. This is called the inverse timeover current characteristic of the Very Inverse curve relay. Then the time setting is made to a maximum of 1.0s and produces a curve where the tripping relay time becomes very slow, this is called the inverse timeover current characteristic of the Extreme Inverse curve.

2. Inverse timeover current relay characteristic curve with a setting current of 3A.



Picture 4.3 inverse time overcurrent relay characteristic curve Setting Current 3A Line "R".



Picture 4.4 inverse time overcurrent relay characteristic curve Setting Current 3A Line "R with trendline.

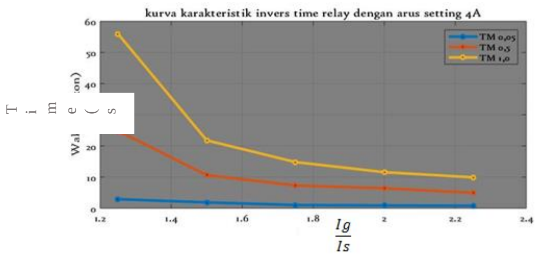
Based on the graph that has been explained, it can be seen that the greater the value of the fault current, the faster the relay trip time. It can also be seen that if given the same fault current but greater timing, the trip time will be slower. The trendline line depicted shows that the experimental data line and the trendline line have some differences because the trendline line is a line that functions to smooth the shape of the curve. For time setting TM 0.05s, the curve is very gentle and the time is close to zero, this is a characteristic of the inverse relay timeover current with the Standard Inverse curve. Furthermore, the setting time value is increased to 0.5s so that the relay trip time is slightly slower than the setting time of 0.05s. This is called the reverse flow time relay characteristic of the Strongly Inverted curve. Then the maximum time setting is 1.0s and produces a curve where the tripping relay time becomes very slow, this is called the inverse timeover current characteristic of the Extreme Inverse curve.

3. Inverse timeover current relay characteristic curve with 4A . current setting

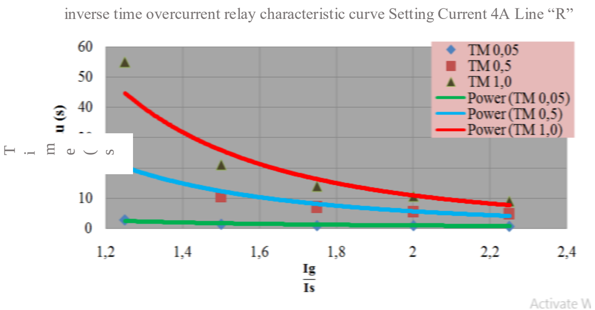
inverse time overcurrent relay characteristic curve Setting Current 4A Line "R"

https://jurnal.polines.ac.id/index.php/eksergi

ISSN 0216-8685 (print); 2528-6889 (online)



Picture 4.5 inverse time overcurrent relay characteristic curve Setting Current 4A Line "R"



Picture 4.6 inverse time overcurrent relay characteristic curve Setting Current 4A Line "R" with trendline

This relay graph illustrates that each current setting is the same but given a fault current and a different time setting will produce a different curve, there are three different curves, but the equations of the three curves above have the same characteristics, namely the greater the value of the fault current, the greater the value of the fault current. large fault current value. A small trip time is required to make the relay work so that the fault current passing through the system can be secured. For the 0.05s TM timing the curve is very smooth and the time is close to zero, this is a characteristic of the relay timing backflow with a Standard Inverse curve. Furthermore, the setting time value is increased to 0.5s so that the relay trip time is slightly slower than the setting time of 0.05s. This is called the reverse timing current characteristic of the Strongly Inverted curve relay. Then the maximum time setting is 1.0s and produces a curve where the tripping relay time becomes very slow, this is called the inverse timeover current characteristic of the Extreme Inverse curve.

2. Percentage of errors

1.Setting current 2A

Table 4.5 Results of Error Percentage With Current Setting 2A Line "R"

Distraction	TM	Test Time	Standard BS142	% Error
Ampere		Second	Second	%
4	0,05	0,924	0,75	23,2
5	0,05	0,7	0,6	16,6667
6	0,05	0,616	0,45	36,8889
7	0,05	0,57	0,43	32,5581
8	0,05	0,532	0,4	33
9	0,05	0,512	0,35	46,2857
4	0,5	6,408	5	28,16
5	0,5	4,504	4,5	0,08889
6	0,5	3,692	3	23,0667
7	0,5	3,172	2,8	13,2857
8	0,5	2,846	2,5	13,84
9	0,5	2,636	2,2	19,818
4	1	12,774	10	27,74
5	1	8,714	8,5	2,52765
6	1	7,052	6	17,5333
7	1	6,076	5,5	10,4727
8	1	5,428	5	8,56
9	1	4,974	4,8	3,625

Based on the calculations, the error percentage obtained is still not high. The highest error percentage is 46.28571% with a fault current of 9A at TM 0.05 while the lowest percentage is 0.088889% with a fault current of 5A at TM 0.5.

2. Setting Current 3A

Table 4.6 Results of the Percentage of Errors with the Current Setting 3A Line "R"

https://jurnal.polines.ac.id/index.php/eksergi

ISSN 0216-8685 (print); 2528-6889 (online)

I Distraction		Test Time	Standard Time BS142	% Error
Ampere	TM	Sekon	Sekon	%
4	0,05	2,384	1,9	25,4737
5	0,05	1,064	0,9	18,2222
6	0,05	0,824	0,75	9,86667
7	0,05	0,702	0,68	3,23529
8	0,05	0,63	0,55	14,5455
9	0,05	0,592	0,45	31,5556
4	0,5	19,278	16,5	16,8364
5	0,5	8,008	8	0,1
6	0,5	5,598	5	11,96
7	0,5	4,452	4,2	6
8	0,5	3,804	3,6	5,66667
9	0,5	3,4	3	13,3333
4	1	35,554	33,5	6,13134
5	1	15,75	11,5	36,9565
6	1	10,942	10	9,42
7	1	8,614	8,5	1,34118
8	1	7,342	7	4,88571
9	1	0,524	6	8,73333

Based on the calculations, the error percentage obtained is still not high. The highest error percentage is 36.95652% with a fault current of 5A at TM 1.0 while the lowest percentage is 0.1% with a fault current of 5A at TM 0.5.

3. Setting Current 4A

Table 4.7 Results of the percentage of errors with the current setting 4A line "R"

I Distraction		Test Time	Standard BS142	% Error
Ampere	TM	Sekon	Sekon	%
5	0,05	2,712	2	35,6
6	0,05	1,276	1	27,6
7	0,05	0,932	0,8	16,5
8	0,05	0,794	0,75	5,86667
9	0,05	0,708	0,7	1,14286
5	0,5	23,83	18,5	28,8108
6	0,5	10,43	8,5	22,7059
7	0,5	6,92	5,8	19,3103
8	0,5	5,416	5	8,32
9	0,5	4,562	4,2	8,61905
5	1	55,07	53,5	2,93458
6	1	21,092	17,8	18,4944
7	1	13,816	11,3	22,2655
8	1	10,572	10	5,72
9	1	9,024	8,8	2,54546

Based on the calculations, the percentage of errors obtained is still not high. The highest error percentage is 22.26549% with a fault current of 7A at TM 1.0 while the lowest percentage is 1.142857% with a fault current of 9A at TM 0.05.

IV. CONCLUSION

Testing NX203AIDMT Over Current Relay can be concluded that:

a. The assembled Practicum module can be used according to its function.

b. Testing is done by testing the current setting of 2A; 3A; 4A, with setting time (0.05; 0.5; 1)s and setting current 2A produces the fastest trip time of 0.502s while setting current 4A produces the longest

https://jurnal.polines.ac.id/index.php/eksergi

ISSN 0216-8685 (print); 2528-6889 (online)

trip time of 55.979s according to the conveying characteristics. Relay inverse time over current is the greater the fault current the faster the trip time.

c. The test curve shown is the same as the inverted time current relay characteristic curve, which means that the tests carried out are proven to be theoretically correct.

d. Installation of inverse time over current relay aims to achieve continuity of service to consumers.
The percentage of error in the inverse time test of the overcurrent relay is 66.67%, so it can be said that the relay is still within the tolerance range of 40% - 120%.

REFERENCES

[1] Abdul Mu'is, Sugianto. 2017.*Perencanaan Sistem Distribusi Listrik Pelaksanaan Proyek Apartemen*. Program Studi Teknik Elektro – ISTN

[2] Anaa Istimaroh, Nasrun Hariyanto, Syahrial, 2013, *Penentuan Setting Rele Arus Lebih Generator dan Rele Diferensial Transformator* Unit 4 PLTA Cirata II, Jurnal Reka Elkomika ©TeknikElektro,Itenas,Vol.1,No.2, Februari 2013

[3] Ali Akmal, Ketut Abimanyu, 2017, studi pengaturan relai arus lebih dan relay hubung tanah timor 4 pada gardu induk studi kasus: Gardu Induk Dawuan, vol.2 no. 1,Jurnal Teknologi Informasi Dan Elektronika

[4] Ananta S.D, 2015, *Studi Koordinasi Proteksi Rele Arus Lebih,Diferensial Dan Ground Fault Pada Pt. Linde Indonesia, Cilegon*, Jurusan Teknik Elektro Fakultas Teknologi Industri Institut Teknologi Sepuluh Nopember Surabaya

[5] Ade Wahyu Hidayat, Herri Gusmedi, Lukmanu Hakim, Dipride Despa,2013, *Analisa Setting Rele Arus Lebihdan Rele Gangguan Tanah pada Penyulang Topan Gardu Induk Teluk Betung*, Volume 7, No. 3, September 2013, Jurnal Rekayasa dan Teknologi Elektro

[6] Affandi, Irfan. 2009. *Analisa Setting Relai Arus Lebih dan Relai Gangguan Tanah pada Penyulang Sadewa di GI Cawang*. Skripsi Program Studi Teknik Elektro Kekhususan ElektroUniversitas Indonesia.

[7] Chomarudin,Riki. 2018. *Rele Proteksi pada Saluran Transmisi dan Gardu Induk*. Universitas Gajah Mada

[8] Engla Pafela, Eddi H.,2017, *Studi Penyetelan Relay Arus Lebih (OCR) pada Gardu Induk Teluk Lembu Pekanbaru*, Teknik Elektro Universitas Riau. Jom Fteknik vol 4 no 1 Februari 2017

[9] Hazairin, Samaulan. 2004. *Dasar-Dasar Sistem Proteksi Tenaga Listrik*. Unsri.

[10] Indra Roza1, AgusAlmiNasution, Rele Analisa Koordinasi Setting Rele Mengurangi Daerah Padam Pada Penyulang PE6 Di PT. PLN (PERSERO) Rayon Kotanopan, vol 4 no. 2, 2022, Jurnal Teknik Elektro.

[11] D.G. Agung Budhi, I.D Diyana Arjuna, Tjok Gede Indra Partha, 2017, *Studi Analisis koordinasi Over current relay(OCR) dan ground fault Relay(GFR) pada recloser penjulangan jaringan penebel*, Teknologi Elektro vol. 16 no, 2 Mei-Agustus 2017

[12] MisfaSusanto, Sitronella Nurfitriani Hasim, and Helmy Fitriawan, *Relay-Based Clustering Method for Interference Management in Heterogeneous Wireless Cellular Network*, JurnalTeknikElektro Vol. 13 No. 2 P-ISSN 1411 - 0059

[13] Muhalan,Yanto Husodo Budi. *Jurnal Analisa Perhitungan dan Pengaturan Relai Arus Lebih dan Relai Gangguan Tanah pada Kubikel Cakra 20 kV di PT. XYZ*, hal 166. ISSN: 1410-233

[14] *NX203A IDMT Over Current Relay User's Guide*

[15] Sanzarian, Yogi.2015. *Koordinasi Rele Arus Lebih dan Rele Gangguan Tanah Menggunakan Program Berbasis Electrical Transient And Analysis Program (ETAP) Pada Gardi Induk Bungaran Di PT. PLN*. Politeknik negeri Sriwijaya Hal 17

[16] Sahi Aiyub, Zaman, Aulia Kasyfi, 2018, Penggunaan relai arus lebih type sel 351A sebagai proteksi motor induksi 3 fasa, vol. 2 no. 1 2018, ISSN 25973959

[17] Sarimun,Wahyudi.2012.*Proteksi Sistem Distribusi Tenaga Listrik*. Jawa Barat:Garamond

[18] TEMI TIMOTIUS D. NGEDI.2016.*Pengggunaan Over Current Relay Dalam System Tenaga Listrik*. UNIVERSITAS NUSACENDANA

ISSN 0216-8685 (print); 2528-6889 (online)