

# **ANALISIS SISTEM DISTRIBUSI DAN KOORDINASI PROTEKSI SISTEM 33KV AKIBAT TERJADINYA SHORT CIRCUIT PADA TRANSFORMATOR TH-TR-01 DI ISLAND TANJUNG HARAPAN PT PUPUK KALTIM MENGGUNAKAN METODE REVIEW BY EVIDENT**

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**Dwi Iqbal Aripa 2212100138**

**Pembimbing :**

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Surabaya 2015**



# OUTLINE

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- Latar belakang
- Permasalahan
- Batasan masalah
- Teori penunjang
- Simulasi dan analisis





# LATAR BELAKANG

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- PT PKT disuplai oleh KDM Utility Center
- KDM mensuplai listrik dalam beberapa island
- Island Tanjung Harapan merupakan salah satu island yg disuplai
- Pembangunan beban baru Island Tanjung Harapan yg belum selesai menyebabkan trafo tidak terbebani
- Trafo yg tidak terbebani mengalami hubung singkat karna embun yg terjebak dalam jointing box mengenai bushing sehingga terhubung
- Gangguan tersebut menyebabkan tripnya beberapa CB di Island Tanjung Harapan dalam waktu yang bersamaan
- Selain itu juga mengakibatkan tripnya CB lain yang berada di luar Island Tanjung Harapan
- Tripnya CB pada sistem mengakibatkan PT PKT berhenti beroperasi



# PERMASALAHAN

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- Bagaimana mendapatkan koordinasi proteksi dan sistem distribusi yang baik, sehingga ketika terjadi gangguan dapat segera diatasi dan tidak mengganggu sistem?





# BATASAN MASALAH

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- Analisis sistem distribusi Island Tanjung Harapan berdasarkan Evident
- Koordinasi proteksi rele arus lebih tegangan menengah
  1. Gangguan fasa
  2. Gangguan Tanah



# TEORI PENUNJANG

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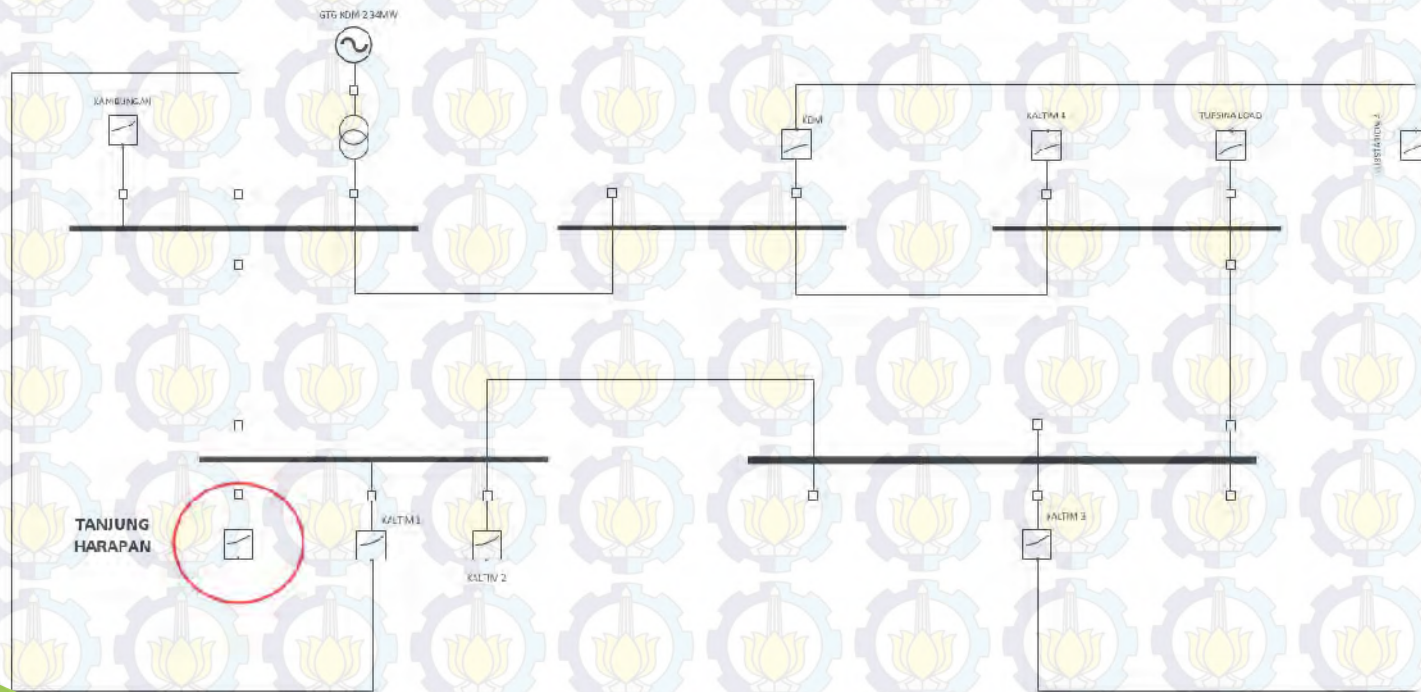
- Penyetelan Rele Waktu Invers  
 $1,05FLA < I_{set} < 1,3FLA$
- Penyetelan Rele Waktu Instan  
 $1,6FLA \leq I_{set} \leq 0,8 I_{SC} \text{ min}$
- Penyetelan Time Dial  
$$t_d(I) = \frac{k}{\left(\frac{I}{I_s}\right)^\alpha - 1} \times \frac{T}{\beta}$$
- Penyetelan Rele Gangguan Tanah  
 $5 - 10\% I_{unbalance} \leq I_{set} \leq 50\% I_{unbalance}$



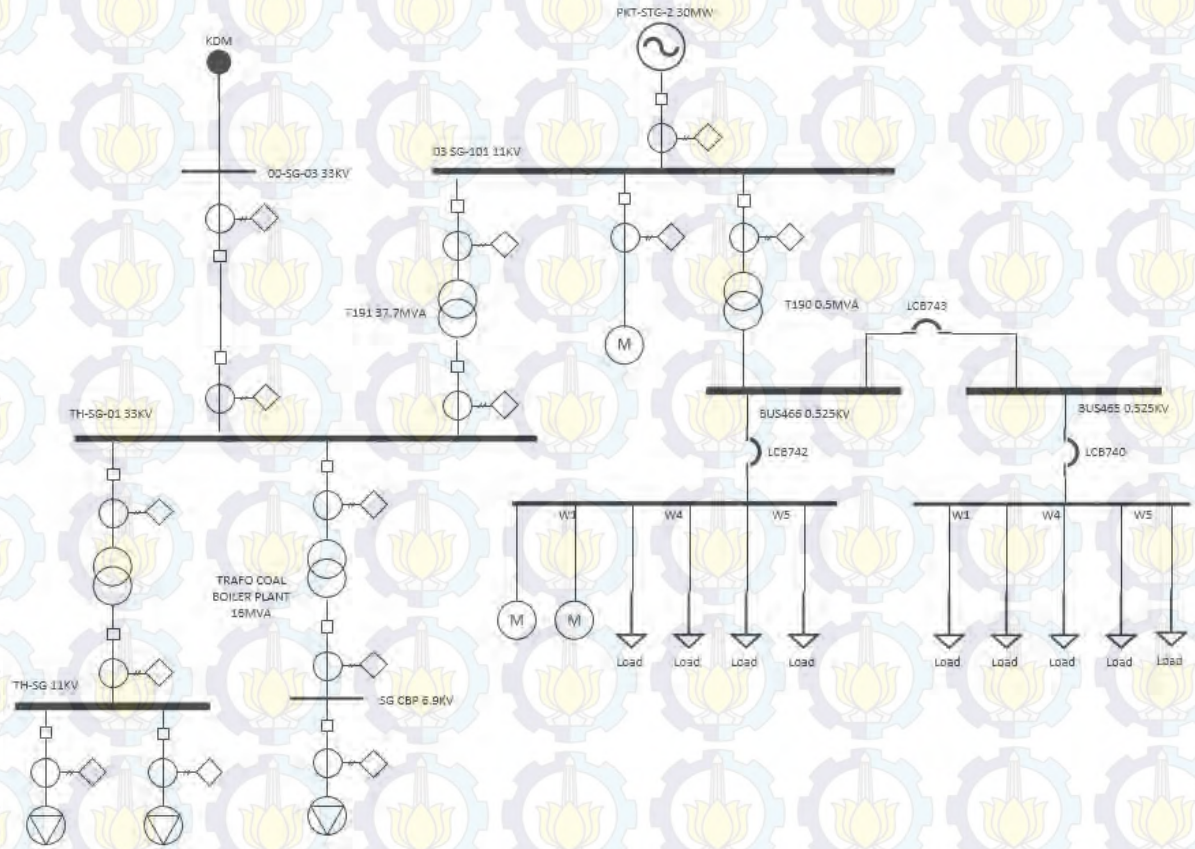


# SIMULASI DAN ANALISIS

- KDM Utility Center

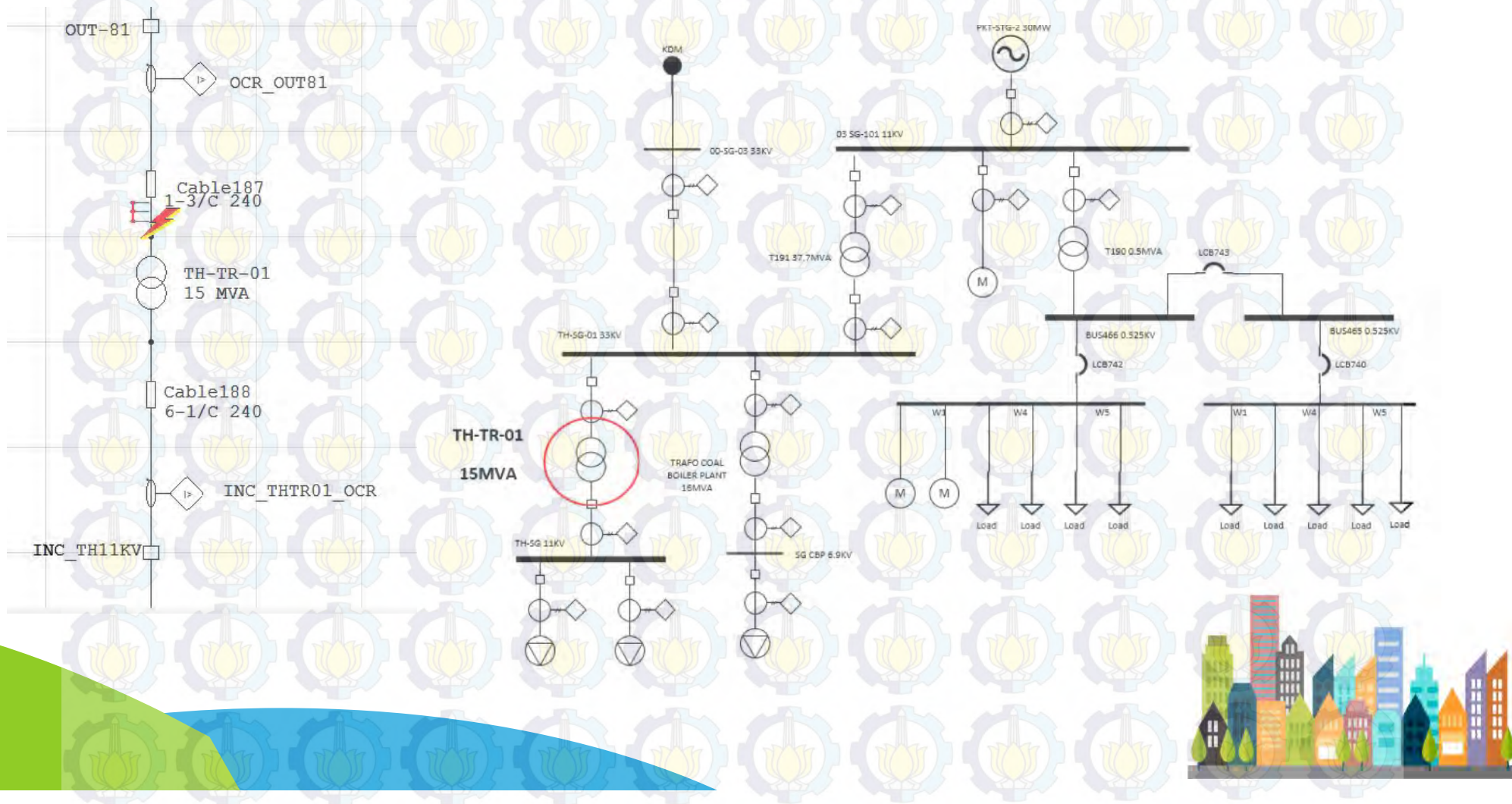


- Island Tanjung Harapan

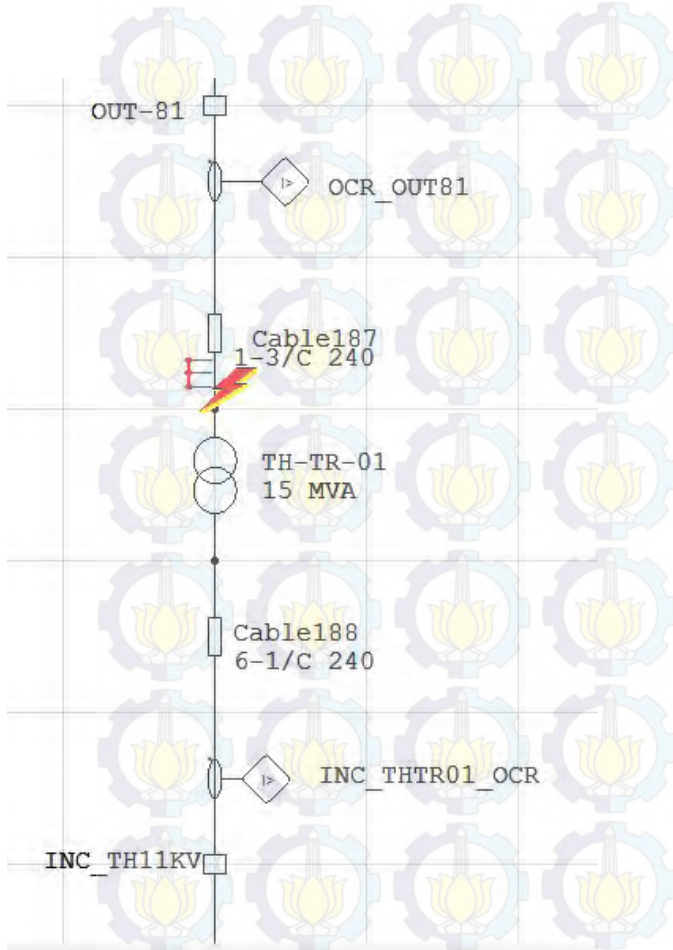




- Simulasi Hubung Singkat pada Trafo TH-TR-01 berdasarkan Evident







Sequence-of-Operation Events - Output Report: Untitled

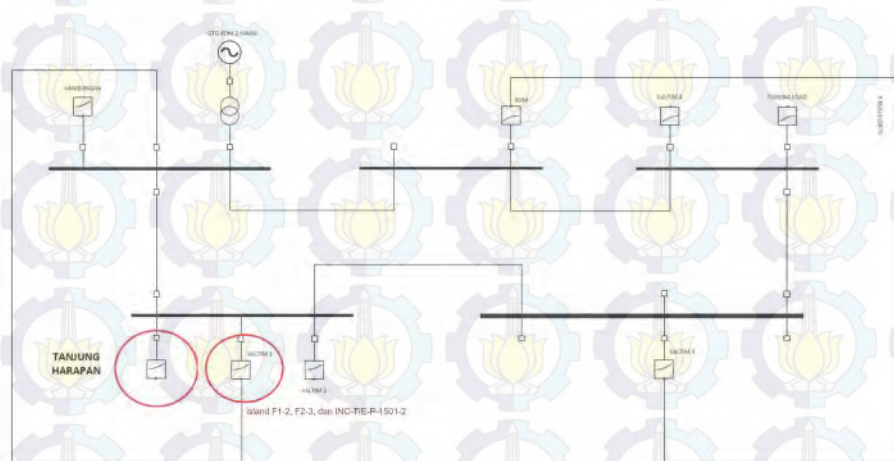
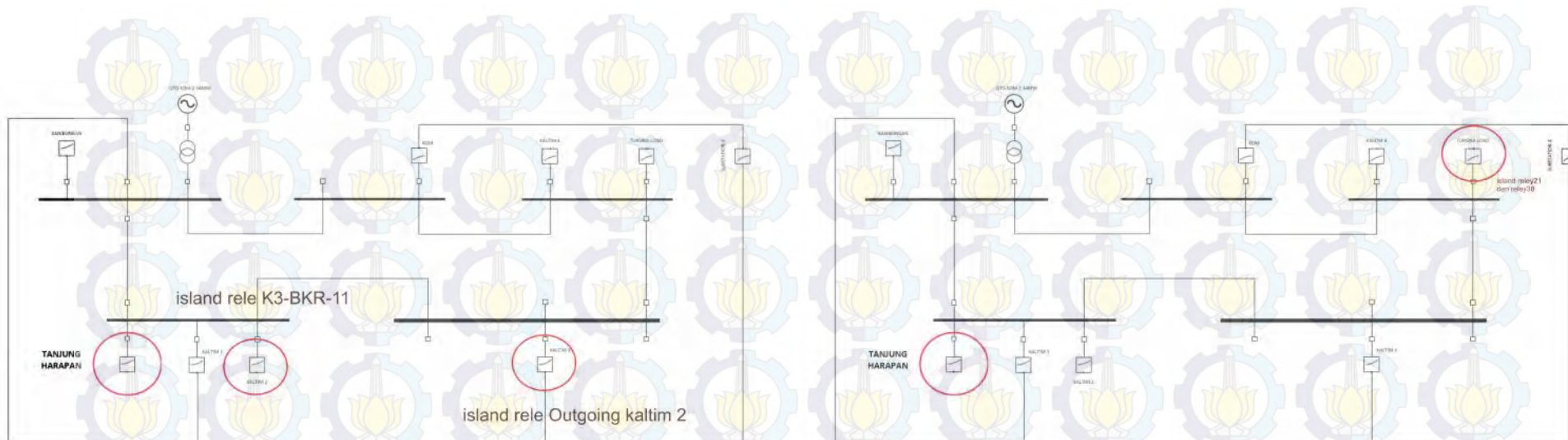
3-Phase (Symmetrical) fault on bus: Bus480

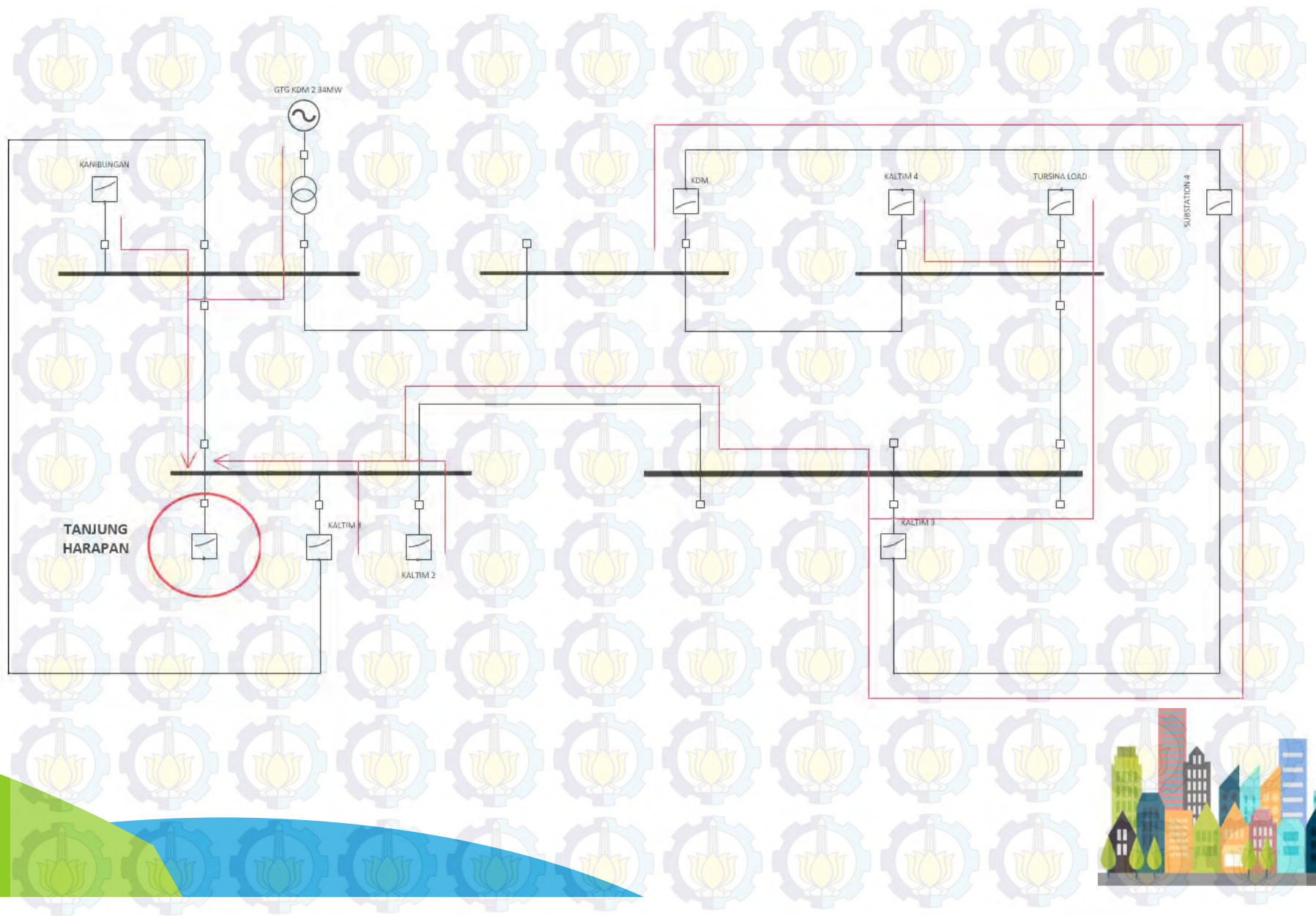
Data Rev.: Base Config: SCmax Date: 24-04-2016

Time (ms)	ID	If (kA)	T1 (ms)	T2 (ms)	Condition
100	OCR_INC81	11.842	100		Phase - OC1 - 50
100	OCR_OUT81	13.17	100		Phase - OC1 - 50
100	OCR_SP31	11.842	100		Phase - OC1 - 50
100	Relay21	3.072	100		Phase - OC1 - 50
100	Relay30	3.072	100		Phase - OC1 - 50
110	OUT-81		10.0		Tripped by OCR_OUT81 Phase - OC1 - 50
160	SP-31		60.0		Tripped by OCR_SP31 Phase - OC1 - 50
300	F1-2	3.752	300		Phase - OC1 - 50
300	F2-3	3.752	300		Phase - OC1 - 51
300	INC-TIE-P-1...	3.752	300		Phase - OC1 - 51
300	K3-BKR-11	4.969	300		Phase - OC1 - 50
300	Outgoing ka...	4.934	300		Phase - OC1 - 50
360	CB334		60.0		Tripped by Outgoing kaltim 2 Phase - OC1 - 50
360	CB357		60.0		Tripped by K3-BKR-11 Phase - OC1 - 50
360	CB460		60.0		Tripped by F1-2 Phase - OC1 - 50
360	CB461		60.0		Tripped by INC TIE P-1501 3 Phase - OC1 - 51











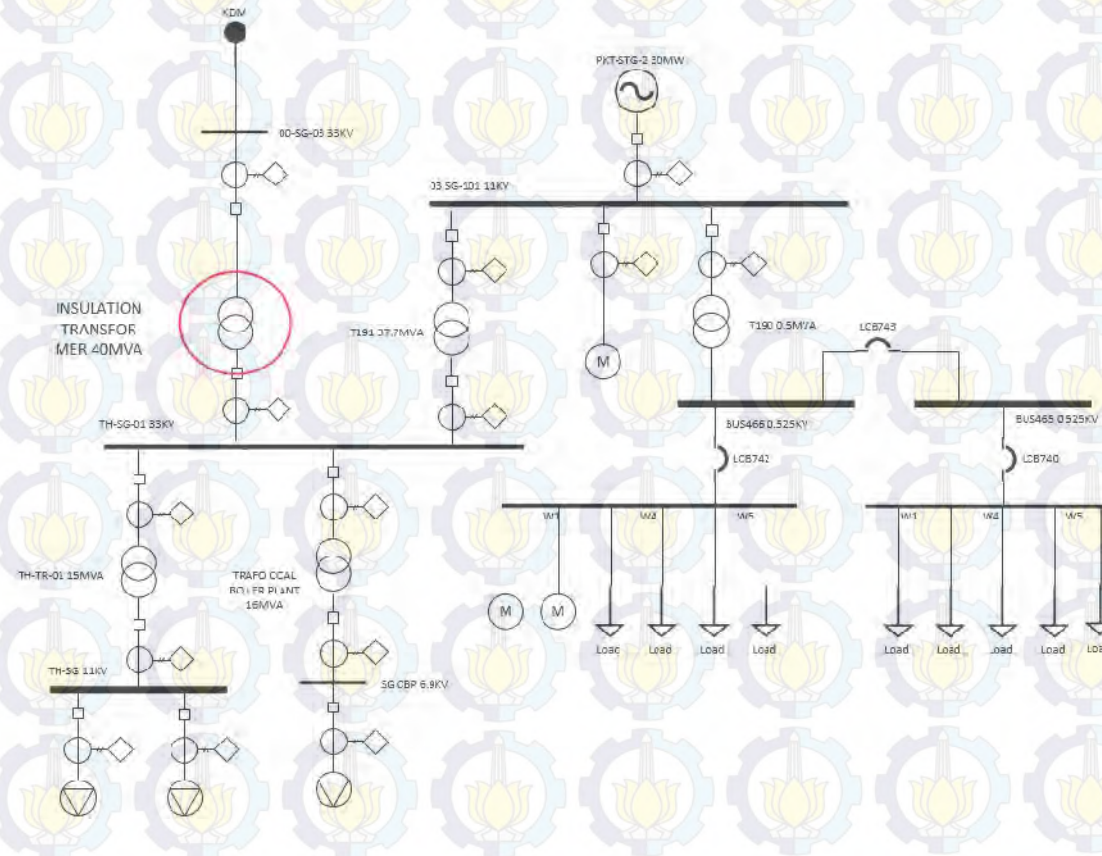
# SOLUSI?

- Dibutuhkan cara untuk mengurangi arus pada titik gangguan



- Simulasi dengan Trafo Isolasi

Menambahkan trafo sebesar 40MVA 12.5% impedansi pada sistem dan perbandingan belitan 1:1





- Dilakukan kembali hubung singkat pada trafo TH-TR-01 berdasarkan Evident

Sequence-of-Operation Events - Output Report: Untitled

3-Phase (Symmetrical) fault on bus: Bus480

Data Rev.: Base      Config: SCmax      Date: 24-04-2016

Time (ms)	ID	If (kA)	T1 (ms)	T2 (ms)	Condition
100	OCR_INC81	11.842	100		Phase - OC1 - 50
100	OCR_OUT81	13.17	100		Phase - OC1 - 50
100	OCR_SP31	11.842	100		Phase - OC1 - 50
100	Relay21	3.072	100		Phase - OC1 - 50
100	Relay30	3.072	100		Phase - OC1 - 50
110	OUT-81		10.0		Tripped by OCR_OUT81 Phase - OC1 - 50
160	SP-31		60.0		Tripped by OCR_SP31 Phase - OC1 - 50
300	F1-2	3.752	300		Phase - OC1 - 50
300	F2-3	3.752	300		Phase - OC1 - 51
300	INC-TIE-P-1...	3.752	300		Phase - OC1 - 51
300	K3-BKR-11	4.969	300		Phase - OC1 - 50
300	Outgoing ka...	4.934	300		Phase - OC1 - 50
360	CB334		60.0		Tripped by Outgoing kaltim 2 Phase - OC1 - 50
360	CB357		60.0		Tripped by K3-BKR-11 Phase - OC1 - 50
360	CB460		60.0		Tripped by F1-2 Phase - OC1 - 50
360	CB461		60.0		Tripped by F1-2 Phase - OC1 - 50

Sequence-of-Operation Events - Output Report: Untitled

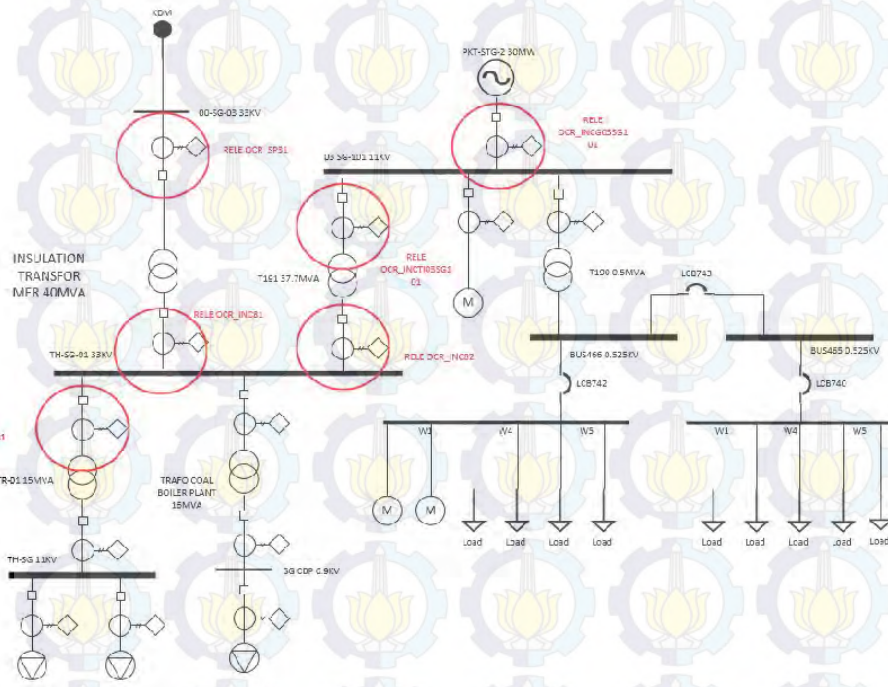
3-Phase (Symmetrical) fault on bus: Bus480

Data Rev.: Base      Config: SCmax      Date: 24-04-2016

Time (ms)	ID	If (kA)	T1 (ms)	T2 (ms)	Condition
100	OCR_OUT81	5.017	100		Phase - OC1 - 50
110	OUT-81		10.0		Tripped by OCR_OUT81 Phase - OC1 - 50
308	OCR_SP31	3.778	308		Phase - OC1 - 51
313	OCR_INC81	3.683	313		Phase - OC1 - 51
368	SP-31		60.0		Tripped by OCR_SP31 Phase - OC1 - 51
913	OCR_INC82	1.334	913		Phase - OC1 - 51
1193	OCR_INCTI...	4.177	1193		Phase - OC1 - 51
1253	INCT_03S...		60.0		Tripped by OCR_INCTI03SG101 Phase - OC1 - 51
3725	OCR_INCG...	4.177	3725		Phase - OC1 - 51
3785	INCG_03SG...		60.0		Tripped by OCR_INCG03SG101 Phase - OC1 - 51
26857	OCR_CP41	1.66	26857		Phase - OC1 - 51
26917	CP-41		60.0		Tripped by OCR_CP41 Phase - OC1 - 51
31611	OCR_CP21	1.564	31611		Phase - OC1 - 51
31671	CP-21		60.0		Tripped by OCR_CP21 Phase - OC1 - 51
96204	OCR_CP51	1.073	96204		Phase - OC1 - 51
96264	CP-51		60.0		Tripped by OCR_CP51 Phase - OC1 - 51







### Sequence-of-Operation Events - Output Report: Untitled

3-Phase (Symmetrical) fault on bus: Bus480

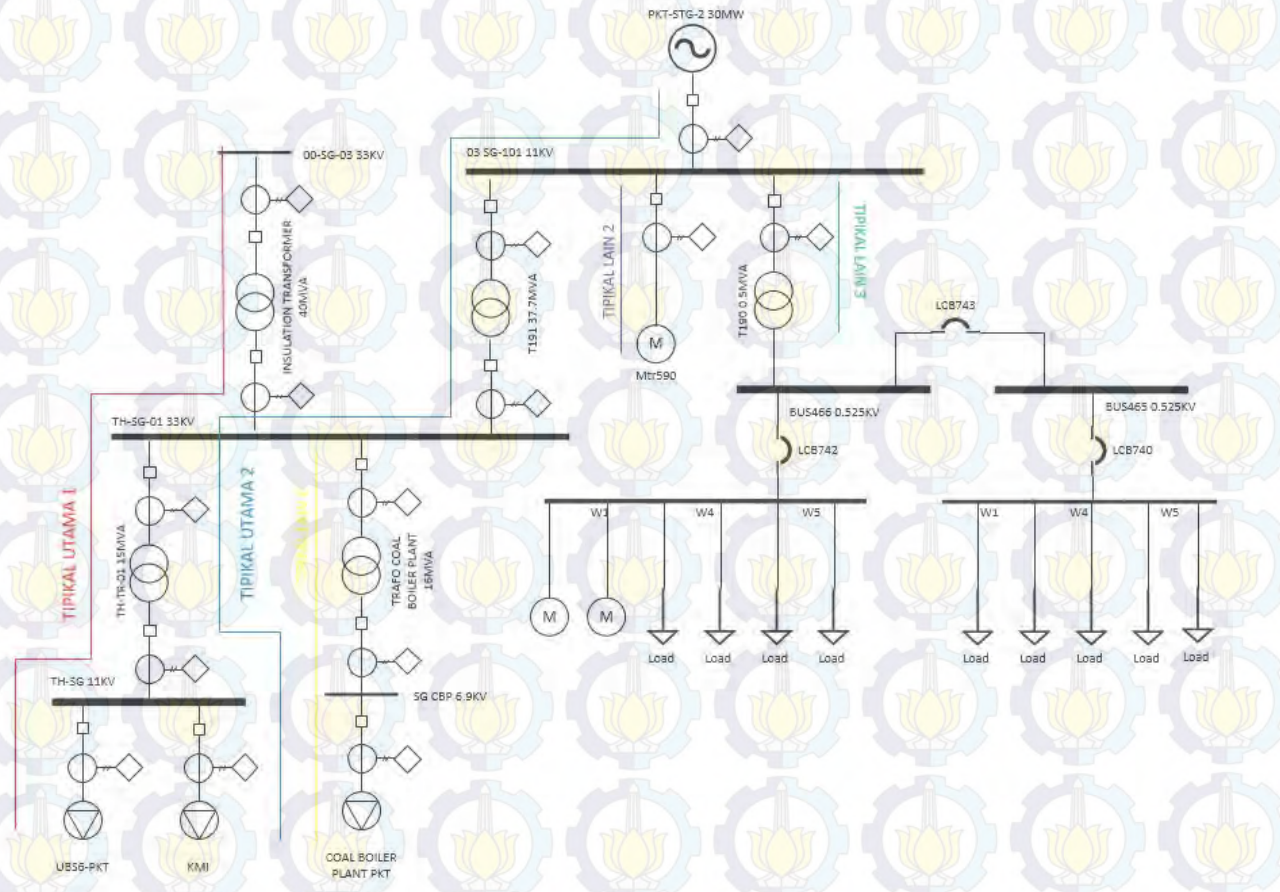
Data Rev.: Base      Config: SCmax      Date: 24-04-2016

Time (ms)	ID	If (kA)	T1 (ms)	T2 (ms)	Condition
100	OCR_OUT81	5.017	100		Phase - OC1 - 50
110	OUT-81		10.0		Tripped by OCR_OUT81 Phase - OC1 - 50
308	OCR_SP31	3.778	308		Phase - OC1 - 51
313	OCR_INC81	3.683	313		Phase - OC1 - 51
368	SP-31		50.0		Tripped by OCR_SP31 Phase - OC1 - 51
913	OCR_INCG2	1.334	913		Phase - OC1 - 51
1193	OCR_INCTI...	4.177	1193		Phase - OC1 - 51
1253	INCT_03S...		50.0		Tripped by OCR_INCT103SG101 Phase - OC1 - 51
3725	OCR_INCG...	4.177	3725		Phase - OC1 - 51
3785	INCG_03SG...		50.0		Tripped by OCR_INCG03SG101 Phase - OC1 - 51
26857	OCR_CP41	1.66	26857		Phase - OC1 - 51
26917	CP-41		50.0		Tripped by OCR_CP41 Phase - OC1 - 51
31611	OCR_CP21	1.584	31611		Phase - OC1 - 51
31671	CP-21		50.0		Tripped by OCR_CP21 Phase - OC1 - 51
96204	OCR_CP51	1.073	96204		Phase - OC1 - 51
96204	CP-51		50.0		Tripped by OCR_CP51 Phase - OC1 - 51





- Koordinasi Proteksi Rele Arus Lebih Gangguan Fasa



- Nilai Arus Hubung Singkat

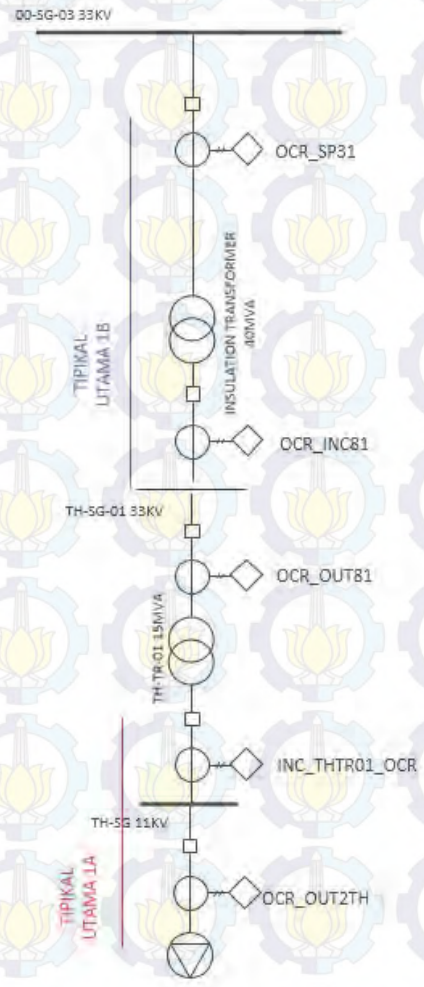
No	ID	Tegangan (KV)	Arus Hubung Singkat Minimum 2 Fasa 30 Cycle (KA)
1	TH-SG-11	11	4,62
2	SG-CBP	6.9	7,68
3	TH-SG-01	33	4,8
4	03-SG-101	11	12,19
5	00-SG-03	33	13,16

No	ID	Tegangan (KV)	Arus Hubung Singkat Maximum 3 Fasa 4 Cycle (KA)
1	TH-SG-11	11	7,43
2	SG-CBP	6.9	14,3
3	TH-SG-01	33	7,42
4	03-SG-101	11	18,52
5	00-SG-03	33	19,9
6	Bus466	0,525	9,7

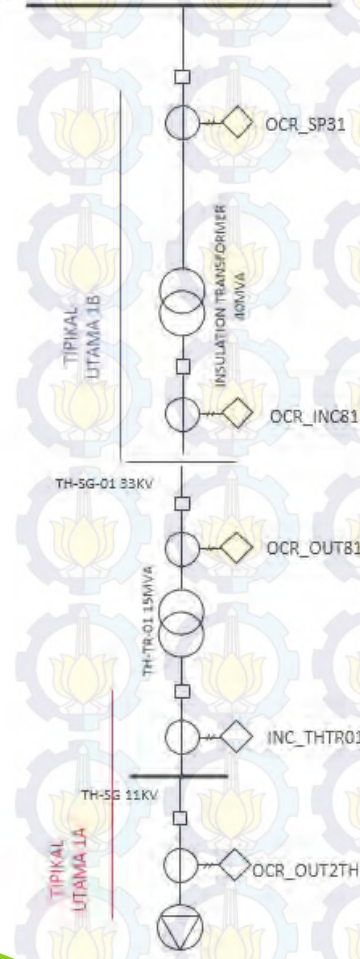




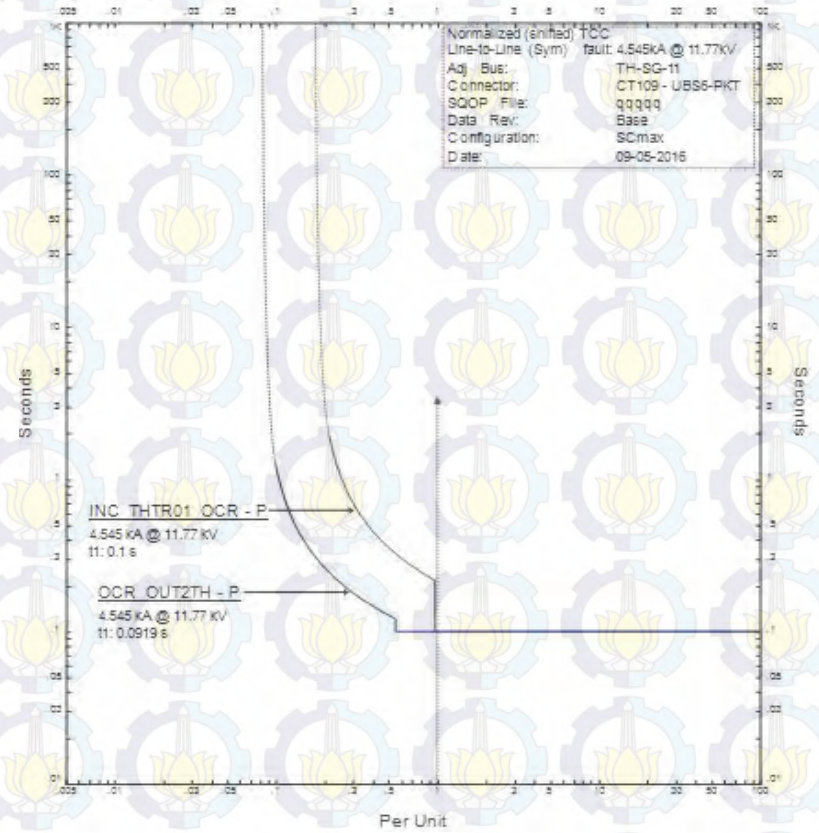
- Tipikal Utama 1



00-SG-03 33KV



Gambar *Time-current curve existing* tipikal utama 1a





## Rele OCR OUT2TH

### Time Overcurrent Pickup

$$\begin{aligned}
 1,05 \times \text{FLA Beban} &< I_{set} < 1,4 \times \text{FLA Beban} \\
 1,05 \times 314,9 &< I_{set} < 1,4 \times 314,9 \\
 330,645 &< I_{set} < 440,86 \\
 \frac{330,645}{1250} I_n &< \text{Tap} < \frac{440,86}{1250} I_n \\
 0,264 I_n &< \text{Tap} < 0,352 I_n
 \end{aligned}$$

memiliki tap dengan range : 0,2 – 2,4 x CT sekunder dengan step 0,05 In  
dipilih tap = 0,3 In  
dengan Iset = 375 A

### Time dial

Waktu operasi (t) = 0,2s

$$t_d(I) = \frac{k}{\left(\frac{I}{I_s}\right)^\alpha - 1} \times \frac{T}{\beta}$$

$$0,2 = \frac{0,14}{\left(\frac{I_{sc} \text{ Max bus}}{\text{tap} \times CT \text{ primer}}\right)^{0,02} - 1} \times \frac{T}{2,97}$$

$$T = \frac{0,2 \times 2,97 \times \left[ \left(\frac{I_{sc} \text{ Max bus}}{\text{tap} \times CT \text{ primer}}\right)^{0,02} - 1 \right]}{0,14}$$

$$T = \frac{0,2 \times 2,97 \times \left[ \left(\frac{7430}{0,3 \times 1250}\right)^{0,02} - 1 \right]}{0,14}$$

$$T = 0,26$$

memiliki tap dengan range : 0,1 - 12,5 dengan step 0,1  
dipilih *time dial* = 0,3

### Instantaneous Pickup

$$\begin{aligned}
 1,6 \times \text{FLA Beban} &< I_{set} < 0,8 \times I_{sc} \text{ min} \\
 1,6 \times 314,9 &< I_{set} < 0,8 \times 4620 \\
 503,84 &< I_{set} < 3696 \\
 \frac{503,84}{1250} I_n &< \text{Tap} < \frac{3696}{1250} I_n \\
 0,40 I_n &< \text{Tap} < 2,95 I_n
 \end{aligned}$$

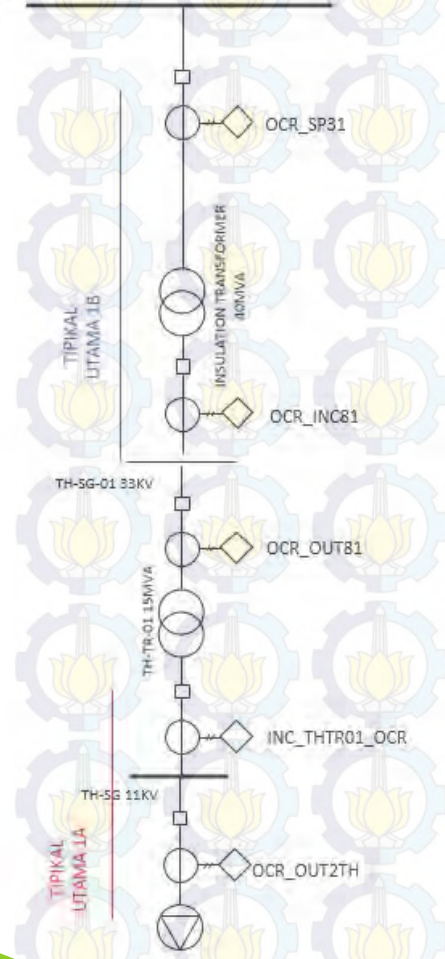
memiliki tap dengan range : 1 - 24 x CT sekunder dengan step 0,1 In  
dipilih tap = 2 In  
dengan Iset = 2500 A

### Time delay

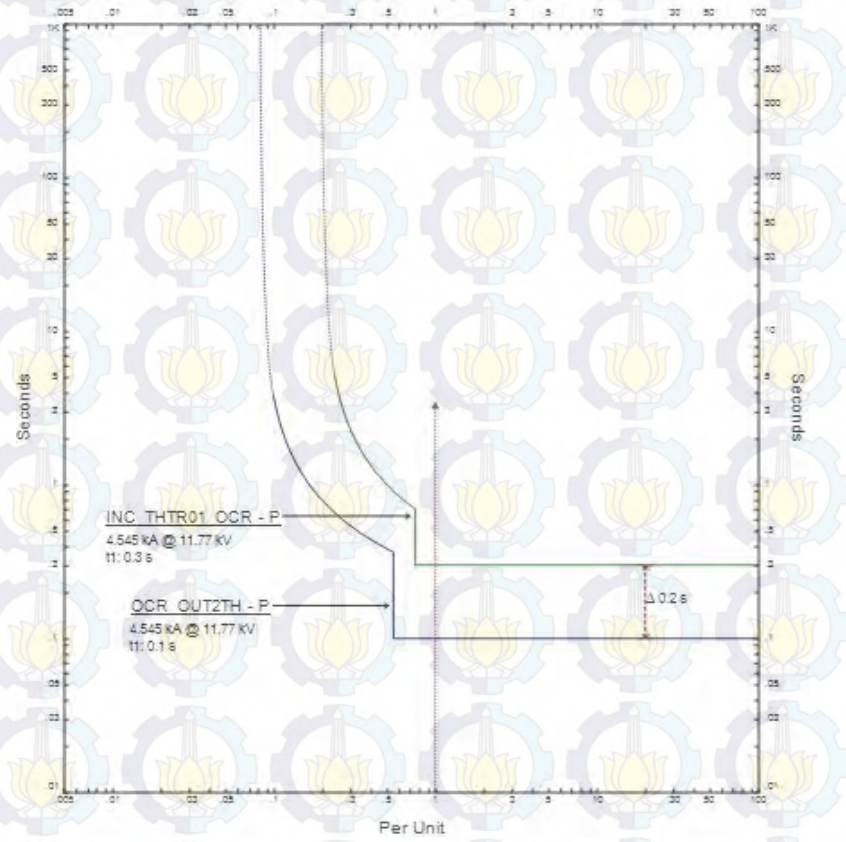
dipilih *time delay* = 0,1 detik

ID Relez	Invers		Instantaneous	
	Pickup	Time Dial	Pickup	Time Delay
Rele OCR OUT2TH	0.3	0.3	2	0.1
Rele INC THTR01 OCR	0.45	0.4	1.7	0.3
Rele OCR OUT81	0.7	0.9	7	0.1
Rele OCR INC81	1.05	0.8	3.5	0.5
Rele OCR SP31	1.2	1.5	10	0.1

00-SG-03 33KV

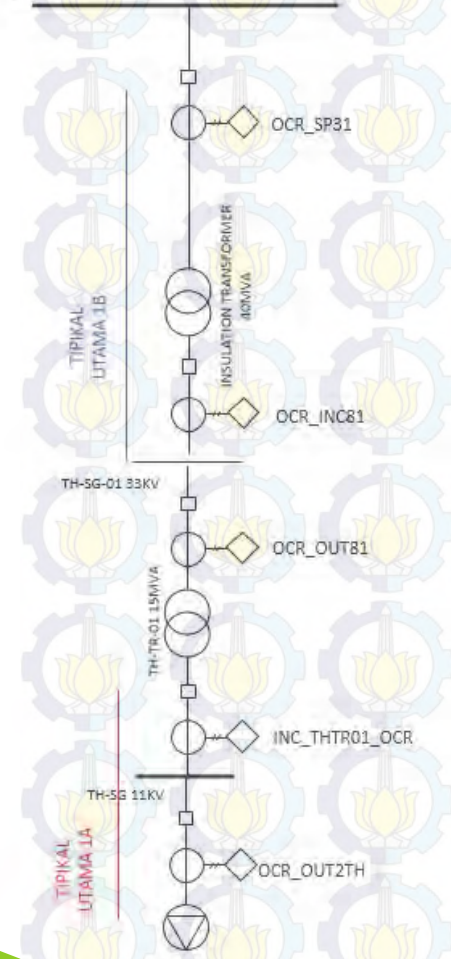


Gambar *Time-current curve resetting* tipikal utama 1a

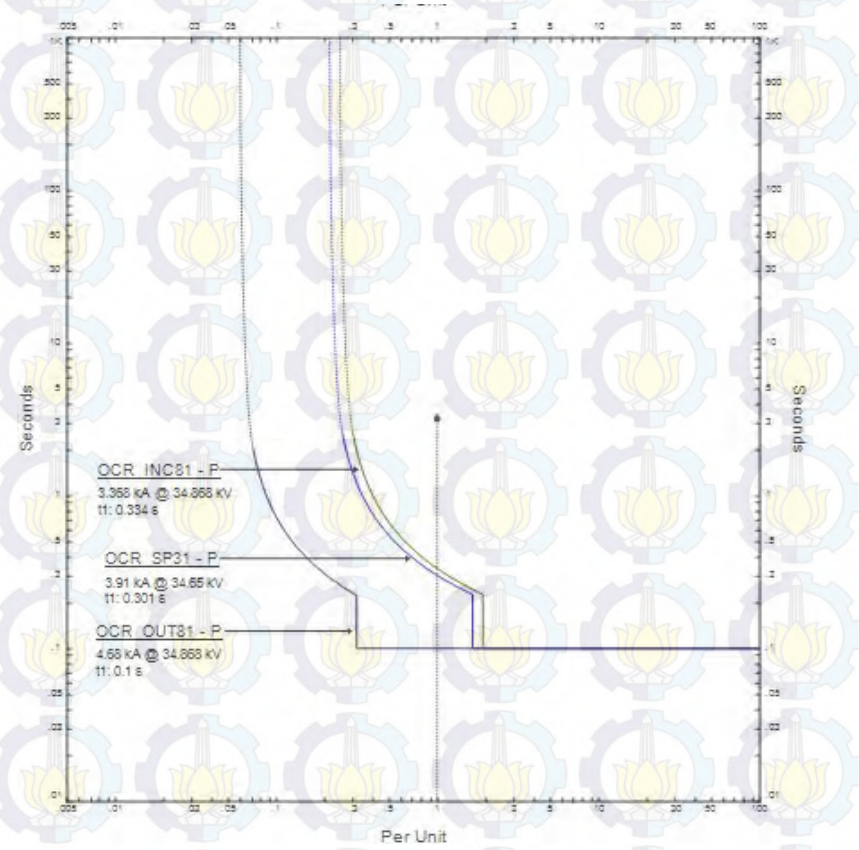




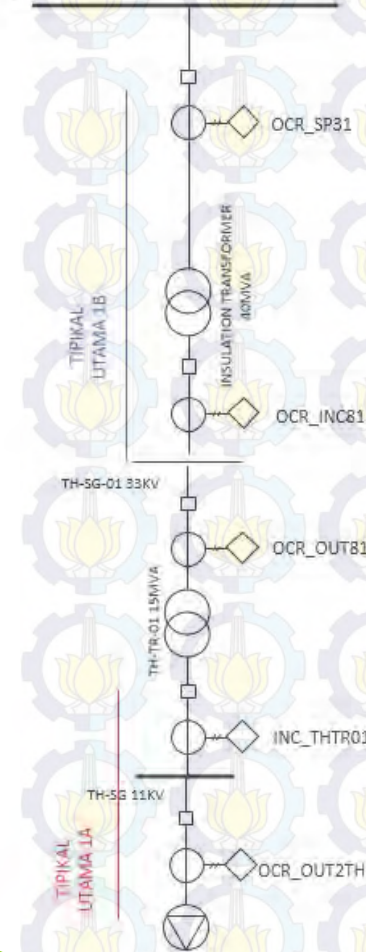
00-SG-03 33KV



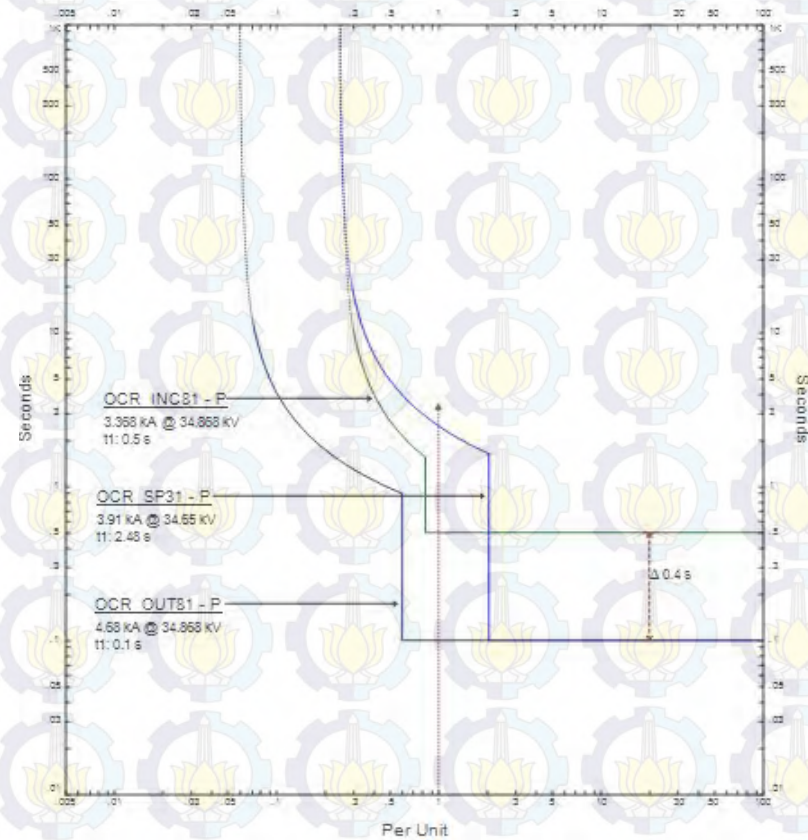
Gambar Time-current curve existing tipikal utama 1b



00-SG-03 33KV

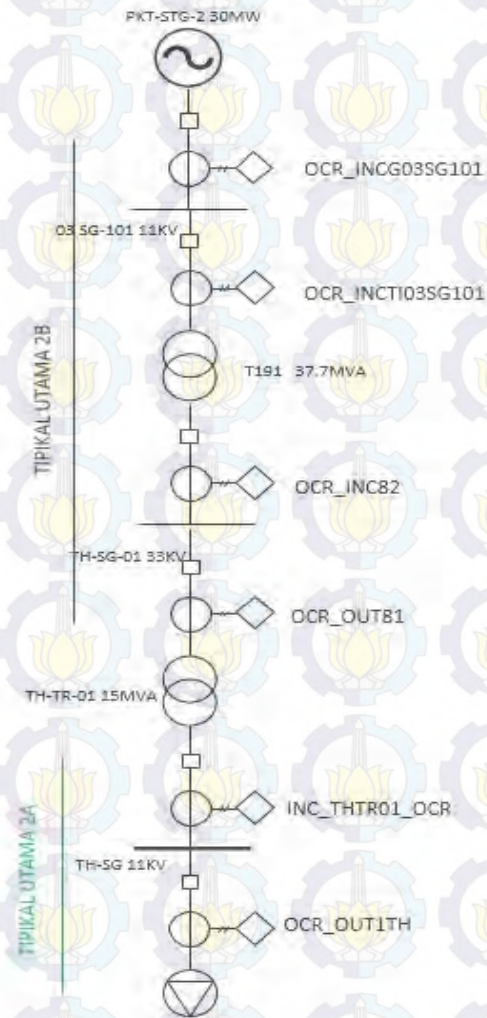


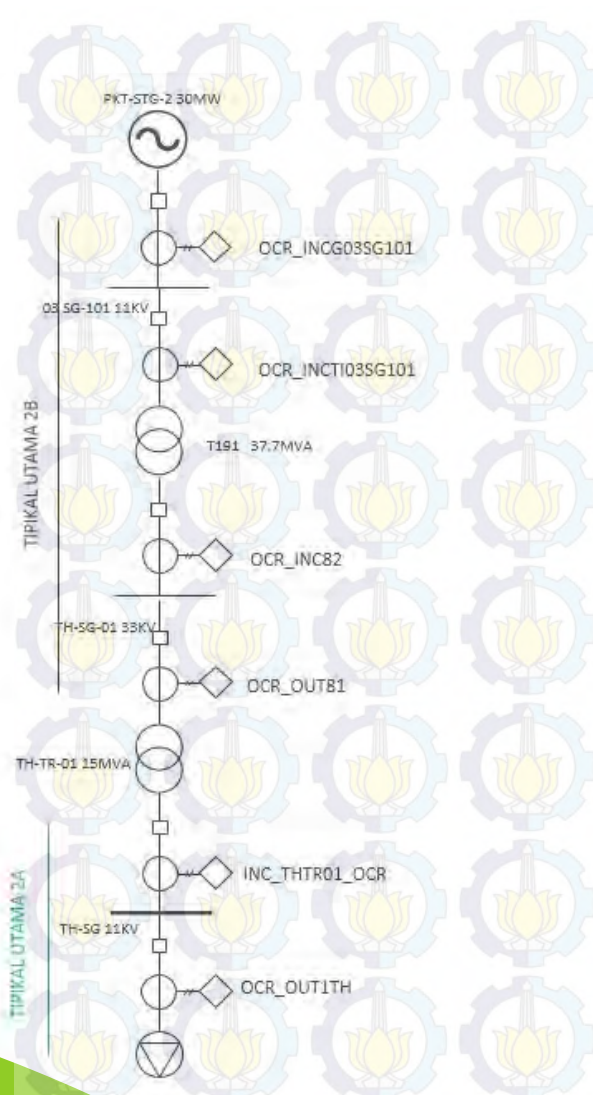
Gambar Time-current curve resetting tipikal utama 1b



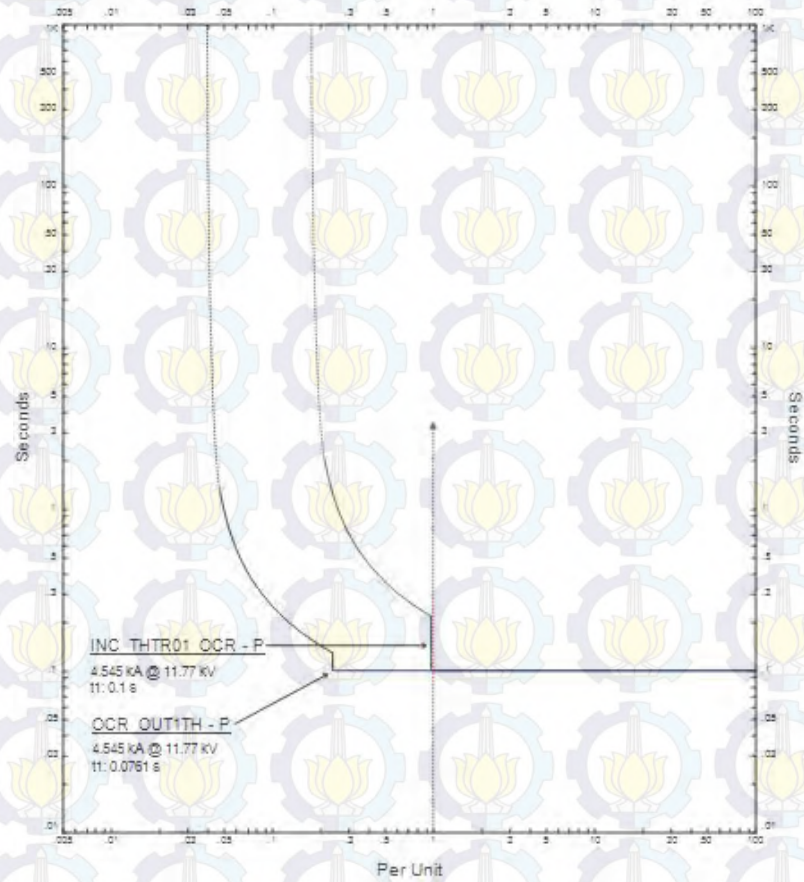


- Tipikal Utama 2





Gambar *Time-current curve existing* tipikal utama 2a





### Rele OCR OUT1TH

#### Time Overcurrent Pickup

$$1,05 \times \text{FLA Beban} < I_{set} < 1,4 \times \text{FLA Beban}$$

$$1,05 \times 185,3 < I_{set} < 1,4 \times 185,3$$

$$194,56 < I_{set} < 259,42$$

$$\frac{194,56}{600} I_n < \text{Tap} < \frac{259,42}{600} I_n$$

$$0,324 I_n < \text{Tap} < 0,432 I_n$$

memiliki tap dengan range : 0,2 – 2,4 x CT sekunder dengan step 0,05 In  
dipilih tap = 0,35 In  
dengan Iset = 210 A

#### Time dial

Waktu operasi (t) = 0,2s

$$t_d(I) = \frac{k}{\left(\frac{I}{I_s}\right)^\alpha - 1} \times \frac{T}{\beta}$$

$$0,2 = \frac{0,14}{\left(\frac{I_{sc} \text{ Max bus}}{\text{tap} \times CT \text{ primer}}\right)^{0,02} - 1} \times \frac{T}{2,97}$$

$$T = \frac{0,2 \times 2,97 \times \left[ \left(\frac{I_{sc} \text{ Max bus}}{\text{tap} \times CT \text{ primer}}\right)^{0,02} - 1 \right]}{0,14}$$

$$T = \frac{0,2 \times 2,97 \times \left[ \left(\frac{7430}{0,3 \times 1250}\right)^{0,02} - 1 \right]}{0,14}$$

$$T = 0,26$$

memiliki tap dengan range : 0,1 - 12,5 dengan step 0,1  
dipilih *time dial* = 0,3

#### Instantaneous Pickup

$$1,6 \times \text{FLA Beban} < I_{set} < 0,8 \times I_{sc} \text{ min}$$

$$1,6 \times 185,3 < I_{set} < 0,8 \times 4620$$

$$296,48 < I_{set} < 3696$$

$$\frac{296,48}{600} I_n < \text{Tap} < \frac{3696}{600} I_n$$

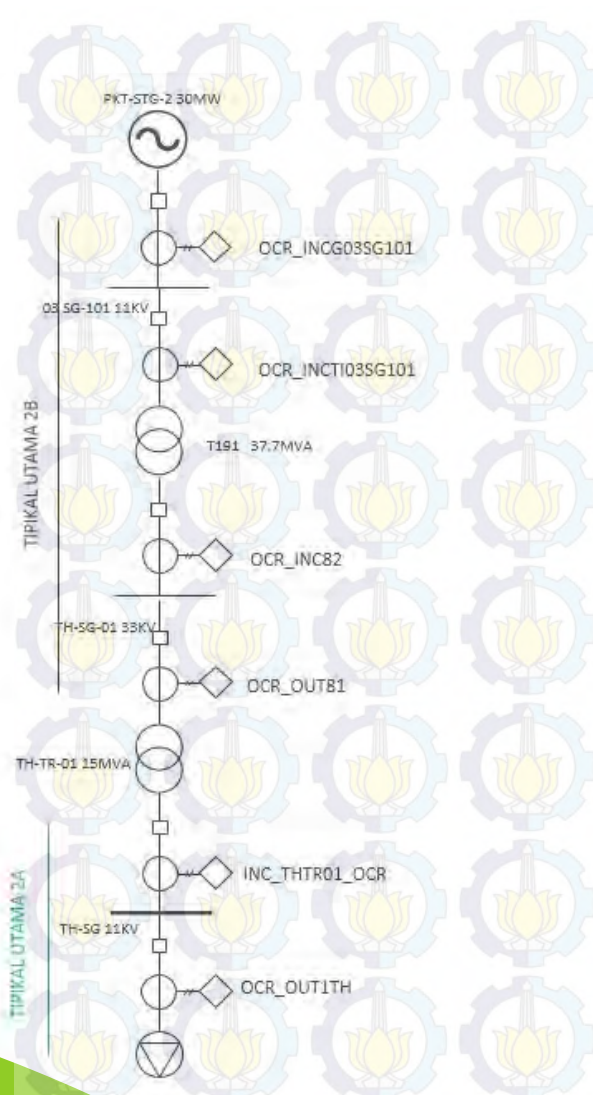
$$0,49 I_n < \text{Tap} < 6,16 I_n$$

memiliki tap dengan range : 1 - 24 x CT sekunder dengan step 0,1 In  
dipilih tap = 5 In  
dengan Iset = 3000 A

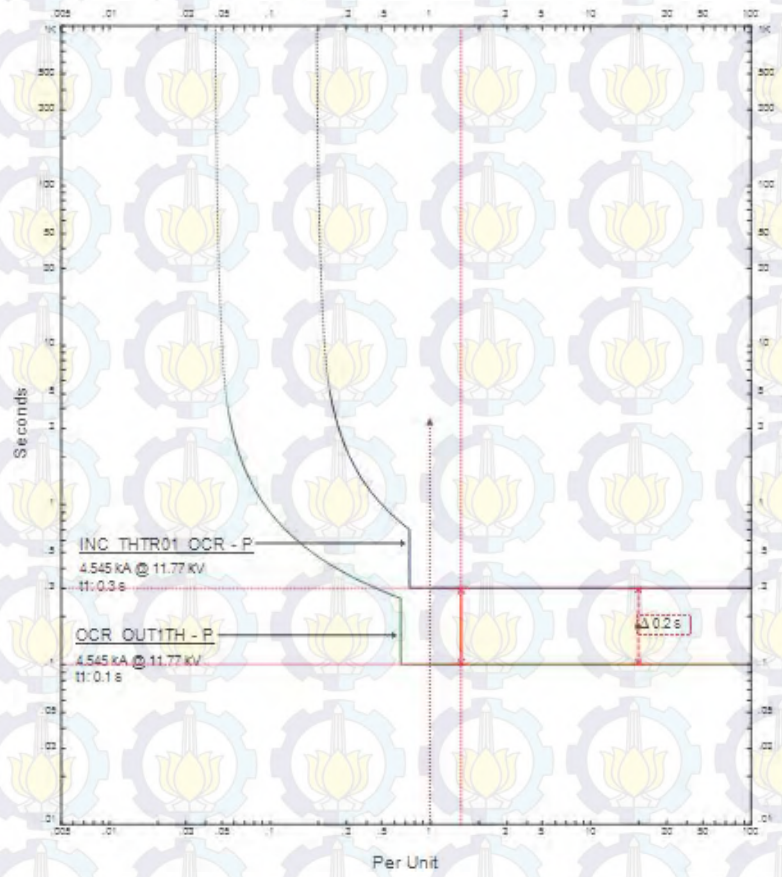
#### Time delay

dipilih *time delay* = 0,1 detik

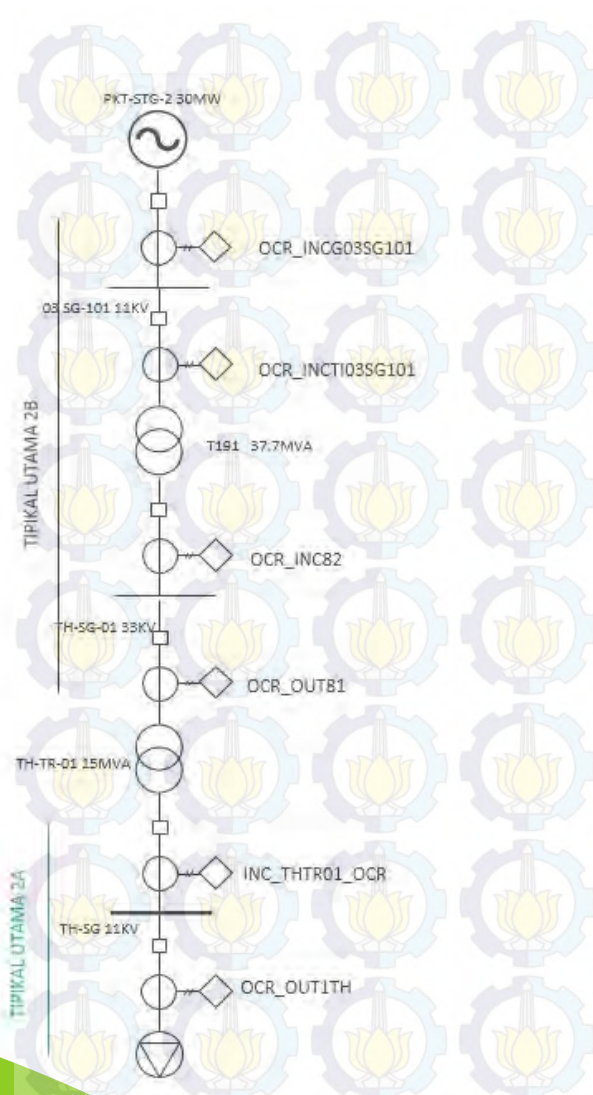
ID Rele	Invers		Instantaneous	
	Pickup	Time Dial	Pickup	Time Delay
Rele OCR OUT1TH	0.35	0.3	5	0.1
Rele INC THTR01 OCR	0.45	0.4	1.7	0.3
Rele OCR OUT81	0.7	0.3	7	0.1
Rele OCR INC82	1.05	0.4	1.4	0.3
Rele OCR INCTI03SG101	1.1	0.5	2.8	0.3
Rele OCR INCG03SG101	0.85	2.1	2.1	0.5



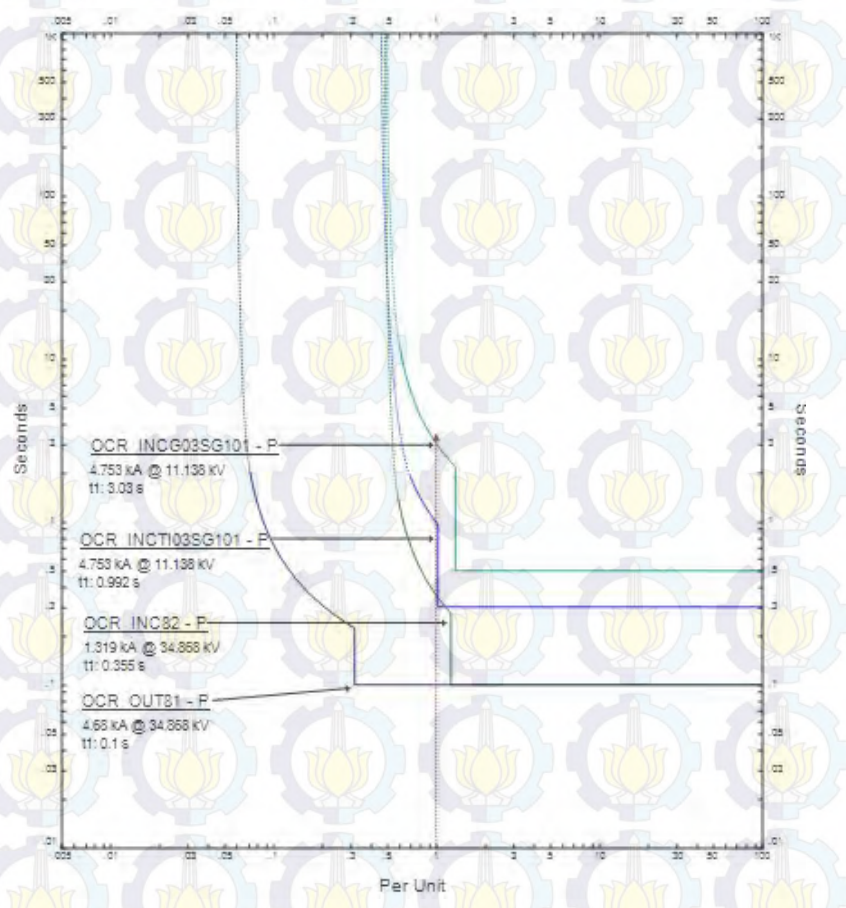
Gambar *Time-current curve resetting* tipikal utama 2a





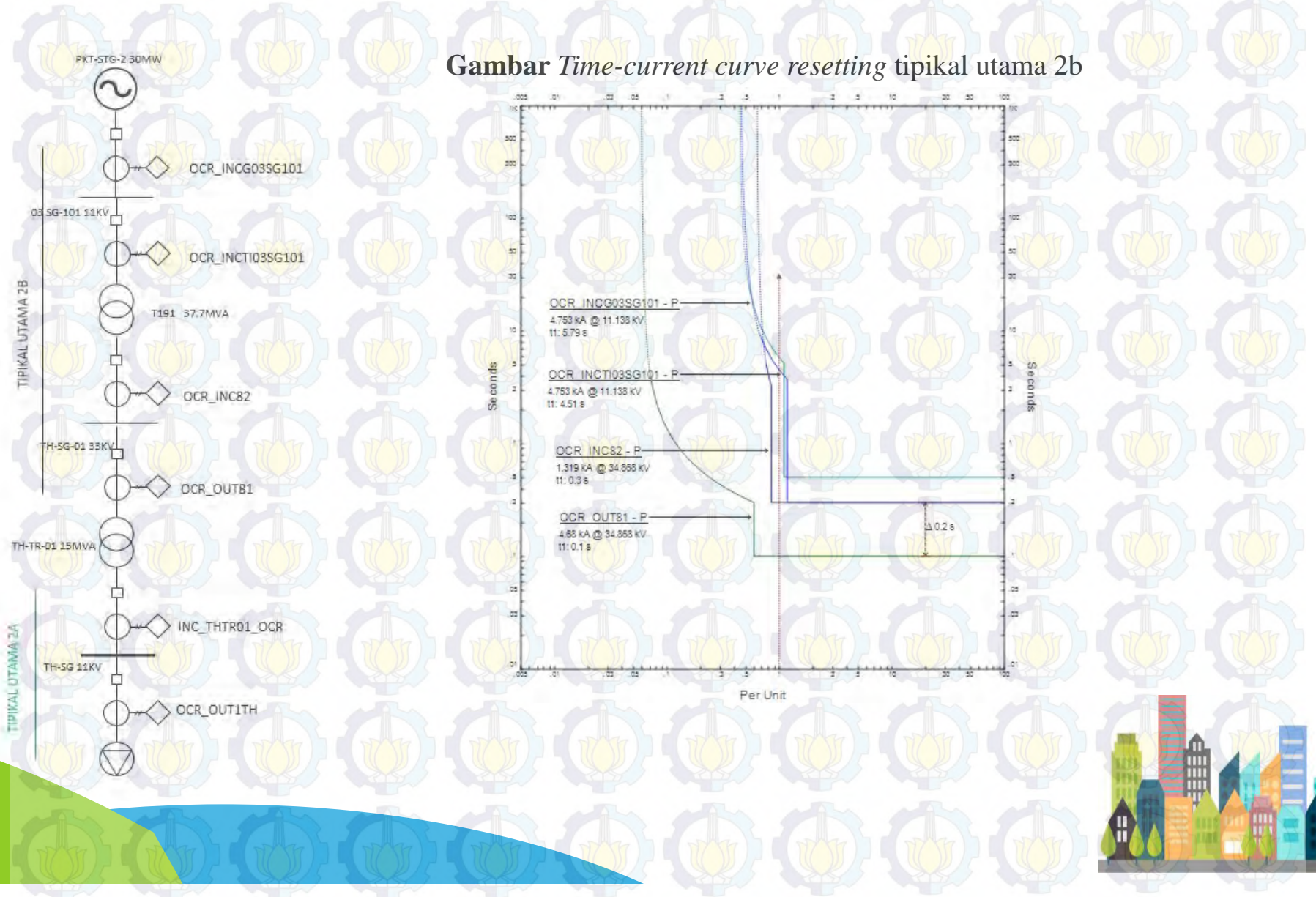


Gambar *Time-current curve existing tipikal utama 2b*



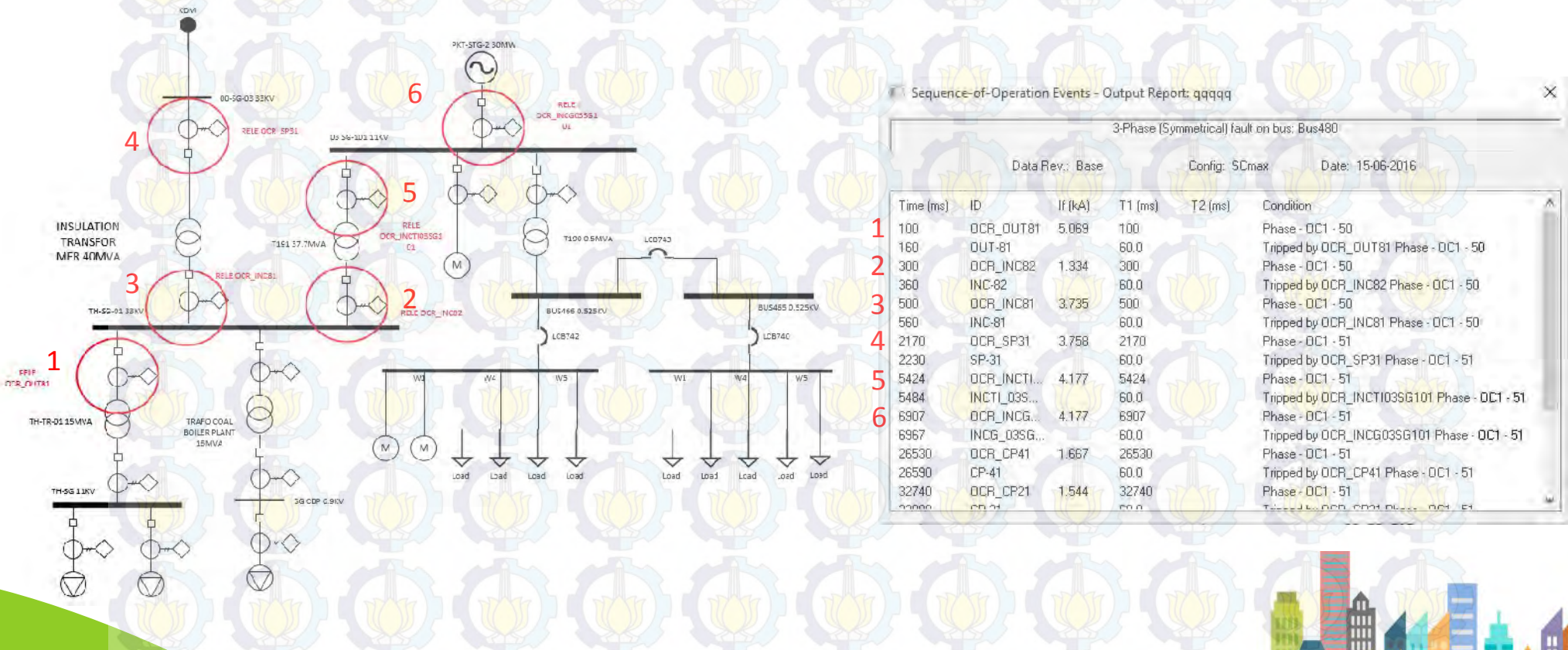


Gambar *Time-current curve resetting* tipikal utama 2b



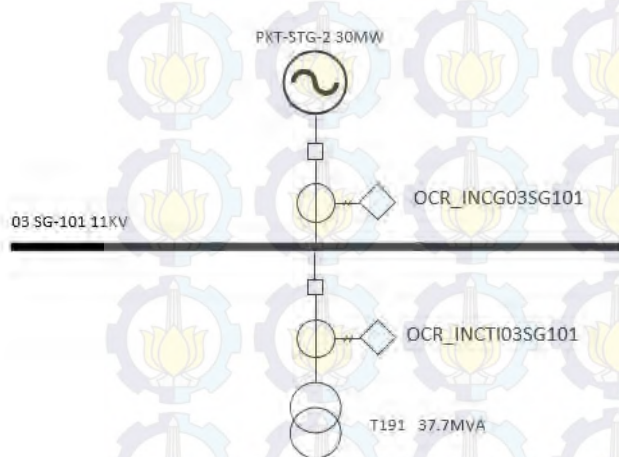


- Hasil Resetting Rele ketika Terjadi Hubung Singkat pada Trafo TH-TR-01 berdasarkan Evident





- Koordinasi Proteksi Rele Arus Lebih Gangguan Tanah



**Rele OCR\_INCTI03SG101**

Manufacturer : ABB  
 Model : SPAJ 140C  
 CT Ratio : 50/5  
 Isc NGR PK-STG-2 : 10 A

Instantaneous Pickup

$$\begin{aligned}
 &I_{sc\ unbalance} < I_{set} < 50\% \times I_{sc\ LG} \\
 &5 - 10\% \times NGR < I_{set} < 50\% \times NGR \\
 &5\% \times 10\ A < I_{set} < 50\% \times 10\ A \\
 &\frac{0,5}{50}\ In < Tap < \frac{5}{50}\ In \\
 &0,01\ In < Tap < 0,1\ In
 \end{aligned}$$

memiliki tap range : 0,1 - 10 x CT sekunder dengan step 0,01 In  
 dipilih tap = 0,1 In  
 dengan Iset = 5 A

Time delay

dipilih time delay = 0,1 detik

**OCR\_INCG03SG101**

Manufacturer : Merlin Gerin  
 Model : Sepam 1000  
 CT Ratio : 50/5  
 NGR Insulated Transformer : 10 A

Instantaneous Pickup

$$\begin{aligned}
 &I_{sc\ unbalance} < I_{set} < 50\% \times I_{sc\ LG} \\
 &5 - 10\% \times NGR < I_{set} < 50\% \times NGR \\
 &5\% \times 10\ A < I_{set} < 50\% \times 10\ A \\
 &\frac{0,5}{50}\ In < Tap < \frac{5}{50}\ In \\
 &0,01\ In < Tap < 0,1\ In
 \end{aligned}$$

memiliki tap range : 0,05 - 10 x CT sekunder dengan step 0,05 In  
 dipilih tap = 0,05 In  
 dengan Iset = 2,5 A

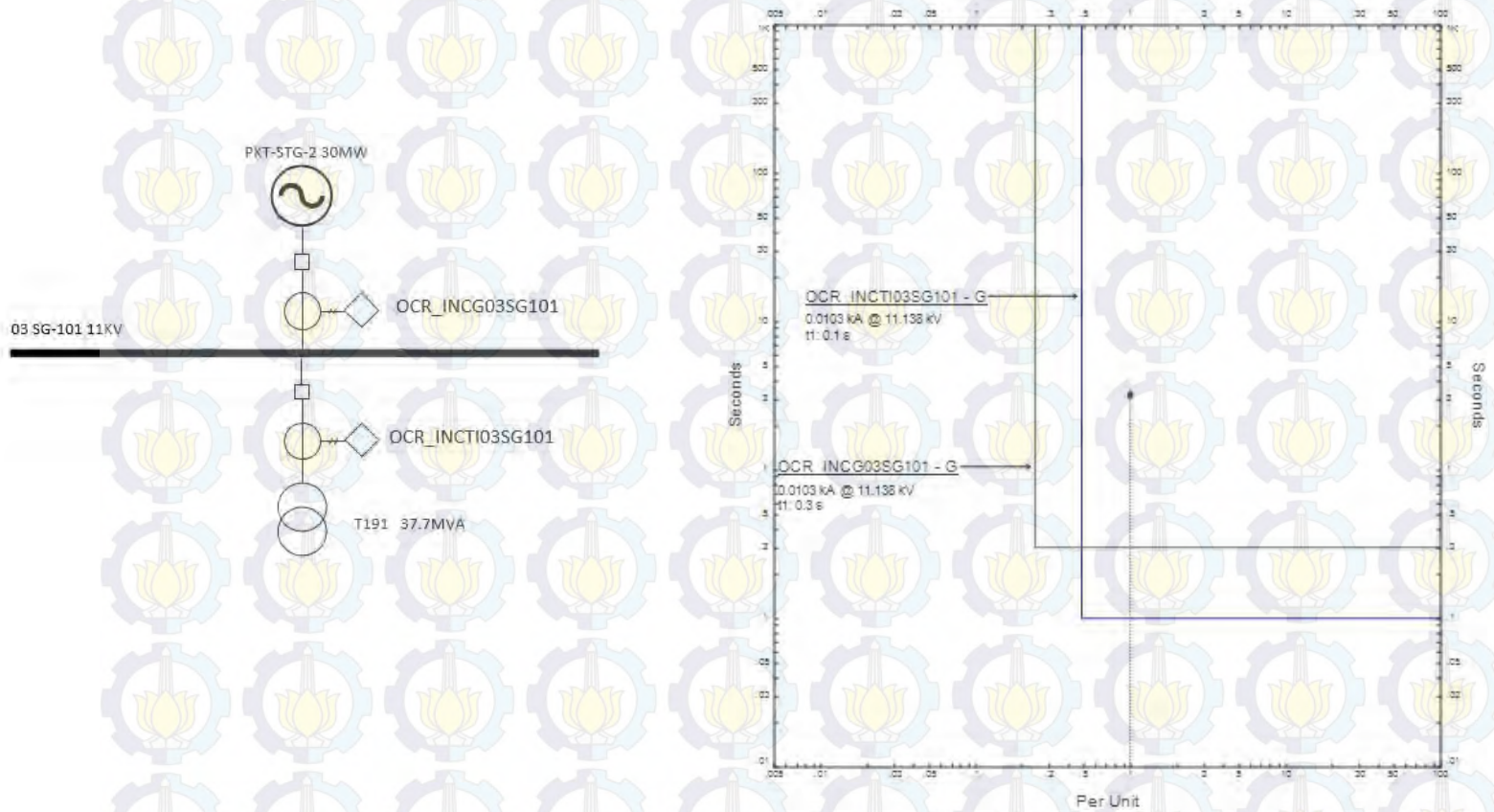
Time delay

dipilih time delay = 0,3 detik





Gambar *Time-current curve* tipikal 2



# KESIMPULAN

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- Setelah menambahkan trafo isolasi pada sistem distribusi Island Tanjung Harapan, rele-rele yang berada jauh dari titik gangguan tidak merasakan gangguan lagi dan resetting koordinasi proteksi pada Island Tanjung Harapan dapat dilakukan.
- Sistem proteksi eksisting pada Island Tanjung Harapan tidak bekerja secara tepat dan setelah dilakukan resetting, sistem proteksi dapat bekerja dengan baik.
- Pada sistem eksisting belum terdapat CT ground sehingga perlu ditambahkan untuk mengatasi jika terjadi gangguan ke tanah.





**TERIMA KASIH**

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