LAMPIRAN

DAFTAR SINGKATAN

L1a = panjang penghantar Mranggen – Purwodadi OHL Hawk

L1b = panjang penghantar Mranggen – Purwodadi ACC amsterdam

L1aa & L1bb= panjang penghantar Ungaran –Purwodadi OHL Hawk

RL11 = Nilai total resistif urutan positif konduktor jaringan transmisi Mranggen arah Purwodadi [Ω]

XL11 = Nilai total reaktansi urutan positif konduktor jaringan transmisi Mranggen arah Purwoda [Ω] dengan jenis penghantar

R11a = Nilai resistif urutan positif konduktor jaringan transmisi Mranggen arah Purwodadi,dengan jenis penghantar 1xHAWK [Ω /km]

X11a = Nilai reaktansi urutan positif konduktor jaringan transmisi Mranggen arah Purwodadi, dengan jenis penghantar 1xHAWK [Ω /km]

R11b = Nilai resistif urutan positif konduktor jaringan transmisi Mranggen arah Purwodadi,dengan jenis penghantar 2xACCC [Ω /km]

X11b = Nilai reaktansi urutan positif konduktor jaringan transmisi Mranggen arah Purwodadi, dengan jenis penghantar 2xACCC [Ω /km]

RL10 = Nilai total resistif urutan nol konduktor jaringan transmisi Mranggen arah Purwodadi, [Ω]

XL10 = Nilai total reaktansi urutan nol konduktor jaringan transmisi Mranggen arah Purwodadi, [Ω /km]

R10a = Nilai resistif urutan nol konduktor jaringan transmisi Mranggen arah Purwodadi,dengan jenis penghantar 1xHAWK [Ω /km]

X10a = Nilai reaktansi urutan nol konduktor jaringan transmisi Mranggen arah Purwodadi, dengan jenis penghantar 1xHAWK [Ω /km]

R10b = Nilai resistif urutan nol konduktor jaringan transmisi Mranggen arah Purwodadi,dengan jenis penghantar 2xACCC [Ω /km]

X10b = Nilai reaktansi urutan nol konduktor jaringan transmisi Mranggen arah Purwodadi, dengan jenis penghantar 2xACCC [Ω /km]

ZL11 = Nilai impedansi mutlak urutan positif konduktor jaringan transmisi Mranggen arah Purwodadi , [Ω]

Θph1 = Sudut impedansi urutan positif konduktor jaringan transmisi Mranggen arah Purwodadi, [°]

ZL10 = Nilai impedansi mutlak urutan nol konduktor jaringan transmisi Mranggen arah Purwodadi , [Ω]

Θph10 = Sudut impedansi urutan nol konduktor jaringan transmisi Mranggen arah Purwodadi, [°]

RL21 = Nilai total resistif urutan positif konduktor jaringan transmisi Purwodadi arah Kudus [Ω]

XL21 =Nilai total reaktansi urutan positif konduktor jaringan transmisi Purwodadi arah Kudus [Ω]

R21 = Nilai resistif urutan positif konduktor jaringan transmisi Purwodadi arah Kudus, [Ω /km]

X21 = Nilai reaktansi urutan positif konduktor jaringan transmisi Purwodadi arah Kudus, [Ω /km]

RL20 = Nilai resistif urutan nol konduktor jaringan transmisi Purwodadi arah Kudus, [Ω /km]

XL20 = Nilai reaktansi urutan nol konduktor jaringan transmisi Purwodadi arah Kudus, [Ω /km]

R20 = Nilai resistif urutan nol konduktor jaringan transmisi Purwodadi arah Kudus, [Ω /km]

X20 = Nilai reaktansi urutan nol konduktor jaringan transmisi Purwodadi arah Kudus, [Ω /km]

ZL21 = Nilai impedansi mutlak urutan positif konduktor jaringan transmisi Purwodadi arah Kudus, [Ω]

Θph2 = Sudut impedansi urutan positif konduktor jaringan transmisi Purwodadi arah Kudus, [°]

ZL20 = Nilai impedansi mutlak urutan nol konduktor jaringan transmisi Purwodadi arah Kudus, [Ω]

Θph20 = Sudut impedansi urutan nol konduktor jaringan transmisi Purwodadi arah Kudus, [°]

XT1 = Impedansi trafo, [Ω]

RL31 = Nilai total resistif urutan positif konduktor jaringan transmisi Kudus arah Sayung [Ω]

XL31 =Nilai total reaktansi urutan positif konduktor jaringan transmisi Kudus arah Sayung [Ω]

R31 = Nilai resistif urutan positif konduktor jaringan transmisi Kudus arah Sayung, [Ω /km]

X31 = Nilai reaktansi urutan positif konduktor jaringan transmisi Kudus arah Sayung, [Ω /km]

RL30 = Nilai resistif urutan nol konduktor jaringan transmisi Kudus arah Sayung, [Ω /km]

XL30 = Nilai reaktansi urutan nol konduktor jaringan transmisi Kudus arah Sayung, [Ω /km]

R30 = Nilai resistif urutan nol konduktor jaringan transmisi Kudus arah Sayung, [Ω /km]

X30 = Nilai reaktansi urutan nol konduktor jaringan transmisi Kudus arah Sayung, [Ω /km]

ZL31 = Nilai impedansi mutlak urutan positif konduktor jaringan transmisi Kudus arah Sayung, [Ω]

Θph3 = Sudut impedansi urutan positif konduktor jaringan transmisi Kudus arah Sayung, [°]

ZL30 = Nilai impedansi mutlak urutan nol konduktor jaringan transmisi Kudus arah Sayung, [Ω]

Θph30 = Sudut impedansi urutan nol konduktor jaringan transmisi Kudus arah Sayung, [°]

CT1 = Rasio trafo arus

PT1 = Rasio tarfo tegangan

n1 = Nilai yang digunakan untuk konversi nilai primer ke sekunder dengan cara di kalikan

Larc = Panjang isolator

I arc = Arus arching

Rfoot = Tahanan pentanahan kaki tower : 10 ohm (hasil pengukuran atau asumsi terburuk)

Rarc1 = Resistansi Arching

RZ1P =Pemilihan resistansi zone 1 dengan nilai Resistansi melihat panjang jaringan transmisi Mranggen arah Purwodadi dan resistansi arching, dalam besaran resistansi primer, [Ω]

RZ1 = Nilai penetapan nilai parameter (setting) Resitansi zone 1 dalam besaran resistansi sekunder, [Ω]

XZ1P = Pemilihan resistansi zone 1 dengan nilai Reaktansi melihat panjang jaringan transmisi Mranggen arah Purwodadi, dalam besaran reaktansi primer, [Ω]

XZ1 = Nilai penetapan nilai parameter (setting) Reaktansi zone 1 dalam besaran reaktansi sekunder, [Ω]

Z1P = Nilai penetapan nilai parameter (setting) Impedansi zone 1 dalam besaran impedansi primer, [Ω]

Z1% = nilai persen Impedansi zone 1 dalam besaran Impedansi primer dibagi dengan impedansi konduktor jaringan transmisi Mranggen-Purwodadi

RGZ1P= Pemilihan Resistansi ground zone 1 dengan nilai Resistansi melihat panjang jaringan transmisi Mranggen arah Purwodadi,serta faktor infeed, resistansi arching, dan resistansi pentanahan, dalam besaran resistansi primer [Ω]

RGZ1 =Nilaipenetapan nilai parameter (setting) Resistansi ground zone 2 dalam besaran resistansi sekunder, [Ω]

RZ2P = Pemilihan resistansi zone 2 dengan nilai resistansi melihat panjang jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudus serta faktor infeed dan resistansi arching, dalam besaran resistansi primer, [Ω]

RZ2 = Nilai penetapan nilai parameter (setting) Resistansi zone 2 dalam besaran resistansi sekunder, [Ω]

XZ2Pmin = Pemilihan reaktansizone 2 dengan nilai reaktansi 120% dari reaktansi jaringan transmisi Mranggen arah Purwodadi,dalam besaran reaktansi primer, [Ω]

XZ2Pmax1= Pemilihan reaktansizone 2 dengan nilai reaktansi melihat panjang jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudus serta faktor infeed, dalam besaran reaktansi primer, [Ω]

XZ2Pmax2= Batas atas reaktansi zone 2 dihitung dari reaktansi trafo, dalam besaran reaktansi primer [Ω]

XZ2 = Nilai penetapan nilai parameter (setting) Reaktansi zone 2 dalam besaran reaktansi sekunder, [Ω]

Z2P = Nilai Impedansi zone 2 dalam besaran impedansi primer, [Ω]

Z2% = Nilai persen impedansi zone 2 dalam besaran impedansi primer dibagi dengan impedansi konduktor jaringan transmisi Mranggen-Purwodadi

RG Z2P = Pemilihan resistansi ground zone 2 dengan nilai resistansi melihat panjang jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudus serta faktor infeed, resistansi arching, dan resistansi pentanahan, dalam besaran resistansi primer [Ω]

RG Z2 = Nilai penetapan nilai parameter (setting) Resistansi ground zone 2 dalam besaran resistansi sekunder, [Ω]

RZ3P = Pemilihan resistansi zone 3 dengan nilai resistansi melihat panjang jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudus serta faktor infeed dan resistansi arching, dalam besaran resistansi primer, [Ω]

RZ3 = Nilai penetapan nilai parameter (setting) Resistansi zone 3 dalam besaran resistansi sekunder, [Ω]

XZ3Pmin= Pemilihan reaktansi zone 3 dengan nilai reaktansi 120% dari reaktansi jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudus, dalam besaran reaktansi primer, [Ω]

XZ3Pmax1= Pemilihan reaktansi zone 3 dengan nilai reaktansi melihat panjang jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudusserta faktor infeed, dalam besaran reaktansi primer, [Ω]

XZ3Pmax2= Pemilihan reaktansi zone 3 dengan nilai reaktansi melihat panjang jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudus, Kudus arah Sayung serta faktor infeed, dalam besaran reaktansi primer, [Ω]

XZ3Pmax3= Batas atas reaktansi zone 3 dihitung dari reaktansi trafo, dalam besaran reaktansi primer, [Ω]

XZ3 = Nilai penetapan nilai parameter (setting) Reaktansi zone 3 dalam besaran reaktansi sekunder, [Ω]

Z3P = Nilai Impedansi zone 3 dalam besaran impedansi primer, [Ω]

Z3% = Nilai persen impedansi zone 3 dalam besaran impedansi primer dibagi dengan impedansi konduktor jaringan transmisi Mranggen-Purwodadi

RG Z3P = Pemilihan resistansi ground zone 3 dengan nilai resistansi melihat panjang jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudus serta faktor infeed, resistansi arching, dan resistansi pentanahan, dalam besaran resistansi primer, [Ω]

RG Z3 = Nilai penetapan nilai parameter (setting) Resistansi ground zone 3 dalam besaran resistansi sekunder, [Ω]

ZRZ1P = Pemilihan resistansi zone 1 dengan nilai Impedansi melihat panjang jaringan transmisi Mranggen arah Purwodadi, dalam besaran impedansi primer, [Ω]

ZRZ1 = Nilai penetapan nilai parameter (setting) Impedansi zone 1 dalam besaran impedansi sekunder, [Ω]

ZRZ1% = nilai persen Impedansi zone 1 dalam besaran Impedansi primer dibagi dengan impedansi konduktor jaringan transmisi Mranggen-Purwodadi

ZRZ2P = Pemilihan impedansi zone 2 dengan nilai impedansi melihat panjang jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudus serta faktor infeed, dalam besaran impedansi primer, [Ω]

ZRZ2 = Nilai penetapan nilai parameter (setting) impedansi zone 2 dalam besaran impedansi sekunder, [Ω]

Z2min = Pemilihan impedansi zone 2 dengan nilai impedansi 120% dari impedansi jaringan transmisi Mranggen arah Purwodadi, dalam besaran impedansi primer, [Ω]

Z2mak1 = Pemilihan reaktansi zone 2 dengan nilai reaktansi melihat panjang jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudus serta faktor infeed, dalam besaran impedansi primer, [Ω]

ZTrf = Batas atas impedansi zone 2 dihitung dari reaktansi trafo, dalam besaran impedansi primer [Ω]

ZRZ2% = Nilai persen impedansi zone 2 dalam besaran impedansi primer dibagi dengan impedansi konduktor jaringan transmisi Mranggen-Purwodadi

ZRZ3P = Pemilihan impedansizone 3 dengan nilai impedansi melihat panjang jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudus serta faktor infeed, dalam besaran impedansi primer, [Ω]

ZRZ3 = Nilai penetapan nilai parameter (setting) Impedansizone 3 dalam besaran impedansi sekunder, [Ω]

Z3min = Pemilihan impedansizone 3 dengan nilai impedansi 120% dari impedansi jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudus, dalam besaran impedansi primer, [Ω]

Z3mak1 = Pemilihan impedansizone 3 dengan nilai impedansi melihat panjang jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudus serta faktor infeed, dalam besaran reaktansi primer, [Ω]

Z3mak2 = Pemilihan impedansizone 3 dengan nilai impedansi melihat panjang jaringan transmisi Mranggen arah Purwodadi dan Purwodadi arah Kudus, Kudus arah Sayung serta faktor infeed, dalam besaran impedansi primer, [Ω]

Z3Trf = Batas atas impedansi zone 3 dihitung dari reaktansi trafo, dalam besaran impedansi primer, [Ω]

ZRZ3% = Nilai persen impedansi zone 3 dalam besaran impedansi primer dibagi dengan impedansi konduktor jaringan transmisi Mranggen-Purwodadi

T2a = Nilai setting waktu untuk *impedansi zone* 2, [S] sebesar 0,4 detik

T2b = Nilai setting waktu untuk *impedansi zone* 2, [S] sebesar 0,8 detik

q = Nilai dari pengurangan *impedansi zone* 2 dikurangi impedansi penhantar Mranggen arah Purwodadi, [Ω]

zone1depan= Nilai impedansi Zone 1 di depan Mranggen Purwodadi yaitu Nilai *impedansi zone* 1 untuk jaringan transmisi Purwodadi arah Kudus, [Ω]

T3 = Nilai setting waktu untuk *impedansi zone* 3, [S]

FAKULTAS TEKNOLOGI INDUSTRI
Universitas Islam Sultan Agung (UNISSULA)
Jl. Raya Kaligawe Km 4 Telp. 024-6583584 Psw. 340 Faks. 024-6582455
Semarang 50112 http://www.unissula.ac.id

LEMBAR REVISI dan TUGAS UJIAN SARJANA

Berdasarkan Rapat Tim Penguji Ujian Sarjana

Hari	:	Kamis
Tanggal	:	22 Maret 2018
Tempat	:	R. Sidang

Memutuskan bahwa mahasiswa :

Nama	:	Gracia Dyestisari
NIM	:	30601301510
Judul TA	:	Analisis Scanning Dan Setting Distance Relay Sutt 150 Kv Mranggen-Purwodadi 1-2 Dengan Aplikasi NATHCAD

wajib melakukan perbaikan dan membuat tugas seperti tercantum dibawah ini:

NO	REVISI	BATAS REVISI
1.	Perbaiki format YS Sitandai.	Acc 28/10
2.	Tabel & Gambar Jayan terlebih dg Ket. Tabel & Ket Gambar.	
3.	Setiap Persamaan di Bab IV harus di acu dari Bab II.	

NO	TUGAS	
4.	Daftar Pustaka & Sitasinya.	Acc 28/10

Semarang, 22 Maret 2018

Mengetahui,
Ketua Tim Penguji

Ir. Agus Adhi Nugroho, MT
NIDN. 0628086501

Penguji 3,

DR. Hj. Sri Arttini Dwi P., M.Si.
NIDN. 0620026501

FAKULTAS TEKNOLOGI INDUSTRI
Universitas Islam Sultan Agung (UNISSULA)
Jl. Raya Kaligawe Km.4 Telp. 024-6583584 Psw. 340 Fakс. 024-6582455
Semarang 50112 http://www.unissula.ac.id

LEMBAR REVISI dan TUGAS UJIAN SARJANA

Berdasarkan Rapat Tim Penguji Ujian Sarjana

Hari	:	Kamis
Tanggal	:	22 Maret 2018
Tempat	:	R. Sidang

Memutuskan bahwa mahasiswa :

Nama	:	Gracia Dyestisari
NIM	:	30601301510
Judul TA	:	Analisis Scanning Dan Setting Distance Relay Sutt 150 Kv Mranggen-Purwodadi 1-2 Dengan Aplikasi NATHCAD

wajib melakukan perbaikan dan membuat tugas seperti tercantum dibawah ini:

NO	REVISI	BATAS REVISI
	- Pasar teori impedansi antara +, -, 0 (bab 2) - Perlihatkan impedansi manual - daftar singkatan (lampiran) - Rumus? bab 2 dilengkapi	28/9-2018

NO	TUGAS

Semarang, 22 Maret 2018

Mengetahui,
Ketua Tim Penguji

Ir. Agus Adhi Nugroho, MT
NIDN. 0628086501

Penguji 1,

Ir. Agus Adhi Nugroho, MT
NIDN. 0628086501

FAKULTAS TEKNOLOGI INDUSTRI
Universitas Islam Sultan Agung (UNISSULA)
Jl. Raya Kaligawe Km.4 Telp. 024-6583584 Psw. 340 Faks. 024-6582455
Semarang 50112 http://www.unissula.ac.id

LEMBAR REVISI dan TUGAS UJIAN SARJANA

Berdasarkan Rapat Tim Penguji Ujian Sarjana

Hari	:	Kamis
Tanggal	:	22 Maret 2018
Tempat	:	R. Sidang

Memutuskan bahwa mahasiswa :

Nama	:	Gracia Dyestisari
NIM	:	30601301510
Judul TA	:	Analisis Scanning Dan Setting Distance Relay Sutt 150 Kv Mranggen-Purwodadi 1-2 Dengan Aplikasi NATHCAD

wajib melakukan perbaikan dan membuat tugas seperti tercantum dibawah ini:

NO	REVISI	BATAS REVISI
1	Revisi Abstrak kurang FOKUS ?	
2	Revisi kesimpulan kurang ~~AA~~ Konek dg. permasalahan	
3	Daftar pustaka .	

NO	TUGAS

Semarang, 22 Maret 2018
Penguji 2,

Ir. H. Budi Sukoco, M.T.
NIDN. 0014016401

Mengetahui,
Ketua Tim Penguji

Ir. Agus Adhi Nugroho, MT
NIDN. 0628086501

FAKULTAS TEKNOLOGI INDUSTRI
Universitas Islam Sultan Agung (UNISSULA)
Jl. Raya Kaligawe Km.4 Telp. 024-6583584 Psw. 340 Faks. 024-6582455
Semarang 50112 http://www.unissula.ac.id

LEMBAR REVISI SEMINAR TUGAS AKHIR

Berdasarkan Rapat Tim Penilai Seminar Tugas Akhir

Hari	:	Jum'at
Tanggal	:	5 Januari 2018
Tempat	:	R. 202

Memutuskan bahwa mahasiswa :

Nama	:	Gracia Dyestisari
NIM	:	30601301510
Bidang Peminatan	:	Teknik Elektro
Judul Tugas Akhir	:	Analisis Scanning Dan Setting Distance Relay Sutt 150 Kv Mranggen-Purwodadi 1-2 Dengan Aplikasi NATHCAD

wajib melakukan perbaikan seperti tercantum dibawah ini:

NO.	REVISI	BATAS REVISI
	- no hal dg angka arab. - manfaat diper jelas. - tujuan di pergelas. - kesimpulan lebih ke hasil akhir. jangan angka? - terangkan mengenai pembahasan saluran nya.	

Semarang, 5 Januari 2018

Penguji 1,

Ir. Agus Adhi Nugroho, MT

NIDN : 0628086501

KEGIATAN ASISTENSI PERIODE I

(1 minggu)

Tanggal : 20 Februari s/d tanggal : 27 Februari 2017

No	Tanggal	Paraf dosen	Catatan
			o> Pengajuan Proposal o> Pengajuan Bab I, II, III
			o> Revisi Bab I, II, III o> Pengajuan Bab IV
			o> Pengajuan Bab I - Bab IV & V

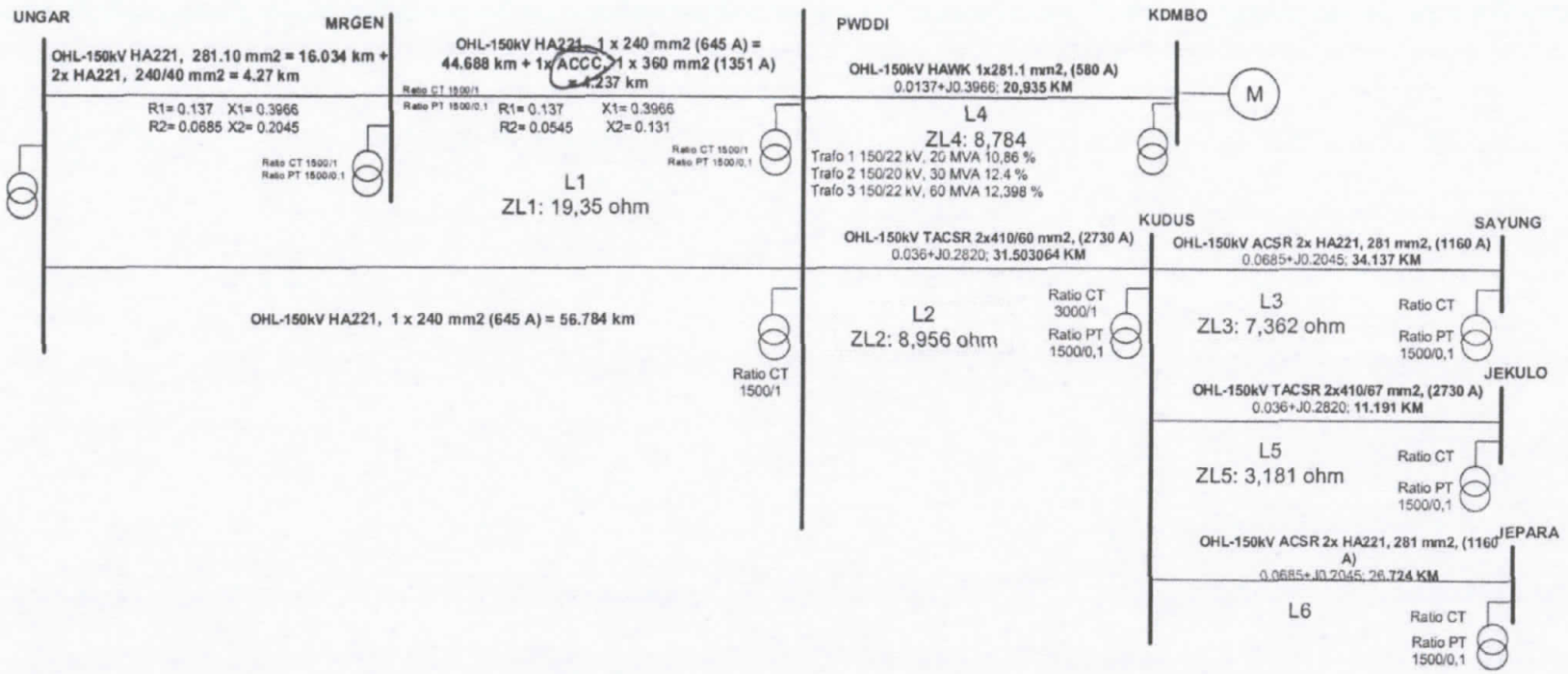
KEGIATAN ASISTENSI PERIODE III

(2 bulan)

Tanggal : 12 Desember s/d tanggal : 16 Desember 2017.

No	Tanggal	Paraf dosen	Catatan
			o> Pengajuan Bab I - V
			o> Revisi Bab I - V o> Pengajuan Bab I - V
			o> ACC Lanjut Seminar

SEBELUM PERUBAHAN JARINGAN



sebelum setting ulang

1.1 MRANGGEN - PURWODADI

UNGRN PDADI

KETETAPAN $j := \sqrt{(-1)}$ $k := \frac{2 \cdot \pi}{360}$

$L1aa := 56.784$ km

$L1bb := 0$ km

Jenis penghantar

L1a : OHL-150kV HAWK,1x240 mm2 (645 A)

L1b : ACCC,AMSTERDAM 2x360 mm2 (2702 A)

$L1a := 44.688$ km

$L1b := 4.237$ km

$R11a := 0.137$ $X11a := 0.3966$

$R11b := 0.0545$ $X11b := 0.131$

$CCC1a := 645$

$CCC1b := 2703$

$Vn := 150000$

$L1 := L1a + L1b$

$L1 = 48.925$ km

Imp. urutan positif

$RL11 := (L1aa \cdot R11a) + (L1bb \cdot R11b)$ $XL11 := (L1aa \cdot X11a) + (L1bb \cdot X11b)$

$ZL11 := (RL11 + j \cdot XL11)$ $ZL11 = 7.779 + 22.521i\ \Omega$

$RL11 = 7.779$ $XL11 = 22.521$

$ZL11 := \sqrt{RL11^2 + XL11^2}$ $|ZL11| = 23.826\ \Omega$

$\theta ph1 := \operatorname{atan}\left(\frac{XL11}{RL11}\right) \cdot \frac{1}{k}$ $\theta ph1 = 70.943$

Imp. urutan nol

$R10a := 0.287$ $X10a := 1.191$

$R10b := 0.2045$ $X10b := 0.3933$

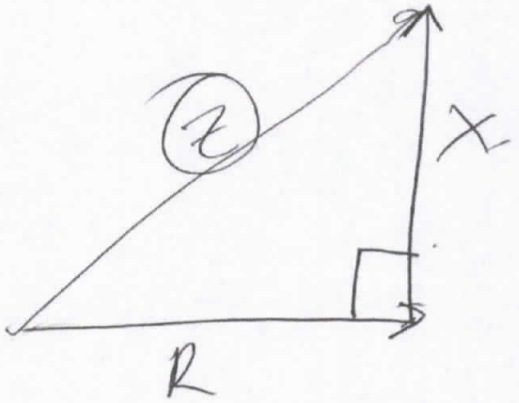
$RL10 := [L1aa \cdot (R10a)] + [L1bb \cdot (R10b)]$ $XL10 := (L1aa \cdot X10a) + (L1bb \cdot X10b)$

$ZL10 := (RL10 + j \cdot XL10)$ $ZL10 = 16.297 + 67.63i\ \Omega$

$RL10 = 16.297$ $XL10 = 67.63$

$ZL10 := \sqrt{RL10^2 + XL10^2}$ $|ZL10| = 69.566\ \Omega$

$\theta ph10 := \operatorname{atan}\left(\frac{XL10}{RL10}\right) \cdot \frac{1}{k}$ $\theta ph10 = 76.452$ deg



1.2 Purwodadi Kudus- 1/2

Jenis penghantar **TACSR, 2x410/60 mm2, CCC = 2730 A**

$L2 := 31.503\ km$

$R21 := 0.038 \quad X21 := 0.2790\ \Omega/km$

$CCC1 := 2730$

$Vn := 150000$

Imp. urutan positif

$RL21 := R21 \cdot L2 \qquad XL21 := X21 \cdot L2\ \Omega$

$ZL21 := (RL21 + j \cdot XL21) \qquad ZL21 = 1.197 + 8.789i\ \Omega$

$RL21 = 1.197 \quad XL21 = 8.789$

$ZL21 := \sqrt{RL21^2 + XL21^2} \qquad |ZL21| = 8.87\ \Omega$

$\theta ph2 := \operatorname{atan}\left(\frac{XL21}{RL21}\right) \cdot \frac{1}{k} \qquad \theta ph2 = 82.244\ deg$

Imp. urutan nol

$R20 := 0.168 \quad X20 := 0.8095\ \Omega/km$

$RL20 := R20 \cdot L2 \qquad XL20 := X20 \cdot L2\ \Omega$

$ZL20 := (RL20 + j \cdot XL20) \qquad ZL20 = 5.293 + 25.502\ \Omega$

$RL20 = 5.293 \quad XL20 = 25.502$

$ZL20 := \sqrt{RL20^2 + XL20^2} \qquad |ZL20| = 26.045\ \Omega$

$\theta ph20 := \operatorname{atan}\left(\frac{XL20}{RL20}\right) \cdot \frac{1}{k} \qquad \theta ph20 = 78.276\ deg$

1.3 Kudus - Sayung

Jenis penghantar **ACSR, 2x281 mm2, CCC = 1160 A** L3 := 34.137 km

R31 := 0.0685 X31 := 0.2045 Ω /km

Imp. urutan positif

RL31 := R31·L3 XL31 := X31·L3 Ω

ZL31 := (RL31 + j·XL31) ZL31 = 2.338 + 6.981i Ω

RL31 = 2.338 XL31 = 6.981

$ZL31 := \sqrt{RL31^2 + XL31^2}$ |ZL31| = 7.362 Ω

$\theta ph3 := \operatorname{atan}\left(\frac{XL31}{RL31}\right)\cdot\frac{1}{k}$ θph3 = 71.481 deg

Imp. urutan nol

R30 := 0.2185 X30 := 0.6135 Ω /km

RL30 := R30·L3 XL30 := X30·L3 Ω

ZL30 := (RL30 + j·XL30) ZL30 = 7.459 + 20.943 Ω

RL30 = 7.459 XL30 = 20.943

$ZL30 := \sqrt{RL30^2 + XL30^2}$ |ZL30| = 22.232 Ω

$\theta ph30 := \operatorname{atan}\left(\frac{XL30}{RL30}\right)\cdot\frac{1}{k}$ θph30 = 70.396 deg

1.4 Purwodadi - kdmbo1-2

Jenis penghantar **ACSR, 240 mm2, CCC = 600 A** L4 := 20.935 km

R41 := 0.137 X41 := 0.3966 Ω /km

Imp. urutan positif

RL41 := R41·L4 XL41 := X41·L4

ZL41 := (RL41 + j·XL41) ZL41 = 2.868 + 8.303i Ω |ZL41| = 8.784

$\theta ph4 := \arg(ZL41)\cdot k^{-1}$ θph4 = 70.943 deg

Imp. urutan nol

XL40 := 3·X41·L4 RL40 := (R41 + 0.15)·L4

ZL40 := (RL40 + j·XL40) |ZL40| = 25.623 Ω

TRA

Siemens 7SA522

1.5 Kudus - Jekulo

Jenis penghantar **TACSR, 2x410 mm2, CCC = 2730 A** $L5 := 11.191$ km

$R51 := 0.036$ $X51 := 0.282$ Ω /km

Imp. urutan positif

$RL51 := R51 \cdot L5$ $XL51 := X51 \cdot L5$

$ZL51 := (RL51 + j \cdot XL51)$ $ZL51 = 0.403 + 3.156i$ Ω $|ZL51| = 3.181$

$\theta ph5 := \arg(ZL51) \cdot k^{-1}$ $\theta ph5 = 82.725$ deg

Imp. urutan nol

$XL50 := 3 \cdot X51 \cdot L5$ $RL50 := (R51 + 0.15) \cdot L5$

$ZL50 := (RL50 + j \cdot XL50)$ $|ZL50| = 9.694$ Ω

2. Impedansi Trafo GI Purwodadi

2.1 GI Purwodadi Trf 3 60 MVA, 12,398 %

$$XT1 := \frac{0.12398 \cdot 150^2}{60}$$

dipilih impedansi terkecil jika terdapat beberapa trafo

$XT1 = 46.492$ Ω

3. PERHITUNGAN SETELAN RELAI JARAK

3.1 LINE 150 KV Purwodadi-Mranggen

Distance relay Siemens - 7SA522 (Pola PUTT)

3.1.1 Ratio CT & PT

$$CT1 := \frac{2000}{1}\ A \qquad PT1 := \frac{150000}{100}\ Volt \qquad In := 1\ A$$

$$n1 := \frac{CT1}{PT1} \qquad n1 = 1.333 \qquad Vn := 100\ V$$

3.1.2 Scope of Functions

0110	: Trip Mode	1 Pole -/3 Pole
0112	: 21 Phase Distance Protection	Mho
0113	: 21G Ground Distance Protection	Quadrilateral
0121	: 85-21 Pilot Protection for Distance	PUTT
0124	: 50HS High Speed SOTF	Enable
0131	: Earth Fault O/C	Not Used
0132	: Teleprot E/F	Not Used
0138	: Fault Locator	Enable

3.1.3 Power System Data

Line Angle

$\theta ph1 = 70.943$ deg

$\theta ph1 := 71$ degree

1110 : X'

$|X11| = 0.46$ $\frac{Ohm}{km}$

1111 : Line Length

$L1 = 48.925$ km

1116 : RE/RL(Z1)

- Zero Sequence compensatio factor RG/RL(Z1) : R01

$$R01 := \frac{1}{3}\cdot\left(\frac{RL10}{RL11} - 1\right) \qquad R01 = 0.365 \qquad R01 := 0.253$$

1117 : XE/XL(Z1)

- Zero Sequence compensatio factor XG/XL(Z1) : X01

$$X01 := \frac{1}{3}\cdot\left(\frac{XL10}{XL11} - 1\right) \qquad X01 = 0.668 \qquad X01 := 0.479$$

1118 : RE/RL(ZB..Z5)

- Zero Sequence compensatio factor RG/RL(ZB...5) : R0B...5

$$R0B5 := \frac{1}{3}\cdot\left(\frac{RL20}{RL21} - 1\right) \qquad R0B5 = 1.14$$

R0B5 := 1.14

R0B5 := 1.14

1119 : XE/XL(ZB..Z5)

- Zero Sequence compensatio factor XG/XL(ZB...5) : X0B...5

$$X0B5 := \frac{1}{3}\cdot\left(\frac{XL20}{XL21} - 1\right) \qquad X0B5 = 0.634$$

X0B5 := 0.634

X0B5 := 0.634

3.1.3 Paramaterblock 12xx: 21 Distance protection, general setting

1201 : FCT Distance = On
1202 : Minimum Iph> = 0.1 A
1232 : Inst. Trip SOTF = with Zone1B

1241 : R load (ph-E) =

Vn := 150000

CCC := 600

- Load impedance $Zld := \left[\frac{Vn}{(\sqrt{3}\cdot CCC)}\right]\cdot n1$ Zld = 192.45 Ω (secondary)

- Power factor load angle θld := [(32 + 5)·k]

- Resistance/Reactance impedance limit
  Rld := Zld·cos(θld)·0.5 Rld = 76.849 Ω (secondary)
  Xld := Zld·sin(θld)·0.5 Xld = 57.91 Ω (secondary)

Resistansi Tanah Gangguan fenah diasumsikan 40 Ohm

- Foot resistance Rf := 40 Ω (Primer)

Resistive Reach calculation :

Zloadmin := Zld·0.8 Zloadmin = 153.96 Ω sekunder
Z1safety := 0.5·Zld Z1safety = 96.225 Ω (sekunder)

Setting Resistive Reach dibatasi 50% dari Impedansi beban maksimum

Resistive reach max : Rgmax := Z1safety Rgmax = 96.225 Ω sekunder

Siemens 7 **Resistive reach min :** Rgmin := 40·n1 Rgmin = 53.333 Ω sekunder TRA

R load (ph-E) RLphE := Rgmax Ω sekunder

1242 : phi load (ph-E) $\theta LphE := \frac{\theta ld}{k}$ $\theta LphE = 37$ degree

1243 : R load (ph-ph) $RLphph := Rgmax$ $RLphph = 96.225$ Ω sekunder

1244 : phi load (ph-ph) $\theta Lphph := \frac{\theta ld}{k}$ $\theta Lphph = 37$ degree

1203 : 3I0>, load current unbalance $Io := 0.1$ $Io = 0.1$ A sekunder

1204 : 3V0>, load voltage unbalance $Vo := 20$ $Vo = 20$ V sekunder

1207A : 3I0>Iphmax $IoIph := 0.1$ $IoIph = 0.1$ V sekunder

3.1.4 Paramaterblock 13xx: 21 Distance Zones Quadrilateral

$In := 1$ A

Rod insulator length $Larc := 7.5$ m

Arc current $Iarc := 2500$ A

Resistansi tahanan kaki tower diasumsikan 10 Ohm

Foot resistance of tower (Rfoot) $Rfoot := 10$ Ohm

Arc resistance $Rarc1 := \frac{28700 \cdot Larc}{Iarc^{1.4}}$ $Rarc1 = 3.766$ Ω primer

Rarc dipilih 0 bila nilai Rarc > dari RL11

$Rarc := Rarc1 \cdot (|Rarc1| < |RL11|) + 0 \cdot (|RL11| < |Rarc1|)$ dipilih : $Rarc = 3.766$

Group Zone1 setting:

1301 : Op. mode Z1 = Forward

1302 : R (Z1) $RZ1P := [(0.8RL11) + (0.5 \cdot Rarc)]$ $RZ1P = 8.106$ Ω (Primer)

$RZ1 := RZ1P \cdot n1$ $|RZ1| = 10.808$ Ω (Sekunder)

1303 : X (Z1)

$XZ1P := 0.8XL11$ $XZ1P = 18.016$ Ω (Primer)

$XZ1 := XZ1P \cdot n1$ $|XZ1| = 24.022$ Ω (Sekunder)

$Z1P := (RZ1P + j \cdot XZ1P)$ $|Z1P| = 19.756$

Setting Zone-1 terhadap Z line adalah

$Z1\% := \frac{|Z1P|}{|ZL11|} \cdot 100$ %

$|ZL11| = 23.826$

$Z1\% = 82.917$ %

1302 : RG (Z1)

RGZ1P := [(0.8RL11) + Rfoot + Rarc] RGZ1P = 19.989 Ω (Primer)

RGZ1 := RGZ1P·n1 |RGZ1| = 26.65? Ω (Sekunder)

Group Zone1B settings :

1351 : Op. mode Z1B = Forward

1352 : R (Z1B) Iinfeed := 1

RZ1BP := [0.8·(RL11 + 0.8·RL21·Iinfeed) + (0.5·Rarc)] RZ1BP = 8.872 Ω (Primer)

RZ1B := RZ1BP·n1 |RZ1B| = 11.83 Ω (Sekunder)

1353 : X (Z1B)

XZ1BPmin := 1.2·XL11 XZ1BPmin = 27.025 Ω (Primer)

XZ1BPmax1 := 0.8·(XL11 + 0.8·XL21·Iinfeed) XZ1BPmax1 = 23.642 Ω (Primer)

XZ1BPmax2 := 0.8·(XL11 + 0.5·XT1·Iinfeed) XZ1BPmax2 = 36.613 Ω (Primer)

Dipilih Zone 1B terbesar tetapi tidak lebih besar dari zone 1B trafo

X21Bmak := XZ1BPmin·(|XZ1BPmin| > |XZ1BPmax1|) + XZ1BPmax1·(|XZ1BPmax1| > |XZ1BPmin|

X1BP := X21Bmak·(|X21Bmak| < |XZ1BPmax2|) + XZ1BPmax2·(|XZ1BPmax2| < |X21Bmak|)

X1BP = 27.025 |X1BP| = 27.025 Ω (Primer)

XZ1B := X1BP·n1 |XZ1B| = 36.033 Ω (Sekunder)

Z1BP := (RZ1BP + j·X1BP) |Z1BP| = 28.444 Ω (Primer)

Setting Zone-1B terhadap Z line adalah

$$Z1B\% := \frac{|Z1BP|}{|ZL11|}\cdot 100 \quad \%$$

Z1B% = 119.38 %

1352 : RG (Z1B)

RGZ1BP := [0.8·(RL11 + 0.8·RL21·Iinfeed) + Rarc + 2·Rfoot] RGZ1BP = 30.75 Ω (Primer)

RGZ1B := RGZ1BP·n1 |RGZ1B| = 41.007 Ω (Sekunder)

Group Zone2 settings :

1311 : Op. mode Z2 = Forward

1312 : R (Z2) Iinfeed := 1

$RZ2P := [0.8 \cdot (RL11 + 0.8 \cdot RL21 \cdot Iinfeed) + (0.5 \cdot Rarc)]$ $RZ2P = 8.872$ Ω (Primer)

$RZ2 := RZ2P \cdot n1$ $|RZ2| = 11.83$ Ω (Sekunder)

1313 : X (Z2)

$XZ2Pmin := 1.2 \cdot XL11$ $XZ2Pmin = 27.025$ Ω (Primer)

$XZ2Pmax1 := 0.8 \cdot (XL11 + 0.8 \cdot XL21 \cdot Iinfeed)$ $XZ2Pmax1 = 23.64$ Ω (Primer)

$XZ2Pmax2 := 0.8 \cdot (XL11 + 0.5 \cdot XT1 \cdot Iinfeed)$ $XZ2Pmax2 = 36.61$ Ω (Primer)

Dipilih Zone 2 terbesar tetapi tidak lebih besar dari zone 2 trafo

$X21mak := XZ2Pmin \cdot (|XZ2Pmin| > |XZ2Pmax1|) + XZ2Pmax1 \cdot (|XZ2Pmax1| > |XZ2Pmin|)$

$X2P := X21mak \cdot (|X21mak| < |XZ2Pmax2|) + XZ2Pmax2 \cdot (|XZ2Pmax2| < |X21mak|)$

$X2P = 27.025$ $|X2P| = 27.025$ Ω (Primer)

$XZ2 := (X2P) \cdot n1$ $|XZ2| = 36.033$ Ω (Sekunder)

$Z2P := (RZ2P + j \cdot X2P)$ $|Z2P| = 28.444$ Ω (Primer)

Setting Zone-2 terhadap Z line adalah

$$Z2\% := \frac{|Z2P|}{|ZL11|} \cdot 100\%$$

$Z2\% = 119.38$ %

1314 : RG (Z2)

$RGZ2P := [0.8 \cdot (RL11 + 0.8 \cdot RL21 \cdot Iinfeed) + Rarc + 2 \cdot Rfoot]$ $RGZ2P = 30.755$ Ω (Primer)

$RGZ2 := RGZ2P \cdot n1$ $|RGZ2| = 41.007$ Ω (Sekunder)

Group Zone3 settings

1321 : Op. mode Z3 = Forward

1322 : R (Z3) Iinfeed := 1

$RZ3P := [1.2 \cdot (RL11 + RL21 \cdot Iinfeed) + (0.5 \cdot Rarc)]$ $RZ3P = 12.655$ Ω (Primer)

$RZ3 := RZ3P \cdot n1$ $|RZ3| = 16.873$ Ω (Sekunder)

1323 : X (Z3)

$XZ3Pmin := 1.2 \cdot (XL11 + XL21)$ $XZ3Pmin = 37.572$ Ω (Primer)

$XZ3Pmax1 := 0.8[XL11 + (Iinfeed \cdot 1.2 \cdot XL21)]$ $XZ3Pmax1 = 26.45$ Ω (Primer)

$XZ3Pmax2 := 0.8 \cdot [XL11 + [Iinfeed \cdot 0.8 \cdot (XL21 + 0.8 \cdot XL31)]]$ $XZ3Pmax2 = 27.21$ Ω (Primer)

$XZ3Pmax3 := 0.8 \cdot (XL11 + 0.8 \cdot XT1 \cdot Iinfeed)$ $XZ3Pmax3 = 47.77$ Ω (Primer)

Dipilih Zone 32 terbesar tetapi tidak lebih besar dari zone 3 trafo

$X31 := XZ3Pmin \cdot (|XZ3Pmin| > |XZ3Pmax1|) + XZ3Pmax1 \cdot (|XZ3Pmax1| > |XZ3Pmin|)$

$X32 := XZ3Pmax2 \cdot (|XZ3Pmax2| > |X31|) + X31 \cdot (|X31| > |XZ3Pmax2|)$

$X3P := XZ3Pmax3 \cdot (|X32| > |XZ3Pmax3|) + X32 \cdot (|XZ3Pmax3| > |X32|)$

$X3P = 37.572$ $|X3P| = 37.572$ Ω (Primer)

$XZ3 := X3P \cdot n1$ $|XZ3| = 50.096$ Ω (Sekunder)

$Z3P := (RZ3P + j \cdot X3P)$ $|Z3P| = 39.646$ Ω (Primer)

Setting Zone-3 terhadap Z line adalah

$$Z3\% := \frac{|Z3P|}{|ZL11|} \cdot 100 \%$$

$Z3\% = 166.395$ %

1324 : RG (Z3)

$RGZ3P := [1.2 \cdot (RL11 + RL21 \cdot Iinfeed) + Rarc + 2 \cdot Rfoot]$ $RGZ3P = 34.537$ Ω (Primer)

$RGZ3 := RGZ3P \cdot n1$ $|RGZ3| = 46.05$ Ω (Sekunder)

Group Zone4 settings settings : NOT ACTIVE

Group Zone5 settings : NOT ACTIVE

3.1.5 Paramaterblock 13xx: 21 Distance Zones MHO

Group Zone1 (MHO) settings

1401 : Op. mode Z1 = Forward

1402 : ZR (Z1)

$ZRZ1P := 0.8 \cdot ZL11$ $|ZRZ1P| = 19.061$ Ω (Primer)

$ZRZ1 := ZRZ1P \cdot n1$ $|ZRZ1| = 25.415$ Ω (Sekunder)

Setting Zone-1 terhadap Z line adalah

$$ZRZ1\% := \frac{|ZRZ1P|}{|ZL11|} \cdot 100 \%$$

$ZRZ1\% = 80$ %

Group Zone13 - Extends (MHO) settings

Siemens SIPROTEC 7SA522 TRA

1451 : Op. mode Z1B = Forward

1452 : ZR (Z1B) Iinfeed := 1

$Z2min := 1.2 \cdot ZL11$ $|Z2min| = 28.592$ Ω (Primer)

$Z2mak1 := [ZL11 + (0.8 \cdot ZL21) \cdot Iinfeed] \cdot 0.8$ $|Z2mak1| = 24.738$ Ω (Primer)

$Z2mak2 := (ZL11 + 0.8 \cdot ZL21) \cdot 0.8$ $|Z2mak2| = 24.738$ Ω (Primer)

$ZTrf := 0.8 \cdot (ZL11 + 0.5 \cdot XT1 \cdot j)$ arah trafo di GI Purwodadi

$|ZTrf| = 26.63$ Ω (Primer)

Dipilih Zone 2 terbesar tetapi tidak lebih besar dari zone 2 trafo

$Z21mak := Z2mak1 \cdot (|Z2mak1| > |Z2min|) + Z2min \cdot (|Z2min| > |Z2mak1|)$

$ZRZ1BP := Z21mak \cdot (|Z21mak| < |ZTrf|) + ZTrf \cdot (|ZTrf| < |Z21mak|)$

$ZRZ1BP = 19.061 + 18.597i$ $|ZRZ1BP| = 26.63$ Ω (Primer)

$ZRZ1B := ZRZ1BP \cdot n1$ $|ZRZ1B| = 35.507$ Ω (Sekunder)

$\theta phZRZ1B := \arg(ZRZ1B) \cdot k^{-1}$ $\theta phZRZ1B = 44.294$ deg

Setting Zone-1B terhadap Z line adalah

$$Z1B\% := \frac{|ZRZ1BP|}{|ZL11|} \cdot 100 \quad \%$$

$Z1B\% = 111.768$ %

1357 : Z1B enabled before 1st AR : NO

Group Zone2 (MHO) settings :

1411 : Op. mode Z2 = Forward

1412 : ZR (Z2) $Iinfeed := 1$

$Z2min := 1.2 \cdot ZL11$ $|Z2min| = 28.592$ Ω (Primer)

$Z2mak1 := [ZL11 + (0.8 \cdot ZL21) \cdot Iinfeed] \cdot 0.8$ $|Z2mak1| = 24.738$ Ω (Primer)

$ZTrf := 0.8 \cdot (ZL11 + 0.5 \cdot XT1 \cdot j)$ arah trafo di GI Purwodadi

$|ZTrf| = 26.63$ Ω (Primer)

Dipilih Zone 2 terbesar tetapi tidak lebih besar dari zone 2 trafo

$Z21mak := Z2mak1 \cdot (|Z2mak1| > |Z2min|) + Z2min \cdot (|Z2min| > |Z2mak1|)$

$ZRZ2P := Z21mak \cdot (|Z21mak| < |ZTrf|) + ZTrf \cdot (|ZTrf| < |Z21mak|)$

$ZRZ2P = 19.061 + 18.597i$ $|ZRZ2P| = 26.63$ Ω (Primer)

$ZRZ2 := ZRZ2P \cdot n1$ $|ZRZ2| = 35.507$ Ω (Sekunder)

Setting Zone-2 terhadap Z line adalah

$$ZRZ2\% := \frac{|ZRZ2P|}{|ZL11|} \cdot 100\ \%$$

$ZRZ2\% = 111.768$ %

Group Zone3 (MHO) settings :

1421 : Op. mode Z3 = Forward

1422 : ZR (Z3) Infeed := 1

$Z3min := 1.2 \cdot (ZL11 + ZL21)$ $|Z3min| = 39.236$ Ω (Primer)

$Z3mak1 := 0.8 \cdot [ZL11 + (1.2 \cdot ZL21) \cdot Iinfeed] = 27.577$ $|Z3mak1| = 27.577$ Ω (Primer)

$Z3mak2 := 0.8 \cdot [ZL11 + [0.8 \cdot (ZL21 + 0.8 \cdot ZL31) \cdot Iinfeed]]$ $|Z3mak2| = 28.508$ Ω (Primer)

$Z3Trf := 0.8 \cdot (ZL11 + 0.8 \cdot XT1 \cdot j)$ arah trafo di GI PURWODADI

$|Z3Trf| = 35.337$

$Z31 := Z3mak1 \cdot (|Z3mak1| > |Z3mak2|) + Z3mak2 \cdot (|Z3mak2| > |Z3mak1|)$

$Z32 := Z31 \cdot (|Z31| > |Z3min|) + Z3min \cdot (|Z3min| > |Z31|)$

$ZRZ3P := Z3Trf \cdot (|Z32| > |Z3Trf|) + Z32 \cdot (|Z3Trf| > |Z32|)$

$|ZRZ3P| = 35.337$ Ω (Primer)

$ZRZ3 := ZRZ3P \cdot n1$ $|ZRZ3| = 47.116$ Ω (Sekunder)

Setting Zone-3 terhadap Z line adalah

$$ZRZ3\% := \frac{|ZRZ3P|}{|ZL11|} \cdot 100 \quad \%$$

$ZRZ3\% = 148.31$ %

Group Zone4 (MHO) settings settings : NOT ACTIVE

Group Zone5 (MHO) settings : NOT ACTIVE

3.1.6 Paramaterblock 13xx: 21 Distance Protection, time delays

Timer Zone 2,3

A. Timer Zone 2

$|ZL11| = 23.826$ $|Z2P| = 28.444$

$q := |Z2P| - (|ZL11|)$ $Zone1depan := 0.8 \cdot ZL21$

$q = 4.618$ kurang dari $|Zone1depan| = 7.096$ Ω (Primer)

Lihat apakah nilai impedansi (Z2 yang di pilih - ZL11)itu nilainya kurang dari zone 1 di GI depannya. Jika kurang maka nilai waktu yang dipilih T2=0,4 jika hasilnya lebih dari maka nilai yang dipilih adalah T= 0.8

$T2a := 0.4$ $T2b := 0.8$

$T2 := T2a \cdot [(|Z2P| - |ZL11|) < (|Zone1depan|)] + T2b \cdot [(|Z2P| - |XL11|) > (|Zone1depan|)]$

$T2 = 0.4$ detik

B. Timer Zone 3 $|ZL11| = 23.826$

Setting waktu tunda untuk Zone-3 ditentukan 1.6 detik

$T3 := 1.6$ detik

1305 : T1-1phase	= 0.00 sec
1306 : T1-multiphase	= 0.00 sec
1315 : T2-1phase	= 0.40 sec
1316 : T2-multiphase	= 0.40 sec
1325 : T3 delay	= 1.60 sec

3.2.1 Paramaters 21xx: 85-21 Teleprotection for Distance protection

2101 : FCT Telep. Dis.	= ON
2102 : Type of line	= Two terminals

3.2.2 Paramaters 24xx: Instantenous High Speed SOTF

2401 : FCT SOTF-O/C	= ON

2402 : 50HS SOTF Pickup

SOTF := 2.5·In SOTF = 2.5 A

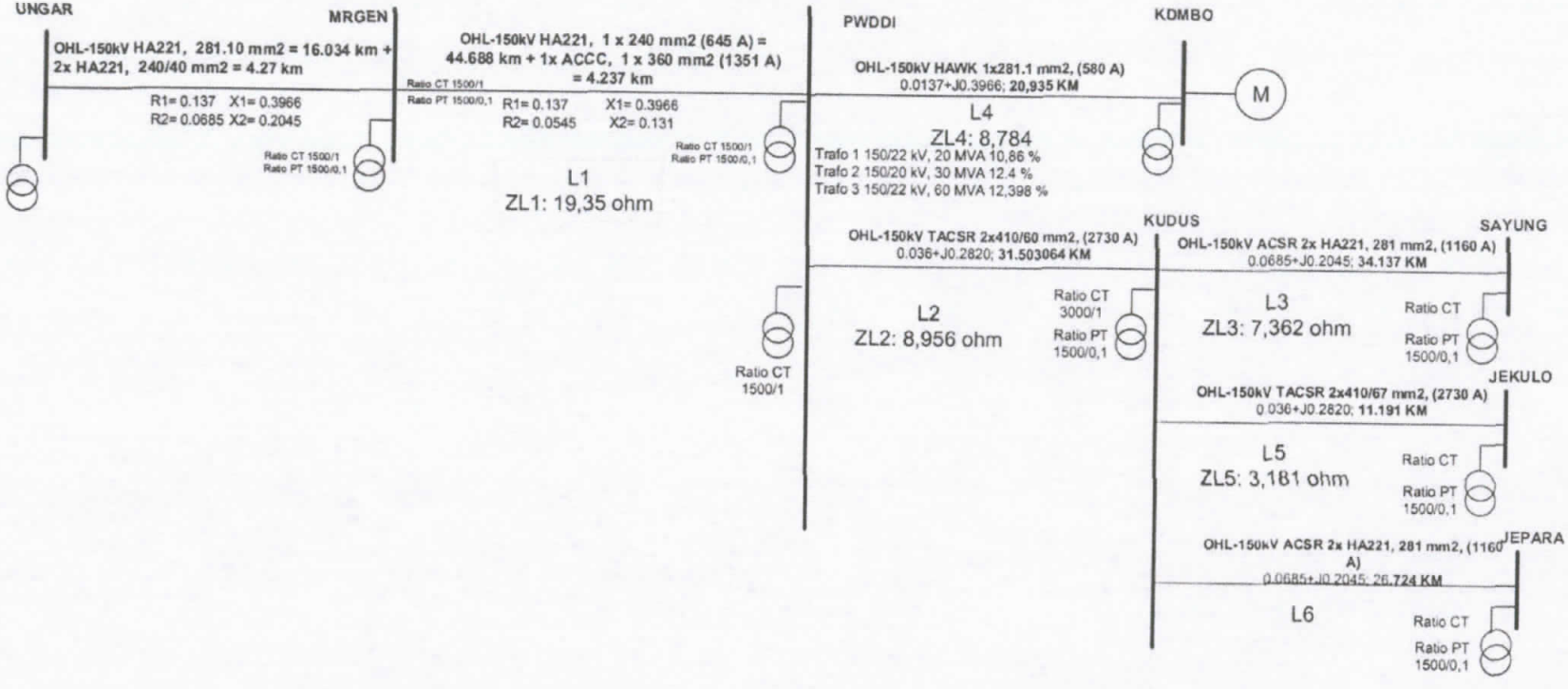
3.3 DEF

3101	FCT E.F OC	: NO
3102	Blocked for DR	: W/ every pickup
3103	Block 1pDeadTime	: YES
3110	Op mode 3I0>>>	: Inactive
3120	Op mode 3I0>>>	: Inactive
3140	Op mode 3I0>>>	: Inactive
3110	Op mode 3I0>	: Forward
3131	3I0>	: 0.2 A
3132	T 3I0>	: 2 detik
3133	Instant trip pilot	: YES
3134	Instant trip SOTF	: NO
3135	Instant blocking	: YES
3160	POLARIZATION	: UO+IY
3201	85-67 Pilot Prot For Dir GF	: ON
3202	Type of line	: Two terminal

Timer DEF

With teleproteksi	TDEF0 := 0.0	second
Without teleproteksi	TDEFbu := 2.0	seconds

SESUDAH PERUBAHAN JARINGAN



sesudah setting ulang.

1.1 MRANGGEN - PURWODADI

KETETAPAN $j := \sqrt{(-1)}$ $k := \frac{2 \cdot \pi}{360}$

Jenis penghantar

L1a : OHL-150kV HAWK,1x240 mm2 (645 A) L1a := 44.688 km

L1b : ACCC,AMSTERDAM 2x360 mm2 (2702 A) L1b := 4.237 km

R11a := 0.137 X11a := 0.3966 CCC1a := 645 LI := L1a + L1b

R11b := 0.0545 X11b := 0.131 CCC1b := 2703 LI = 48.925 km

Vn := 150000

Imp. urutan positif

RL11 := (L1a·R11a) + (L1b·R11b) XL11 := (L1a·X11a) + (L1b·X11b)

ZL11 := (RL11 + j·XL11) ZL11 = 6.353 + 18.278i Ω

RL11 = 6.353 XL11 = 18.278

DIPILIH

$ZL11 := \sqrt{RL11^2 + XL11^2}$ |ZL11| = 19.351 Ω

$\theta ph1 := \operatorname{atan}\left(\frac{XL11}{RL11}\right) \cdot \frac{1}{k}$ θph1 = 70.834

Imp. urutan nol

R10a := 0.287 X10a := 1.191

R10b := 0.2045 X10b := 0.3933

RL10 := [L1a·(R10a)] + [L1b·(R10b)] XL10 := (L1a·X10a) + (L1b·X10b)

ZL10 := (RL10 + j·XL10) ZL10 = 13.692 + 54.89i Ω

RL10 = 13.692 XL10 = 54.89

$ZL10 := \sqrt{RL10^2 + XL10^2}$ |ZL10| = 56.572 Ω

$\theta ph10 := \operatorname{atan}\left(\frac{XL10}{RL10}\right) \cdot \frac{1}{k}$ θph10 = 75.994 deg

1.2 Purwodadi Kudus- 1/2

Jenis penghantar **TACSR, 2x410/60 mm2, CCC = 2730 A**

$L2 := 31.503\ km$

$R21 := 0.038 \quad X21 := 0.2790\ \Omega/km$

$CCC1 := 2730$

$Vn := 150000$

Imp. urutan positif

$RL21 := R21 \cdot L2$ $\quad XL21 := X21 \cdot L2\ \Omega$

$ZL21 := (RL21 + j \cdot XL21)$ $\quad ZL21 = 1.197 + 8.789i\ \Omega$

$RL21 = 1.197 \quad XL21 = 8.789$

$ZL21 := \sqrt{RL21^2 + XL21^2}$ $\quad |ZL21| = 8.87\ \Omega$

$\theta ph2 := \operatorname{atan}\left(\frac{XL21}{RL21}\right) \cdot \frac{1}{k}$ $\quad \theta ph2 = 82.244\ deg$

Imp. urutan nol

$R20 := 0.168 \quad X20 := 0.8095\ \Omega/km$

$RL20 := R20 \cdot L2$ $\quad XL20 := X20 \cdot L2\ \Omega$

$ZL20 := (RL20 + j \cdot XL20)$ $\quad ZL20 = 5.293 + 25.502\ \Omega$

$RL20 = 5.293 \quad XL20 = 25.502$

$ZL20 := \sqrt{RL20^2 + XL20^2}$ $\quad |ZL20| = 26.045\ \Omega$

$\theta ph20 := \operatorname{atan}\left(\frac{XL20}{RL20}\right) \cdot \frac{1}{k}$ $\quad \theta ph20 = 78.276\ deg$

1.3 Kudus - Sayung

Jenis penghantar **ACSR, 2x281 mm2, CCC = 1160 A** L3 := 34.137 km

R31 := 0.0685 X31 := 0.2045 Ω /km

Imp. urutan positif

RL31 := R31·L3 XL31 := X31·L3 Ω

ZL31 := (RL31 + j·XL31) ZL31 = 2.338 + 6.981i Ω

RL31 = 2.338 XL31 = 6.981

$ZL31 := \sqrt{RL31^2 + XL31^2}$ |ZL31| = 7.362 Ω

$\theta ph3 := \operatorname{atan}\left(\frac{XL31}{RL31}\right)\cdot\frac{1}{k}$ θph3 = 71.481 deg

Imp. urutan nol

R30 := 0.2185 X30 := 0.6135 Ω /km

RL30 := R30·L3 XL30 := X30·L3 Ω

ZL30 := (RL30 + j·XL30) ZL30 = 7.459 + 20.943 Ω

RL30 = 7.459 XL30 = 20.943

$ZL30 := \sqrt{RL30^2 + XL30^2}$ |ZL30| = 22.232 Ω

$\theta ph30 := \operatorname{atan}\left(\frac{XL30}{RL30}\right)\cdot\frac{1}{k}$ θph30 = 70.396 deg

1.4 Purwodadi - kdmbo1-2

Jenis penghantar **ACSR, 240 mm2, CCC = 600 A** L4 := 20.935 km

R41 := 0.137 X41 := 0.3966 Ω /km

Imp. urutan positif

RL41 := R41·L4 XL41 := X41·L4

ZL41 := (RL41 + j·XL41) ZL41 = 2.868 + 8.303i Ω |ZL41| = 8.784

$\theta ph4 := \arg(ZL41)\cdot k^{-1}$ θph4 = 70.943 deg

Imp. urutan nol

XL40 := 3·X41·L4 RL40 := (R41 + 0.15)·L4

Siemens 7SA522 ZL40 := (RL40 + j·XL40) |ZL40| = 25.623 Ω

1.5 Kudus - Jekulo

Jenis penghantar **TACSR, 2x410 mm2, CCC = 2730 A** $L5 := 11.191$ km

$R51 := 0.036$ $X51 := 0.282$ Ω /km

Imp. urutan positif

$RL51 := R51 \cdot L5$ $XL51 := X51 \cdot L5$

$ZL51 := (RL51 + j \cdot XL51)$ $ZL51 = 0.403 + 3.156i$ Ω $|ZL51| = 3.181$

$\theta ph5 := \arg(ZL51) \cdot k^{-1}$ $\theta ph5 = 82.725$ deg

Imp. urutan nol

$XL50 := 3 \cdot X51 \cdot L5$ $RL50 := (R51 + 0.15) \cdot L5$

$ZL50 := (RL50 + j \cdot XL50)$ $|ZL50| = 9.694$ Ω

2. Impedansi Trafo GI Purwodadi

2.1 GI Purwodadi Trf 3 60 MVA, 12,398 %

$$XT1 := \frac{0.12398 \cdot 150^2}{60}$$

dipilih impedansi terkecil jika terdapat beberapa trafo

$XT1 = 46.492$ Ω

3. PERHITUNGAN SETELAN RELAI JARAK

3.1 LINE 150 kV -Purwodadi-Mranggen

Distance relay Siemens - 7SA522 (Pola PUTT)

3.1.1 Ratio CT & PT

$CT1 := \frac{1500}{1}$ A $PT1 := \frac{150000}{100}$ Volt $In := 1$ A

$n1 := \frac{CT1}{PT1}$ $n1 = 1$ $Vn := 100$ V

3.1.2 Scope of Functions

0110	: Trip Mode	1 Pole -/3 Pole
0112	: 21 Phase Distance Protection	Mho
0113	: 21G Ground Distance Protection	Quadrilateral
0121	: 85-21 Pilot Protection for Distance	PUTT
0124	: 50HS High Speed SOTF	Enable
0131	: Earth Fault O/C	Not Used
0132	: Teleprot E/F	Not Used
0138	: Fault Locator	Enable

3.1.3 Power System Data

Line Angle $\theta ph1 = 70.834$ deg

Dipilih $\theta ph1 := 71$ degree

1110 : X' $|X11| = 0.374 \frac{Ohm}{km}$

1111 : Line Length $L1 = 48.925$ km

1116 : RE/RL(Z1)

- Zero Sequence compensatio factor RG/RL(Z1) : R01

$R01 := \frac{1}{3} \cdot \left(\frac{RL10}{RL11} - 1 \right)$ $R01 = 0.385$ $R01 := 0.38$

1117 : XE/XL(Z1)

- Zero Sequence compensatio factor XG/XL(Z1) : X01

$X01 := \frac{1}{3} \cdot \left(\frac{XL10}{XL11} - 1 \right)$ $X01 = 0.668$ $X01 := 0.67$

1118 : RE/RL(ZB..Z5)

- Zero Sequence compensatio factor RG/RL(ZB...5) : R0B...5

$$R0B5 := \frac{1}{3}\cdot\left(\frac{RL20}{RL21} - 1\right) \qquad R0B5 = 1.14$$

R0B5 := 0.403

R0B5 := −0.279

1119 : XE/XL(ZB..Z5)

- Zero Sequence compensatio factor XG/XL(ZB...5) : X0B...5

$$X0B5 := \frac{1}{3}\cdot\left(\frac{XL20}{XL21} - 1\right) \qquad X0B5 = 0.634$$

X0B5 := 0.67

X0B5 := −0.302

3.1.3 Paramaterblock 12xx: 21 Distance protection, general setting

1201 : FCT Distance = On
1202 : Minimum Iph> = 0.1 A
1232 : Inst. Trip SOTF = with Zone1B

1241 : R load (ph-E) =

Vn := 150000

CCC := 600

- Load impedance $Zld := \left[\frac{Vn}{(\sqrt{3}\cdot CCC)}\right]\cdot n1$ Zld = 144.338 Ω (secondary)

- Power factor load angle θld := [(32 + 5)·k]

- Resistance/Reactance *impedance limit*
  Rld := Zld·cos(θld)·0.5 Rld = 57.637 Ω (secondary)
  Xld := Zld·sin(θld)·0.5 Xld = 43.432 Ω (secondary)

Resistansi Tahanan Gangguan tanah diasumsikan 40 Ohm

- Foot resistance Rf := 40 Ω (Primer)

Resistive Reach calculation :

Zloadmin := Zld·0.8 Zloadmin = 115.47 Ω sekunder

Z1safety := 0.5·Zld Z1safety = 72.169 Ω (sekunder)

Setting Resistive Reach dibatasi 50% dari Impedansi beban maksimum

Resistive reach max : Rgmax := Z1safety Rgmax = 72.169 Ω sekunder

Resistive reach min : Rgmin := 40·n1 Rgmin = 40 Ω sekunder

R load (ph-E) RLphE := Rgmax RLphE = 72.169 Ω sekunder

1242 : phi load (ph-E) $\theta LphE := \frac{\theta ld}{k}$ $\theta LphE = 37$ degree

1243 : R load (ph-ph) $RLphph := Rgmax$ $RLphph = 72.169$ Ω sekunder

1244 : phi load (ph-ph) $\theta Lphph := \frac{\theta ld}{k}$ $\theta Lphph = 37$ degree

1203 : 3I0>, load current unbalance $Io := 0.1$ $Io = 0.1$ A sekunder

1204 : 3V0>, load voltage unbalance $Vo := 20$ $Vo = 20$ V sekunder

1207A : 3I0>Iphmax $IoIph := 0.1$ $IoIph = 0.1$ V sekunder

3.1.4 Paramaterblock 13xx: 21 Distance Zones Quadrilateral $In := 1$ A

Rod insulator length $Larc := 7.5$ m

Arc current $Iarc := 2500$ A

Resistansi tahanan kaki tower diasumsikan 10 Ohm

Foot resistance of tower (Rfoot) $Rfoot := 10$ Ohm

Arc resistance $Rarc1 := \frac{28700 \cdot Larc}{Iarc^{1.4}}$ $Rarc1 = 3.766$ Ω primer

Rarc dipilih 0, bila nilai Rarc > dari RL11

$Rarc := Rarc1 \cdot (|Rarc1| < |RL11|) + 0 \cdot (|RL11| < |Rarc1|)$ dipilih : $Rarc = 3.766$

Group Zone1 settings :

1301 : Op. mode Z1 = Forward

1302 : R (Z1) $RZ1P := [(0.8 \cdot RL11) + (0.5 \cdot Rarc)]$ $RZ1P = 6.965$ Ω (Primer)

$RZ1 := RZ1P \cdot n1$ $|RZ1| = 6.965$ Ω (Sekunder)

1303 : X (Z1)

$XZ1P := 0.8 \cdot XL11$ $XZ1P = 14.623$ Ω (Primer)

$XZ1 := XZ1P \cdot n1$ $|XZ1| = 14.623$ Ω (Sekunder)

$Z1P := (RZ1P + j \cdot XZ1P)$ $|Z1P| = 16.197$

Setting Zone-1 terhadap Z line adalah

$Z1\% := \frac{|Z1P|}{|ZL11|} \cdot 100$ %

$|ZL11| = 0.698$

$Z1\% = 2.321 \times \%^3$

1302 : RG (Z1)

$RGZ1P := [(0.8 \cdot RL11) + Rfoot + Rarc]$ $RGZ1P = 18.848\ \Omega$ (Primer)

$RGZ1 := RGZ1P \cdot n1$ $|RGZ1| = 18.841\ \Omega$ (Sekunder)

Group Zone1B settings :

1351 : Op. mode Z1B = Forward

1352 : R (Z1B) $Iinfeed := 1$

$RZ1BP := [0.8 \cdot (RL11 + 0.8 \cdot RL21 \cdot Iinfeed) + (0.5 \cdot Rarc)]$ $RZ1BP = 7.731\ \Omega$ (Primer)

$RZ1B := RZ1BP \cdot n1$ $|RZ1B| = 7.731\ \Omega$ (Sekunder)

1353 : X (Z1B)

$XZ1BPmin := 1.2 \cdot XL11$ $XZ1BPmin = 21.934\ \Omega$ (Primer)

$XZ1BPmax1 := 0.8 \cdot (XL11 + 0.8 \cdot XL21 \cdot Iinfeed)$ $XZ1BPmax1 = 20.248\ \Omega$ (Primer)

$XZ1BPmax2 := 0.8 \cdot (XL11 + 0.5 \cdot XT1 \cdot Iinfeed)$ $XZ1BPmax2 = 33.22\ \Omega$ (Primer)

Dipilih Zone 1B terbesar tetapi tidak lebih besar dari zone 1B trafo

$X21Bmak := XZ1BPmin \cdot (|XZ1BPmin| > |XZ1BPmax1|) + XZ1BPmax1 \cdot (|XZ1BPmax1| > |XZ1BPmin|$

$X1BP := X21Bmak \cdot (|X21Bmak| < |XZ1BPmax2|) + XZ1BPmax2 \cdot (|XZ1BPmax2| < |X21Bmak|)$

$X1BP = 21.934$ $|X1BP| = 21.934\ \Omega$ (Primer)

$XZ1B := X1BP \cdot n1$ $|XZ1B| = 21.934\ \Omega$ (Sekunder)

$Z1BP := (RZ1BP + j \cdot X1BP)$ $|Z1BP| = 23.257\ \Omega$ (Primer)

Setting Zone-1B terhadap Z line adalah

$$Z1B\% := \frac{|Z1BP|}{|ZL11|} \cdot 100 \quad \%$$

$Z1B\% = 3.332 \times 10^{2}\ \%$

1352 : RG (Z1B)

$RGZ1BP := [0.8 \cdot (RL11 + 0.8 \cdot RL21 \cdot Iinfeed) + Rarc + 2 \cdot Rfoot]$ $RGZ1BP = 29.61\ \Omega$ (Primer)

$RGZ1B := RGZ1BP \cdot n1$ $|RGZ1B| = 29.614\ \Omega$ (Sekunder)

Group Zone2 settings :

1311 : Op. mode Z2 = Forward

1312 : R (Z2) Iinfeed := 1

RZ2P := [0.8·(RL11 + 0.8·RL21·Iinfeed) + (0.5·Rarc)] RZ2P = 7.731 Ω (Primer)

RZ2 := RZ2P·n1 |RZ2| = 7.731 Ω (Sekunder)

1313 : X (Z2)

XZ2Pmin := 1.2·XL11 XZ2Pmin = 21.934 Ω (Primer)

XZ2Pmax1 := 0.8·(XL11 + 0.8·XL21·Iinfeed) XZ2Pmax1 = 20.24 Ω (Primer)

XZ2Pmax2 := 0.8·(XL11 + 0.5·XT1·Iinfeed) XZ2Pmax2 = 33.22 Ω (Primer)

Dipilih Zone 2 terbesar tetapi tidak lebih besar dari zone 2 trafo

X21mak := XZ2Pmin·(|XZ2Pmin| > |XZ2Pmax1|) + XZ2Pmax1·(|XZ2Pmax1| > |XZ2Pmin|)

X2P := X21mak·(|X21mak| < |XZ2Pmax2|) + XZ2Pmax2·(|XZ2Pmax2| < |X21mak|)

X2P = 21.934 |X2P| = 21.934 Ω (Primer)

XZ2 := (X2P)·n1 |XZ2| = 21.934 Ω (Sekunder)

Z2P := (RZ2P + j·X2P) |Z2P| = 23.257 Ω (Primer)

Setting Zone-2 terhadap Z line adalah

$$Z2\% := \frac{|Z2P|}{|ZL11|}\cdot 10(\%$$

$Z2\% = 3.332 \times 10^{3}$ %

1314 : RG (Z2)

RGZ2P := [0.8·(RL11 + 0.8·RL21·Iinfeed) + Rarc + 2·Rfoot] RGZ2P = 29.614 Ω (Primer)

RGZ2 := RGZ2P·n1 |RGZ2| = 29.614 Ω (Sekunder)

Group Zone3 settings :

1321 : Op. mode Z3 = Forward

1322 : R (Z3) Iinfeed := 1

RZ3P := [1.2·(RL11 + RL21·Iinfeed) + (0.5·Rarc)] RZ3P = 10.943 Ω (Primer)

RZ3 := RZ3P·n1 |RZ3| = 10.943 Ω (Sekunder)

1323 : X (Z3)

XZ3Pmin := 1.2·(XL11 + XL21) XZ3Pmin = 32.481 Ω (Primer)

XZ3Pmax1 := 0.8[XL11 + (Iinfeed·1.2·XL21)] XZ3Pmax1 = 23.06 Ω (Primer)

Siemens 7SA522 XZ3Pmax2 := 0.8·[XL11 + [Iinfeed·0.8·(XL21 + 0.8·XL31)]] XZ3Pmax2 = 23.82 Ω (Primer) TRA

XZ3Pmax3 := 0.8·(XL11 + 0.8·XT1·Iinfeed) XZ3Pmax3 = 44.37 Ω (Primer)

Dipilih Zone 3 terbesar tetapi tidak lebih besar dari zone 3 trafo

$X31 := XZ3Pmin \cdot (|XZ3Pmin| > |XZ3Pmax1|) + XZ3Pmax1 \cdot (|XZ3Pmax1| > |XZ3Pmin|)$

$X32 := XZ3Pmax2 \cdot (|XZ3Pmax2| > |X31|) + X31 \cdot (|X31| > |XZ3Pmax2|)$

$X3P := XZ3Pmax3 \cdot (|X32| > |XZ3Pmax3|) + X32 \cdot (|XZ3Pmax3| > |X32|)$

$X3P = 32.481$ $|X3P| = 32.481$ Ω (Primer)

$XZ3 := X3P \cdot n1$ $|XZ3| = 32.481$ Ω (Sekunder)

$Z3P := (RZ3P + j \cdot X3P)$ $|Z3P| = 34.275$ Ω (Primer)

Setting Zone-3 terhadap Z line adalah

$$Z3\%_{\bullet} := \frac{|Z3P|}{|ZL11|} \cdot 100 \%$$

$Z3\% = 4.911 \times 10^{3}$ %

1324 : RG (Z3)

$RGZ3P := [1.2 \cdot (RL11 + RL21 \cdot Iinfeed) + Rarc + 2 \cdot Rfoot]$ $RGZ3P = 32.826$ Ω (Primer)

$RGZ3 := RGZ3P \cdot n1$ $|RGZ3| = 32.826$ Ω (Sekunder)

Group Zone4 settings settings : NOT ACTIVE

Group Zone5 settings : NOT ACTIVE

3.1.5 Paramaterblock 13xx: 21 Distance Zones MHO

Group Zone1 (MHO) settings :

1401 : Op. mode Z1 = Forward

1402 : ZR (Z1)

$ZRZ1P := 0.8 \cdot ZL11$ $|ZRZ1P| = 0.558$ Ω (Primer)

$ZRZ1 := ZRZ1P \cdot n1$ $|ZRZ1| = 0.558$ Ω (Sekunder)

Setting Zone-1 terhadap Z line adalah

$$ZRZ1\% := \frac{|ZRZ1P|}{|ZL11|} \cdot 100 \quad \%$$

$ZRZ1\% = 80$ %

Group Zone1B- Extends (MHO) settings :

1451 : Op. mode Z1B = Forward

1452 : ZR (Z1B)

$Iinfeed := 1$

Siemens 7SA522 $Z2min := 1.2 \cdot ZL11$ $|Z2min| = 0.837$ Ω (Primer) TRA

$Z2mak1 := [ZL11 + (0.8 \cdot ZL21) \cdot Iinfeed] \cdot 0.8$ $|Z2mak1| = 5.842$ Ω (Primer)

$Z2mak2 := (ZL11 + 0.8 \cdot ZL21) \cdot 0.8$ $|Z2mak2| = 5.842$ Ω (Primer)

$ZTrf := 0.8 \cdot (ZL11 + 0.5 \cdot XT1 \cdot j)$ arah trafo di GI Purwodadi

$|ZTrf| = 19.138$ Ω (Primer)

Dipilih Zone 2 terbesar tetapi tidak lebih besar dari zone 2 trafo

$Z21mak := Z2mak1 \cdot (|Z2mak1| > |Z2min|) + Z2min \cdot (|Z2min| > |Z2mak1|)$

$ZRZ1BP := Z21mak \cdot (|Z21mak| < |ZTrf|) + ZTrf \cdot (|ZTrf| < |Z21mak|)$

$ZRZ1BP = 5.817 + 0.54i$ $|ZRZ1BP| = 5.842$ Ω (Primer)

$ZRZ1B := ZRZ1BP \cdot n1$ $|ZRZ1B| = 5.842$ Ω (Sekunder)

$\theta phZRZ1B := \arg(ZRZ1B) \cdot k^{-1}$ $\theta phZRZ1B = 5.308$ deg

Setting Zone-1B terhadap Z line adalah

$$Z1B\% := \frac{|ZRZ1BP|}{|ZL11|} \cdot 100 \quad \%$$

$Z1B\% = 837.11$ %

1357 : Z1B enabled before 1st AR : NO

Group Zone2 (MHO) settings :

1411 : Op. mode Z2 = Forward

1412 : ZR (Z2) $Iinfeed := 1$

$Z2min := 1.2 \cdot ZL11$ $|Z2min| = 0.837$ Ω (Primer)

$Z2mak1 := [ZL11 + (0.8 \cdot ZL21) \cdot Iinfeed] \cdot 0.8$ $|Z2mak1| = 5.842$ Ω (Primer)

$ZTrf := 0.8 \cdot (ZL11 + 0.5 \cdot XT1 \cdot j)$ arah trafo di GI Purwodadi

$|ZTrf| = 19.138$ Ω (Primer)

Dipilih Zone 2 terbesar tetapi tidak lebih besar dari zone 2 trafo

$Z21mak := Z2mak1 \cdot (|Z2mak1| > |Z2min|) + Z2min \cdot (|Z2min| > |Z2mak1|)$

$ZRZ2P := Z21mak \cdot (|Z21mak| < |ZTrf|) + ZTrf \cdot (|ZTrf| < |Z21mak|)$

$ZRZ2P = 5.817 + 0.54i$ $|ZRZ2P| = 5.842$ Ω (Primer)

$ZRZ2 := ZRZ2P \cdot n1$ $|ZRZ2| = 5.842$ Ω (Sekunder)

Setting Zone-2 terhadap Z line adalah

$$ZRZ2\% := \frac{|ZRZ2P|}{|ZL11|} \cdot 100\ \%$$

$ZRZ2\% = 837.11$ %

Group Zone3 (MHO) settings :

1421 : Op. mode Z3 = Forward

1422 : ZR (Z3) Infeed := 1

$Z3min := 1.2 \cdot (ZL11 + ZL21)$ $|Z3min| = 10.885$ Ω (Primer)

$Z3mak1 := 0.8 \cdot [ZL11 + (1.2 \cdot ZL21) \cdot Iinfeed] = 8.656 + 0.5$ $|Z3mak1| = 8.673$ Ω (Primer)

$Z3mak2 := 0.8 \cdot [ZL11 + [0.8 \cdot (ZL21 + 0.8 \cdot ZL31) \cdot Iinfeed]]$ $|Z3mak2| = 9.602$ Ω (Primer)

$Z3Trf := 0.8 \cdot (ZL11 + 0.8 \cdot XT1 \cdot j)$ arah trafo di GI PURWODADI

$|Z3Trf| = 30.296$

$Z31 := Z3mak1 \cdot (|Z3mak1| > |Z3mak2|) + Z3mak2 \cdot (|Z3mak2| > |Z3mak1|)$

$Z32 := Z31 \cdot (|Z31| > |Z3min|) + Z3min \cdot (|Z3min| > |Z31|)$

$ZRZ3P := Z3Trf \cdot (|Z32| > |Z3Trf|) + Z32 \cdot (|Z3Trf| > |Z32|)$

$|ZRZ3P| = 10.885$ Ω (Primer)

$ZRZ3 := ZRZ3P \cdot n1$ $|ZRZ3| = 10.885$ Ω (Sekunder)

Setting Zone-3 terhadap Z line adalah

$$ZRZ3\% := \frac{|ZRZ3P|}{|ZL11|} \cdot 100 \quad \%$$

$ZRZ3\% = 1.56 \times 10^3$ %

Group Zone4 (MHO) settings settings : NOT ACTIVE

Group Zone5 (MHO) settings : NOT ACTIVE

3.1.6 Paramaterblock 13xx: 21 Distance Protection, time delays

Timer Zone 2,3

A. Timer Zone 2

$|ZL11| = 0.698$ $|Z2P| = 23.257$

$q := |Z2P| - (|ZL11|)$ $\quad$ $Zone1depan := 0.8 \cdot ZL21$

$q = 22.559$ kurang dari $|Zone1depan| = 7.096$ Ω (Primer)

Lihat apakah nilai impedansi (Z2 yang di pilih - ZL11)itu nilainya kurang dari zone 1 di GI depannya. Jika kurang maka nilai waktu yang dipilih T2=0,4 jika hasilnya lebih dari maka nilai yang dipilih adalah T= 0.8

$T2a := 0.4$ $\quad$ $T2b := 0.8$

$T2 := T2a \cdot [(|Z2P| - |ZL11|) < (|Zone1depan|)] + T2b \cdot [(|Z2P| - |XL11|) > (|Zone1depan|)]$

$T2 = 0$ detik

B. Timer Zone 3 $\quad$ $|ZL11| = 0.698$

Setting waktu tunda untuk Zone-3 ditentukan 1.6 detik

$T3 := 1.6$ detik

1305 : T1-1phase = 0.00 sec
1306 : T1-multiphase = 0.00 sec

1315 : T2-1phase = 0.40 sec
1316 : T2-multiphase = 0.40 sec

1325 : T3 delay = 1.60 sec

3.2.1 Paramaters 21xx: 85-21 Teleprotection for Distance protection

2101 : FCT Telep. Dis. = ON

2102 : Type of line = Two terminals

3.2.2 Paramaters 24xx: Instantenous High Speed SOTF

2401 : FCT SOTF-O/C = ON

2402 : 50HS SOTF Pickup

SOTF := 2.5·In SOTF = 2.5 A

3.3 DEF

3101	FCT E.F OC	: NO
3102	Blocked for DR	: W/ every pickup
3103	Block 1pDeadTime	: YES
3110	Op mode 3I0>>>	: Inactive
3120	Op mode 3I0>>>	: Inactive
3140	Op mode 3I0>>>	: Inactive
3110	Op mode 3I0>	: Forward
3131	3I0>	: 0.2 A
3132	T 3I0>	: 2 detik
3133	Instant trip pilot	: YES
3134	Instant trip SOTF	: NO
3135	Instant blocking	: YES
3160	POLARIZATION	: UO+IY
3201	85-67 Pilot Prot For Dir GF	: ON
3202	Type of line	: Two terminal

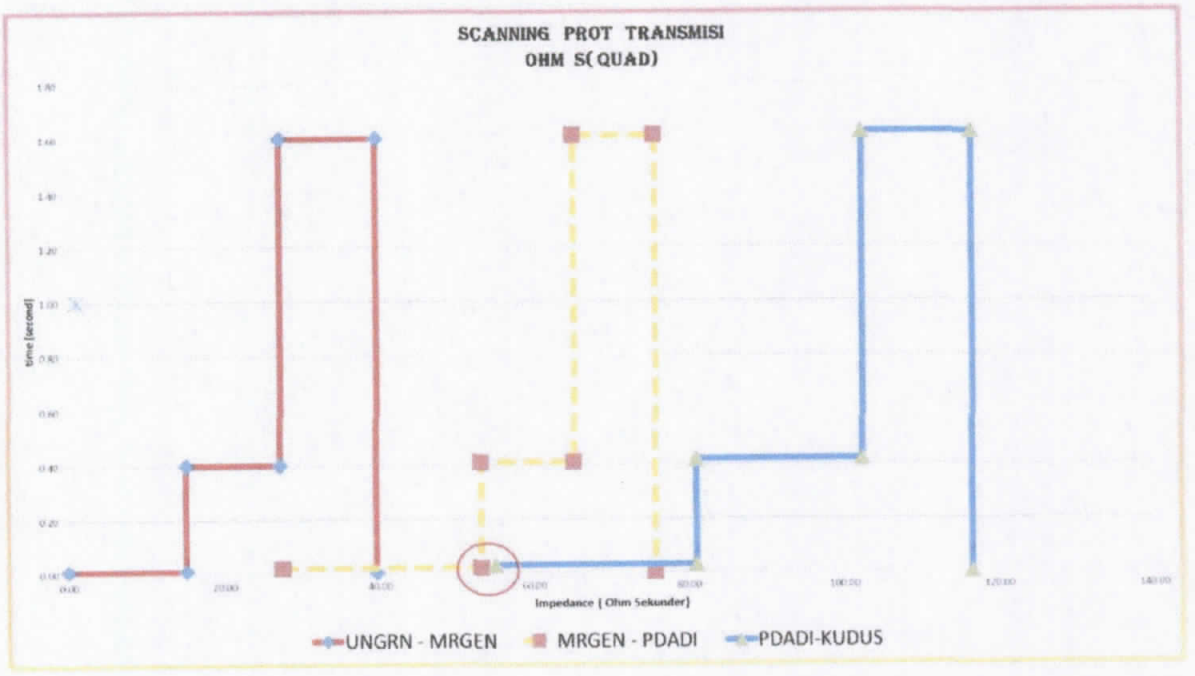
Timer DEF

With teleproteksi	TDEF0 := 0.0	second
Without teleproteksi	TDEFbu := 2.0	seconds

Jka ZL Lama lebih panjang 15% dari ZL Baru, tidak overlap

		HAWK 240 + AC3			HAWK 240 + AC3			HAWK 240 + AC3	
		R	X	R	X	R	X		
		0.1920	0.5280	0.1920	0.5280	0.1750	0.6760		
Segmen Penghantar	UNGRN - MRGEN			MRGEN - PDADI			PDADI-KUDUS		
PT Rasio (V)	1500			1500			1500		
CT Rasio (A)	1500			1500			1500		
Jenis Konduktor	HAWK 240 + AC3			HAWK 240 + AC3			2X TACSR 2X410 + HAWK 240		
Impedansi Konduktor (ohm)	0.192+0.528i			0.192+0.528i			0.175+0.676i		
Panjang penghantar (km)	48.9			48.9			31.5		
Impedansi Penghantar (ohm)	27.48450814 ohm P			27.48731727 ohm P			21.99316313 ohm P		
	27.48450814 Ohm S			27.48731727 Ohm S			21.99316313 Ohm S		
Rasio CT/PT	1.0000			1.0000			1.0000		
	Ohm sekunder	Ohm primer	Panjang (km)	Ohm sekunder	Ohm primer	Panjang (km)	Ohm sekunder	Ohm primer	Panjang (km)
Zone 1 (ohm)	15.12	15.12	26.91	25.82	25.816	45.9502	26.03	26.03	46.33
Zone 2 (ohm)	27.16	27.16	48.34	37.78	37.78	67.2451	47.39	47.39	84.35
Zone 3 (ohm)	39.64	39.64	99.10	48.24	48.24	85.8629	61.53	61.53	109.52
T Zone 1 (sec)	0.01			0.02			0.03		
T Zone 2 (sec)	0.40			0.41			0.42		
T Zone 3 (sec)	1.60			1.61			1.62		

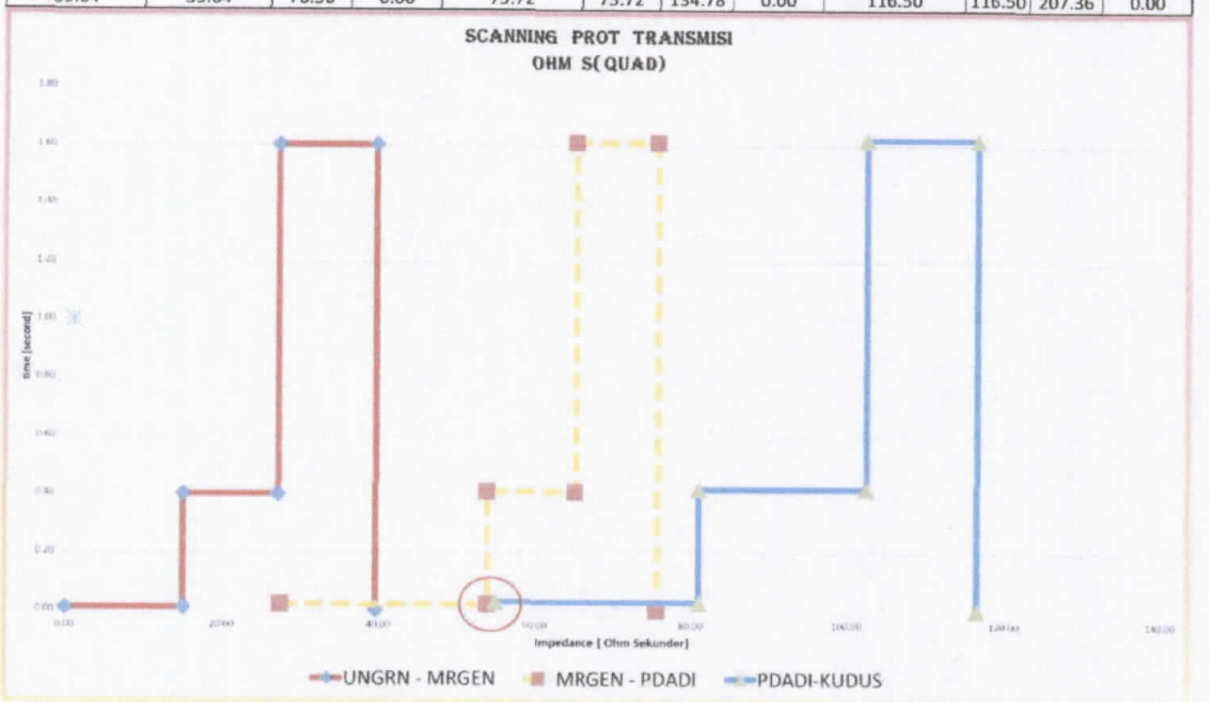
OHM S	OHM P	LENGTH	TIME	OHM S	OHM P	LENGTH	TIME	OHM S	OHM P	LENGTH	TIME
0.00	0.00	0.00	0.01	27.48	27.48	48.92	0.02	54.97	54.97	97.85	0.03
15.12	15.12	26.91	0.01	53.30	53.30	94.87	0.02	81.00	81.00	144.18	0.03
15.12	15.12	26.91	0.40	53.30	53.30	94.87	0.41	81.00	81.00	144.18	0.42
27.16	27.16	48.34	0.40	65.26	65.26	116.17	0.41	102.36	102.36	182.20	0.42
27.16	27.16	48.34	1.60	65.26	65.26	116.17	1.61	102.36	102.36	182.20	1.62
39.64	39.64	70.56	1.60	75.72	75.72	134.78	1.61	116.50	116.50	207.36	1.62
39.64	39.64	70.56	0.00	75.72	75.72	134.78	0.00	116.50	116.50	207.36	0.00



Jka ZL Lama lebih panjang 20% dari ZL Baru, masih overlap

Segmen Penghantar	UNGRN - MRGEN			MRGEN - PDADI			PDADI-KUDUS		
PT Rasio (V)	1500			1500			1500		
CT Rasio (A)	1500			1500			1500		
Jenis Konduktor	HAWK 240 + AC3			HAWK 240 + AC3			2X TACSR 2X410 + HAWK 240		
Impedansi Konduktor (ohm)	0.192+0.528i			0.192+0.528i			0.175+0.676i		
Panjang penghantar (km)	48.9			48.9			31.5		
Impedansi Penghantar (ohm)	27.48450814 ohm P 27.48450814 Ohm S			27.48731727 ohm P 27.48731727 Ohm S			21.99316313 ohm P 21.99316313 Ohm S		
Rasio CT/PT	1.0000			1.0000			1.0000		
	Ohm sekunder	Ohm primer	Panjang (km)	Ohm sekunder	Ohm primer	Panjang (km)	Ohm sekunder	Ohm primer	Panjang (km)
Zone 1 (ohm)	15.12	15.12	26.91	26.49	26.487	47.1445	26.03	26.03	46.33
Zone 2 (ohm)	27.16	27.16	48.34	37.78	37.78	67.2451	47.39	47.39	84.35
Zone 3 (ohm)	39.64	39.64	99.10	48.24	48.24	85.8629	61.53	61.53	109.52
T Zone 1 (sec)	0.01			0.02			0.03		
T Zone 2 (sec)	0.40			0.41			0.42		
T Zone 3 (sec)	1.60			1.61			1.62		

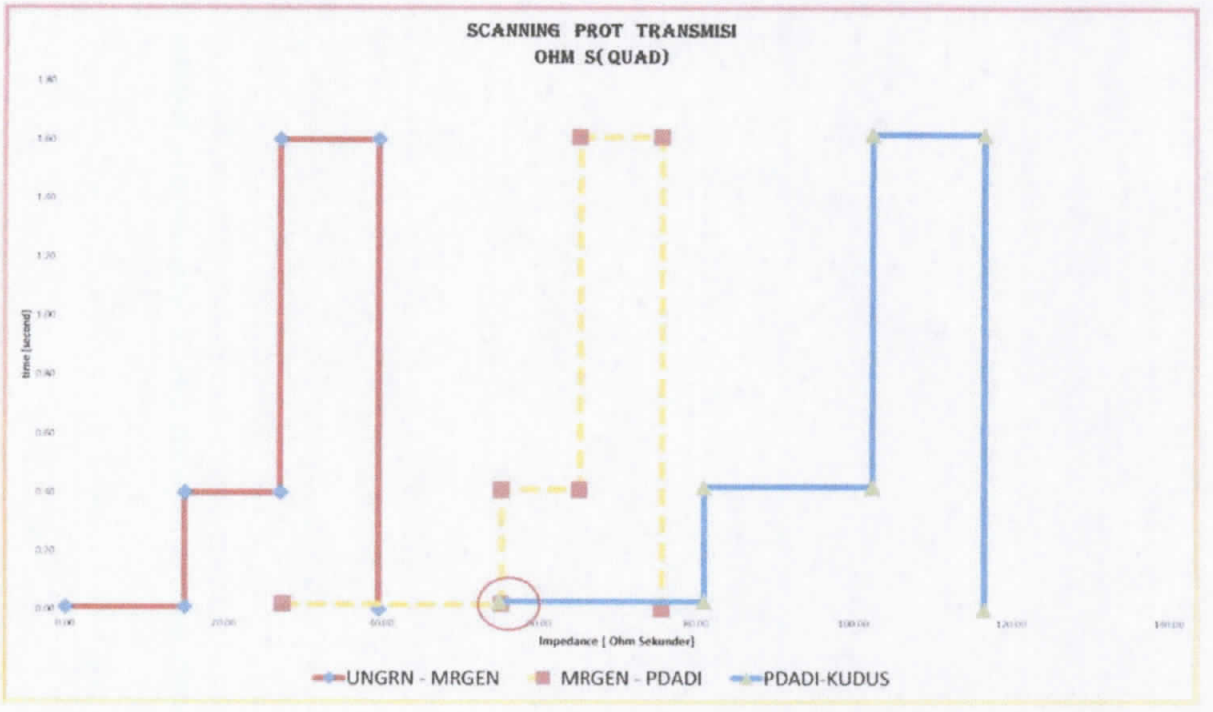
OHM S	OHM P	LENGTH	TIME	OHM S	OHM P	LENGTH	TIME	OHM S	OHM P	LENGTH	TIME
0.00	0.00	0.00	0.01	27.48	27.48	48.92	0.02	54.97	54.97	97.85	0.03
15.12	15.12	26.91	0.01	53.97	53.97	96.06	0.02	81.00	81.00	144.18	0.03
15.12	15.12	26.91	0.40	53.97	53.97	96.06	0.41	81.00	81.00	144.18	0.42
27.16	27.16	48.34	0.40	65.26	65.26	116.17	0.41	102.36	102.36	182.20	0.42
27.16	27.16	48.34	1.60	65.26	65.26	116.17	1.61	102.36	102.36	182.20	1.62
39.64	39.64	70.56	1.60	75.72	75.72	134.78	1.61	116.50	116.50	207.36	1.62
39.64	39.64	70.56	0.00	75.72	75.72	134.78	0.00	116.50	116.50	207.36	0.00



Jka ZL Lama lebih panjang 30% dari ZL Baru, masih overlap

		HAWK 240 + AC3			HAWK 240 + AC3			HAWK 240 + AC3	
		R	X		R	X		R	X
		0.1920	0.5280		0.1920	0.5280		0.1750	0.6760
Segmen Penghantar	**UNGRN - MRGEN**			**MRGEN - PDADI**			**PDADI-KUDUS**		
PT Rasio (V)	1500			1500			1500		
CT Rasio (A)	1500			1500			1500		
Jenis Konduktor	HAWK 240 + AC3			HAWK 240 + AC3			2X TACSR 2X410 + HAWK 240		
Impedansi Konduktor (ohm)	0.192+0.528i			0.192+0.528i			0.175+0.676i		
Panjang penghantar (km)	48.9			48.9			31.5		
Impedansi Penghantar (ohm)	27.48450814 ohm P 27.48450814 Ohm S			27.48731727 ohm P 27.48731727 Ohm S			21.99316313 ohm P 21.99316313 Ohm S		
Rasio CT/PT	1.0000			1.0000			1.0000		
	Ohm sekunder	Ohm primer	Panjang (km)	**Ohm sekunder**	Ohm primer	Panjang (km)	**Ohm sekunder**	Ohm primer	Panjang (km)
Zone 1 (ohm)	**15.12**	15.12	26.91	**27.85**	27.845	49.5616	**26.03**	26.03	46.33
Zone 2 (ohm)	**27.16**	27.16	48.34	**37.78**	37.78	67.2451	**47.39**	47.39	84.35
Zone 3 (ohm)	**39.64**	39.64	99.10	**48.24**	48.24	85.8629	**61.53**	61.53	109.52
T Zone 1 (sec)	**0.01**			**0.02**			**0.03**		
T Zone 2 (sec)	**0.40**			**0.41**			**0.42**		
T Zone 3 (sec)	**1.60**			**1.61**			**1.62**		

OHM S	OHM P	LENGTH	TIME	OHM S	OHM P	LENGTH	TIME	OHM S	OHM P	LENGTH	TIME
0.00	0.00	0.00	0.01	27.48	27.48	48.92	0.02	54.97	54.97	97.85	0.03
15.12	15.12	26.91	0.01	55.33	55.33	98.48	0.02	81.00	81.00	144.18	0.03
15.12	15.12	26.91	0.40	55.33	55.33	98.48	0.41	81.00	81.00	144.18	0.42
27.16	27.16	48.34	0.40	65.26	65.26	116.17	0.41	102.36	102.36	182.20	0.42
27.16	27.16	48.34	1.60	65.26	65.26	116.17	1.61	102.36	102.36	182.20	1.62
39.64	39.64	70.56	1.60	75.72	75.72	134.78	1.61	116.50	116.50	207.36	1.62
39.64	39.64	70.56	0.00	75.72	75.72	134.78	0.00	116.50	116.50	207.36	0.00



2C lama > 15% 2C baru.

UNGRN PDADI

1.1 MRANGGEN - PURWODADI

KETETAPAN $j := \sqrt{(-1)}$ $k := \frac{2 \cdot \pi}{360}$

$L1aa := 56.784$ km

$L1bb := 0$ km

Jenis penghantar **L1a : OHL-150kV HAWK,1x240 mm2 (645 A)**
L1b : ACCC,AMSTERDAM 2x360 mm2 (2702 A)

$L1a := 44.688$ km

$L1b := 4.237$ km

$R11a := 0.137$ $X11a := 0.3966$

$R11b := 0.0545$ $X11b := 0.131$

$CCC1a := 645$
$CCC1b := 2703$
$Vn := 150000$

$L1 := L1a + L1b$
$L1 = 48.925$ km

Imp. urutan positif

$RL11 := (L1aa \cdot R11a) + (L1bb \cdot R11b)$ $XL11 := (L1aa \cdot X11a) + (L1bb \cdot X11b)$

$ZL11 := (RL11 + j \cdot XL11)$ $ZL11 = 7.779 + 22.521i\ \Omega$

$RL11 = 7.779$ $XL11 = 22.521$
dipilih

$RL11 := 7.265586$ $XL11 := 21.034614$

$ZL11 := \sqrt{RL11^2 + XL11^2}$ $|ZL11| = 22.254\ \Omega$

$\theta ph1 := \operatorname{atan}\left(\frac{XL11}{RL11}\right) \cdot \frac{1}{k}$ $\theta ph1 = 70.945$

Imp. urutan nol

$R10a := 0.287$ $X10a := 1.191$

$R10b := 0.2045$ $X10b := 0.3933$

$RL10 := [L1aa \cdot (R10a)] + [L1bb \cdot (R10b)]$ $XL10 := (L1aa \cdot X10a) + (L1bb \cdot X10b)$

$ZL10 := (RL10 + j \cdot XL10)$ $ZL10 = 16.297 + 67.63i\ \Omega$

$RL10 = 16.297$ $XL10 = 67.63$

$ZL10 := \sqrt{RL10^2 + XL10^2}$ $|ZL10| = 69.566\ \Omega$

$\theta ph10 := \operatorname{atan}\left(\frac{XL10}{RL10}\right) \cdot \frac{1}{k}$ $\theta ph10 = 76.452$ deg

1242 : phi load (ph-E) $\theta LphE := \frac{\theta ld}{k}$ $\theta LphE = 37$ degree

1243 : R load (ph-ph) $RLphph := Rgmax$ $RLphph = 72.169$ Ω sekunder

1244 : phi load (ph-ph) $\theta Lphph := \frac{\theta ld}{k}$ $\theta Lphph = 37$ degree

1203 : 3I0>, load current unbalance $Io := 0.1$ $Io = 0.1$ A sekunder

1204 : 3V0>, load voltage unbalance $Vo := 20$ $Vo = 20$ V sekunder

1207A : 3I0>Iphmax $IoIph := 0.1$ $IoIph = 0.1$ V sekunder

3.1.4 Paramaterblock 13xx: 21 Distance Zones Quadrilateral $In := 1$ A

Rod insulator length $Larc := 7.5$ m

Arc current $Iarc := 2500$ A

Resistansi tahanan kaki tower diasumsikan 10 Ohm

Foot resistance of tower (Rfoot) $Rfoot := 10$ Ohm

Arc resistance $Rarc1 := \frac{28700 \cdot Larc}{Iarc^{1.4}}$ $Rarc1 = 3.766$ Ω primer

Rarc dipilih 0 bila nilai Rarc > dari RL11

$Rarc := Rarc1 \cdot (|Rarc1| < |RL11|) + 0 \cdot (|RL11| < |Rarc1|)$ dipilih : $Rarc = 3.766$

Group Zone1 settings

1301 : Op. mode Z1 = Forward

1302 : R (Z1) $RZ1P := [(0.8RL11) + (0.5 \cdot Rarc)]$ $RZ1P = 7.695$ Ω (Primer)

$RZ1 := RZ1P \cdot n1$ $|RZ1| = 7.695$ Ω (Sekunder)

1303 : X (Z1)

$XZ1P := 0.8XL11$ $XZ1P = 16.828$ Ω (Primer)

$XZ1 := XZ1P \cdot n1$ $|XZ1| = 16.828$ Ω (Sekunder)

$Z1P := (RZ1P + j \cdot XZ1P)$ $|Z1P| = 18.504$

Setting Zone-1 terhadap Z line adalah

$Z1\% := \frac{|Z1P|}{|ZL11|} \cdot 100$ %

$|ZL11| = 22.254$

$Z1\% = 83.148$ %

1302 : RG (Z1)

$RGZ1P := [(0.8RL11) + Rfoot + Rarc]$ $RGZ1P = 19.578\ \Omega$ (Primer)

$RGZ1 := RGZ1P \cdot nl$ $|RGZ1| = 19.571\ \Omega$ (Sekunder)

Group Zone1B settings

1351 : Op. mode Z1B = Forward

1352 : R (Z1B) $Iinfeed := 1$

$RZ1BP := [0.8 \cdot (RL11 + 0.8 \cdot RL21 \cdot Iinfeed) + (0.5 \cdot Rarc)]$ $RZ1BP = 8.461\ \Omega$ (Primer)

$RZ1B := RZ1BP \cdot nl$ $|RZ1B| = 8.461\ \Omega$ (Sekunder)

1353 : X (Z1B)

$XZ1BPmin := 1.2 \cdot XL11$ $XZ1BPmin = 25.242\ \Omega$ (Primer)

$XZ1BPmax1 := 0.8 \cdot (XL11 + 0.8 \cdot XL21 \cdot Iinfeed)$ $XZ1BPmax1 = 22.453\ \Omega$ (Primer)

$XZ1BPmax2 := 0.8 \cdot (XL11 + 0.5 \cdot XT1 \cdot Iinfeed)$ $XZ1BPmax2 = 35.425\ \Omega$ (Primer)

Dipilih Zone 1B terbesar tetapi tidak lebih besar dari zone 1B trafo

$X21Bmak := XZ1BPmin \cdot (|XZ1BPmin| > |XZ1BPmax1|) + XZ1BPmax1 \cdot (|XZ1BPmax1| > |XZ1BPmin|$

$X1BP := X21Bmak \cdot (|X21Bmak| < |XZ1BPmax2|) + XZ1BPmax2 \cdot (|XZ1BPmax2| < |X21Bmak|)$

$X1BP = 25.242$ $|X1BP| = 25.242\ \Omega$ (Primer)

$XZ1B := X1BP \cdot nl$ $|XZ1B| = 25.242\ \Omega$ (Sekunder)

$Z1BP := (RZ1BP + j \cdot X1BP)$ $|Z1BP| = 26.622\ \Omega$ (Primer)

Setting Zone-1B terhadap Z line adalah

$$Z1B\% := \frac{|Z1BP|}{|ZL11|} \cdot 100 \quad \%$$

$Z1B\% = 119.627$ %

1352 : RG (Z1B)

$RGZ1BP := [0.8 \cdot (RL11 + 0.8 \cdot RL21 \cdot Iinfeed) + Rarc + 2 \cdot Rfoot]$ $RGZ1BP = 30.34\ \Omega$ (Primer)

$RGZ1B := RGZ1BP \cdot nl$ $|RGZ1B| = 30.344\ \Omega$ (Sekunder)

ZL lama > 20% ZL baru

UNGRN PDAD

1.1 MRANGGEN - PURWODADI

KETETAPAN $j := \sqrt{(-1)}$ $k := \frac{2 \cdot \pi}{360}$

Jenis penghantar

L1a : OHL-150kV HAWK,1x240 mm2 (645 A)
L1b : ACCC,AMSTERDAM 2x360 mm2 (2702 A)

$R11a := 0.137$ $X11a := 0.3966$

$R11b := 0.0545$ $X11b := 0.131$

$CCC1a := 645$
$CCC1b := 2703$
$Vn := 150000$

$L1aa := 56.784$ km
$L1bb := 0$ km
$L1a := 44.688$ km
$L1b := 4.237$ km
$Ll := L1a + L1b$
$Ll = 48.925$ km

Imp. urutan positif

$RL11 := (L1aa \cdot R11a) - (L1bb \cdot R11b)$ $XL11 := (L1aa \cdot X11a) + (L1bb \cdot X11b)$

$ZL11 := (RL11 + j \cdot XL11)$ $ZL11 = 7.779 + 22.521i\ \Omega$

$RL11 = 7.779$ $XL11 = 22.521$
dipilih

$RL11 := 7.5814134$ $XL11 := 21.9489666$

$ZL11 := \sqrt{RL11^2 + XL11^2}$ $|ZL11| = 23.221\ \Omega$

$\theta ph1 := \operatorname{atan}\left(\frac{XL11}{RL11}\right) \cdot \frac{1}{k}$ $\theta ph1 = 70.945$

Imp. urutan nol

$R10a := 0.287$ $X10a := 1.191$

$R10b := 0.2045$ $X10b := 0.3933$

$RL10 := [L1aa \cdot (R10a)] + [L1bb \cdot (R10b)]$ $XL10 := (L1aa \cdot X10a) + (L1bb \cdot X10b)$

$ZL10 := (RL10 + j \cdot XL10)$ $ZL10 = 16.297 + 67.63i\ \Omega$

$RL10 = 16.297$ $XL10 = 67.63$

$ZL10 := \sqrt{RL10^2 + XL10^2}$ $|ZL10| = 69.566\ \Omega$

$\theta ph10 := \operatorname{atan}\left(\frac{XL10}{RL10}\right) \cdot \frac{1}{k}$ $\theta ph10 = 76.452$ deg

1242 : phi load (ph-E) $\theta LphE := \frac{\theta ld}{k}$ $\theta LphE = 37$ degree

1243 : R load (ph-ph) $RLphph := Rgmax$ $RLphph = 72.169$ Ω sekunder

1244 : phi load (ph-ph) $\theta Lphph := \frac{\theta ld}{k}$ $\theta Lphph = 37$ degree

1203 : 3I0>, load current unbalance $Io := 0.1$ $Io = 0.1$ A sekunder

1204 : 3V0>, load voltage unbalance $Vo := 20$ $Vo = 20$ V sekunder

1207A : 3I0>Iphmax $IoIph := 0.1$ $IoIph = 0.1$ V sekunder

3.1.4 Paramaterblock 13xx: 21 Distance Zones Quadrilateral

$In := 1$ A

Rod insulator length $Larc := 7.5$ m

Arc current $Iarc := 2500$ A

Resistansi tahanan kaki tower diasumsikan 10 Ohm

Foot resistance of tower (Rfoot) $Rfoot := 10$ Ohm

Arc resistance $Rarc1 := \frac{28700 \cdot Larc}{Iarc^{1.4}}$ $Rarc1 = 3.766$ Ω primer

Rarc dipilih 0 bila nilai Rarc > dari RL11

$Rarc := Rarc1 \cdot (|Rarc1| < |RL11|) + 0 \cdot (|RL11| < |Rarc1|)$ dipilih : $Rarc = 3.766$

Group Zone1 settings :

1301 : Op. mode Z1 = Forward

1302 : R (Z1) $RZ1P := [(0.8RL11) + (0.5 \cdot Rarc)]$ $RZ1P = 7.948$ Ω (Primer)

$RZ1 := RZ1P \cdot n1$ $|RZ1| = 7.948$ Ω (Sekunder)

1303 : X (Z1) $XZ1P := 0.8XL11$ $XZ1P = 17.559$ Ω (Primer)

$XZ1 := XZ1P \cdot n1$ $|XZ1| = 17.559$ Ω (Sekunder)

$Z1P := (RZ1P + j \cdot XZ1P)$ $|Z1P| = 19.274$

Setting Zone-1 terhadap Z line adalah

$Z1\% := \frac{|Z1P|}{|ZL11|} \cdot 100$ %

$|ZL11| = 23.221$

$Z1\% = 83.002$ %

1302 : RG (Z1)

RGZ1P := [(0.8RL11) + Rfoot + Rarc] RGZ1P = 19.831 Ω (Primer)

RGZ1 := RGZ1P·n1 |RGZ1| = 19.831Ω (Sekunder)

Group Zone1B settings :

1351 : Op. mode Z1B = Forward

1352 : R (Z1B) Iinfeed := 1

RZ1BP := [0.8·(RL11 + 0.8·RL21·Iinfeed) + (0.5·Rarc)] RZ1BP = 8.714 Ω (Primer)

RZ1B := RZ1BP·n1 |RZ1B| = 8.714 Ω (Sekunder)

1353 : X (Z1B)

XZ1BPmin := 1.2·XL11 XZ1BPmin = 26.339 Ω (Primer)

XZ1BPmax1 := 0.8·(XL11 + 0.8·XL21·Iinfeed) XZ1BPmax1 = 23.184 Ω (Primer)

XZ1BPmax2 := 0.8·(XL11 + 0.5·XT1·Iinfeed) XZ1BPmax2 = 36.156 Ω (Primer)

Dipilih Zone 1B terbesar tetapi tidak lebih besar dari zone 1B trafo

X21Bmak := XZ1BPmin·(|XZ1BPmin| > |XZ1BPmax1|) + XZ1BPmax1·(|XZ1BPmax1| > |XZ1BPn

X1BP := X21Bmak·(|X21Bmak| < |XZ1BPmax2|) + XZ1BPmax2·(|XZ1BPmax2| < |X21Bmak|)

X1BP = 26.339 |X1BP| = 26.339 Ω (Primer)

XZ1B := X1BP·n1 |XZ1B| = 26.339 Ω (Sekunder)

Z1BP := (RZ1BP + j·X1BP) |Z1BP| = 27.743 Ω (Primer)

Setting Zone-1B terhadap Z line adalah

$$Z1B\% := \frac{|Z1BP|}{|ZL11|}\cdot 100 \quad \%$$

Z1B% = 119.471 %

1352 : RG (Z1B)

RGZ1BP := [0.8·(RL11 + 0.8·RL21·Iinfeed) + Rarc + 2·Rfoot] RGZ1BP = 30.59 Ω (Primer)

RGZ1B := RGZ1BP·n1 |RGZ1B| = 30.597 Ω (Sekunder)

ZL Lama 7 30% ZL baru.

UNGRN PDADI

1.1 MRANGGEN - PURWODADI

KETETAPAN $j := \sqrt{(-1)}$ $k := \frac{2 \cdot \pi}{360}$

Jenis penghantar **L1a : OHL-150kV HAWK,1x240 mm2 (645 A)**
L1b : ACCC,AMSTERDAM 2x360 mm2 (2702 A)

$R11a := 0.137$ $X11a := 0.3966$ $CCC1a := 645$
$R11b := 0.0545$ $X11b := 0.131$ $CCC1b := 2703$
$Vn := 150000$

$L1aa := 56.784\,km$
$L1bb := 0\ km$
$L1a := 44.688\,km$
$L1b := 4.237\ km$
$L1 := L1a + L1b$
$L1 = 48.925\ km$

Imp. urutan positif

$RL11 := (L1aa \cdot R11a) + (L1bb \cdot R11b)$ $XL11 := (L1aa \cdot X11a) + (L1bb \cdot X11b)$

$ZL11 := (RL11 + j \cdot XL11)$ $ZL11 = 7.779 + 22.521i\ \Omega$

$RL11 = 7.779$ $XL11 = 22.521$
dipilih

$RL11 := 8.213068$ $XL11 := 23.77767$

$ZL11 := \sqrt{RL11^2 + XL11^2}$ $|ZL11| = 25.156\ \Omega$

$\theta ph1 := \operatorname{atan}\left(\frac{XL11}{RL11}\right) \cdot \frac{1}{k}$ $\theta ph1 = 70.945$

Imp. urutan nol

$R10a := 0.287$ $X10a := 1.191$
$R10b := 0.2045$ $X10b := 0.3933$

$RL10 := [L1aa \cdot (R10a)] + [L1bb \cdot (R10b)]$ $XL10 := (L1aa \cdot X10a) + (L1bb \cdot X10b)$

$ZL10 := (RL10 + j \cdot XL10)$ $ZL10 = 16.297 + 67.63i\ \Omega$

$RL10 = 16.297$ $XL10 = 67.63$

$ZL10 := \sqrt{RL10^2 + XL10^2}$ $|ZL10| = 69.566\ \Omega$

$\theta ph10 := \operatorname{atan}\left(\frac{XL10}{RL10}\right) \cdot \frac{1}{k}$ $\theta ph10 = 76.452\ deg$

1242 : phi load (ph-E) $\theta LphE := \frac{\theta ld}{k}$ $\theta LphE = 37$ degree

1243 : R load (ph-ph) $RLphph := Rgmax$ $RLphph = 72.169$ Ω sekunder

1244 : phi load (ph-ph) $\theta Lphph := \frac{\theta ld}{k}$ $\theta Lphph = 37$ degree

1203 : 3I0>, load current unbalance $Io := 0.1$ $Io = 0.1$ A sekunder

1204 : 3V0>, load voltage unbalance $Vo := 20$ $Vo = 20$ V sekunder

1207A : 3I0>Iphmax $IoIph := 0.1$ $IoIph = 0.1$ V sekunder

3.1.4 Paramaterblock 13xx: 21 Distance Zones Quadrilateral $In := 1$ A

Rod insulator length $Larc := 7.5$ m

Arc current $Iarc := 2500$ A

Resistansi tahanan kaki tower diasumsikan 10 Ohm

Foot resistance of tower (Rfoot) $Rfoot := 10$ Ohm

Arc resistance $Rarc1 := \frac{28700 \cdot Larc}{Iarc^{1.4}}$ $Rarc1 = 3.766$ Ω primer

Rarc dipilih 0, bila nilai Rarc ≥ dari RL11

$Rarc := Rarc1 \cdot (|Rarc1| < |RL11|) + 0 \cdot (|RL11| < |Rarc1|)$ dipilih : $Rarc = 3.766$

Group Zone1 settings :

1301 : Op. mode Z1 = Forward

1302 : R (Z1) $RZ1P := [(0.8RL11) + (0.5 \cdot Rarc)]$ $RZ1P = 8.453$ Ω (Primer)

$RZ1 := RZ1P \cdot n1$ $|RZ1| = 8.453$ Ω (Sekunder)

1303 : X (Z1) $XZ1P := 0.8XL11$ $XZ1P = 19.022$ Ω (Primer)

$XZ1 := XZ1P \cdot n1$ $|XZ1| = 19.022$ Ω (Sekunder)

$Z1P := (RZ1P + j \cdot XZ1P)$ $|Z1P| = 20.816$

Setting Zone-1 terhadap Z line adalah

$Z1\% := \frac{|Z1P|}{|ZL11|} \cdot 100$ %

$|ZL11| = 25.156$

$Z1\% = 82.746$ %

1302 : RG (Z1)

$RGZ1P := [(0.8RL11) + Rfoot + Rarc]$ $RGZ1P = 20.336\ \Omega$ (Primer)

$RGZ1 := RGZ1P \cdot n1$ $|RGZ1| = 20.33\ \Omega$ (Sekunder)

Group Zone1B settings

1351 : Op. mode Z1B = Forward

1352 : R (Z1B) $Iinfeed := 1$

$RZ1BP := [0.8 \cdot (RL11 + 0.8 \cdot RL21 \cdot Iinfeed) - (0.5 \cdot Rarc)]$ $RZ1BP = 9.219\ \Omega$ (Primer)

$RZ1B := RZ1BP \cdot n1$ $|RZ1B| = 9.219\ \Omega$ (Sekunder)

1353 : X (Z1B)

$XZ1BPmin := 1.2 \cdot XL11$ $XZ1BPmin = 28.533\ \Omega$ (Primer)

$XZ1BPmax1 := 0.8 \cdot (XL11 + 0.8 \cdot XL21 \cdot Iinfeed)$ $XZ1BPmax1 = 24.647\ \Omega$ (Primer)

$XZ1BPmax2 := 0.8 \cdot (XL11 + 0.5 \cdot XT1 \cdot Iinfeed)$ $XZ1BPmax2 = 37.619\ \Omega$ (Primer)

Dipilih Zone 1B terbesar tetapi tidak lebih besar dari zone 1B trafo

$X21Bmak := XZ1BPmin \cdot (|XZ1BPmin| > |XZ1BPmax1|) + XZ1BPmax1 \cdot (|XZ1BPmax1| > |XZ1BPn$

$X1BP := X21Bmak \cdot (|X21Bmak| < |XZ1BPmax2|) + XZ1BPmax2 \cdot (|XZ1BPmax2| < |X21Bmak|)$

$X1BP = 28.533$ $|X1BP| = 28.533\ \Omega$ (Primer)

$XZ1B := X1BP \cdot n1$ $|XZ1B| = 28.533\ \Omega$ (Sekunder)

$Z1BP := (RZ1BP + j \cdot X1BP)$ $|Z1BP| = 29.986\ \Omega$ (Primer)

Setting Zone-1B terhadap Z line adalah

$$Z1B\% := \frac{|Z1BP|}{|ZL11|} \cdot 100 \quad \%$$

$Z1B\% = 119.198$ %

1352 : RG (Z1B)

$RGZ1BP := [0.8 \cdot (RL11 + 0.8 \cdot RL21 \cdot Iinfeed) + Rarc + 2 \cdot Rfoot]$ $RGZ1BP = 31.10\ \Omega$ (Primer)

$RGZ1B := RGZ1BP \cdot n1$ $|RGZ1B| = 31.102\ \Omega$ (Sekunder)