MICROPROCESSOR BASED POWER SYSTEM PROTECTION

NUMERICAL RELAYS

1.TRANSMISSION LINES PROTECTION

2.TRANSFORMER

3.BUS-BAR

4.DISTRIBUTION FEEDERS

5.GENERATOR

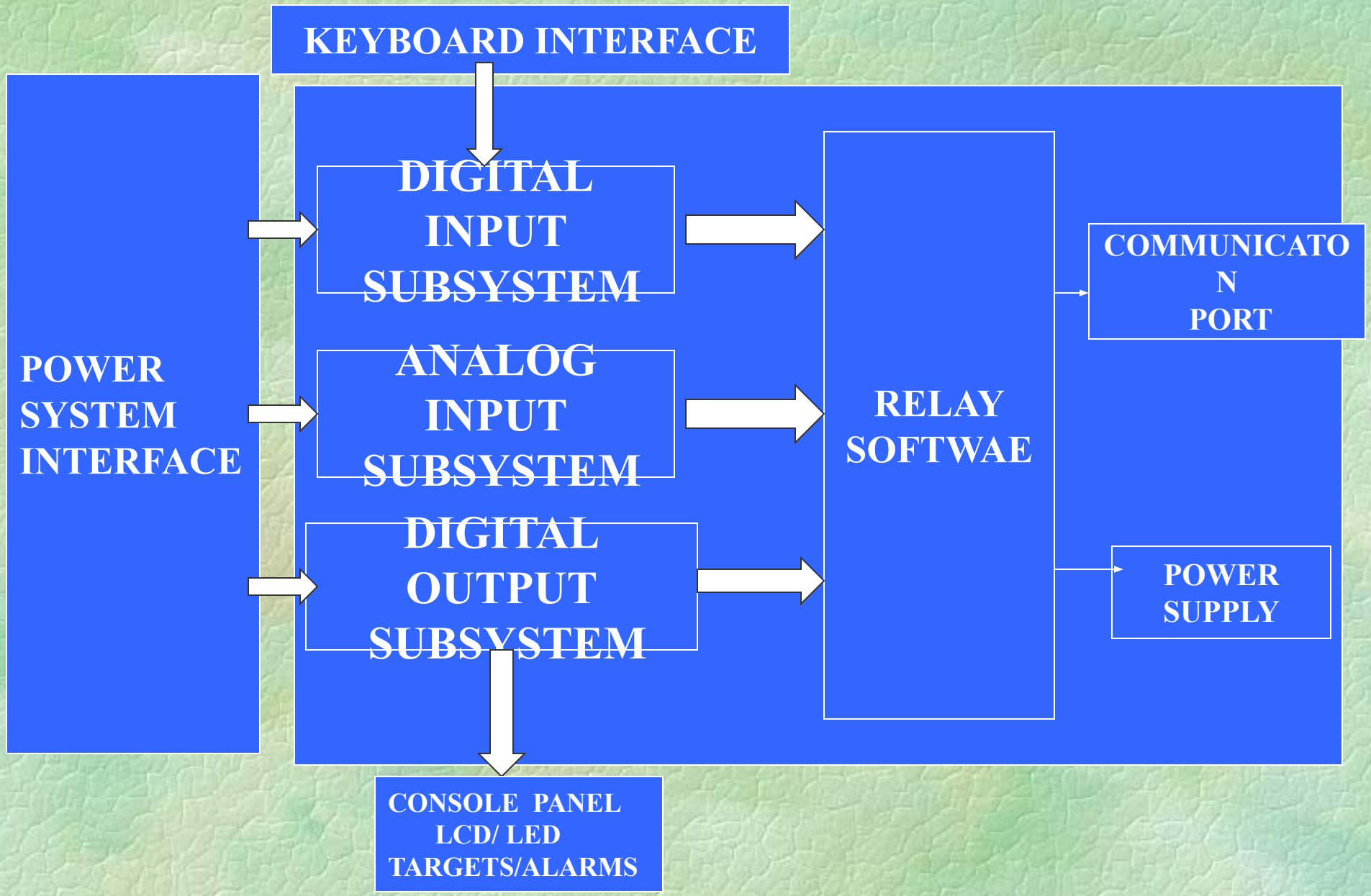
6.MOTOR

DIGITAL RELAYS

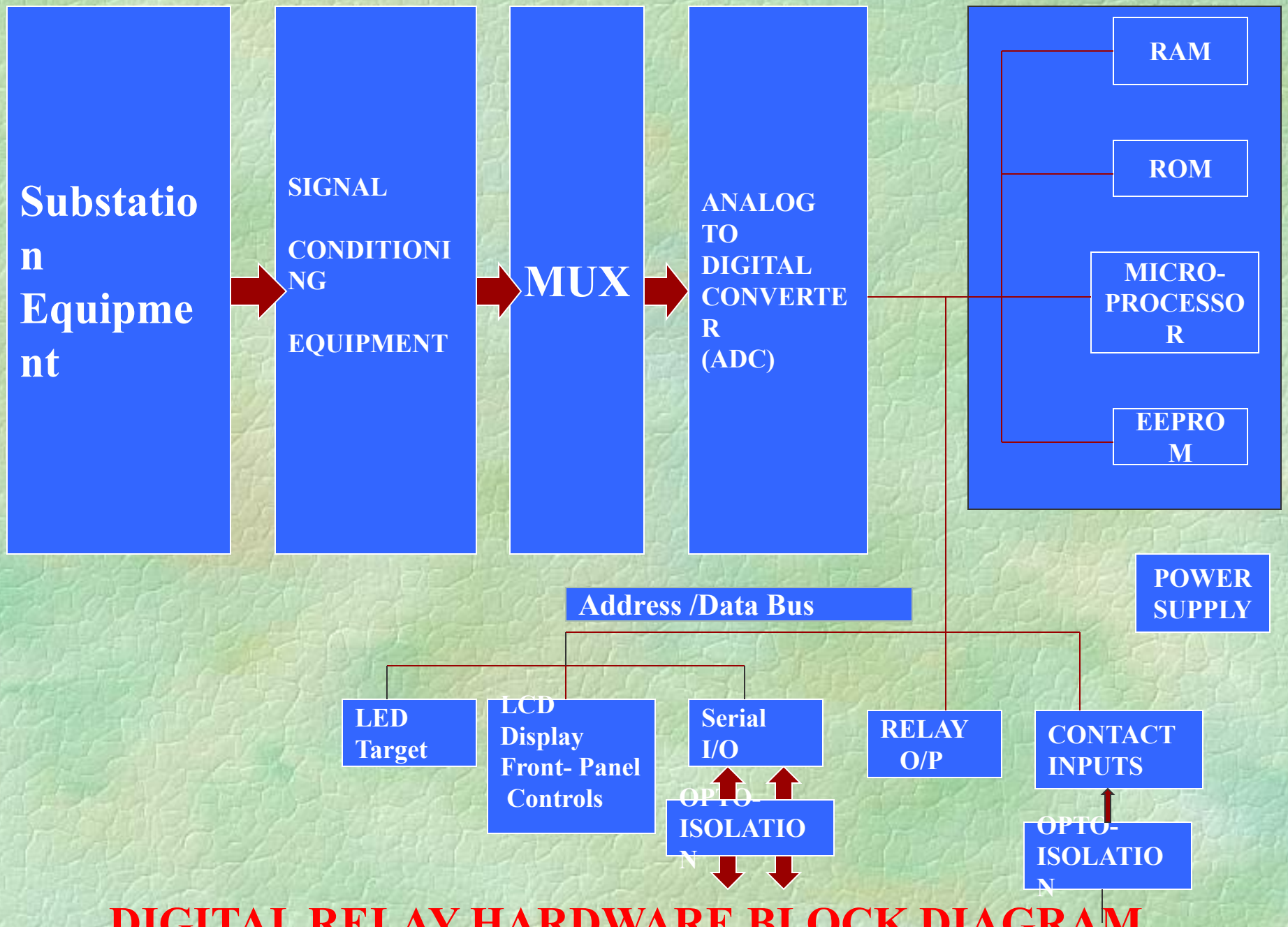
- LOW COST
- MATHEMATICAL CAPABILITY/PROCESSOR BASED
- SELF CHECKING
- LOW CT/PT BURDEN
- METERING
- FAULT REPORT
  - FAULT- LOCATION
  - EVENT LOGGING
  - OSCILLOGRAPHY RECORD/FAULT DATA INFORMATION

DIGITAL RELAYS

- STANDARD HARDWARE
- FLEXIBILITY IN OPERATION
- MULTI FUNCTION
- COMMUNICATION
- ADAPTIVE RELAYING
- CONNECTIVITY WITH SCADA
- ADOPTING RTU FUNCTION

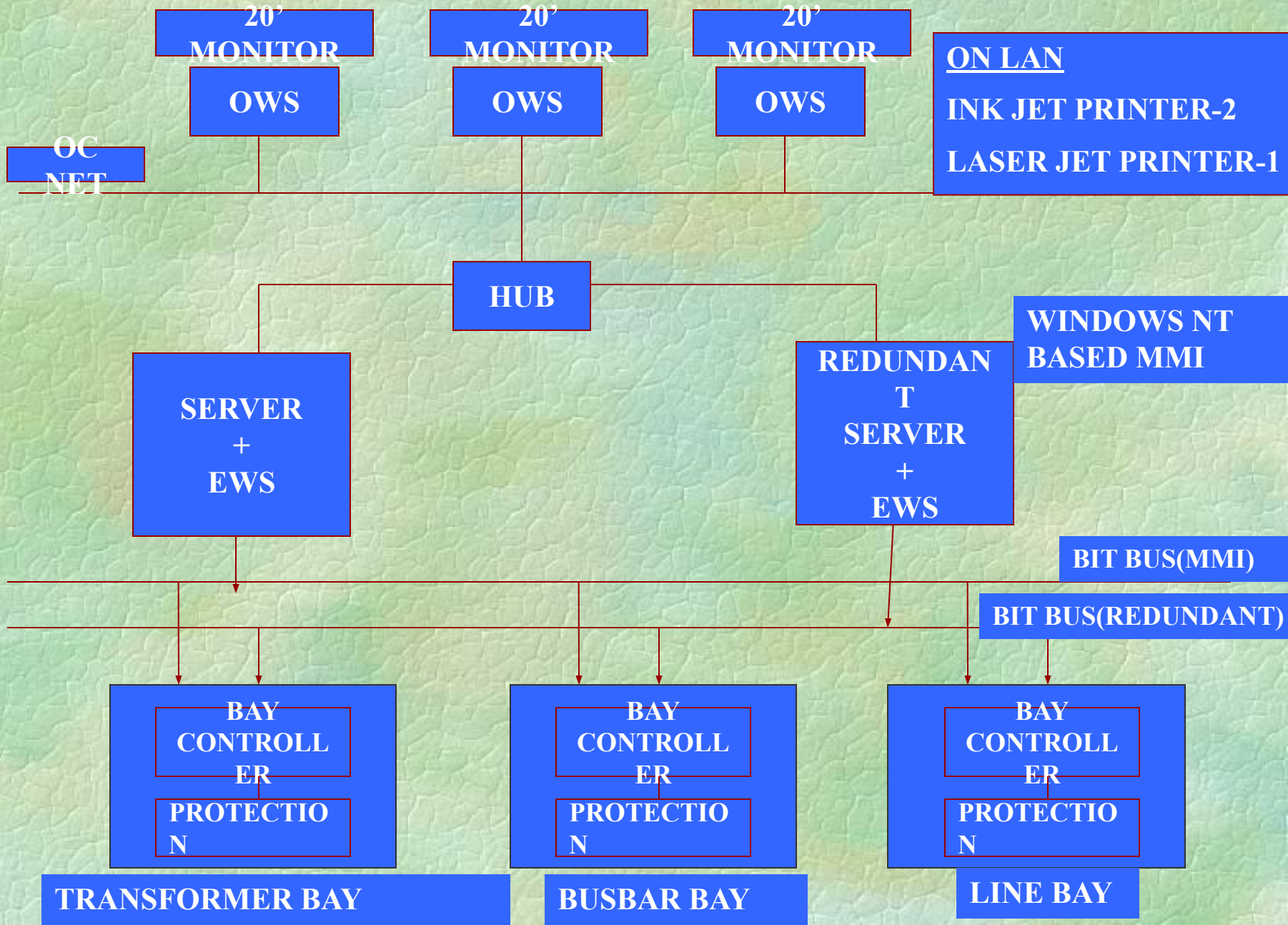


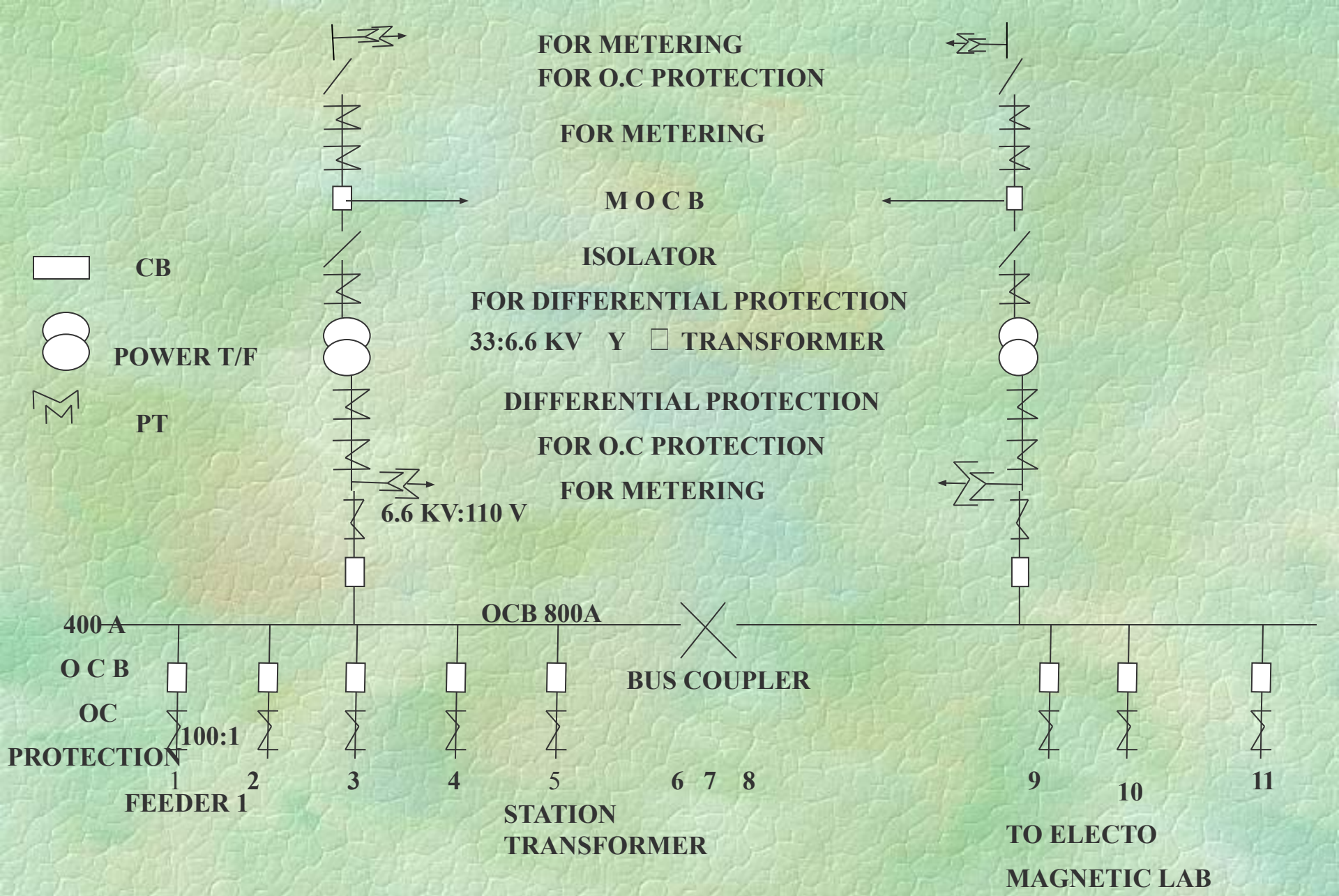
DIGITAL RELAY GENERAL BLOCK DIAGRAM



DIGITAL RELAY HARDWARE BLOCK DIAGRAM

CONFIGURATION FOR DEMONSTRATION



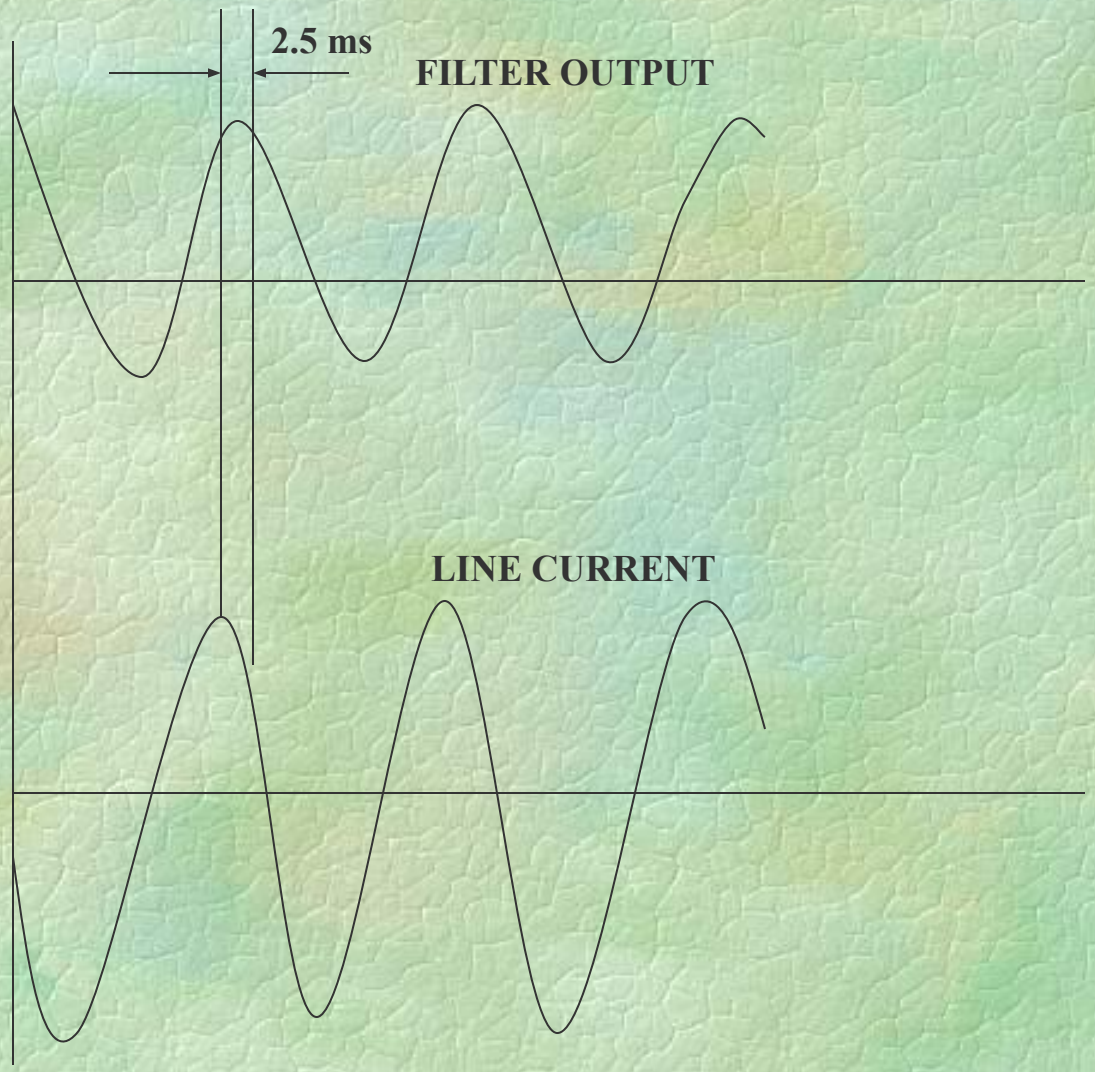


ONE LINE DIAGRAM OF THE DISTRIBUTION SUBSTATION AT

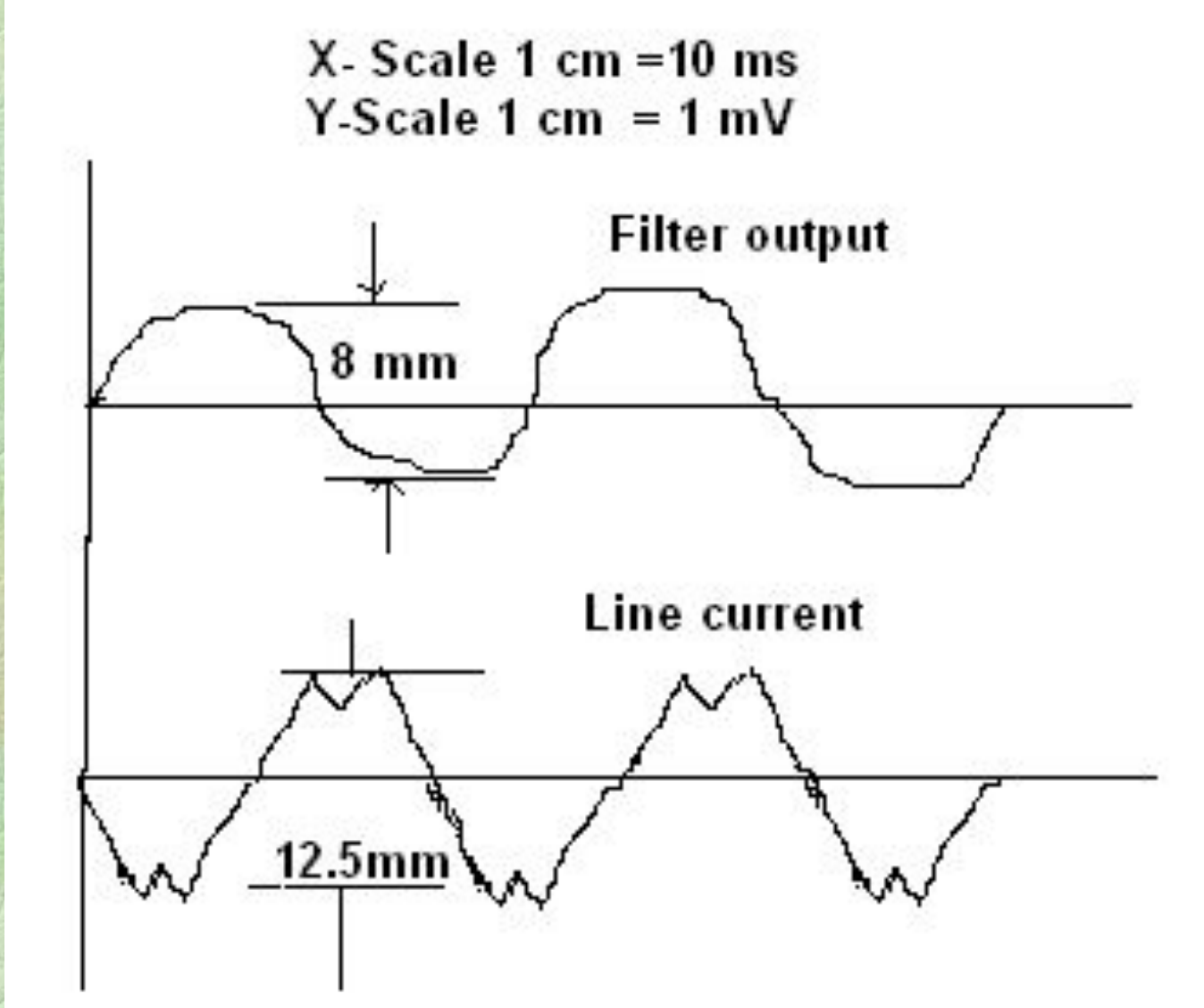
CORP. R & D DIVIN

X-Scale 1cm =10 ms

Y- Scale 1 cm=5 mV



WAVE SHAPE OF CURRENT SIGNAL UNDER LOAD CONDITION



WAVE SHAPE OF CURRENT SIGNAL AT NO LOAD

BASIC ALGORITHMS

1.Man & Morrison

$$I_p^2 = i^2 + \left(\frac{i'}{\omega}\right)^2$$

$$\phi = \tan^{-1}\left(\frac{\omega_i}{i'}\right)$$

$$i_k' = \left(\frac{i_{k+1} - i_{k-1}}{2h}\right)$$

2.RAMA MOORTY

$$Vs = \frac{1}{N}[2\sum_{l=1}^{N-1} V_{k-N+l} Sin(\frac{2\pi l}{N})$$

$$V_c = \frac{1}{N}[V_{k-n} + V_k + 2\sum_{l-1}^{N-1} V_{k-N+1} Cos(\frac{2\pi l}{N})$$

$$V = \sqrt{(V_s^2 + V_c^2}$$

$$\phi_v = \tan^{-1}(\frac{V_c}{V_s})$$

3.Mc Innes & Morrison

$$v = R_{eff}\, i + L_{eff} \frac{di}{dt}$$

$$\begin{bmatrix} v_k \\ v_{k-1} \end{bmatrix} = \left[f(i_k, i_{k-1}) \right] \begin{bmatrix} R_{eff} \\ L_{eff} \end{bmatrix}$$

THE DETAILS OF THE PROTECTION ALGORITHM

OVER CURRENT RELAY TP 51

$$[I_H{}^2 > K_1{}^2]$$

$$[I_L{}^2 > K_2{}^2]$$

UNDER VOLTAGE RELAY B27

$$V_{AB}{}^2 < K_3{}^2 \quad , V_{AB}{}^{(t)} = V_A(t) - V_B(t)$$

RATIO DIFFERENTIAL RELAY B 87

$$\{I_s{}^2 - K_4{}^2.\mathrm{MAX}.(I_1{}^2, I_2{}^2)\} > K_5{}^2$$

$$I_t{}^2 < K_s{}^2$$

$$I_s(t) = \sum_{n=1}^{7} i_n(t);$$

$$i_t(t) = \sum_{n=2}^{7} i_n(t)$$

PROTEC – BR
Numerical Feeder Protection Relay

PROTEC-BR is a microprocessor based multifunction numeric relay for a distribution substation feeder.

FUNCTIONS:

Three phase o/c relay	50 / 51
Earthfault relay	50N / 51N
Thermal Overload relay	49
Undercurrent protection	37
Circuit Breaker failure Detection	50 BF
Cold load pickup	
Latching output contacts	86
Setting groups	2
Blocking logic	
Event recording & Metering	

FEATURES

Applicable to substations of various types and ratings
Compact rack
User configurable protection scheme
Online display of parameters and variables
Powerful self diagnostics and failsafe mode of operation
Can be powered with 110 / 220 V dc from station batteries
CPRI certification as per IEC-60255 standards

AUTORECLOSER RELAY

PROTECTION FUNCTIONS

- THREE PHASE O/C WITH SELECTABLE IDMT/DEFINITE TIME CHARACTERISTICS
- EARTH FAULT WITH SELECTABLE IDMT / DEFINITE TIME CHARACTERISTICS
- COLD LOAD PICKUP LOGIC
- CIRCUIT BREAKER FAILURE
- BROKEN CONDUCTOR

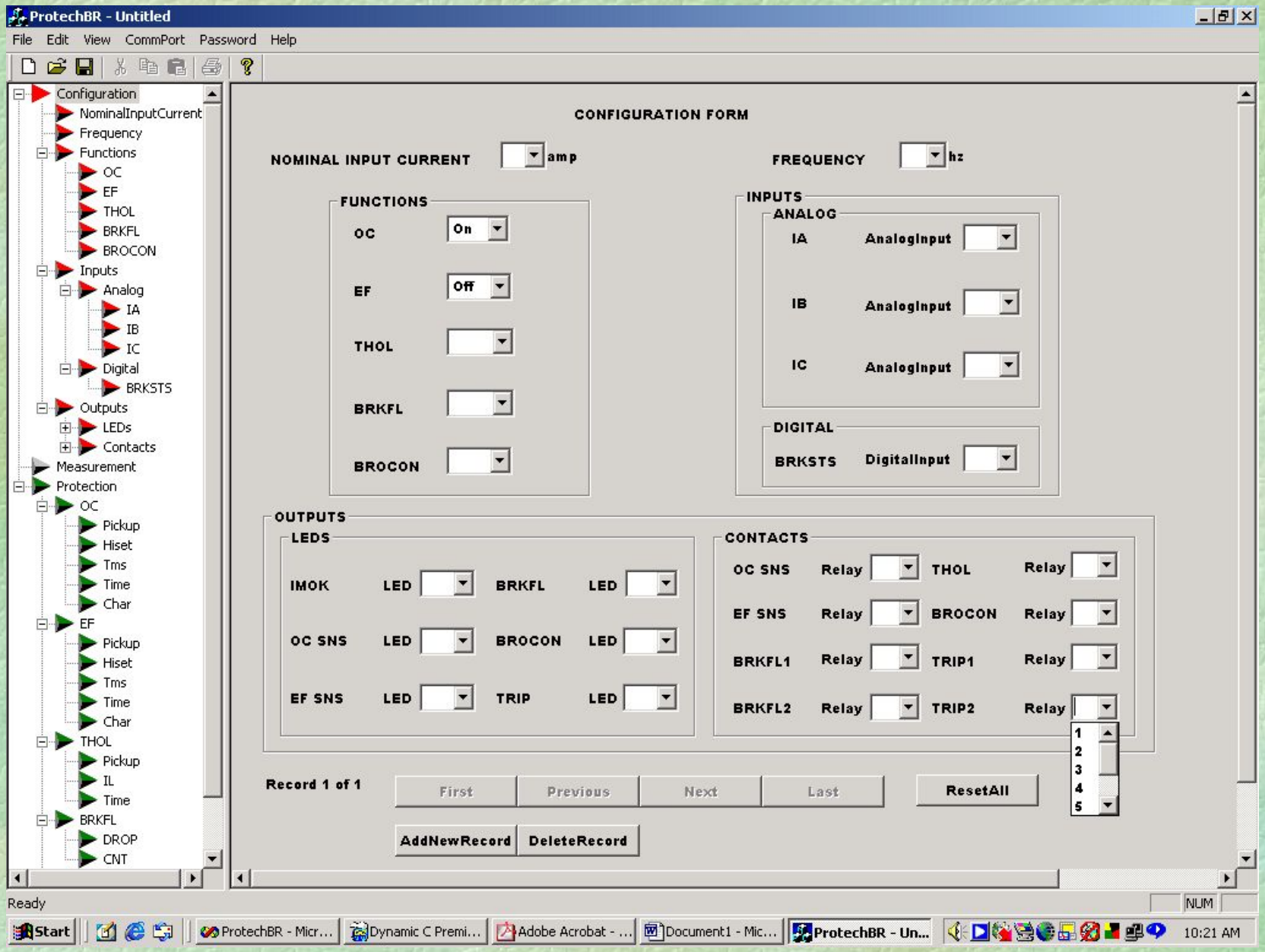
CONTROL FUNCTIONS

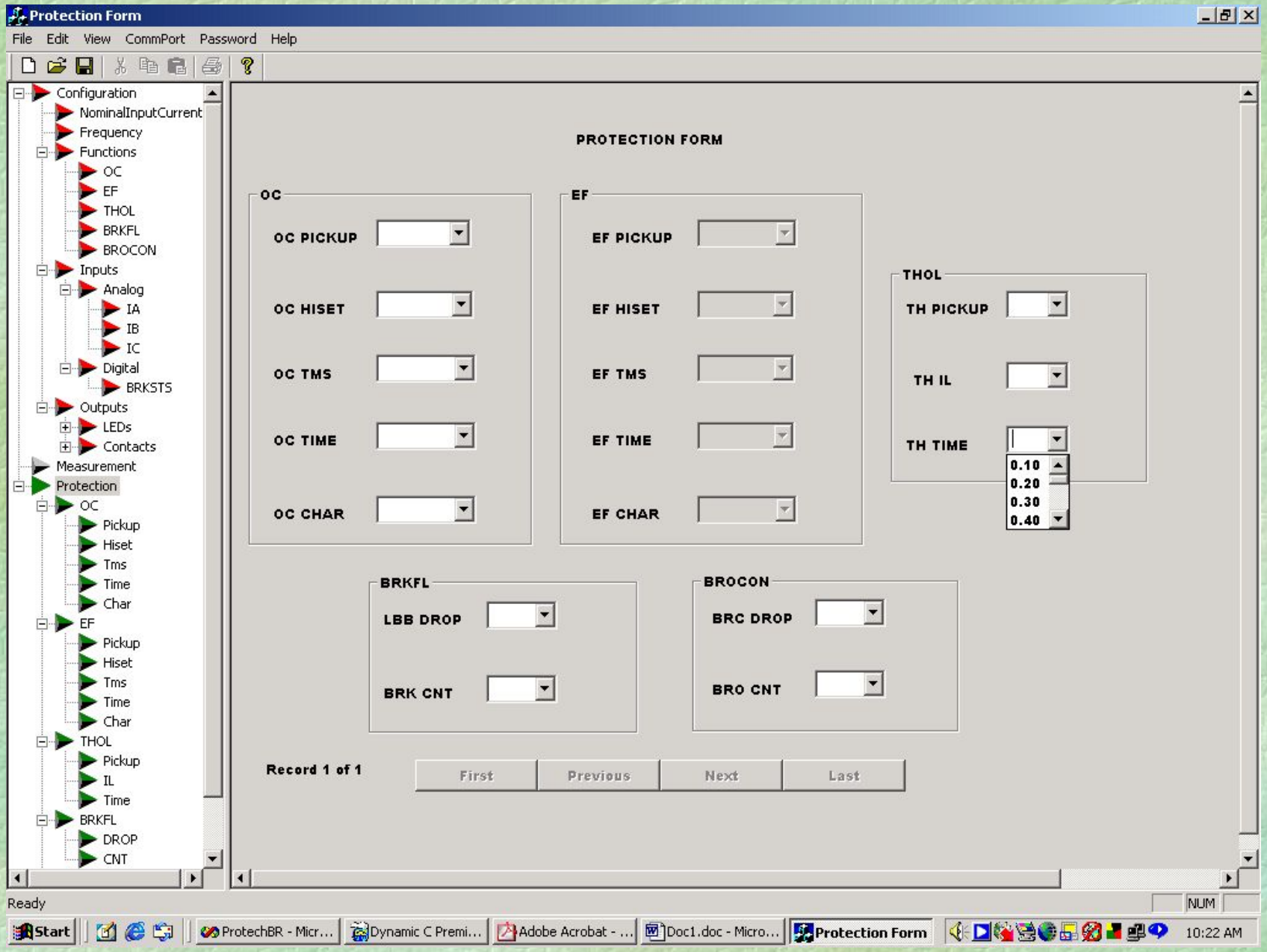
- MULTI-SHOT (4) AUTORECLOSER
- EACH SHOT IS INDEPENDENTLY PROGRAMABLE
- CIRCUIT BREAKER CONTROL TWO SETTING GROUPS

Numerical Motor Protection Relay

FEATURES

- Locked Rotor Protection based on impedance measurement
- Three phase o/c relay with selectable IDMT /definite time characteristics
- Earth fault relay with selectable IDMT / definite time characteristics
- Negative sequence relay
- Thermal Overload protection
- Wide setting range
- Suitable for medium and large motors


ProtechBR - Untitled
File Edit View CommPort Password Help
Configuration
NominalInputCurrent
Frequency
Functions
OC
EF
THOL
BRKFL
BROCON
Inputs
Analog
IA
IB
IC
Digital
BRKSTS
Outputs
LEDs
Contacts
Measurement
Protection
OC
Pickup
Hiset
Tms
Time
Char
EF
Pickup
Hiset
Tms
Time
Char
THOL
Pickup
IL
Time
BRKFL
DROP
CNT
CONFIGURATION FORM
NOMINAL INPUT CURRENT
amp
FREQUENCY
hz
FUNCTIONS
OC
On
EF
Off
THOL
BRKFL
BROCON
INPUTS
ANALOG
IA AnalogInput
IB AnalogInput
IC AnalogInput
DIGITAL
BRKSTS DigitalInput
OUTPUTS
LEDS
IMOK LED
BRKFL LED
OC SNS LED
BROCON LED
EF SNS LED
TRIP LED
CONTACTS
OC SNS Relay
THOL Relay
EF SNS Relay
BROCON Relay
BRKFL1 Relay
TRIP1 Relay
BRKFL2 Relay
TRIP2 Relay
1
2
3
4
5
Record 1 of 1
First
Previous
Next
Last
ResetAll
AddNewRecord
DeleteRecord
Ready
NUM
Start
ProtechBR - Micr...
Dynamic C Premi...
Adobe Acrobat - ...
Document1 - Mic...
ProtechBR - Un...
10:21 AM


Protection Form
File Edit View CommPort Password Help
Configuration
NominalInputCurrent
Frequency
Functions
OC
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Pickup
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Time
Char
THOL
Pickup
IL
Time
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DROP
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PROTECTION FORM
OC
OC PICKUP
OC HISET
OC TMS
OC TIME
OC CHAR
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EF PICKUP
EF HISET
EF TMS
EF TIME
EF CHAR
THOL
TH PICKUP
TH IL
TH TIME
0.10
0.20
0.30
0.40
BRKFL
LBB DROP
BRK CNT
BROCON
BRC DROP
BRO CNT
Record 1 of 1
First
Previous
Next
Last
Ready
NUM
Start
ProtechBR - Micr...
Dynamic C Premi...
Adobe Acrobat - ...
Doc1.doc - Micro...
Protection Form
10:22 AM


SWG 007
SWG 006
SWG 005
INCOMER - II

PROTEC – NR

NUMERICAL LINE PROTECTION RELAY

PROTEC-NR IS A MICROPROCESSOR BASED MULTIFUNCTION NUMERIC RELAY TO PROVIDE DISTANCE PROTECTION FOR TRANSMISSION LINES

PROTECTION FUNCTIONS

DISTANCE RELAY (PHASE TO GROUND)	21 G
DISTANCE RELAY (PHASE TO PHASE)	21 P
THREE PHASE DIR. OVERCURRENT	67 P
DIRECTIONAL EARTH FAULT	67 N
THREE PHASE OVERVOLTAGE	59
THREE PHASE UNDERVOLTAGE	27

AUTORECLOSER WITH VOLTAGE

AND PHASE CHECK SYNCHRONIZATION

CERTIFICATION AT CPRI (As per IEC 60255 Std.)

1.Accuracy Test

2. 1MHz Burst Disturbance test

3.Insulation Test

4.Mechanical Endurance Test

5.Making and Breaking Capacity

6.Thermal Over Load Test

7.Auxiliary Voltage Variation Test

8.Stability Test

9.Overshoot Test

DESIGN AND DEVELOPMENT OF FILTE BANK PROTECTION FOR NATIONAL HVDC PROJECT

ADVANTAGES

- INTERCONNECTION OF TWO SYSTEM AT DIFFERENT FREQUENCY
- FLEXIBILITY IN CONTROL OF POWER FLOW
- REDUCED TRANSMISSION LOSSES
- DAMPINS OUT OSCILLATIONS AND IMPROVE STABILITY MARGINS
- REDUCED CONDUCTOR SIZE AND RIGHT OF WAY
- REDUCED CORONA AND RADIO INTER-FERENCE
- LIMITING TRANSFER OF FAULT CURRENT

NHVDC PROJECT USES ONE CIRCUIT OF EXISTING DOUBLE CIRCUIT 220kV AC LINE BETWEEN BARSOOR AND LOWER SILERU

FIRST STAGE

100kV, 100MW POWER IN THE MONO POLAR MODE USING EARTH RETURN

SECOND STAGE

± 220kV WITH OPERATION IN THE BIPOLAR MODE WITH A TRANSMISSION CAPABILITY OF 400 MW.

MAIN EQUIPMENTS OF NHVDC PROJECT

* TWO SERIES CONNECTED 12 PULSE CONVERTERS CONSISTING OF VALUES AND CONVERTER TRANSFORMER
* SMOOTHING REACTOR IN THE DC CIRCUIT TO REDUCE HARMONIC CURRENT AND TRANSIENT O/C
* FILTERS ON THE AC SIDE AND ON THE DC SIDE ALSO TO BY PASS HARMONIC GENERATED AT THE CONVERTERS
* SHUNT CAPACITORS TO COMPLEMENT THE REACTIVE POWER GENERATED
* CONTROL SYSTEM TO GIVE THE DESIGNED OPERATIONAL PERFORMANCE OF THE TRANSMISSION SYSTEM

DETAILS OF FIFTH/SEVENTH HARMONIC FILTER

$\frac{220}{\sqrt{3}}$ KV.RMS

	1	2	3	4	5	6	7	8	9	10	11
1	1.80	1.74	1.78	1.77	1.77	1.76	1.76	1.75	1.74	1.70	1.74
2	1.80	1.78	1.78	1.78	1.79	1.76	1.75	1.74	1.73	1.71	1.63
3	1.80	1.79	1.78	1.77	1.78	1.75	1.75	1.74	1.74	1.76	1.65
4	1.80	1.79	1.78	1.77	1.76	1.75	1.75	1.73	1.73	1.70	1.69
5	1.75	1.76	1.77	1.78	1.78	1.69	1.69	1.68	1.85	1.75	1.75
6	1.76	1.66	1.69	1.87	1.68	1.68	1.69	1.77	1.77	1.76	1.76
7	1.70	1.71	1.72	1.73	1.85	1.71	1.71	1.72	1.69	1.70	1.70
8	1.72	1.72	1.73	1.74	1.[illegible]	1.85	1.84	1.71	1.70	1.81	1.79
9	1.69	1.82	1.66	1.83	1.71	1.80	1.80	1.69	1.69	1.67	1.68
10	1.81	1.82	1.71	1.71	1.67	1.88	1.85	1.64	1.64	1.70	1.71
11	1.85	1.59	1.62	1.67	1.82	1.78	1.81	1.73	1.64	1.70	1.58
12	1.83	1.83	1.68	1.67	1.85	1.74	1.68	1.63	1.80	1.64	1.74

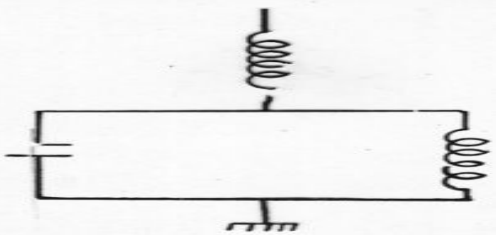


FIG.1. CAPACITORS CONFIGURATION FOR FIFTH/SEVENTH HARMONIC FILTER BANK.

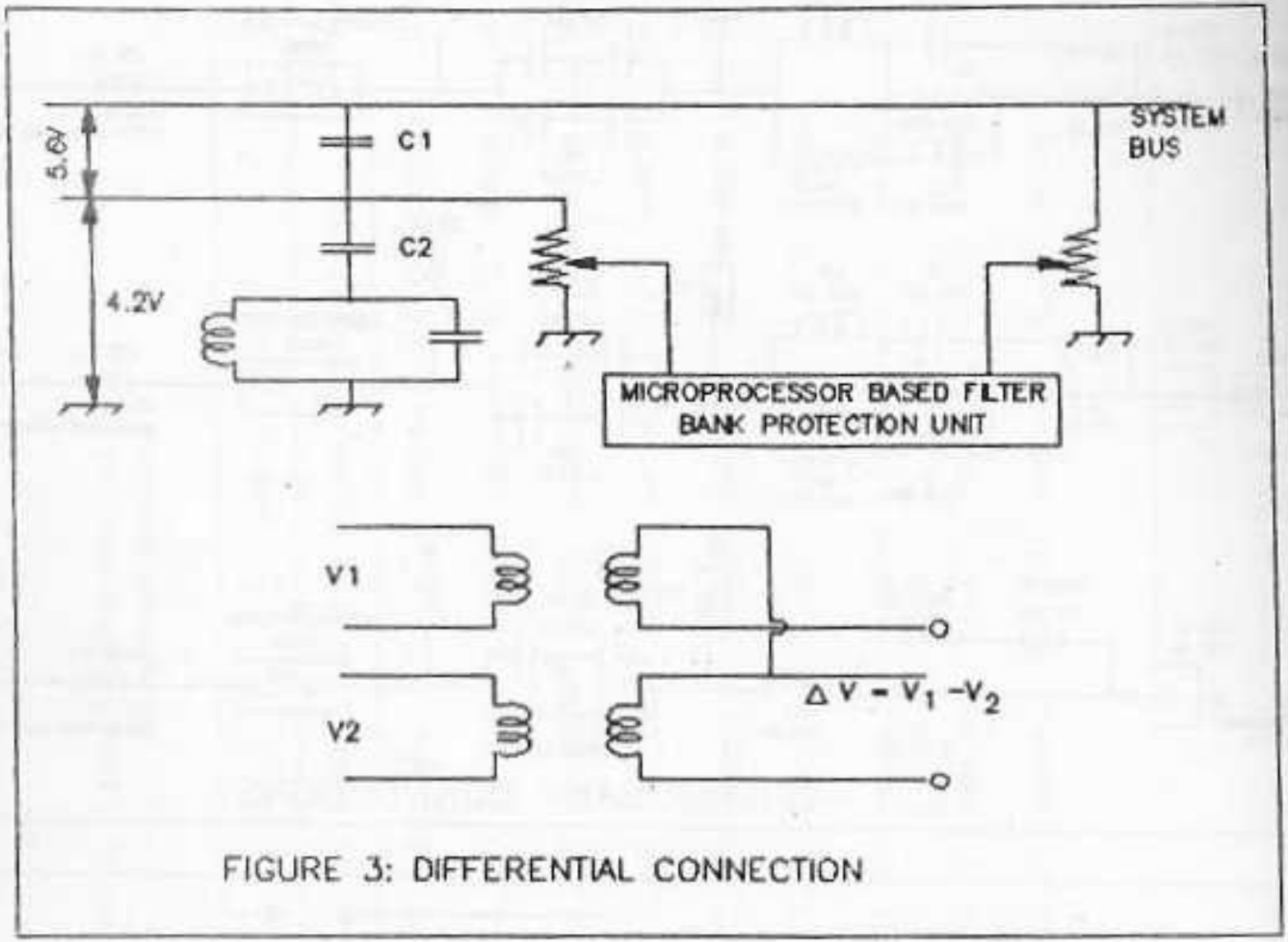


FIGURE 3: DIFFERENTIAL CONNECTION

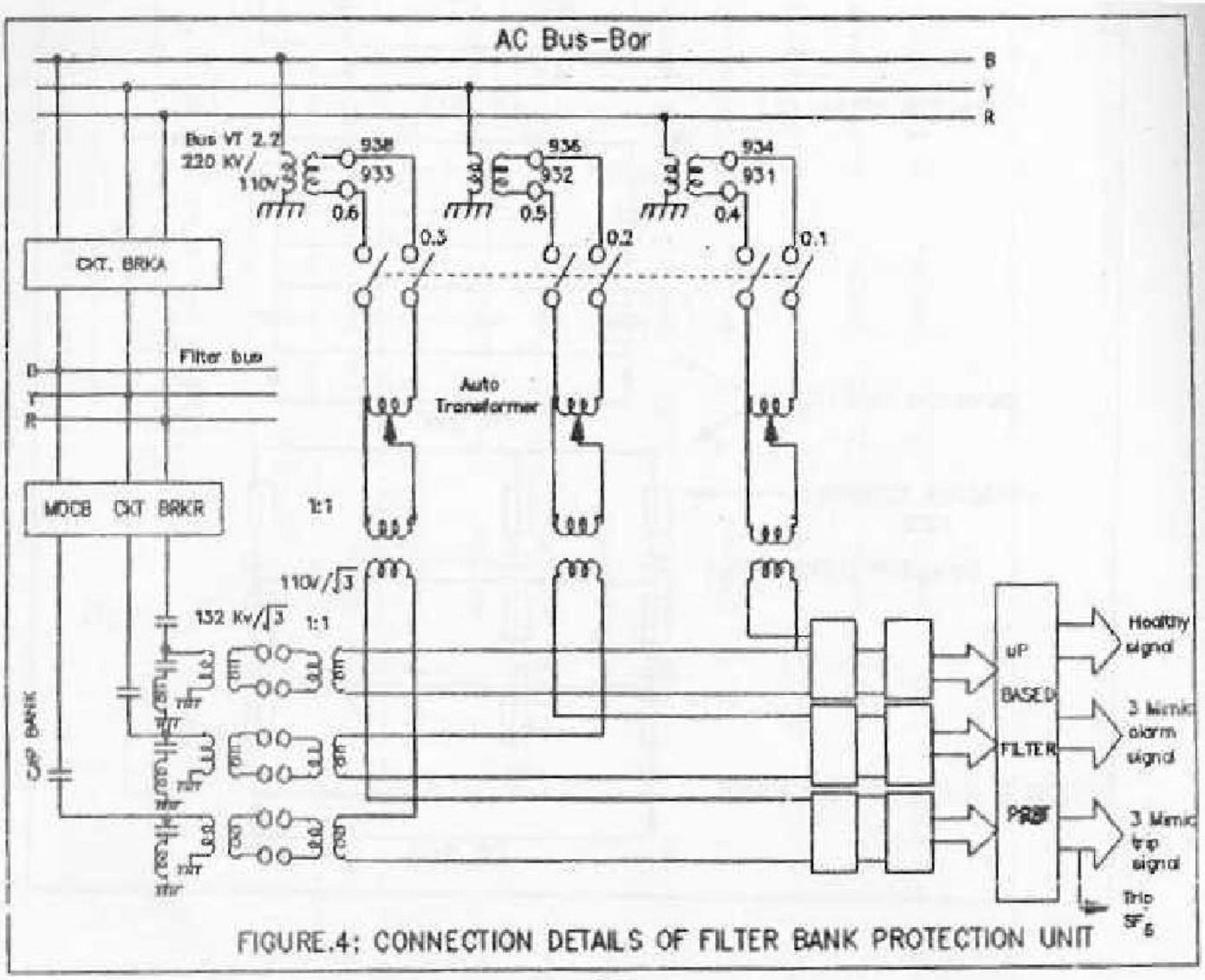
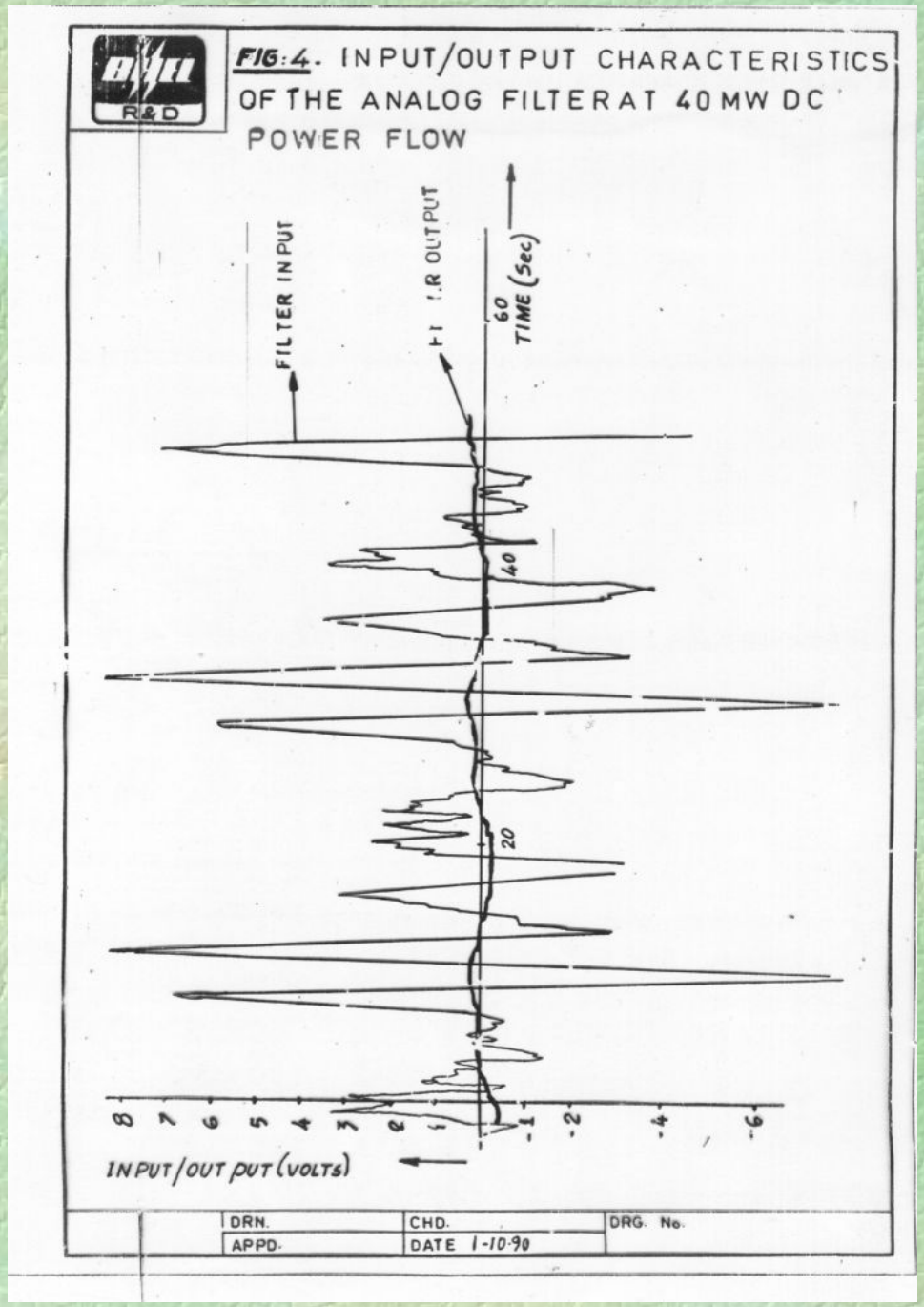
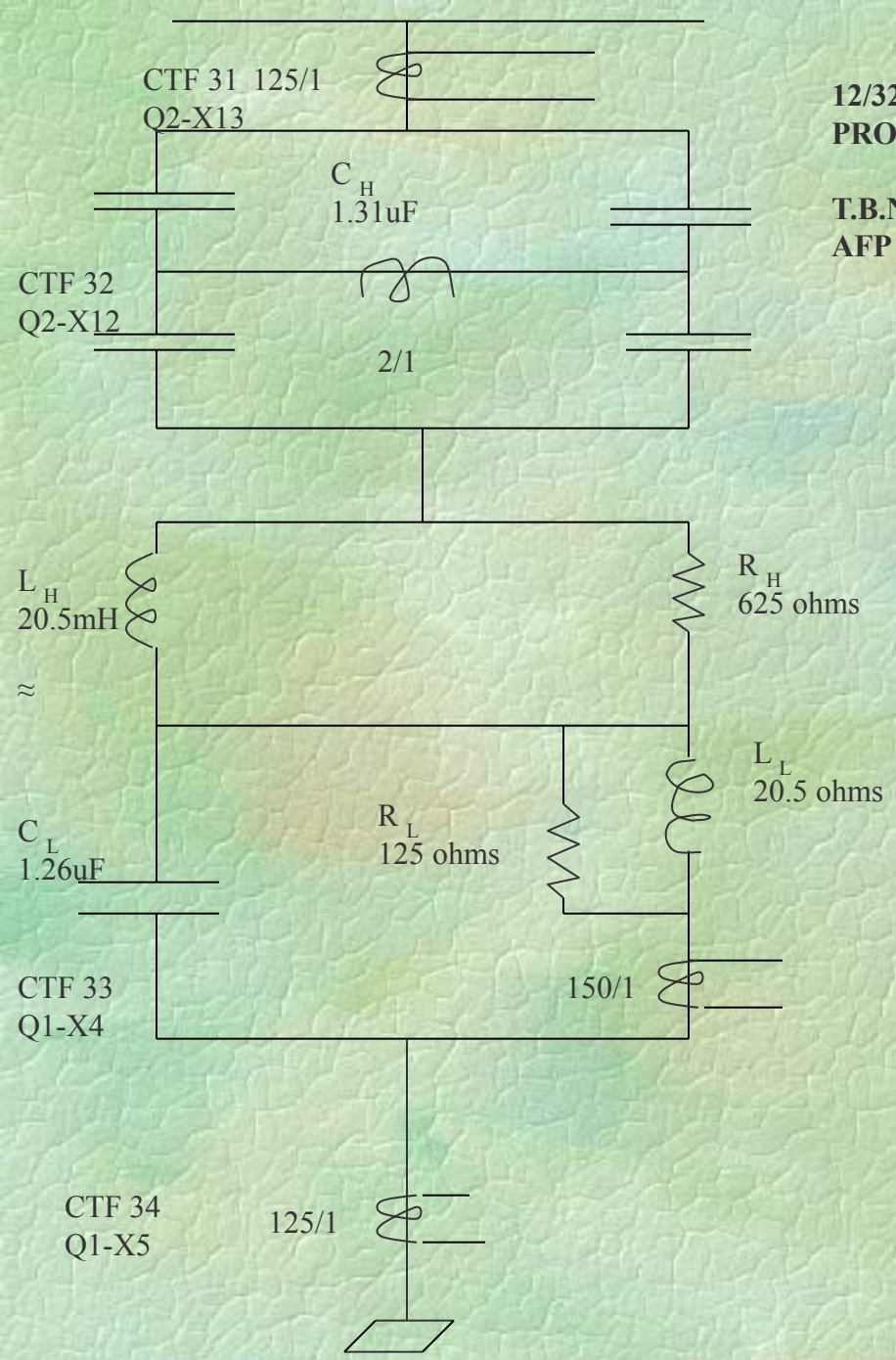


FIGURE.4: CONNECTION DETAILS OF FILTER BANK PROTECTION UNIT


R&D
FIG:4. INPUT/OUTPUT CHARACTERISTICS OF THE ANALOG FILTER AT 40 MW DC POWER FLOW
FILTER INPUT
I.R OUTPUT
60
TIME (Sec)
40
20
8
7
6
5
4
3
2
1
-1
-2
-4
-6
INPUT/OUT PUT (VOLTS)
DRN.
CHD.
DRG. No.
APPD.
DATE 1-10-90



12/32 HARMONIC 20 MVAR FILTER BANK PROTECTION AT NHVDC PROJECT SITE .

(LOWER SILERU)

T.B.No AZ - 14

AFP

Differential Protection:

Alarm : 15 A (pri) / 0.12 A (scy) = 0.348 Vp
at ADC
Trip : 30 A(pri) / 0.24A (scy) = 696 Vp

Capacitor Unbalance Protection:

Alarm : 0.150 A(pri) / 75mA (scy)=0.212 Vp
at ADC
Delayed Trip: 0.124 A(pri) / 107 mA (scy)
≈ 0.302 Vp at ADC
Trip: 0.297 A(pri)≈ 0.1485 A(scy)≈ 0.402 Vp
at ADC
Backup Trip:0.594 A(pri) / 0.297 A(scy)=0.804 Vp
at ADC

Resistor/ Reactor Harmonic overload protecion

Reactor: Alarm – 64.4 A (pri)
Trip 66.0 A (pri)
Alarm 23.0 A (pri)
Resistor Trip 27.0 A (Trip)

Fundamental Frequency Overload Protection

Alarm : 65 A (pri) /0.5 A (scy) =1.47 Vp at ADC
Ktrip : 70 A(pri) /0.55 A(scy) ≈ 1.569 Vp
at ADC
High-set: 80 A(pri)/ 0.65(scy) ≈1.7929 Vp at ADC

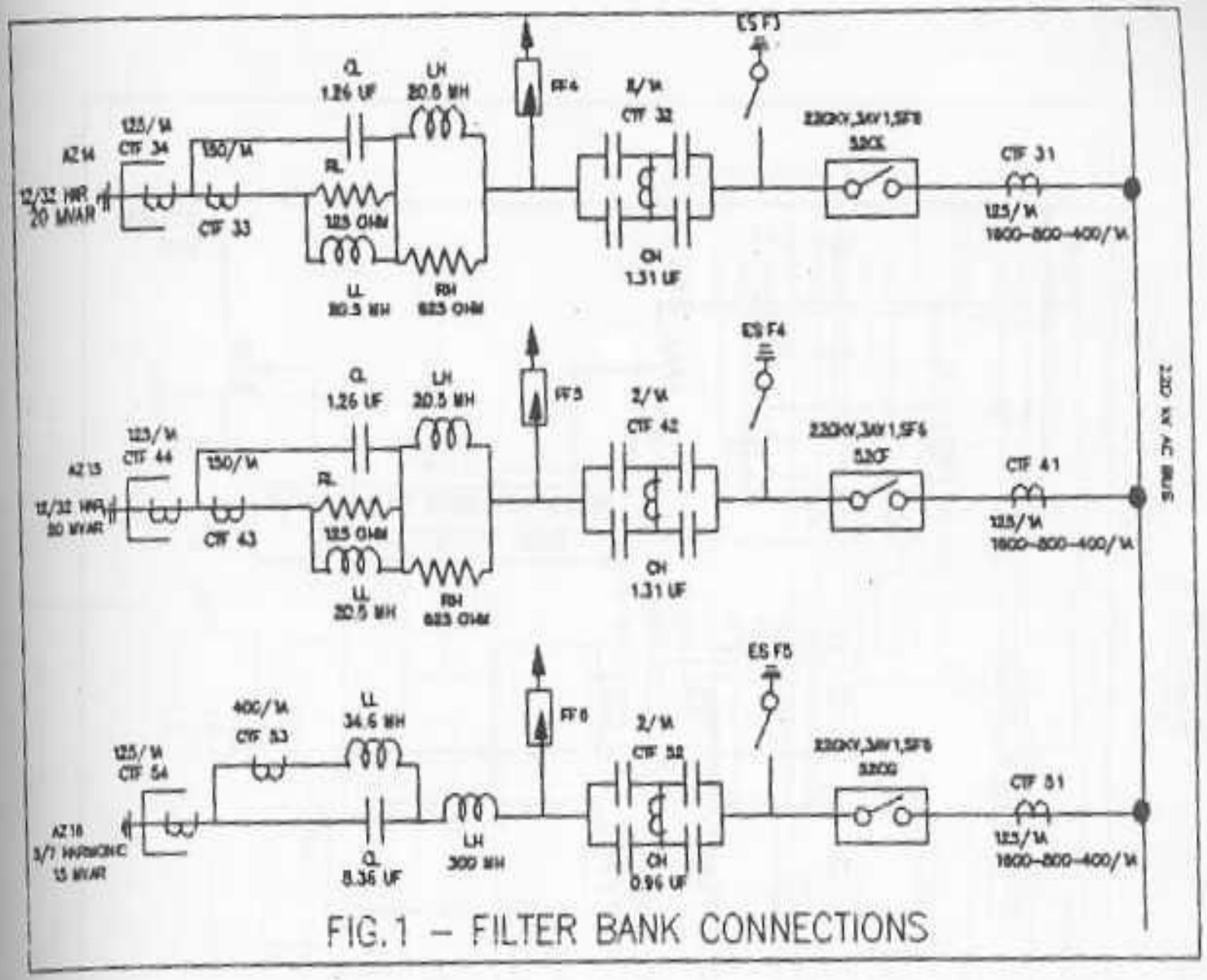
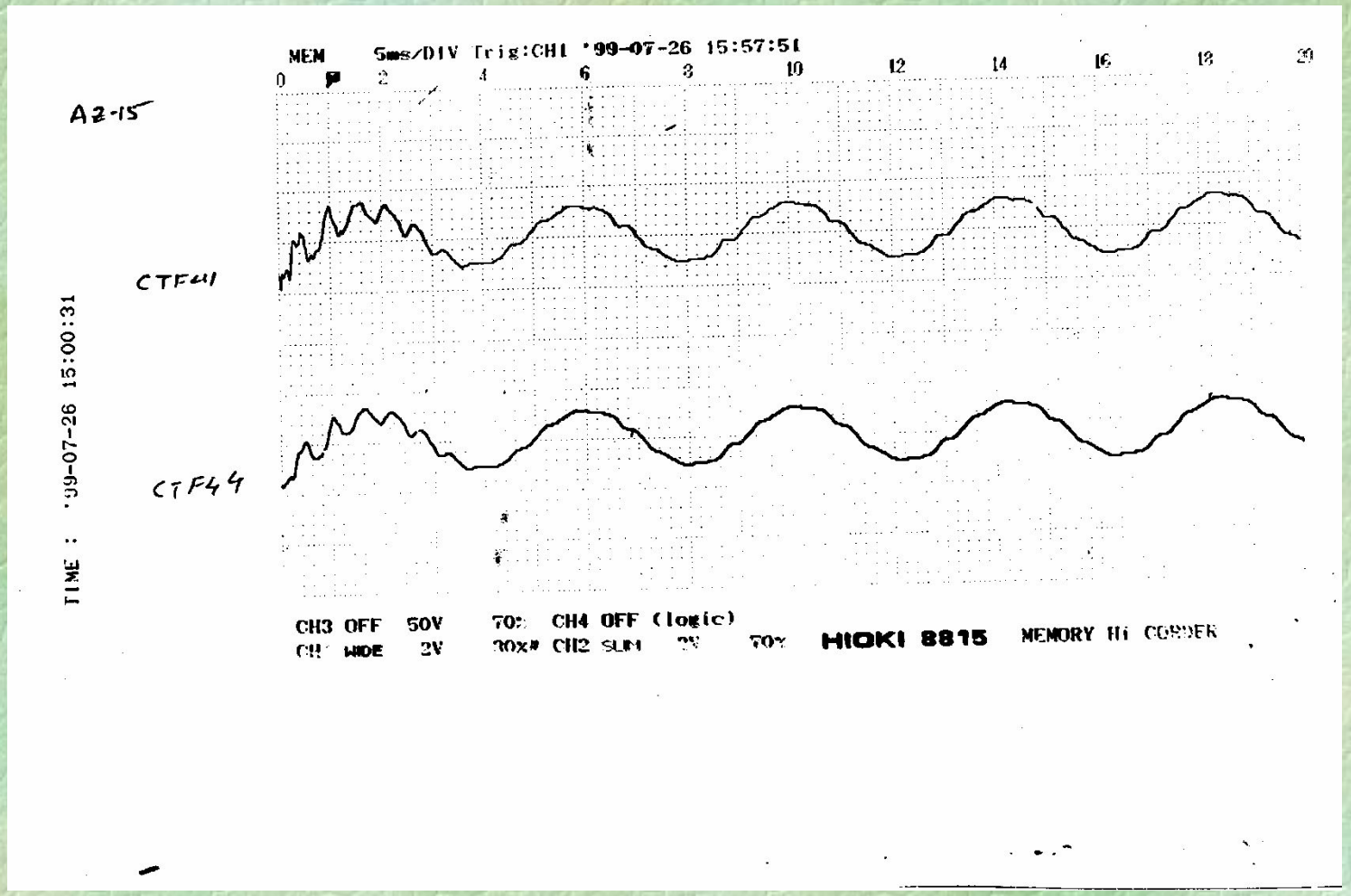
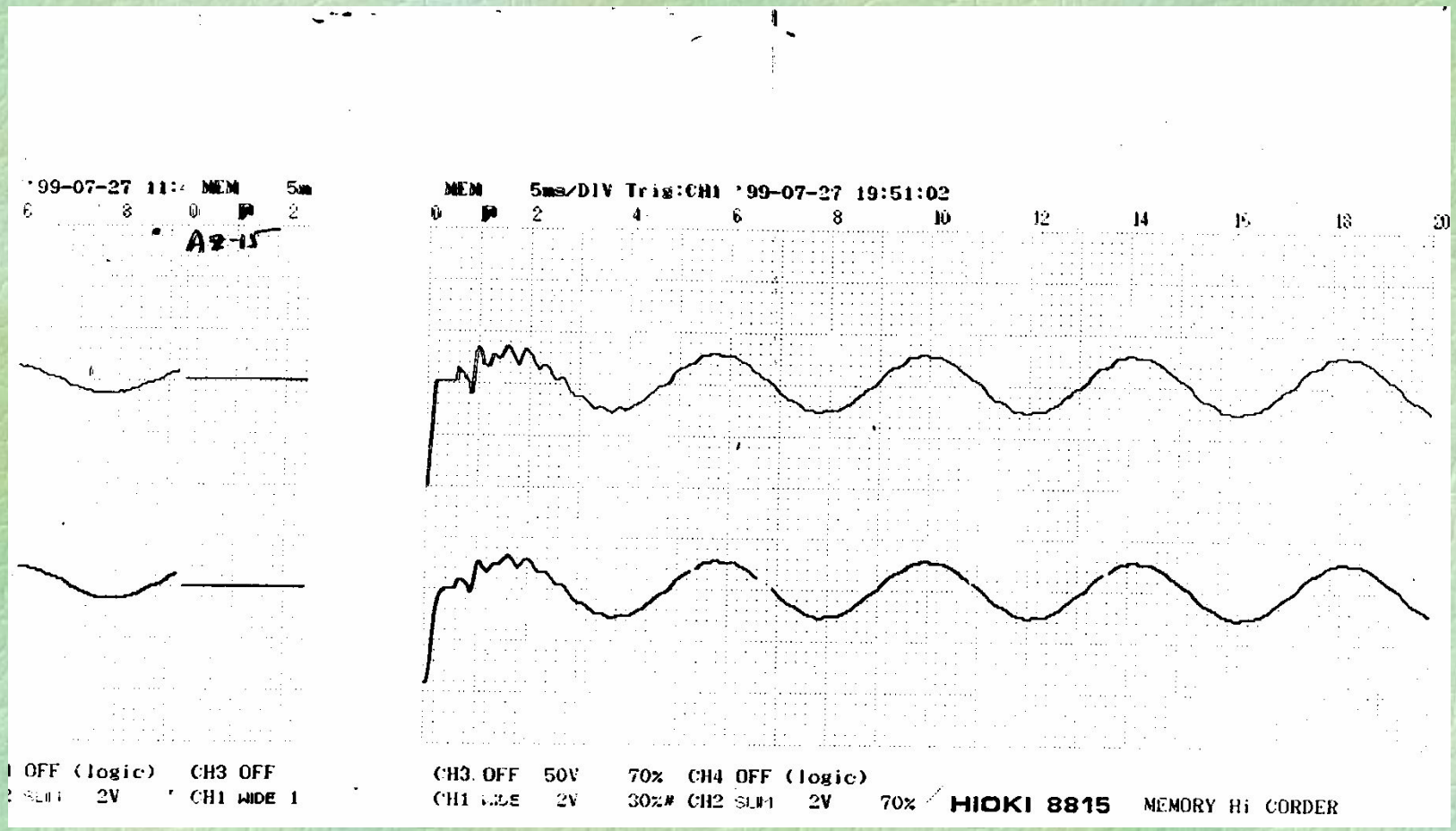


FIG. 1 – FILTER BANK CONNECTIONS

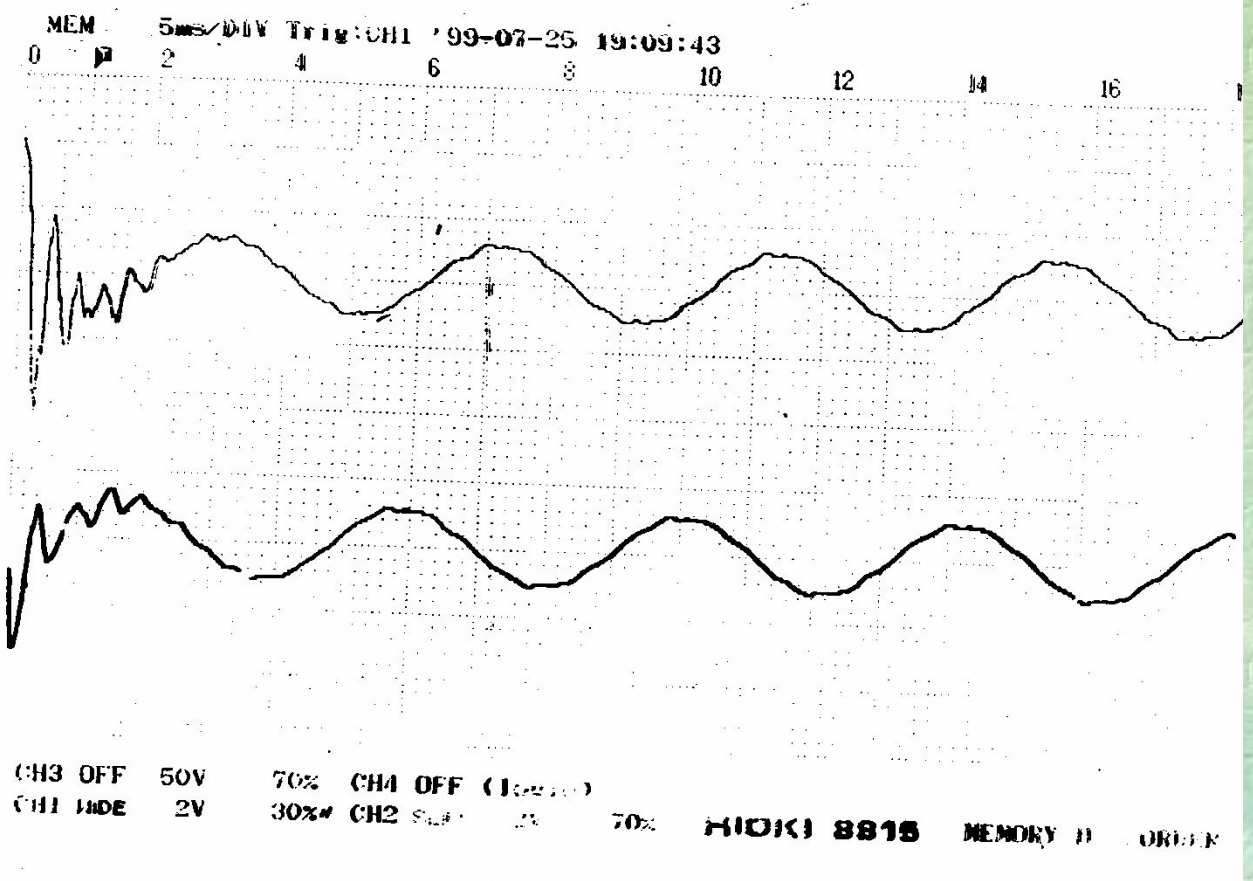

MEM 5ms/DIV Trig:CH1 '99-07-26 15:57:51
0 2 4 6 8 10 12 14 16 18 20
A2-15
CTF41
CTF44
TIME : '99-07-26 15:00:31
CH3 OFF 50V 70% CH4 OFF (logic)
CH1 WIDE 2V 30x# CH2 SLIM 2V 70%
HIOKI 8815 MEMORY Hi COPPER


'99-07-27 11:
MEM 5m
6 8 0 2
A2-15
MEM 5ms/DIV Trig:CH1 '99-07-27 19:51:02
0 2 4 6 8 10 12 14 16 18 20
OFF (logic) CH3 OFF
2V CH1 WIDE 1
CH3 OFF 50V 70% CH4 OFF (logic)
CH1 WIDE 2V 30% CH2 SLIM 2V 70%
HIOKI 8815 MEMORY Hi CORDER

AZ-B

RY

YY



TIME : 99-07-25 19:02:49

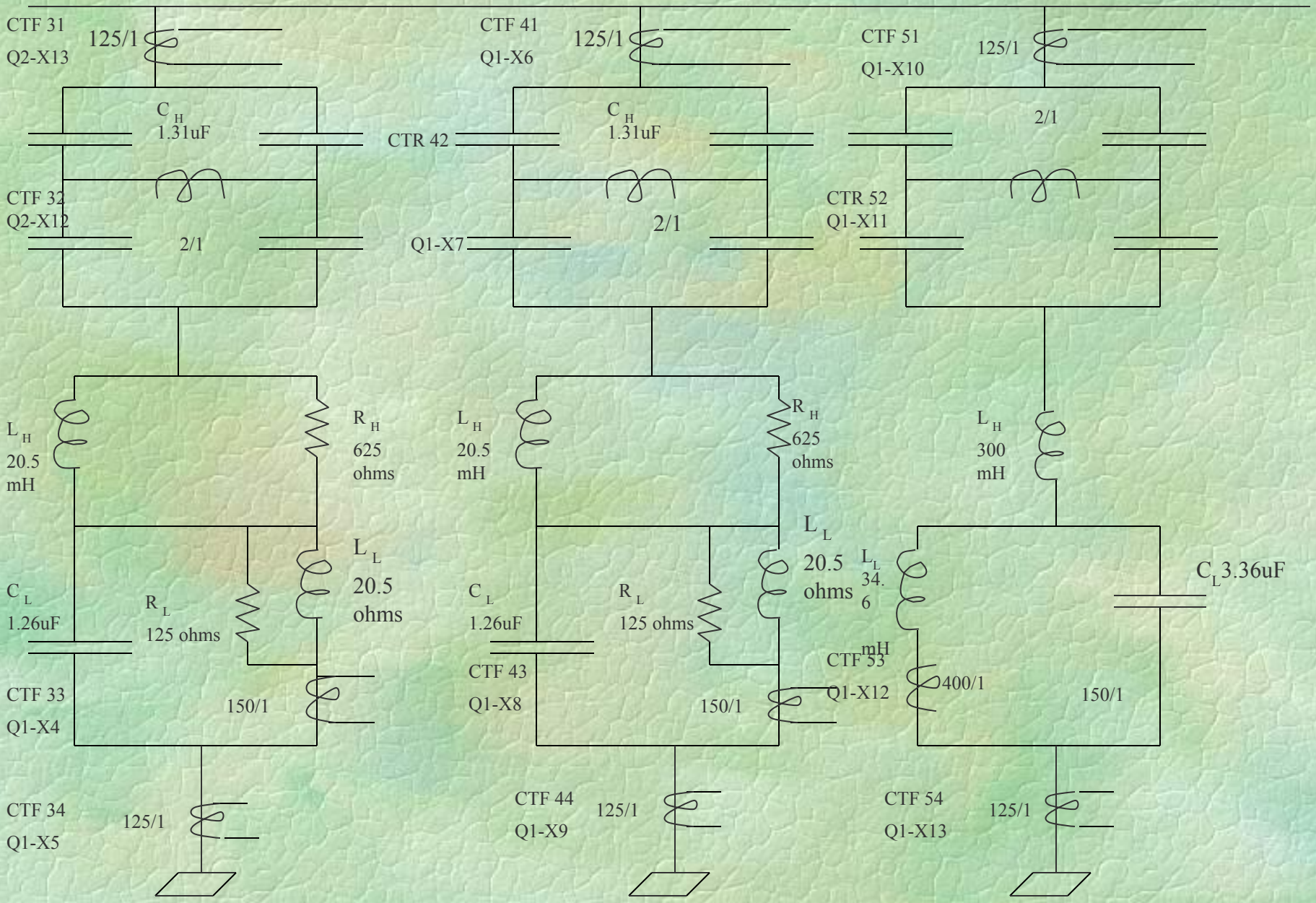
5/7 Filter Bank Current at Various Loads

Harmonic Currents

Power Flow	Fund	Harmonic Currents			
		Third	Fifth	Seventh	11th
30MW	77.9	10	15.8	5.0	---
40MW	75.6	7	22.9	11.2	---
50MW	80.1	15	26.5	12.3	---
60MW	73.8	11.2	34.6	15.6	5.0

HARMONIC CURRENTS AT 100MW

FILTER BANK	Fund	Third	Fifth	Seventh	Eleventh
Third Harmonic	57.4	4.2/5.2	---	---	---
5/7	72.9	---	52.4	28.3	---
HP	44.3	---	---	---	5.2



FILTER BANK CONNECTIONS

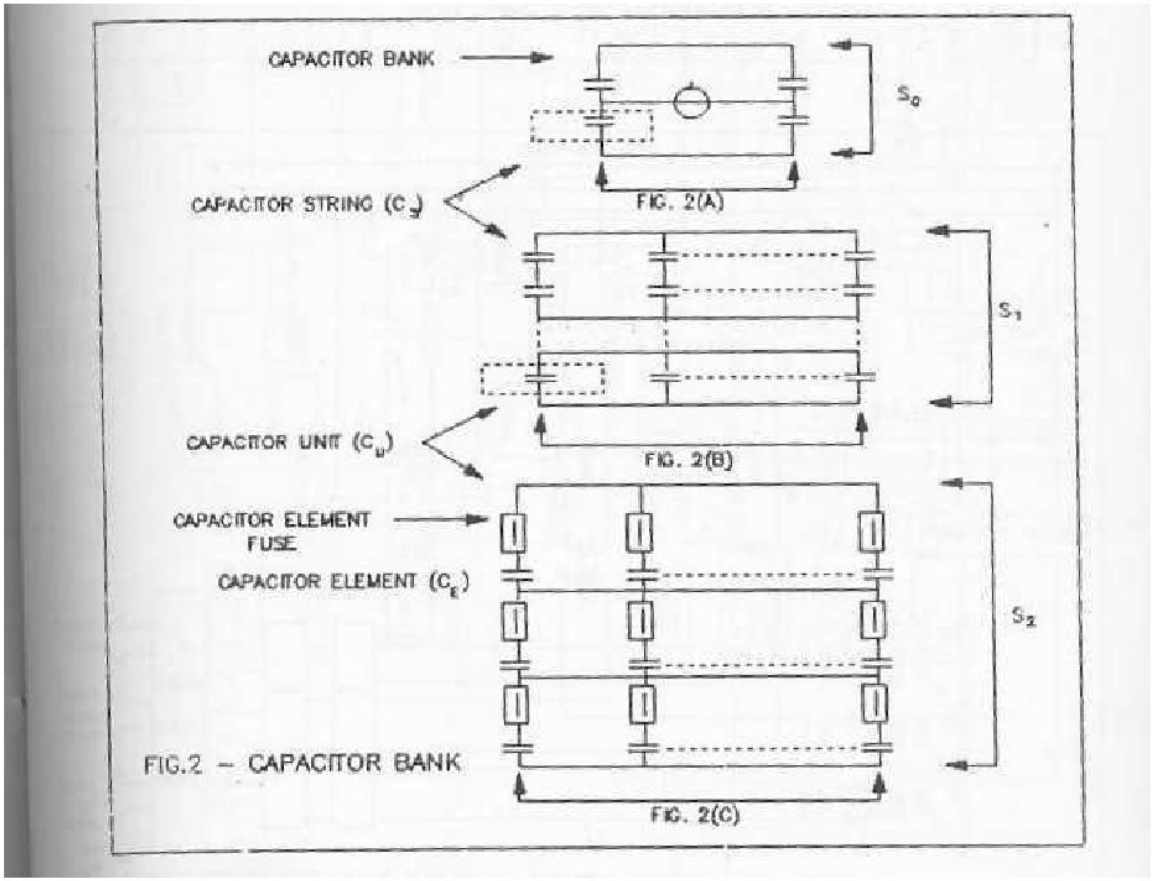


FIG.2 – CAPACITOR BANK

NUMERICAL RELAYS, SCADA

AND

ENERGY METERS

TRANSMISSION & PROTECTION SYSTEM

CORP. R&D DIVISION

NUMERICAL FEEDER PROTECTION

- A multifunction numerical feeder protection relay developed jointly with SWE, Bhopal

- Realized on low cost, powerful microprocessor based hardware

- Integrated with the breaker panels of BHEL, Bhopal and supplied on a commercial basis

- Features and cost comparable with those supplied by leading relay manufacturers like ALSTOM, ABB etc

PROTEC – BR
Numerical Feeder Protection Relay

PROTEC-BR is a microprocessor based multifunction numeric relay for a distribution substation feeder.

FUNCTIONS:

Three phase o/c relay	50 / 51
Earthfault relay	50N / 51N
Thermal Overload relay	49
Undercurrent protection	37
Circuit Breaker failure Detection	50 BF
Cold load pickup	
Latching output contacts	86
Setting groups	2
Blocking logic	
Event recording & Metering	

FEATURES

Applicable to substations of various types and ratings
Compact rack
User configurable protection scheme
Online display of parameters and variables
Powerful self diagnostics and failsafe mode of operation
Can be powered with 110 / 220 V dc from station batteries
CPRI certification as per IEC-60255 standards

PROTEC-BRE

NUMERICAL FEEDER PROTECTION RELAY (ENHANCED)

Enhanced version of PROTEC-BR...

Protection Functions

- Directional / Non-directional Over current relay
- Directional / Non-directional Earth fault relay
- Reverse Power Relay
- Thermal Overload Relay
- Broken Conductor
- Breaker Fail protection

Other Functions

- Cold load Pickup
- 2 Setting Groups

AUTORECLOSER RELAY

PROTECTION FUNCTIONS

- THREE PHASE O/C WITH SELECTABLE IDMT/DEFINITE TIME CHARACTERISTICS
- EARTH FAULT WITH SELECTABLE IDMT / DEFINITE TIME CHARACTERISTICS
- COLD LOAD PICKUP LOGIC
- CIRCUIT BREAKER FAILURE
- BROKEN CONDUCTOR

CONTROL FUNCTIONS

- MULTI-SHOT (4) AUTORECLOSER
- EACH SHOT IS INDEPENDENTLY PROGRAMMABLE
- CIRCUIT BREAKER CONTROL TWO SETTING GROUPS

Numerical Motor Protection Relay

FEATURES

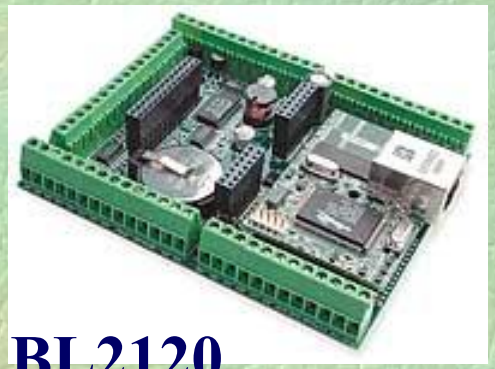
- LOCKED ROTOR PROTECTION BASED ON IMPEDANCE MEASUREMENT
- THREE PHASE O/C RELAY WITH SELECTABLE IDMT / DEFINITE TIME CHARACTERISTICS
- EARTH FAULT RELAY WITH SELECTABLE IDMT / DEFINITE TIME CHARACTERISTICS
- NEGATIVE SEQUENCE RELAY
- THERMAL OVERLOAD PROTECTION

  WIDE SETTING RANGE

- SUITABLE FOR MEDIUM AND LARGE MOTORS

Z WORLD MODULES

BL2020



BL2120

- Low-cost, high performance modules used in protection relays
- Up to 28 digital I/O
- Up to 11 A/D and 2 D/A
- 4 serial ports
- Optional 512K Flash / 512K SRAM
- Onboard relay

FEATURES

Microprocessor	Rabbit 2000T @ 22.1 MHz
Flash	256K
SRAM	128K
Backup Battery	Socketed 3-V lithium coin-type, 265 mA.h, supports RTC and SRAM
Digital Inputs	24: protected to ± 36 V DC
Digital Outputs	16: source/sink 200 mA each, 36 V DC max.
Analog Inputs	11 at 1 MW, 12-bit resolution, ±10 V DC,up to 4,100 samples/sec.
Analog Outputs	Four 12-bit resolution, 0-10 V DC*,update rate 12 kHz
Serial Ports	4 total: two 3-wire (or one 5-wire) RS-232, 1 RS-485, and one 5 V CMOS-compatible (programming)
Real-Time Clock	Yes
Timers	Five 8-bit timers (four cascadable from the first) and one 10-bit timer
Watchdog/Supervisor	Yes
Power	9-36 V DC, 3 W max.
Operating Temp.	-40°C to +70°C
Humidity	5-95%, non-condensing
Board Size	4.14" x 3.41" x 0.93" (105 x 87 x 24 mm)

UPGRADATION & MODERNISATION OF 11 KV SUBSTATIONAT GPX BHEL, BHOPAL

THE CONTROL AND RELAY PANELS PROPOSED TO BE SUPPLIED WILL HAVE

- PROTECTION PANELS FOR ALL INCOMING AND THE OUTGOING FEEDERS

THE CONTROL PANEL WHICH WILL SERVE THE PURPOSE OF OWS & EWS

THE OWS & EWS COMMUNICATE WITH THE REMOTE RTUS THROUGH HUBS CONNECTED BY MEANS OF RS 485 LINK.

THE SCADA WILL HAVE THE FOLLOWING FEATURES

- SINGLE LINE DIAGRAM SHOWING LIVE STATUS OF VARIOUS FEEDERS
- BREAKER & ISOLATOR CONTROL
- METERING
- POWER/ ENERGY MEASUREMENT
- ALARM INDICATIONS
- EVENT RECORDS WITH TIME STAMPING AT RTU LEVEL
- FAULT RECORDS
- SELF DIAGNOSTICS
- PASSWORD PROTECTION FOR CHANGING THE DATA
- MODBUS PROTOCOL COMMUNICATION BETWEEN THE MASTER & SLAVES

- EACH RELAY ACTING AS AN RTU WILL BE COMMUNICATING WITH THE SCADA THROUGH RS 485 PORT
- MODBUS COMMUNICATION IN RTU MODE WILL BE EMPLOYED
- A DATA CONCENTRATOR AT THE MASTER END COMMUNICATES WITH THE RTUS IN THE MULTI DROP MODE ON AN RS 485 BUS
- DATA CONCENTRATOR COMMUNICATES WITH A PC ON AN RS 232 BUS
- THE MMI RESIDES IN THE PC IN THE VB ENVIRONMENT
- FEASIBILITY OF A SINGLE MULTIDROP LOOP FOR ALL RTUS HAS TO BE WORKED OUT

MODBUS FUNCTIONS

- 01 - READ STATUS OF OUTPUT CONTACTS
- 02 - READ STATUS OF DIGITAL INPUTS
- 03 - READ RELAY SETTINGS
- 04 - READ MEASURED VALUES
- 06 - RESET SINGLE OUTPUT
- 16 - PRESET MULTIPLE OUTPUTS

EVENTS / FAULTS

- CHANGE OF ANY DIGITAL OUTPUT
- CHANGE OF ANY DIGITAL INPUT
- PROTECTION FUNCTION PICKING UP
- SETTINGS CHANGE
- PASSWORD CHANGE
- PROTECTION OPERATION

PROPOSED INSTALLATION OF 11 kV SWITCH BOARD PANELS FOR GPX

RELAYS OF THE TYPE PROTEC-BR (4 bipolar analog inputs)

TABLE I

S. NO.	PANEL No.	FEEDER	CT RATIO	CT CLASS	PROTECTIONS	PROTECTION SETTINGS	ANA I/PS	DIG I/PS	DIG O/PS
1.	1.	Ring Main (AUX) 1	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
2.	2.	HRP Test No.1	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
3.	3.	4 MVA Transformer 1	300/5	1 & 5P10	O/C-O/C Winding Temp Alarm, Trip	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	4 BRO,BRC WT ALARM/TRIP	8
4.	5.	Township No. 1	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	5 BRO,BRC Bucholz , OT, WT	8
5.	8.	Ring Main East	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
6.	10.	STN Transformer No. 1	50/5	1 & 5P10	O/C-E/F Winding Temp Alarm, Trip	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	4 BRO,BRC WT ALARM/TRIP	8
7.	11.	TRANS TEST NO. 1	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
8.	12.	Ring Main outer No. 1	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
9.	14.	Ring Main Aux. No. 2	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
10.	15.	Township No. 2	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8

S. NO.	PANEL No.	FEEDER	CT RATIO	CT CLASS	PROTECTIONS	PROTECTION SETTINGS	ANA I/PS	DIG I/PS	DIG O/PS
11.	17.	4 MVA Transformer No. 2	300/5	1 & 5P10	3 O/C-E/F Winding Temp Alarm, Trip	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	4 BRO,BRC WT ALARM/TRIP	8
12.	18.	HRP TEST No.-2	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
13.	20.	STN Transformer No. 2	50/5	1 & 5P10	3 O/C-E/F Winding Temp Alarm, Trip	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC WT ALARM / TRIP	8
14.	22.	LIM TEST	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
15.	23.	6 MWDG Incomer	600/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	4 BRO,BRC	8
16.	25.	Trans. Test No. 2	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
17.	26.	Ring main Outer No. 2	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
18.	28.	RM Electroplating	400/5	1 & 5P10	O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
19.	29.	RM AUX 2	400/5	1 & 5P10	3 O/C-IE/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
20.	30.	STN Transformer No. 3	50/5	1 & 5P10	3 O/C-E/F Winding Temp Alarm, Trip	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	4 BRO,BRC WT ALARM/TRIP	8
21.	32	TG/AG Test	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
22.	36.	HYDRO TEST LAB	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
23.	37.	Induction Furnace	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8
24.	38.	Control Gear Test	400/5	1 & 5P10	3 O/C-E/F	O/C 50-200 % E/F 10- 40 %	3 Ir, Iy, Ib	2 BRO,BRC	8

ELAYS OF THE TYPE PROTEC-BRE (11 bipolar analog inputs)

TABLE II

S. NO.	PANE LNo.	FEEDER	CT RATIO	CT CLASS	RELAY	PROTECTION SETTINGS	ANA I/PS	DIG I/PS	DIG O/PS
25.	4.	Incomer No. 1A	800/5	1 & 5P10	3 O/C-E/F REVERSE POWER	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs	6 Ir, Iy, Ib, Vr, Vy, Vb	2 BRO,BRC	8
26.	6.	Capacitor bank No. 1	300/5	1 & 5P10	3 O/C-E/F, neutral Displacement, UV/OV	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs OV 121-187V UV 55-99V	7 Ir, Iy, Ib, Open delta voltage,Vr, Vy, Vb,	2 BRO,BRC	8
27.	9.	Incomer No. 2A	800/5	1 & 5P10	3 O/C-E/F REVERSE POWER	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs	6 Ir, Iy, Ib, Vr, Vy, Vb	2 BRO,BRC	8
28.	16.	Incomer No. 1B	800/5	1 & 5P10	3 O/C-E/F REVERSE POWER	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs	6 Ir, Iy, Ib, Vr, Vy, Vb	2 BRO,BRC	8
29.	19.	Capacitor bank No. 2	300/5	1 & 5P10	3 O/C-E/F, neutral Displacement, UV/OV	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs OV 121-187V UV 55-99V	7 Ir, Iy, Ib, Open delta voltage, Vr, Vy, Vb	2 BRO,BRC	8
30.	24.	Incomer No. 3A	800/5	1 & 5P10	3 O/C-E/F REVERSE POWER	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs	6 Ir, Iy, Ib, Vr, Vy, Vb	2 BRO,BRC	8
31.	31.	Incomer No. 2B	800/5	1 & 5P10	3 O/C-E/F REVERSE POWE	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs	6 Ir, Iy, Ib, Vr, Vy, Vb	2 BRO,BRC	8
32.	33.	Capacitor bank No. 3	300/5	1 & 5P10	. 3 O/C-E/F, neutral Displacement, UV/OV	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs OV 121-187V UV 55-99V	7 Ir, Iy, Ib, Open delta voltage, Vr, Vy, Vb	2 BRO,BRC	8
33.	35.	Incomer No. 3B	800/5	1 & 5P10	3 O/C-E/F REVERSE POWER REV POW	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs	6 Ir, Iy, Ib, Vr, Vy, Vb	2 BRO,BRC	8

DIGITAL INPUTS : BRO-BREAKER OPEN ; BRC-BREAKER CLOSED; BUCHOLZ-BUCHOLZ ALARM; OT- OIL TEMP.; WT- WINDING TEMP

ELAYS OF THE TYPE PROTEC-BRE (11 bipolar analog inputs)

TABLE II

S. NO.	PANE LNo.	FEEDER	CT RATIO	CT CLASS	RELAY	PROTECTION SETTINGS	ANA I/PS	DIG I/PS	DIG O/PS
25.	4.	Incomer No. 1A	800/5	1 & 5P10	3 O/C-E/F REVERSE POWER	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs	6 Ir, Iy, Ib, Vr, Vy, Vb	2 BRO,BRC	8
26.	6.	Capacitor bank No. 1	300/5	1 & 5P10	3 O/C-E/F, neutral Displacement, UV/OV	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs OV 121-187V UV 55-99V	7 Ir, Iy, Ib, Open delta voltage,Vr, Vy, Vb,	2 BRO,BRC	8
27.	9.	Incomer No. 2A	800/5	1 & 5P10	3 O/C-E/F REVERSE POWER	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs	6 Ir, Iy, Ib, Vr, Vy, Vb	2 BRO,BRC	8
28.	16.	Incomer No. 1B	800/5	1 & 5P10	3 O/C-E/F REVERSE POWER	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs	6 Ir, Iy, Ib, Vr, Vy, Vb	2 BRO,BRC	8
29.	19.	Capacitor bank No. 2	300/5	1 & 5P10	3 O/C-E/F, neutral Displacement, UV/OV	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs OV 121-187V UV 55-99V	7 Ir, Iy, Ib, Open delta voltage, Vr, Vy, Vb	2 BRO,BRC	8
30.	24.	Incomer No. 3A	800/5	1 & 5P10	3 O/C-E/F REVERSE POWER	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs	6 Ir, Iy, Ib, Vr, Vy, Vb	2 BRO,BRC	8
31.	31.	Incomer No. 2B	800/5	1 & 5P10	3 O/C-E/F REVERSE POWE	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs	6 Ir, Iy, Ib, Vr, Vy, Vb	2 BRO,BRC	8
32.	33.	Capacitor bank No. 3	300/5	1 & 5P10	. 3 O/C-E/F, neutral Displacement, UV/OV	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs OV 121-187V UV 55-99V	7 Ir, Iy, Ib, Open delta voltage, Vr, Vy, Vb	2 BRO,BRC	8
33.	35.	Incomer No. 3B	800/5	1 & 5P10	3 O/C-E/F REVERSE POWER REV POW	O/C 50-200 % E/F 10- 40 % R/P relay 5 – 3 secs	6 Ir, Iy, Ib, Vr, Vy, Vb	2 BRO,BRC	8

DIGITAL INPUTS : BRO-BREAKER OPEN ; BRC-BREAKER CLOSED; BUCHOLZ-BUCHOLZ ALARM; OT- OIL TEMP.; WT- WINDING TEMP

3.3 kV SWITCH BOARD PANEL FOR COMPRESSOR IN GPX

RELAYS OF THE TYPE PROTEC-BR (4 bipolar analog inputs)

TABLE III

S. NO.	PANEL No.	FEEDER	CT RATIO & CLASS	RELAY	ANA I/PS	DIG I/PS	DIG O/PS
34.	1.	Compressor C1	200/5 1 & 5P10	3 O/C-E/F	3 Ir, Iy, Ib	2 BRO,BRC	8
35.	2.	Compressor No. 5	200/5 1 & 5P10	3 O/C-E/F	3 Ir, Iy, Ib	2 BRO,BRC	8
36.	3.	Compressor No. 7	200/5 1 & 5P10	3 O/C-E/F	3 Ir, Iy, Ib	2 BRO,BRC	8
37.	4.	Incomer No. 1	800/5 1 & 5P10	3 O/C-E/F	3 Ir, Iy, Ib	2 BRO,BRC	8
38.	5.	Incomer No 2	800/5 1 & 5P10	3 O/C-E/F,	3 Ir, Iy, Ib	2 BRO,BRC	8
39.	6.	Compressor C2	200/5 1 & 5P10	3 O/C-E/F	3 Ir, Iy, Ib	2 BRO,BRC	8
40.	7.	Compressor No. 6	200/5 1 & 5P10	3 O/C-E/F	3 Ir, Iy, Ib	2 BRO,BRC	8
41.	8.	Compressor No. 8	200/5 1 & 5P10	3 O/C-E/F	3 Ir, Iy, Ib	2 BRO,BRC	8

- Configuration
- Measurement
- Protection
- BACK

CONFIGURATION

Rd No: 4 Nominal Input Current 5 Frequency: 20

FUNCTIONS

Oc	Off
Ef	Off
Thol	Off
Brkfl	Off
BroCon	Off

INPUTS

ANALOG

AnalogInput	12.25
AnalogInput	12.25
AnalogInput	12.25

DIGITAL

DigitalInput	12.25

OUTPUTS

LEDS

LED1	Imok	LED4	Imok
LED2	Imok	LED5	Imok
LED3	Imok	LED6	Imok

CONTACTS

Relay1	OcSns	Relay5	OcSns
Relay2	OcSns	Relay6	OcSns
Relay3	OcSns	Relay7	OcSns
Relay4	OcSns	Relay8	EfSns

PROTECTION FORM

Oc

Oc Pickup	00.50
Oc Hiset	25.00
Oc Char	1
Oc Tms	01.00
Oc	05.00

Ef

Ef Pickup	00.20
Ef Hiset	25.00
Ef Char	1
Ef Tms	01.00
Ef	05.00

Thol

Th	00.50
Th IL	01.00
Th Time	01.00

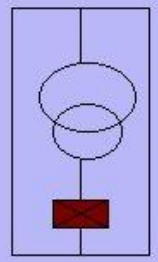
Brkfl

Lbb Dro]	02.00
Brk	00.30

BroCon

Brc Dro[	00.20
Brc Cnt	03.00

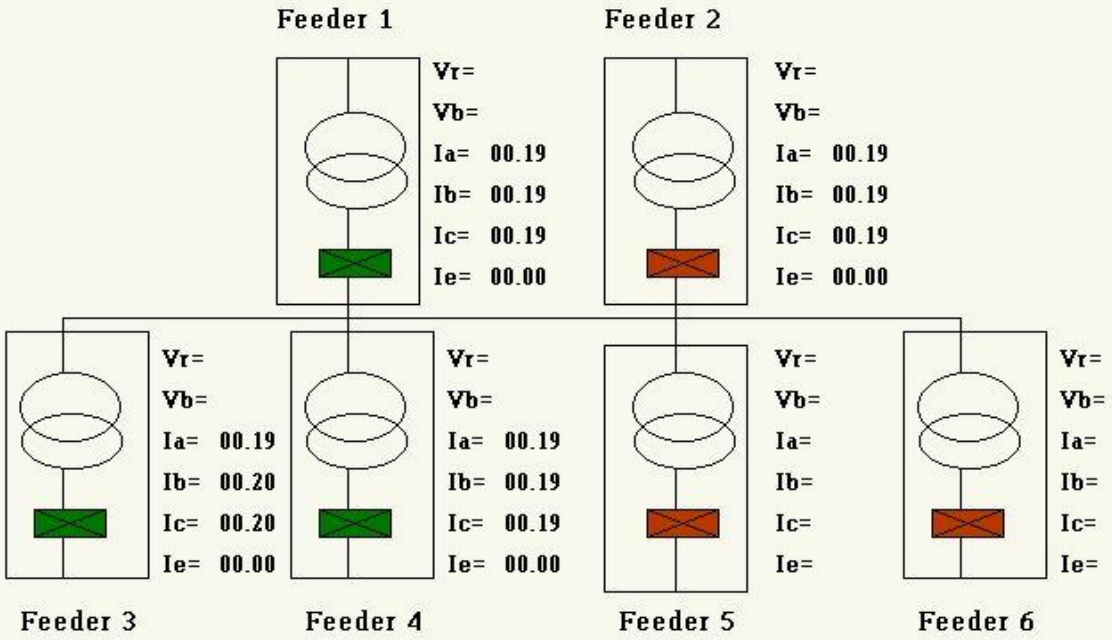
MEASUREMENTS



Vr=
Vb=
Ia= 00.19
Ib= 00.19
Ic= 00.19
Ie= 00.00

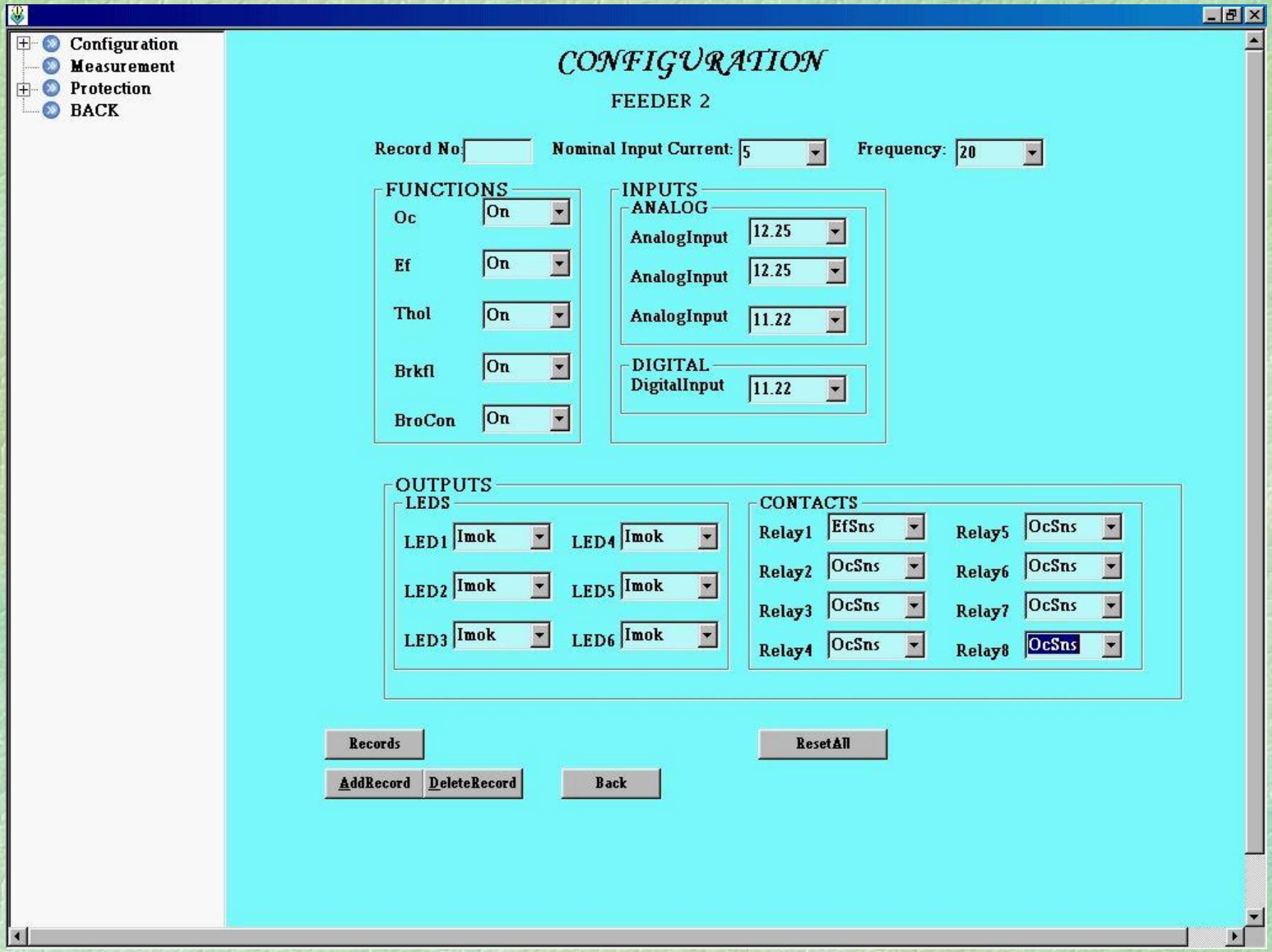
Measurements of all Feeders

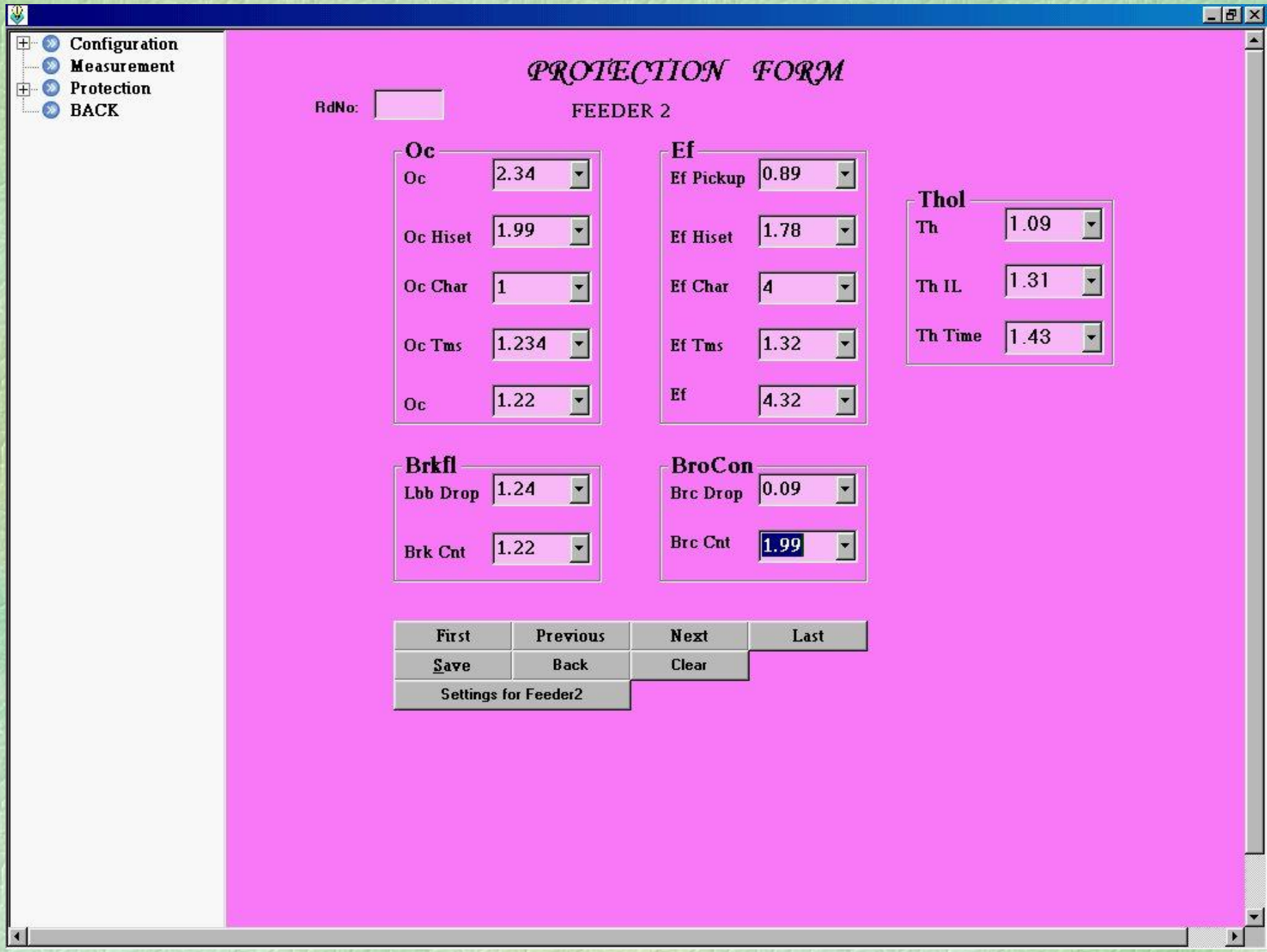
Measurements



Feeder 1 | Feeder 2 | Feeder 3 | Feeder 4 | Feeder 5 | Feeder 6

SETTINGS | Exit

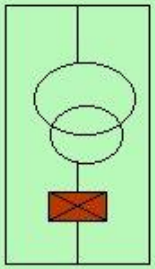

Configuration
Measurement
Protection
BACK
CONFIGURATION
FEEDER 2
Record No:
Nominal Input Current: 5
Frequency: 20
FUNCTIONS
Oc On
Ef On
Thol On
Brkfl On
BroCon On
INPUTS
ANALOG
AnalogInput 12.25
AnalogInput 12.25
AnalogInput 11.22
DIGITAL
DigitalInput 11.22
OUTPUTS
LEDS
LED1 Imok
LED2 Imok
LED3 Imok
LED4 Imok
LED5 Imok
LED6 Imok
CONTACTS
Relay1 EfSns
Relay2 OcSns
Relay3 OcSns
Relay4 OcSns
Relay5 OcSns
Relay6 OcSns
Relay7 OcSns
Relay8 OcSns
Records
ResetAll
AddRecord
DeleteRecord
Back


Configuration
Measurement
Protection
BACK
PROTECTION FORM
RdNo:
FEEDER 2
Oc
Oc
2.34
Oc Hiset
1.99
Oc Char
1
Oc Tms
1.234
Oc
1.22
Ef
Ef Pickup
0.89
Ef Hiset
1.78
Ef Char
4
Ef Tms
1.32
Ef
4.32
Thol
Th
1.09
Th IL
1.31
Th Time
1.43
Brkfl
Lbb Drop
1.24
Brk Cnt
1.22
BroCon
Brc Drop
0.09
Brc Cnt
1.99
First
Previous
Next
Last
Save
Back
Clear
Settings for Feeder2

- Configuration
- Measurement
- Protection
- BACK

MEASUREMENTS

FEEDER 2



Vr=
Vb=
Ia= 00.19
Ib= 00.19
Ic= 00.19
Ie= 00.00

BACK

Hercules-EBX

Hercules is a high-integration EBX format (8.00” x 5.75”) CPU based on the VIA Eden Pentium-3 class processor.

- **Complete CPU on one board – processor, video, audio, Ethernet, I/O, data acquisition**
- **On-board DC/DC power supply for compatibility with a wide range of power systems**
- **Extremely rugged design perfect for mobile and harsh environment applications**
- **PC/104+ expansion capability for great flexibility in customizing with add-on boards**
- **Low power consumption: Only 10-12 watts depending on processor speed**

Hercules offers the highest level of integration of any EBX format CPU. This single board contains all the following features soldered directly on board:

- **Processor**
- **Memory**
- **Video, including VGA, LCD (lvds), and TV output**
- **Audio, including 1Wx2 amplifier and SoundBlaster compatibility**
- **10/100Mbps Ethernet**
- **Extensive system I/O, including 4 USB ports, 4 RS-232/485 ports, and dual IDE channels**
- **Data acquisition option, including 32 analog inputs, 4 analog outputs, 40 digital I/O, 2 counter/timers, 4 pulse-width modulation outputs, and watchdog timer**
- **Built-in DC/DC power supply with wide-range 5-28VDC input and 45W output power**

REAL-TIME OPERATING SYSTEM

- RTLinuxPro, the hard real-time operating system.
- Provides a real-time kernel with Linux running as a pre-emptable thread.
- This design provides superior performance by providing hard real-time functionality with guaranteed latencies.
- Full TCP/IP with deep support of layered protocols and wide driver coverage

ENERGY METERS

- DEVELOPMENT OF 3Ph ENERGY METER WITH MDI, LED DISPLAY, & RTC, BASED ON SAMES ASIC

- DEVELOPMENT OF EPROM BACKED µCONTROLLER BASED 3Ph LCD METER, WITH IEC 61106 PORT (IR PORT), RTC & MDI FOR ELECTRONIC ENERGY METER NON LCD TYPE OF EDN MAKE

METERS - PROJECTS/DEVELOPMENTS

TITLE:DEVELOPMENT OF IrDA PORT FOR SINGLE PHASE ELECTRONIC ENEGY METER WITH LCD DISPLAY

DEVELOPED Version 1 WITH AT89S8252 MICON

DEVELOPED Version 2 WITH AT89C2051 MICON

DEVELOPED Version 3 FOR Ph II OF BHOPAL SCADA PROJECT

STATUS: COMPLETED

- **ADDITIONAL FEATURES LIKE**

i) CHANGE OF Sl.No, & UID No. THROUGH PDA

ii) IMPLEMENTATION OF RS232/RS485 PORT IMPLEMENTED AT THE REQUEST OF EDN

METERS - PROJECTS/DEVELOPMENTS

- LATEST VERSION (VERSION 3), BUILT WITH STATE OF THE ART PIC16F876 MICON
- CONTINUED TECHNICAL SUPPORT PROVIDED DURING MANUFACTURE OF IrDA METER
- COST REDUCTION PROCESS REQUIRES TIME, BHEL EDN TO ADDRESS ALL REQUIREMENTS

IrDA Meter

METERS - PROJECTS/DEVELOPMENTS

JOINT PATENT

- 'A NOVEL SCHEME FOR RURAL & URBAN ELECTRIFICATION BASED ON NEW ENERGY METER MODULES'

METERS - PROJECTS/DEVELOPMENTS

FUTURISTIC TRENDS

GSM TECHNOLOGY FOR PAGING FOR ALL VARIETIES OF METERS

BLUE TOOTH APPLICATIONS 1Ph/3Ph METERS MAX DISTANCE 100Mts

SMART CARD ENERGY METER BASED ON THE STATE OF THE ART CRPTO CARDS,WITH VENDING SOFTWARE

ACTION PLAN

- MANUFACTURE OF NUMERICAL RELAYS
- ROADMAP FOR METERS

FAULT IDENTIFICATION AND LOCATION IN TRANSMISSION LINE BY USING DFT & WAVELET TRANSFORM

Phase to Ground Faults:

- Positive Sequence Impedance of Line upto the Fault from Relay :

$$Z_1 = \frac{V_A}{I_A + \left(\frac{Z_0 - Z_1}{Z_1}\right) I_0}$$

where

$I_0 - I_A/3$ 1

V_A - the phase to ground voltage of faulty line

I_A - line current of phase A

Z_1 - +ve sequence of line impedance

Z_0 - zero sequence of line impedance

Phase to Phase Faults:

- Impedance of the Line upto the Fault from relay:

$$Z_1 = \frac{V_a - V_b}{I_a - I_b}$$

where

V_a - phase to ground voltage of phase A

V_b - phase to ground voltage of phase B

I_a - Line current of phase A

I_b - Line current of phase B

Discrete Fourier Transform:

$$X(t) = [1/N] * \sum_{m=0}^{N-1} X_m e^{-(2\pi km)/N}$$

Where k = 0,1,2,3……(N-1)

The Fourier sine and cosine coefficients are given by

$$a_k = 2/N \sum_{m=1}^{N-1} X_m \cos(2\pi km / N)$$

$$b_k = 2/N \sum_{m=1}^{N-1} x_m \sin(2\pi km / N)$$

R.M.S. Value of signal X (t) is given by

$$X = (1/\sqrt{2}) (\sqrt{a_k^2 + b_k^2})$$

Phasor representation is given by $X1 = F_1 + j F_2$

where $F_1 = b_1/\sqrt{2}$ $F_2 = a_1/\sqrt{2}$

Discrete Wavelet Transform:

- Discrete Wavelet transform (DWT) of the signal X(k) is given by:

$$DWT(m,n) = \left[\sum_k X(k)\, \psi^*_{a,b}(k) \right]$$

Where $\psi_{a,b}(k) = \dfrac{\psi((k-b)/a)}{\sqrt{a}}$

Is a scaled and dilated version of mother wavelet $\psi(k)$.

a is the scale parameter and b is the dilation parameter.

Choose $a = a_0^m$ $b = n a_0^m b$ and

k,m,n are integer values.

For computation efficiency a_0 and b_0 are set to 2 and 1.

In the present analysis GABOR wavelet has taken as mother wavelet

And is given by the following equation.

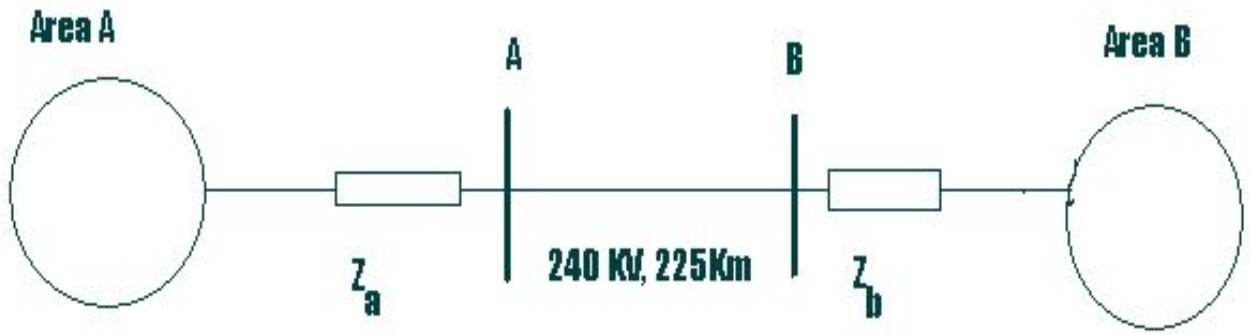
$$\Psi(t) = e^{-(t^2/k)} (\cos(t))$$

Where k =2,4,16,64-------

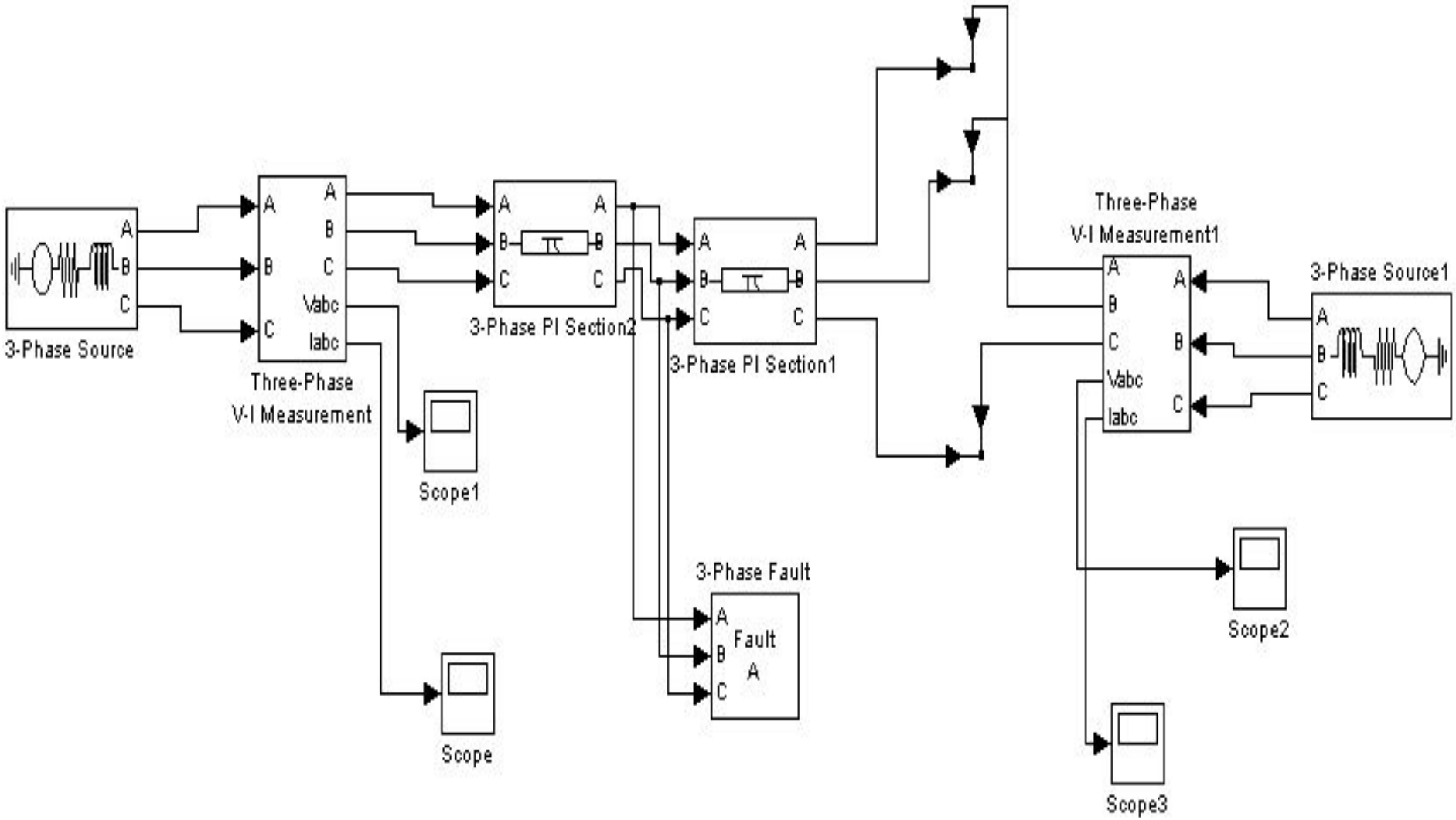
With GABOR wavelet it is easy to find out the frequency

Components of the signal because it is based on exponential

Function like the fourier transform.



Transmission line model System



Transmission Line model System in MATLAB

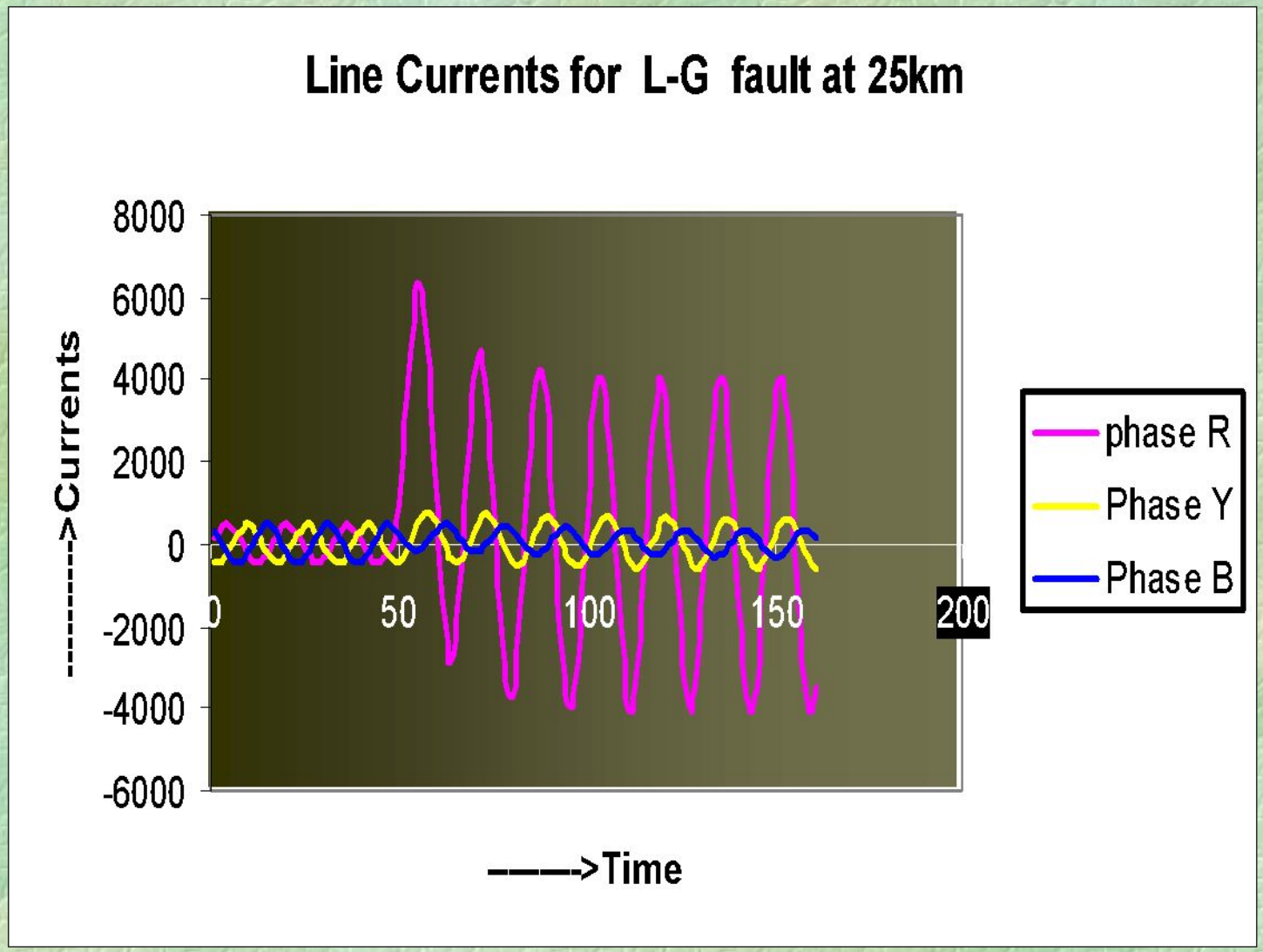
 Representation of Transmission line model in MATLAB:

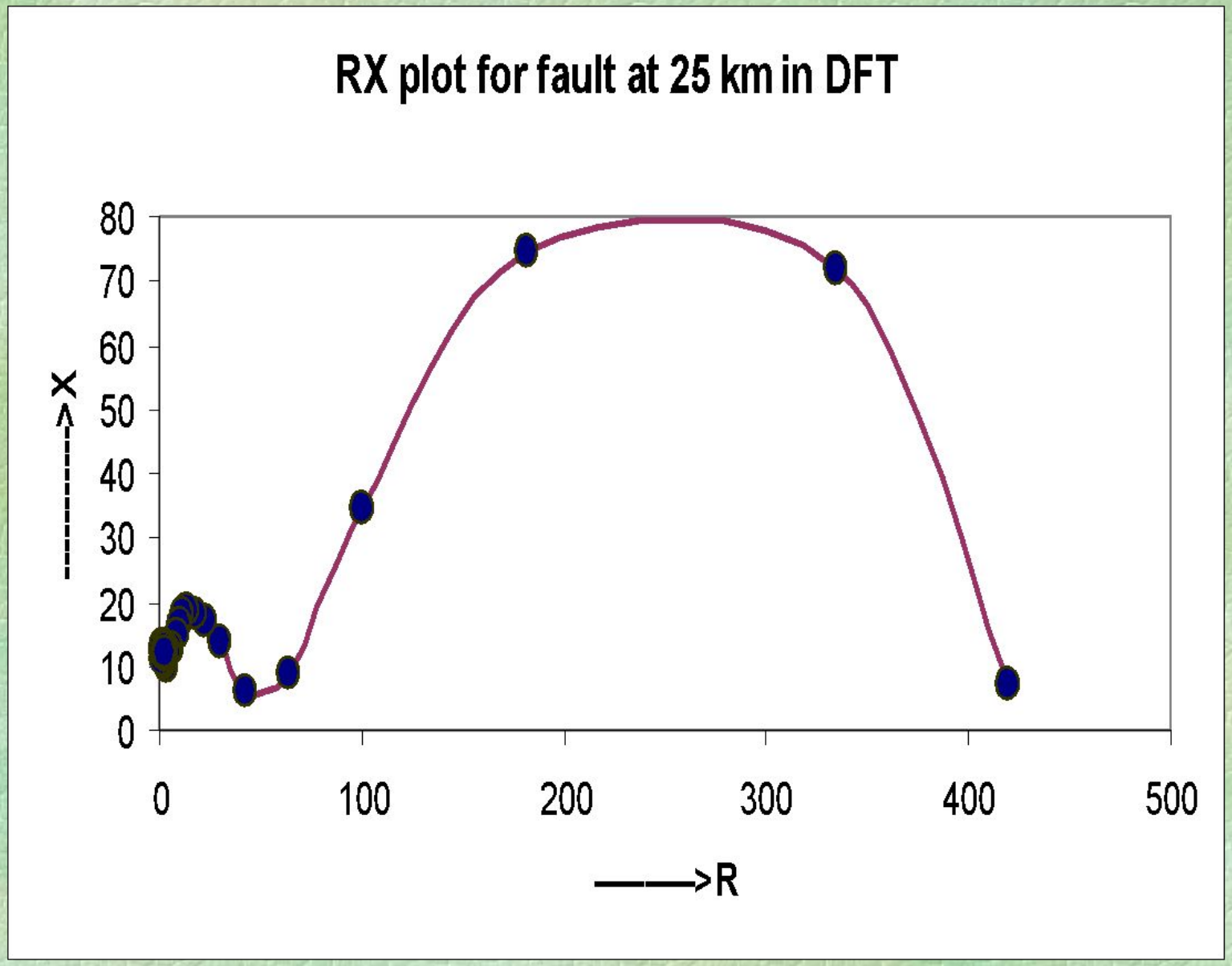
I n this model Transmission line is modeled as distributed Parameters line ,representing a 225-km-long,240-kv ideally Transmission line with
+ve sequence impedance , $Z_L(1) = (8.05 + j\ 110.66)\ \Omega$.
Zreo sequence impedance,$Z_L(0) = (79.19 + j\ 302.77)\ \Omega$.

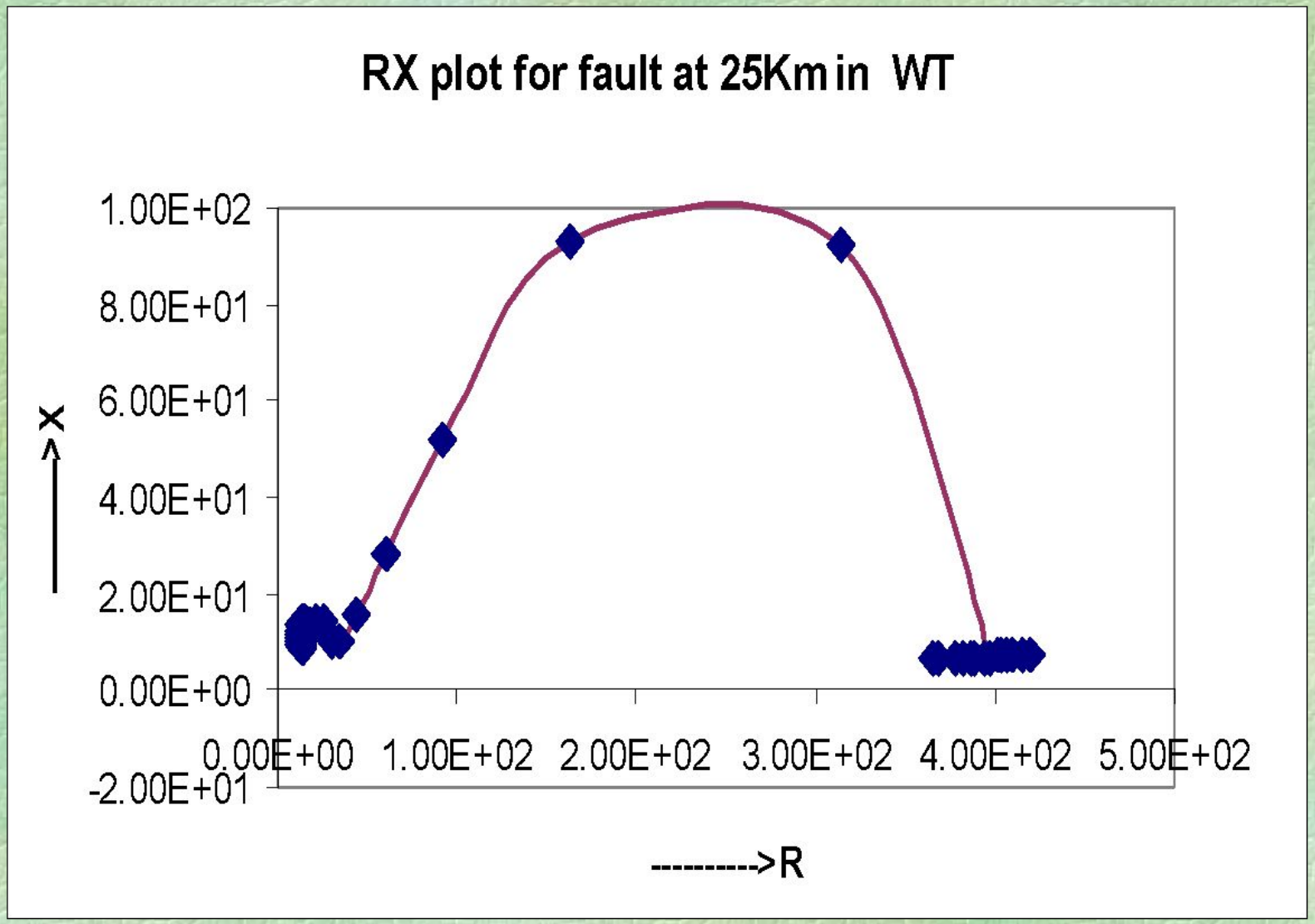
The Thevenin impedance of area A is $Z_a = (5 + j\ 27.7)\ \Omega$.
The Thevenin impedance of area B is $Z_b = 0.6 + j\ 9.3)\ \Omega$.

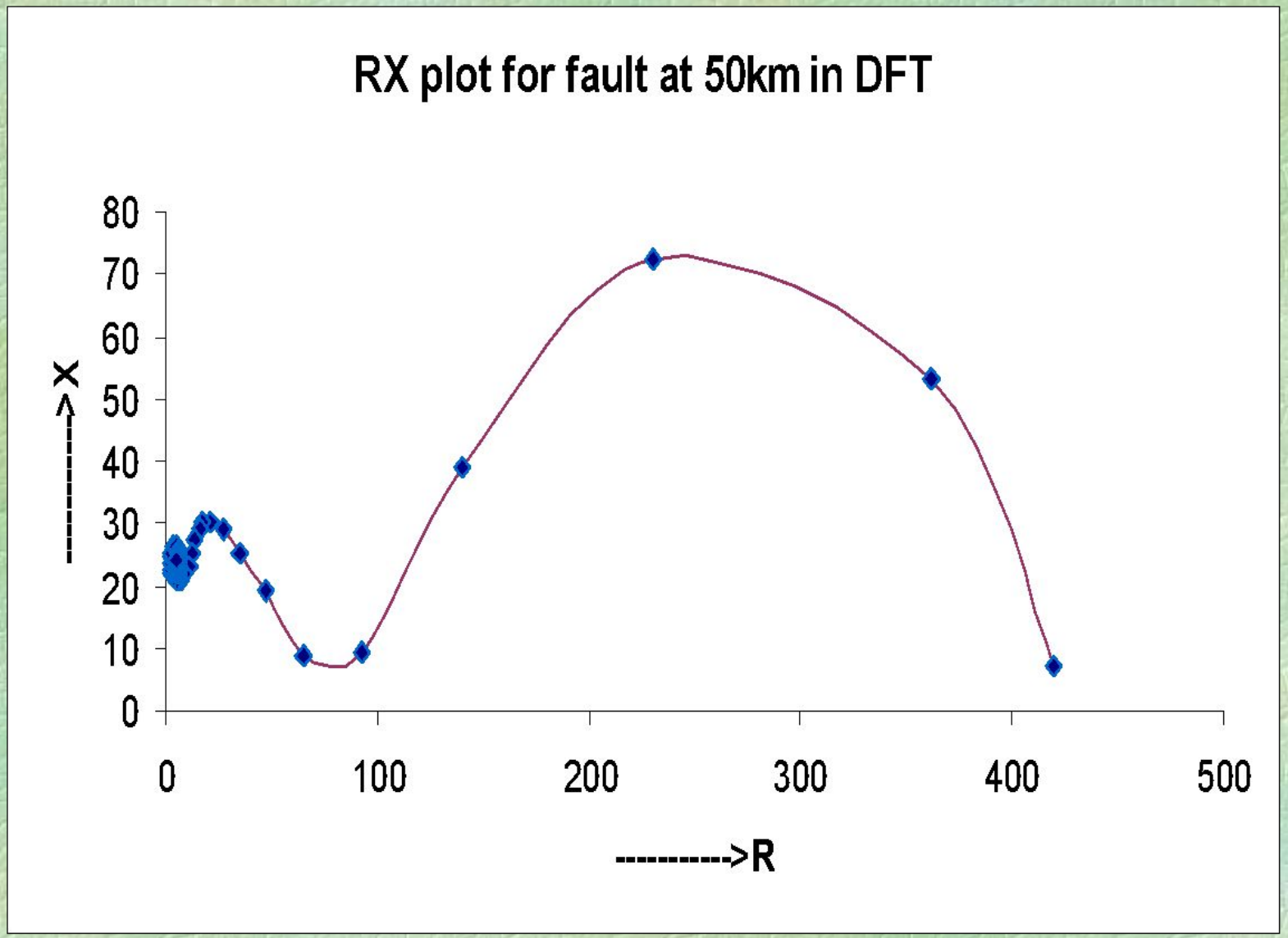
The source voltages are $E_A = 240$KV, and $E_b = 240 \angle \delta$

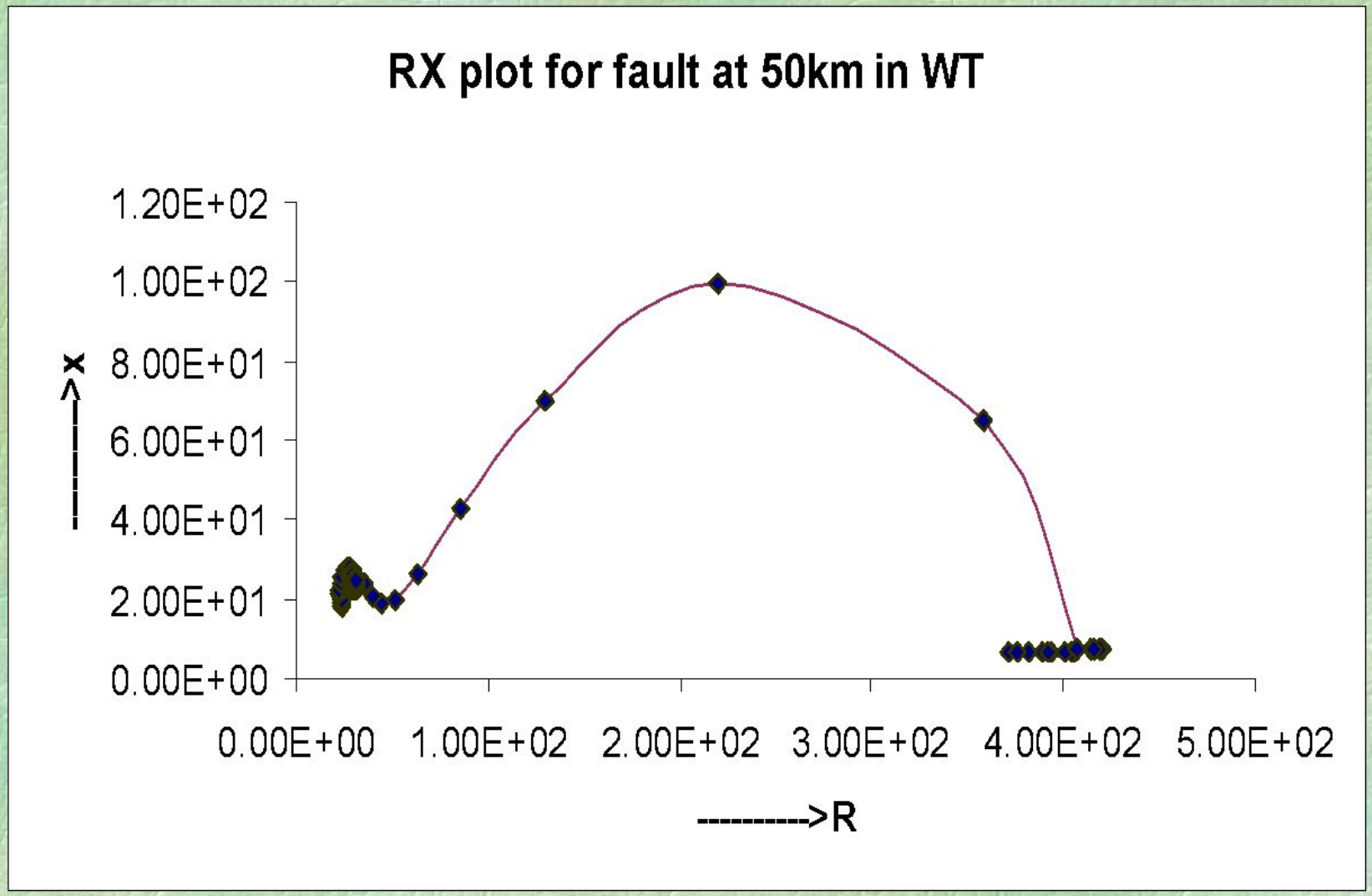
Where δ is the load angle in degrees.

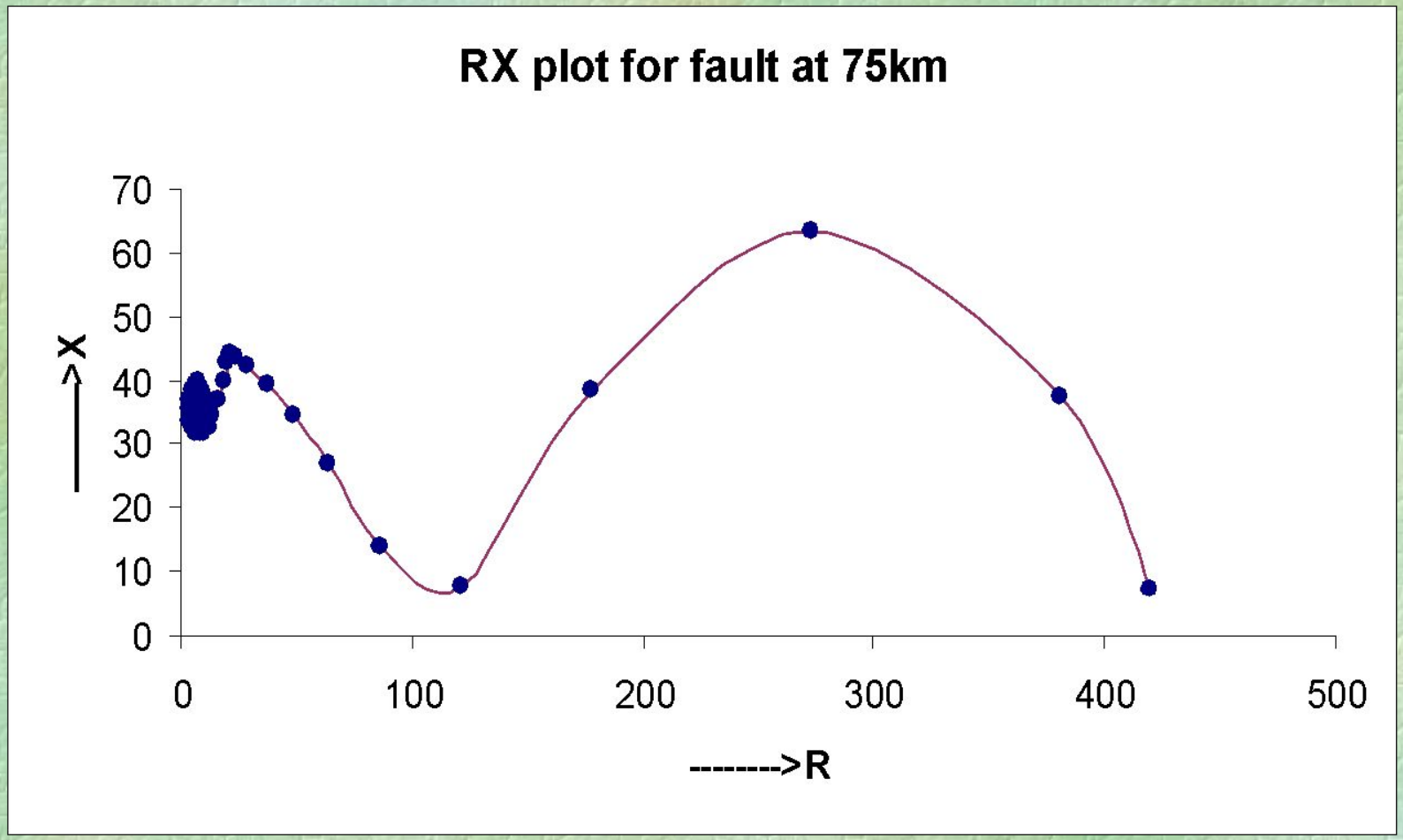

Line Currents for L-G fault at 25km
8000
6000
4000
2000
0
-2000
-4000
-6000
0
50
100
150
200
---------->Currents
---------->Time
phase R
Phase Y
Phase B

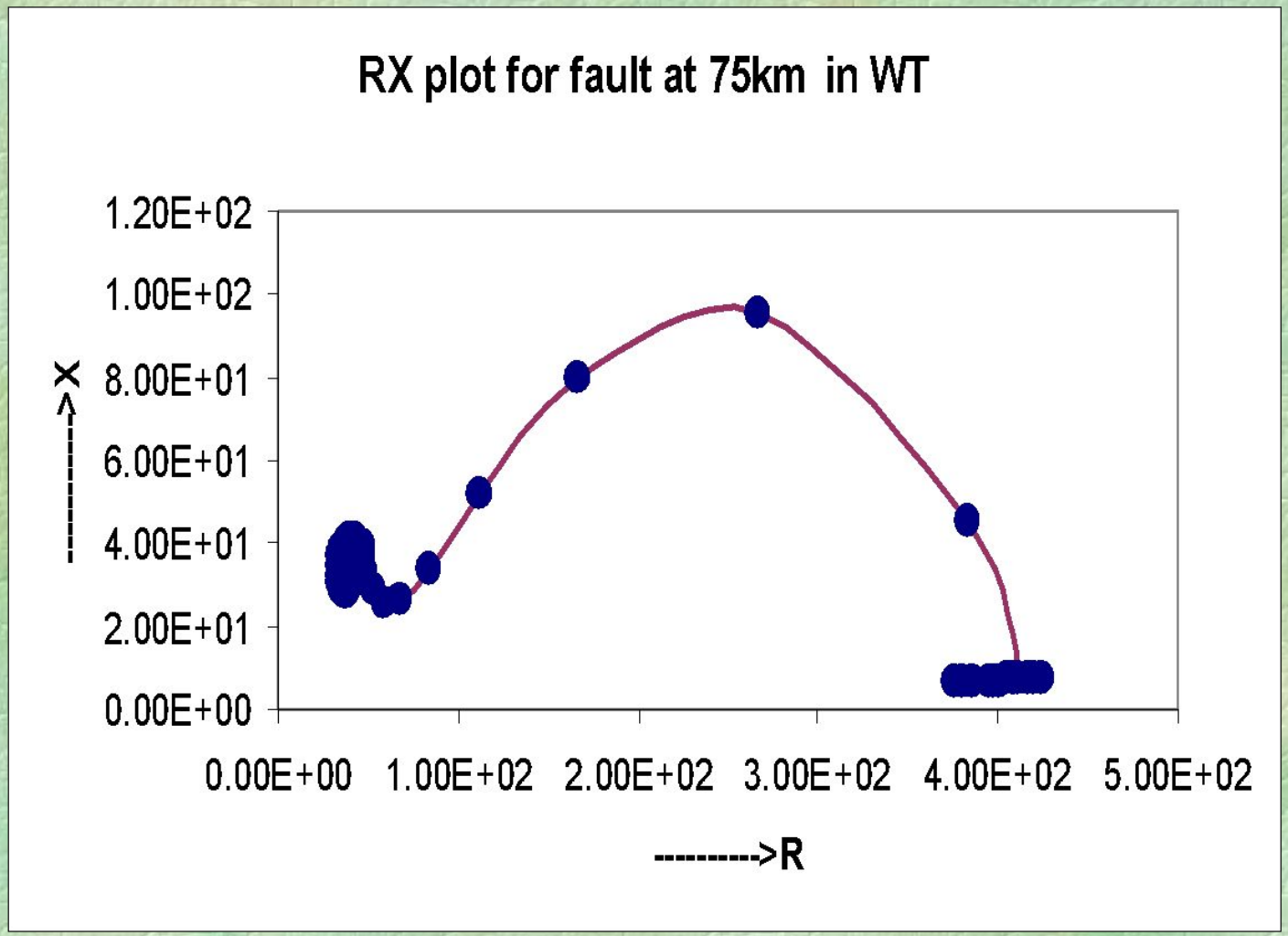

RX plot for fault at 25 km in DFT
80
70
60
50
40
30
20
10
0
X
0
100
200
300
400
500
R

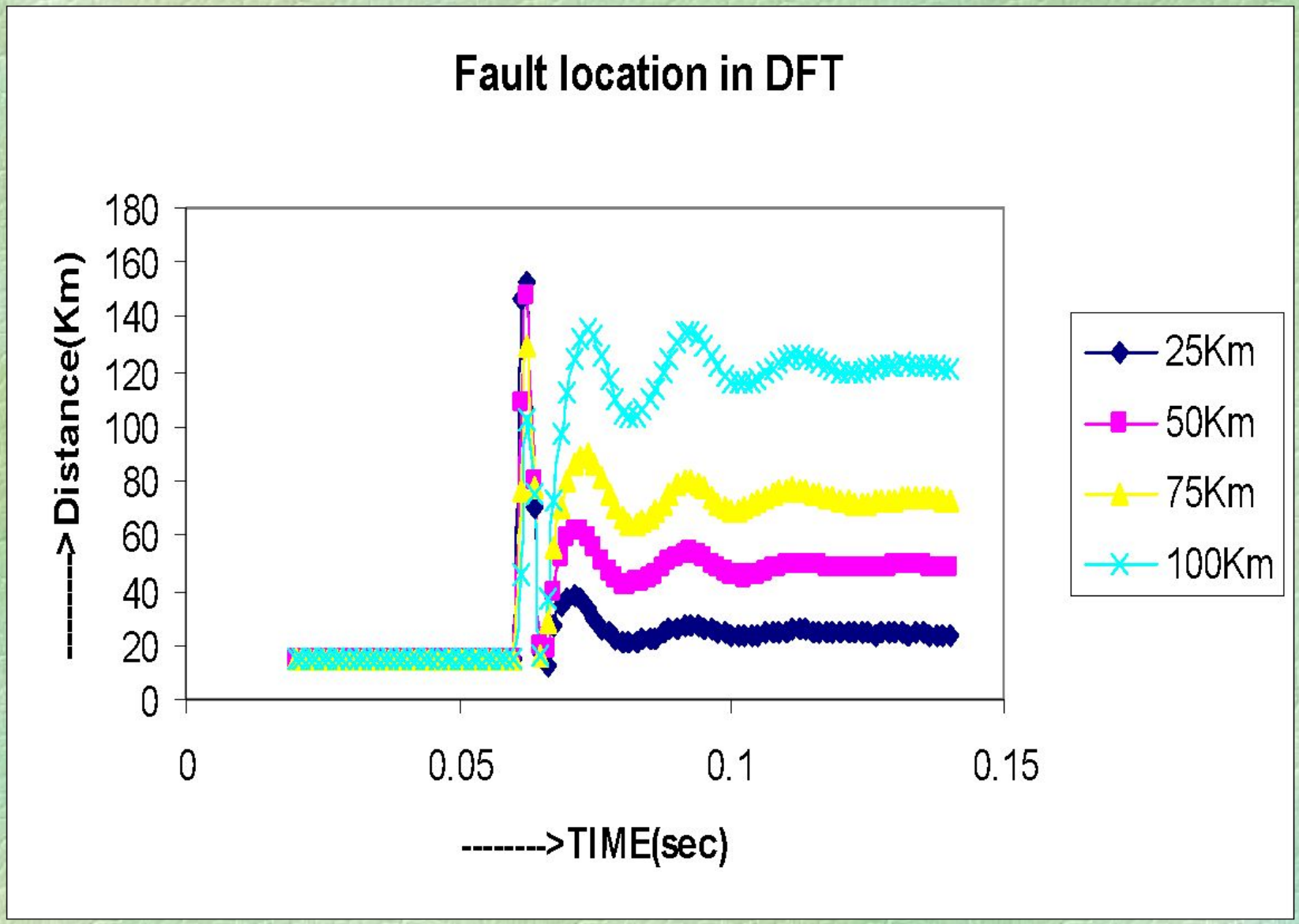

RX plot for fault at 25Km in WT
1.00E+02
8.00E+01
6.00E+01
4.00E+01
2.00E+01
0.00E+00
-2.00E+01
->X
0.00E+00
1.00E+02
2.00E+02
3.00E+02
4.00E+02
5.00E+02
--------->R

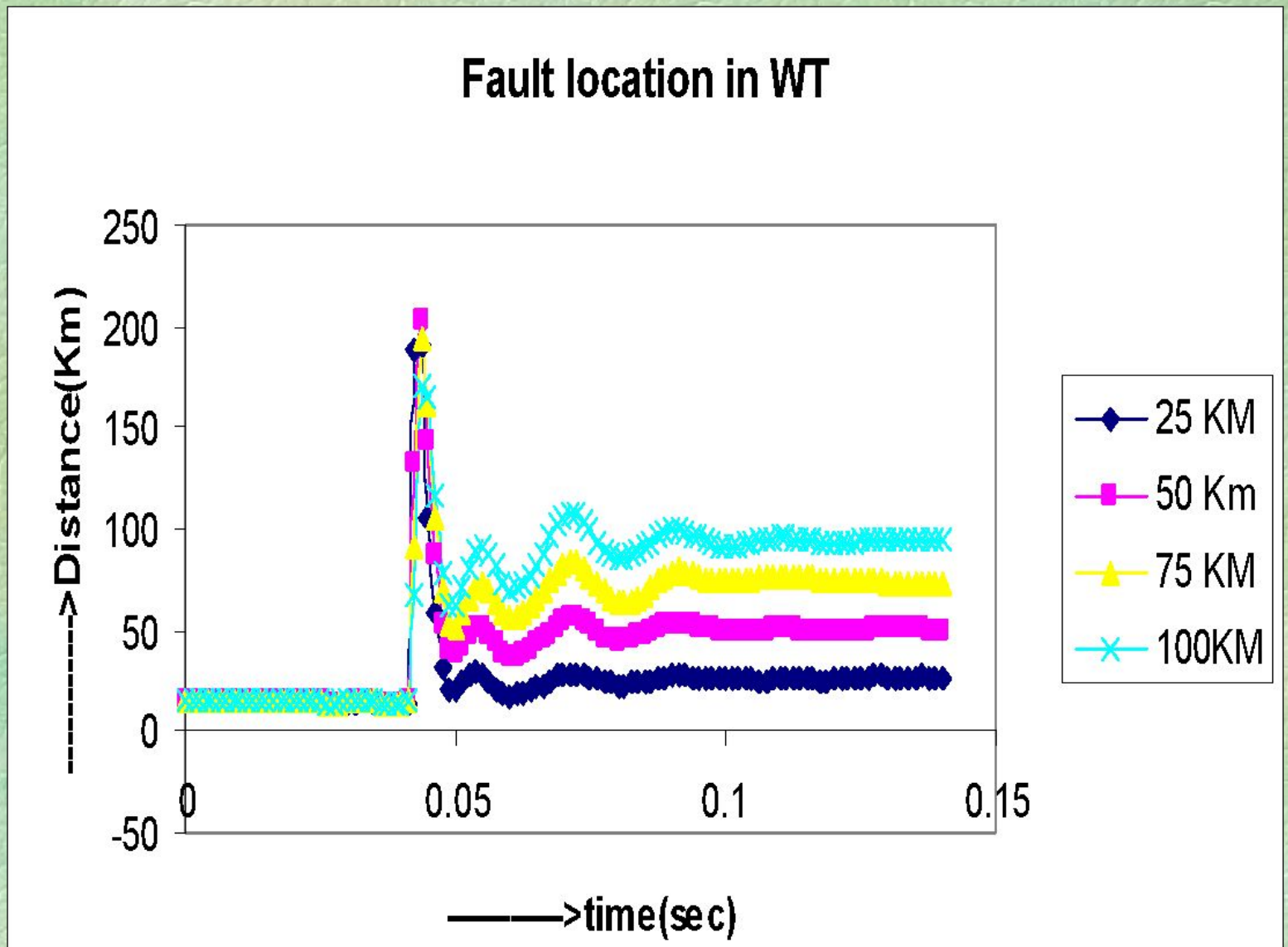

RX plot for fault at 50km in DFT
80
70
60
50
40
30
20
10
0
----->X
0
100
200
300
400
500
---------->R


RX plot for fault at 50km in WT
1.20E+02
1.00E+02
8.00E+01
6.00E+01
4.00E+01
2.00E+01
0.00E+00
X
0.00E+00
1.00E+02
2.00E+02
3.00E+02
4.00E+02
5.00E+02
---------->R


RX plot for fault at 75km
70
60
50
40
30
20
10
0
X
0
100
200
300
400
500
-------->R


RX plot for fault at 75km in WT
1.20E+02
1.00E+02
8.00E+01
6.00E+01
4.00E+01
2.00E+01
0.00E+00
---------->X
0.00E+00
1.00E+02
2.00E+02
3.00E+02
4.00E+02
5.00E+02
--------->R


Fault location in DFT
180
160
140
120
100
80
60
40
20
0
------->Distance(Km)
0
0.05
0.1
0.15
-------->TIME(sec)
25Km
50Km
75Km
100Km


Fault location in WT
250
200
150
100
50
0
-50
0
0.05
0.1
0.15
----------->Distance(Km)
——>time(sec)
25 KM
50 Km
75 KM
100KM

THANK YOU!