SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEM IN ELECTRICITY INDUSTRIES (A CASE STUDY NEPA, SHIRORO NETWORK)

BY

BALARABE ABDULLAHI

PGD/MSC/99/2000/891

A PROJECT SUBMITTED TO THE DEPARTMENT OF MATHEMATICS/COMPUTER SCIENCE, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

IN PARTIAL FULFILLMENT FOR THE AWARD OF POST – GRADUATE DIPLOMA IN COMPUTER SCIENCE

APRIL, 2002

CERTIFICATION

I certify that this project was carried out by Balarabe Abdullahi, PGD Computer Science with Maths and Computer Science Department, Federal University of technology, Minna, Niger State. And has not been presented elsewhere for project work.

Mr Isah Audu
(Supervisor)

Date

Mr L.N Ezeako
Ag (Head of Department)

Date

External Examiner

Date

DEDICATION

This work is specially dedicated to my beloved Mother, Wives and my Children.

ACKNOWLEDGEMENT

Profound gratitude to almighty Allah (S W T) for His special grace on me all these years and also for allowing me to complete the course successfully.

I am very grateful to my able project supervisor, Mallam Isah Audu, for his support, advice and absolute supervision, in fact he is always there wherever I needed him.

I also register my thanks to All the staffs of Maths/Computer Science Department for their assistance during the project research work.

This project will not be completed if I fail to remember my beloved wives, Hauwa, Maryam and also my Children, Mohammed Sani, Safiya, Ibrahim, Khadijat, Amina, Hamza and also my beloved Late son Idrisu for their kind understanding and assistance rendered to me during the course.

It is my prayer that almighty Allah (S W T) will always be with them in all their endeavours.

ABSTRACT

The principal objective of my project focuses on how Scada system can be connected on a network to supervise, control and monitor the transportation of electricity supply in an electrical industry.

NETWORK PARAMETERS AND ABBREVIATION

C.B	-	Circuit Breaker
Iso	-	Isolator
MW	-	Megawatt
Mvar	-	Megavar
Gen	-	Generator
TRI	-	Transformer
KV	-	Kilovolt
HZ	-	Frequency
BB	-	Bus Bar
A	-	Ampere
RTU	-	Remote Terminal Unit
PLC	-	Power Line Carrier
MS	-	Master Station
RS	-	Remote Station
Scada	-	Supervisory Control and Data Acquisition
Sinaut	-	Siemen Network Automation
Lan	-	Local area Network
SNCC	-	Supplementary National Control Centre
EMS	-	Energy management System
TCI	-	Tele Control interface
DASA	-	System Trade MARK (By ABB)
MMI	-	Man Machine Interface
ACC	-	Area Control Centre

TABLE OF CONTENT

CHAPTER ONE (PRELIMINARY)

1.0 INTRODUCTION

The term SCADA is an acronym of supervisory, control and data acquisition. This is a scheme through which a person or persons at a remote location can supervise a plant or network repeated component without having to be physically present at the plant or network in addition he can' control plant or network processes and gather important data about real time plant or network status.

Plant or network control is a many important instrument of power system network operations. The ever increasing demand of electrical energy had resulted in the expansion of both the generating facilities and branched networks which are expected to be reliably operated by using a suitable network control facilities. With the growing requirement of network control SINAUT spectrum, software developed by Siemens, is introduced to power system control. This software was developed to provide remote control facilities for control centres to run expanded and large network with greater security. In modem day control centres, the technologies of SCADA systems are employed to harmonise the grid operations as a network. SCADA System also provide remote control capabilities for dispatchers and enable them acquire much needed data from Remote Stations (RS).

Therefore, NEPA is in its bid to improve the grid operations introduced the new technology of computer based SCADA/EMS systems at the SNCC Shiroro. The SCANDA/EMS Systems at Shiroro are capable of providing facilities on – line to the SNCC such as control (smitch operations with guaranteed systems security). Monitoring (load flow, Engineering studies (System Planning, Data Collation and archiving, total generation of each power station (on daily, monthly or yearly basis and Accounting for the total

SNCC Shiroro. The SCANDA/EMS Systems at Shiroro are capable of providing facilities on – line to the SNCC such as control (switch operations with guaranted systems security). Monitoring (load flow, Engineering studies (System Planning, Data Collation and archiving, total generation of each power station (on daily, monthly or yearly basis and Accounting for the total energy generated by each generator connected to the grid and the power (load) consumption of all the load centres in terms of monetary values.

1.1 SCADA PROCESS INPUT

The scada process input are the component installed in transmission network and the plants are the 330 KV or 132 KV substations or switchyards. The plant components or objects to be monitored are:-

i. **Circuit Breakers**:

These are the most important objects that are monitored in NEPA SCADA SCHEME.

They can either be open or closed and this information is sent to SNCC or Acc.by the SCADA system. The necessary information about the state of the breaker is derived from the pallet switches of the breaker. The DASA system cannot perform properly if the pallet switches do not operate correctly. Thus, the normally open contacts and the normally closed contacts must not assume the same state simultaneously. Therefore if they are both open or both closed, the DASA system will be unable to send the required information to SNCC. Or ACC. For this reason the pallet switches must always be in good condition and must always be promptly serviced when it is necessary.

ii. **Isolators:**

The Isolators or disconnect switches are the next items that are monitored by the DASA. system Specifically their auxiliary contacts are monitored to determine whether the isolator is open or closed. The same observations stated in (i) concerning pallet switches also apply here. The contacts must hence be properly maintained the state of the circuit breakers and the isolators are called double indication because two different relays monitors their open and close positions.

iii **Alarms**

These are the normal stations alarms and are called single indications. The DASA monitors the flagging of the alarm relays in the substation through free contact for each alarms Several alarm are usually parallel i.e group together to onward transmission to SNCC Shiroro.

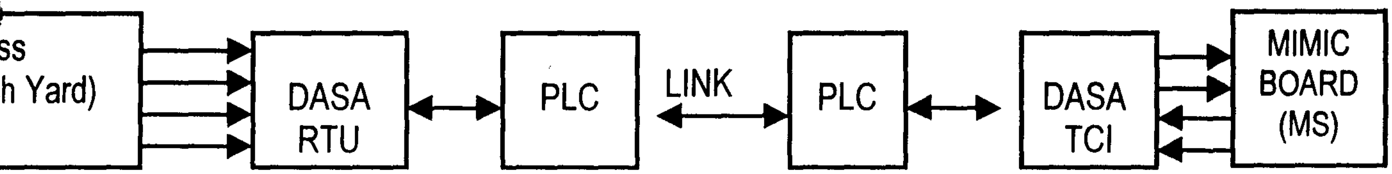
iv **Measurands:**

These are voltage, mega – watt and mega – var they are used to measure feeder flow transformer loadings, generator loadings. Bus voltage etc they are different from indications in that they are dynamic (ie. Change continually) and analogue (i.e they can assume any value within defined limits) these measure ands and sampled at regular intervals measured, and sent to SNCC Shiroro.

CHAPTER TWO

DESCRIPTION OF SHIRORO SCADA NETWORK

2.1 SYSTEM INFORMATION FLOW



Legend RTU – Remote Terminal Unit

RS – Remote Station (Substation)

PLC – Power Line Carrier

MS – Master Station

Fig. 1 Block diagram of Shiroro Area Control Centre Scada Scheme.

As depicted in figure I, status of the process to be monitored is sent to the DASA RTU for processing. The status informations are the indications and measurands from the switchyard. The RTU sends this information through the PLC to the Master Station when requested to do so by the master Station.

The PLC link used is the same used for telex, fax etc. At the master station in SNCC, the information arriving from the remote station is thoroughly analyzed for errors and then displayed on the Mimic Board in the desired form through a computers bases networks.

On Master Station supervises several Remote Stations. It sequentially requests for indication and measured information from each remote station that it is overseeing. The received information is displayed.

Mimic Board's discrepancy switches and meters in the supplementary control centre, Shiroro.

To Recap, the Remote Terminal unit (RTU) takes information about the status of the switchyard objects and encodes it into digital form. This is sent

sent to the equipment (PLC) which transmits it to SNCC where it is received and demodulated by the Plc equipment. The MS SNCC recovers the relevant digital information from this demodulated signal and process it. The final output is used to drive the discrepancy lights and meters of the mimic board.

2.2 SYSTEM CONFIGURATION

(1) **HARDWARE:-** The hardware installation comprise of:-

(a) Telecontrol interface or the master station

(b) 4Nos Personal computer

(c) 5Nos Remote Terminal Units RTU

(d) PLC link ESB 500

(e) 2Nos Line Printers

(f) 4.5KVA UPS

(g) Battery Bank and Charger

(2) **FUNCTIONS:-**

(a) **THE MASTER STATION:-** The master station is the telecontrol interface between the scada computers and RTU's at the remote stations to be monitored and controlled. The TCI process all data to and from RTU computers.

(b) **THE COMPUTER (4 N0)**

These are configurated as:-

1No on – line computer

1 No standby computer

2Nos dialogue computers

The online computer communicates directly with the TCI or master station. The standby takes over the functions of on line in case of breakdown. The dialogue computers are for the operators to overview the system (network) or to make new entries without disturbing the system.

(c) THE REMOTE TERMINAL UNITS

The RTU's process all the station data collected and transmit same via the PLC links to the master station. RTU's must be installed in the individual stations to handle the station data and commands. All RTU processes are microcomputer based. These are performed by SINAUT 8FW64; FW1024 or FW512 depending on station size.

THE PLC LINKS

The siemens PLC links. ESB500 provides the communication links between the remote stations and the master station. This is so because the SCADA signal in super-imposed on the PLC speech channel without interference.

POWER SUPPLY

In addition to the normal battery bank and charger that provides the system with power supply, there is 4.5KVA UPS which provides a steady supply to the TCI and computers.

LINE PRINTERS

The line printers provides on and off line colour print outs of all events and operates, inputs such as change of state of alarm indication.

2.3 THE DASA REMOTE STATION

The remote station has the function of collecting the desired information about the process (i.e switchyard and transmitting same to the SNCC. It also accepts on the process accordingly.

The block diagram of the RS is given in Figure 2.

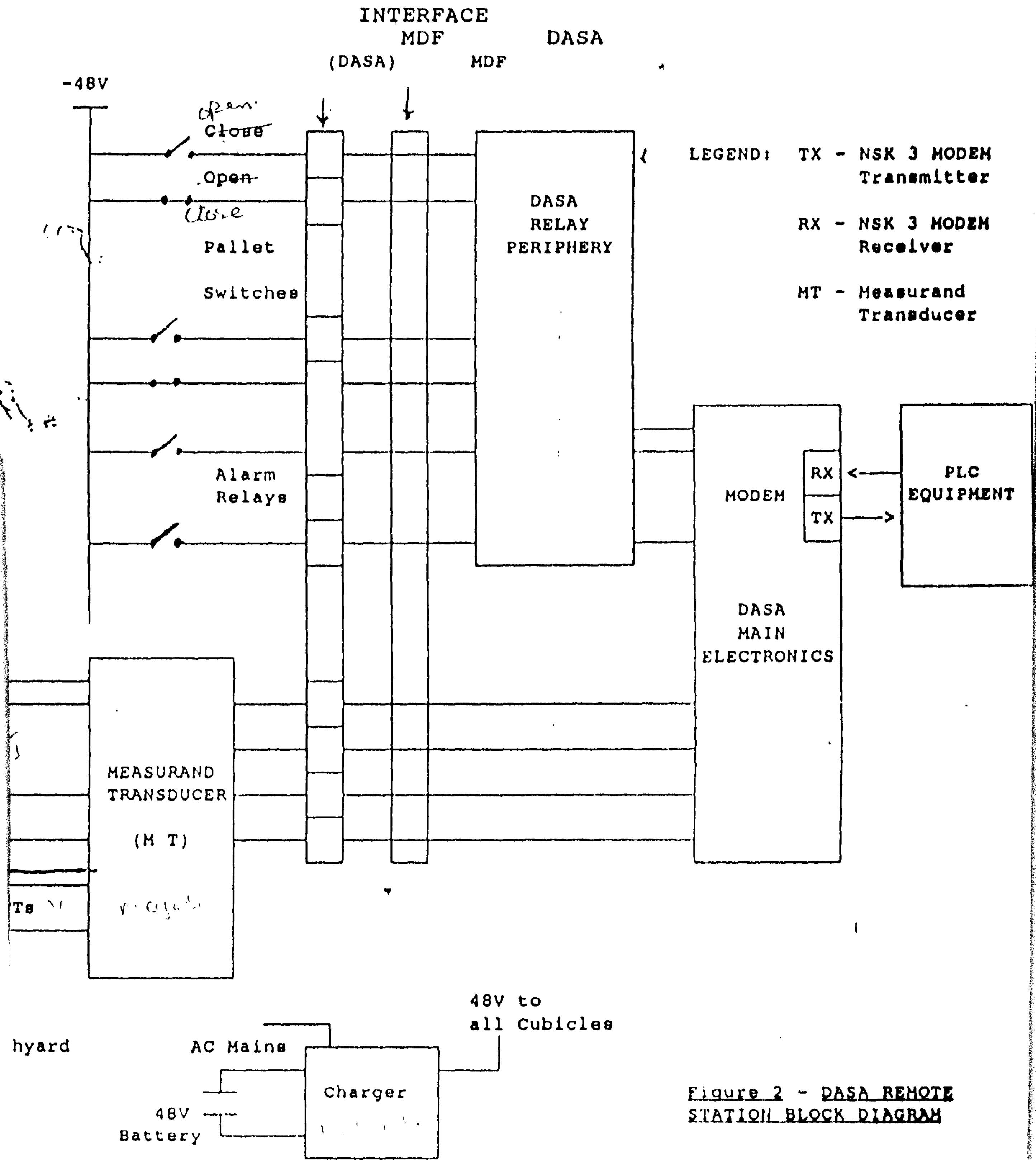


Figure 2 - DASA REMOTE STATION BLOCK DIAGRAM

The pallet switches or auxiliary contracts for the CB's or isolator in the switchyard is wired to the MDF. From here, they are taken into DASA Relay periphery via the DASA MDF. The Relay periphery acts to galvanically separate the DASA electronic from the high voltage, high current switchyard. It also act as a memory of the present indication status. Station alarms are also treated similarly as the double indications. These information are sent to DASA main electronics for processing.

The measured transducers accept inputs from the line CTs and VTs, and product current outputs in milliaps which are proportional to line voltage, MW and MVAR. These are also sent to DASA main electronics for processing.

The main electronics accept inputs from the relay periphery and analogue measurands from the measurand transducers, then processes and encodes them for transmission to SNCC by the PLC equipment.

The NSK 3 MODEM Transmitter, which is part of the main electronics, converts digital signals of the main electronics into frequency shift keying (f.s.k) signals of frequency 2700 +/-90 Hz which is then sent to the input of the PLC. Conversely, the NSK3 MODEM receiver accepts fsk signals from the output of the PLC and converts it into digital signals.

The PLC equipment modulates the 'Carrier' frequency with information and inputs it into the single side-band equipment for transmission by the power line. Similarly it receives and demodulates high frequency SSB signals from the power line into band signals.

The charger and 48v lead-acid battery acts as an uninterruptible power supply (U.P.S.) to all the communication equipment. The charger contains several MCB/switches that are used to switch individually the various equipment connected to it.

A remote terminal unit processes three types of indication namely:

i. The double indication: which describes the status of a breaker or an isolator
ii. Single indicator: In which the state of an alarm is monitored and
iii. Transformer tap-changer position indication.

There are a total of 192 indication status in DADA and each is divided into 16 groups of 12 indicators each. Six of these in group 12 indications each. Six of these in group 15 are however reserved for the purposed of supervising DASA remote stations communications between the master station and the remote stations is necessarily ordered. And it occurs in a sequence whose governing principle is referred to as the DASA cycle. In a atypical DASA cycle. Supervisory Control And Data Acquisition of interest to us here. In so far as the RTU is concerned, is achieved as a result of the following consideration.

i. Data and measurands usually occupy the system continuously and signals bearing information on data or measurands are very dynamic.
ii. Changes in indication status. Which rarely occur are very critical and must therefore reflected immediately.

In addition in order to ensure by the strict adherence to two important rules namely:

a. Initiative belongs to Master Station only.
b. Transmission of a reply is from one remote station at a time only and this occurs after a call has received from the master station.

The brief discussion given in this section has firmly established place of the RTU in a DASA system. And is logically followed by another concerning the Remote Terminal units this is done in 3 which follows.

REMOTE TERMINAL UNITS

A remote terminal unit consist of

i. An electronic cubicle
ii. A relay peripheral cubicle and
iii. A transducer cubicle

Electronic cubicle is characterized by even basic electronic prints. Namely: X3FA, X3FB, X3FC, X3FD, X3FE, X3FF and X3FG which together constitute the central logic control for the operation of the remote stations.

Common to both Master Station and Remote Stations is the X3FA, although different signals are utilized at either station. In the case of the remote stations, a 24MH signal is generated via a quartz oscillator and all other signals derive from this basic clock for use in the Remote stations. Relevant derived signals of importance to the remote terminal unit are:

- TADW which derives from an X3FA which has passed through divide-by-two followed by divide-by-two and divide-by-three stages. Use is made of this signal during conversion of analog input into a digital signal in the Analog-to Digital A/D converter.
- STAGES 5.6 AND 7 CLOCK which is a clock output of divide stages 5(ST5), 6(ST6) and (ST7) necessary for the production of other pules, an examples of which is the UZO.
- UZO which handles the reception and transmission of telegram which drives from ST7 according to an expression given as UZO = ST7E.

- UZO a derivative of UZO is a short pulse of about 2 microseconds duration, which derives from the negative flank of UZO in conjunction with a 240KHz signal.
- ZR is a synchronizing pulse signal whose function is to synchronise all flip-flops signal E in order to ensure that signal ST7 is in phase with the signal received from the master station.

CALL TYPE

DATA	FF	DT
COMMAND		BF
COMMAND TOTAL		AL
INDICATION		DT BF

The X3FC is characterized by two additional signals during cal analysis and these are:

- The monostable Qp: Which checks the arrival of acknowledgement with in a prescribed period
- Signal BAG: Which enables the transfer of command from electronic to periphery.

Information source and types injected during collection of transmitted telegram by X3FC are:

i. At time Z13 of X3FB, the start bit

ii. Remote station address from X3FB

iii. Type of call from X3FC

iv. Parity bit from X3FE

When measurands and indication information are being transmitted, X3FD operates as a parallel-in serial out (PISO) ring shift register. It's operation as a ring shift register implies that the last information items transmitted are retained until the Master Station indicates that no error occurred in the received messages. If an error is detected, the MS orders a retransmission of indication (WIM) or measurand (WID).

In the reception of command mode, X3FD operates as a serial-in parallel-out (SIPO) shift operator. The command wom which is of via the electronic interface to the relay periphery. The enabling signal is the BAG which is applied for a 200 millisecond duration, with an erasure signal which endures for 400 mil-seconds.

CHAPTER THREE: *SYSTEM OVERVIEW*

3.1 <u>SYSTEM CONCEPT:</u>

The SINAUT PC-32 Network Control Center system has been developed for the use in the fields of power system control.

It is a standardized package with modular structure. The system can be easily expanded and enhanced by adding various further modules. The archieved data can be analysed with standard industry type programs (e.g Bas III) or ported to other software packages or to other computers.

SINAUT PC-32 uses the concept of distributed processing. E.g two or more computers connect to a local area network (LAN). The LAN used is an Token-Ring LAN. The various functions are thus divided amongst the workstations. In comparison to conventional systems, this results in greater processing capability and faster reaction times, as each computer performs its own specific functions. In the event of failures a changeover can be performed either automatically or by an operator. (hot or warm stand by).

During the development great importance was placed on the ease of operation and the need for simple data base generation and maintenance. This means that the user can easily reconfigure, change or expand his system by himself, without any specific hardware or software knowledge.

3.2 HARDWARE DESCRIPTION:

COMPUTER HARDWARE:

The system is designed to run on standard hardware. Thus we based our concept on our powerful 32-bit workstations, which are AT-386 compatible. These workstations are manufactured by SIEMENS and are available worldwide for industrial environments. Depending on the requirements, two types of workstations, both with the same CPU but with different clock frequencies, can be used. I.e 16 or 25 MHZ respectively.

The workstation SIEMENS PCD.3T or PCD-3TS are equipped as follows:

- PENTIUM III
- 866MB
- Standard RAM 64 – 120 MB
- Hard Disk 20 GB
- 3 ½ " 1.44 MB Floppy disk drive
- Kebyboard
- Mouse
- 60 MB Magnetic Tape Streamer
- CD ROM

The SINAUT PC-32 system consist of at least two identically equipped workstations. All workstations are interconnected via a 16MB/Sec. Token-Ring-Network. The workstation, which is linked to the telecontrol interface 9TCI) is called the on-line workstation and all the others, dialogue – workstations. Up to six dialogue workstations can be connected to the token-ring LAN, thus realizing a multi workstation control center. In this case the so called on-line workstation plays the role of a sever workstation to the dialogue workstations (please refer to chapters 4 and 5 which describe the different functions). The on-line workstation communicates with the process, providing the other computers with data via the LAN.

The diagrams are displayed on standard colour monitors in the EGA or VGA mode. 14" monitors can be used but 19[th] monitors are recommended.

3.3. TELECONTROL INTERFACE

The telecontrol interface (TCI), the front-end system between the RTUs and the workstations. It consists of components from the standarized SINAUT 8-FW telecontrol system. The SINAUT 8 telecontrol interface handles the traffic to the remote stations and operates either as a stand-alone system or optionally in conjunction with an identical second one in an redundant mode.

The standard traffic modes available are

- Point-to-point traffic
- Multiple point-to-point traffic
- Polling traffic

They are implemented on the basis of the SINAUT 8-FW message structure. The telecontrol interface has an actual message image (replica) of all the connected RTUs and performs preprocessing via this data.

Information messages are compared old-against-new-ones. Only changes in the information are sent to the computer as spontaneous messages. Furthermore, a check is made to establish whether the expected analogues are transmitted from the RTUs to the control centre within a stipulated cycle. Metered value messages are transmitted as spontaneous messages after receipts of the special command, (end of meeting period). The telecontrol interface transmits the corresponding meter advance data to the computer.

All RTUs or a particular RTU can be interrogated (scanned) by the on-line workstation. Commands from the computer are converted in the telecontrol interface to the SINAUT 8-FW message structure and transmitted as spontaneous messages to the particular RTU.

Besides the telecontrol functions, the SINAUT 8-TCI can also perform the tasks of the SINAUT 8-FW central controller (master station). This allows output of process data top mimic diagrams, alarm signal enunciators and instrument panels independent of the computer.

The RTUs of the SINAUT 8-FW series are

- SINAU 8 – FW 1024
- SINAUT 8 – FW 512
- SINAUT 8 – FW 64
- SINAUT 8 – FW 8

The connection of the RTUs to the central control system SINAUT PC-32 is simplified by the use of standardized address and information allocations, classified according to information types.

The SINAUT PC-32 system uses the operating system MS-DOS, which is widely used for workstations and personal computers. It is easy to use and highly transparent on the operator level. The software system for the SINAUT PC-32 control centre system is characterized by its great flexibility.

3.4 PROCESS INTERFACE:

The data acquisition is performed by the RTUs at site and data are transmitted via a communication network to the telecontrol interface. The interface from the TCI to the on-line workstation is standard V.24. The Siemen 3964R procedure, which runs at 9600 Baud, is used as a standard protocol.

The data received from the RTUs are transferred from the TCI to the on-line workstation. The on-line workstation cyclically interrogates the TCI. When changes have occurred telegrams are then transmitted to the on-line workstation. If no changes have taken place the TCI answers with a message – nothing new to report.

Commands and setpoint telegrams are sent to the TCI when initiated by the operator.

The following message types are used between TCI and on-line workstation:

- interrogate and confirm
- alarms and indications
- analogues
- counter values
- commands
- setpoints
- substation interrogation
- start of metering period

3.5 SCREEN LAYOUT:

The display is operated in the VGA/EGA graphics mode. The station diagrams and lists are made up of 25 lines and 80

- display of command and station blocking
- estimated analogue or metered values
- texts to aid operator

Line 3:

- Events Line
- plain text for events and faults occurring in the system independent of which picture is displayed.
- the oldest non-acknowledged event is displayed in this line.
- individual or group acknowledgement is possible via function keys.

ON-LINE WORKSTATION

SYSTEM DISPLAYS (DEVICE FAULTS) DATE/TIME
OPERATOR DIALOGUE WITH SYSTEM
EVENTS LINE
FREELY AVAILABLE AREA FOR REPRESENTATION OF DIAGRAMS AND REPORTS (22 LINES)

The first 3 lines on the display terminal are used for general information, irrespective of the type of diagram displayed.

Line 1:
- device faults
- current date (Day, Month, Year)
- current time (Hrs., Min.)
- (**) the number of unacknowledged alarms

Line 2:
- Operator dialogue with System
- display of all operator inputs e.g. display command ON/OFF
- display of new setpoint value
- display of limit values
- display of new limits during modification of limits

CHAPTER FOUR (ON-LINE WORKSTATION FUNCTIONS:)

4.1 INFORMATION PROCESSING:

Process or plant data are defined as alarms indications, analogues, and metered values.

INDICATIONS AND ALARMS:

Following types are defined:

- 1 – bit indications
- 1 – bit alarms
- 1 – bit fleeting alarms
- 2 – bit indications

They are displayed as follows:

- Alarm list (disturbance overview)
- Station diagrams
- Event lines in station diagrams on the monitor
- Logbook (monitor and printer)
- Event lists (monitor and printer

This alarms and ch of state are printed and/or displayed together with text, the time (hr.min) and date.

SUBSTATION DIAGRAM SYMBOLS:

20 different symbols are available for the representation of 1 and 2 bit indications. They are saved on files and can be changed using the data base management functions.

Various states are displayed in different colours. Any changes of state are indicted by a flashing symbol which goes steady when

The different indication types can be transmitted together in one telecontrol telegram. Indications can be manually updated, blocked, inhibited and unblocked. Manually updated indications are displayed with a brown background. Indications can be excluded form processing by setting inhibit flag.

ANALOGUES:

The analogues can have a resolution of 8, 12 or 16 bits. Values with or without a live zero can be processed. They are checked for plausibility and whether the upper and/or lower limits have been exceeded. Each analogue has two upper and two lower limits. The analogues are displayed in the station diagrams in a digital or analogue form. When the first upper or lower limit is exceeded the value is displayed in red. A warning appears in the Events Line and it is entered in the Events List and Logbook. When the second limit is exceeded it is displayed in red on a white background.

When an analogue range (live zero) is exceeded it is handled as above except that it is displayed in blue. Analogues not acquired at the RTU are displayed in magenta.

As in the case of alarms, analogues can be blocked and manually entered by the operator. Manually updated analogues are displayed in yellow. When a limit has been exceeded also an audible alarm can be sounded.

METERED VALUES:

The Counters are interrogated via a start telegram. The counter contents are transmitted to the TCI and then reset to zero. The cycle period is a parameter which can be set.

As with the analogues the metered values are displayed in the station diagrams and printed in the Events List. These values can also be blocked and manually entered by the operator.
An upper limit can be set which if exceeded at the end of the meeting period can give an alarm.

4.2 COMMANDS:

To execute a command the cursor is positioned with the mouse on the symbol of the device to be switched. The function key, ON or OFF, is then pressed. A message appears in the Events Line showing in plain text the command to be issued.

After pressing the function key, 'Command execution' the command is issued as telegram. The device symbol flashes until the return information form the device is received. When it is received the flashing goes steady. The command and the subsequent indication are entered in the Events List and the Logbook. If the return information is not received within an predetermined time an alarm is given. Devices can be blocked and unblocked via the mouse and the respective function keys. Blocked device indications are displayed with a blue background.

4.3 SETPOINTS:

Setpoints commands are defined by positioning the cursor with the mouse on the symbol of the respective device. The setpoint-value is then typed in and the respective function key is pressed. The message then appears in the Events Line. The execute key then has to be pressed and the command is released. The event is printed in the Logbook and the Events List.

pressed and the command is released. The event is printed in the Logbook and the Events List.

4.4 **DERIVED DATA:**

Forty eight one – bit indications can be combined using OR/NOR functions to form a single one bit indication. In the same way, derived analogues and metered values can be formed from 48 analogue and 48 metered values respectively and displayed in the displays. Addition, subtraction, multiplication, division, and constant operators can be used to form a derived value.

Derived data can have the status on-line, off-line and manually updated and are displayed as such in the displays. The status off line and manually updated are valid when at least one of the variables used in forming a derived date is off-line.

These derived values are calculated when required e.g

- in displays
- in status reports
- in archive files.

REFERENCES

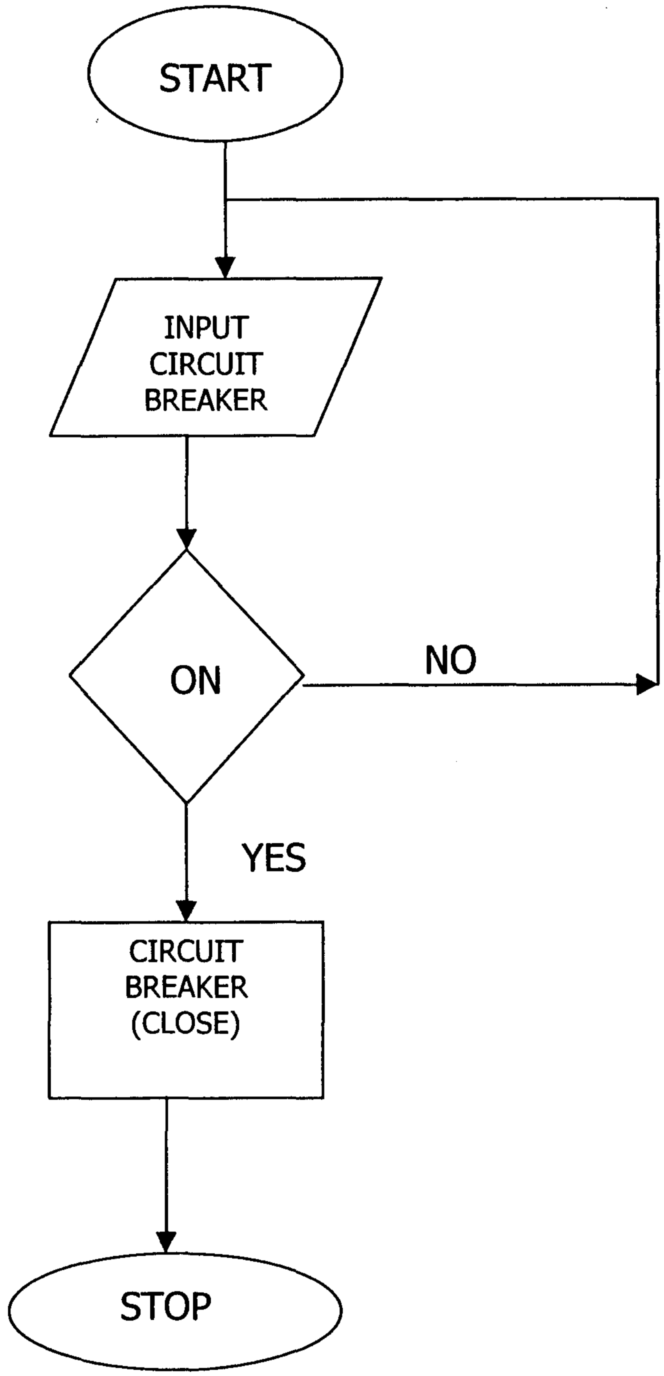
1. Adeyemo B.O (Engr) — Paper presented to professional skill training centre Kainji (Sept, 1996)

2. NEPA — Process/Real time NEPA net station, Shiroro from SNCC Computer daily printout of (10 – 4 – 2002)

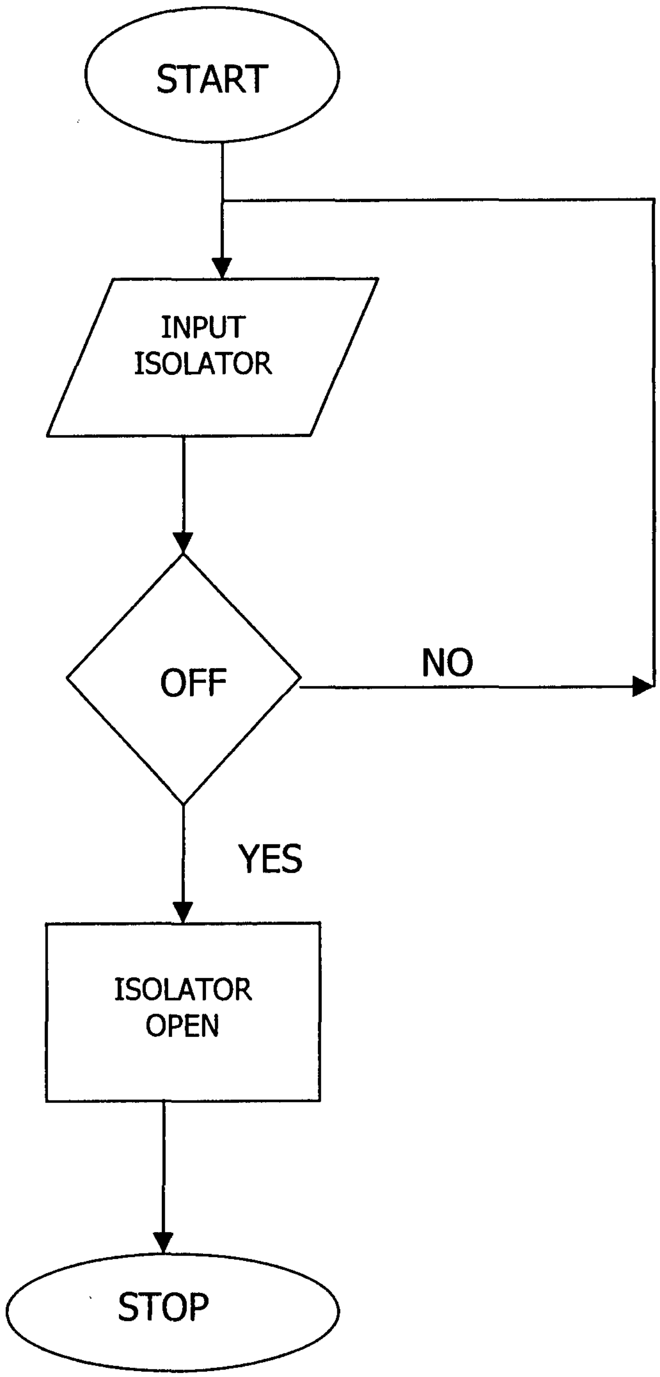
3. NEPA — Process/Real Time message Retrieval from SNCC computer daily printout of (10 – 4 – 2002)

4. SIEMENS — Power System Control Sinaut PC – 32 (Magazine March 1990)

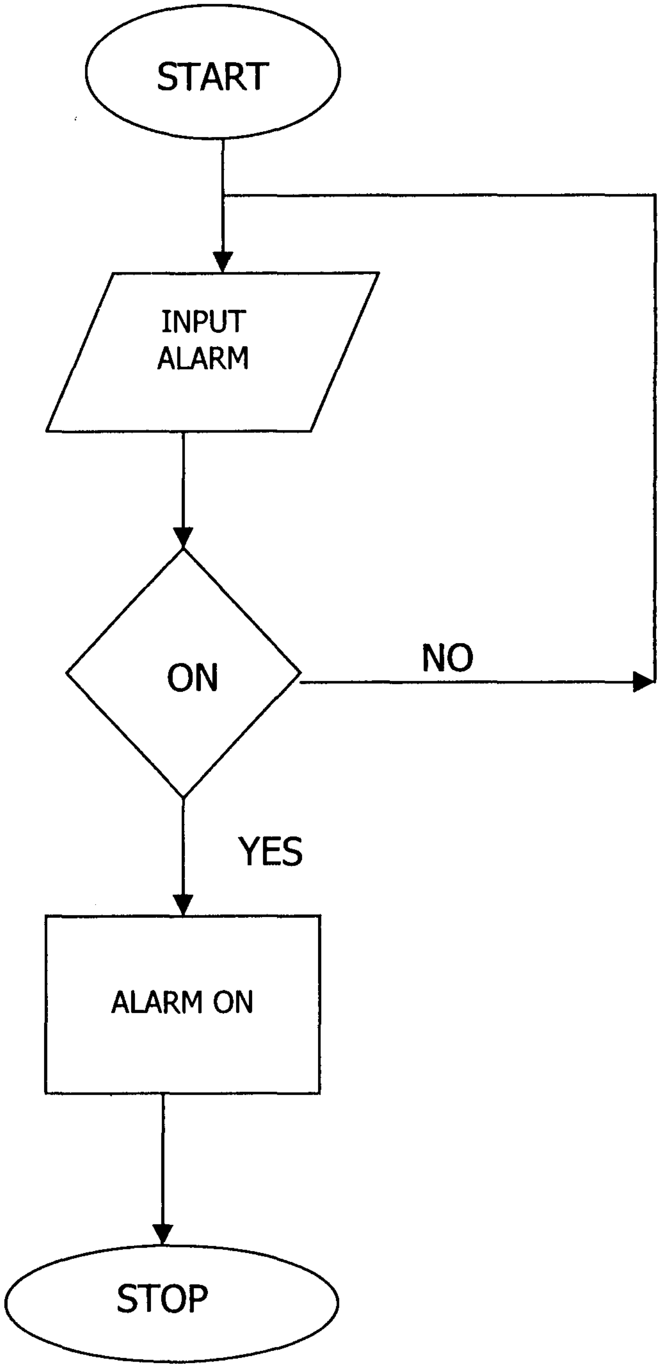
APPENDIX


START
INPUT CIRCUIT BREAKER
ON
NO
YES
CIRCUIT BREAKER (CLOSE)
STOP

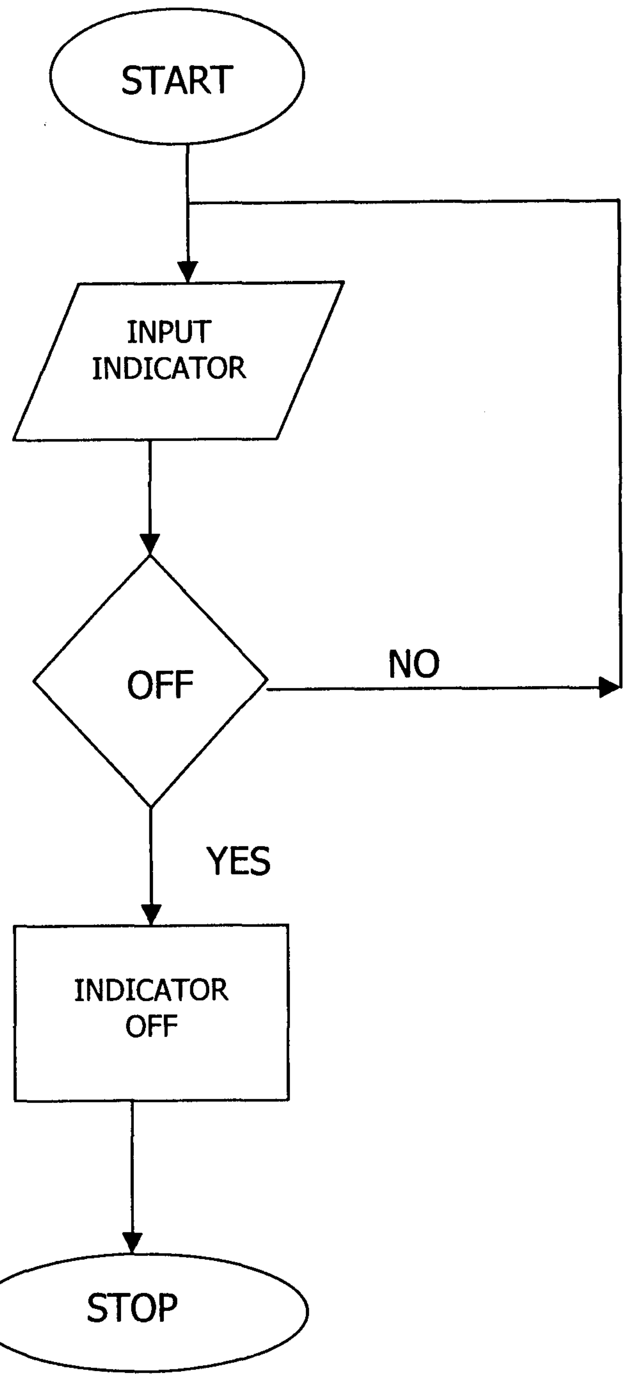
APPENDIX II



APPENDIX III



APPENDIX IV



SYSTEM PROGRMMING (BASIC LANGUAGE)

Programme I.

```
10    REM  Program to identify circuit  breaker status
20    Input Circuit breaker
30    Process circuit breaker status (Open or close)
40.   Print Status
50    END
```

Programme II.

```
10    REM  Program to identify Isolator status
20    Input Isolator
30    Process Isolator status (Open or close)
40    Print Status
50    END
```

Programme III.

```
10    REM  Program to identify Alarm status
20    Input Alarm
30    Process Alarm status (On or Off)
40    Print Status
50    END
```

Programme IV.

```
10    REM  Program to identify Indicator status
20    Input Indicator
30    Process Indicator status (On or off)
40    Print Status
50    END
```

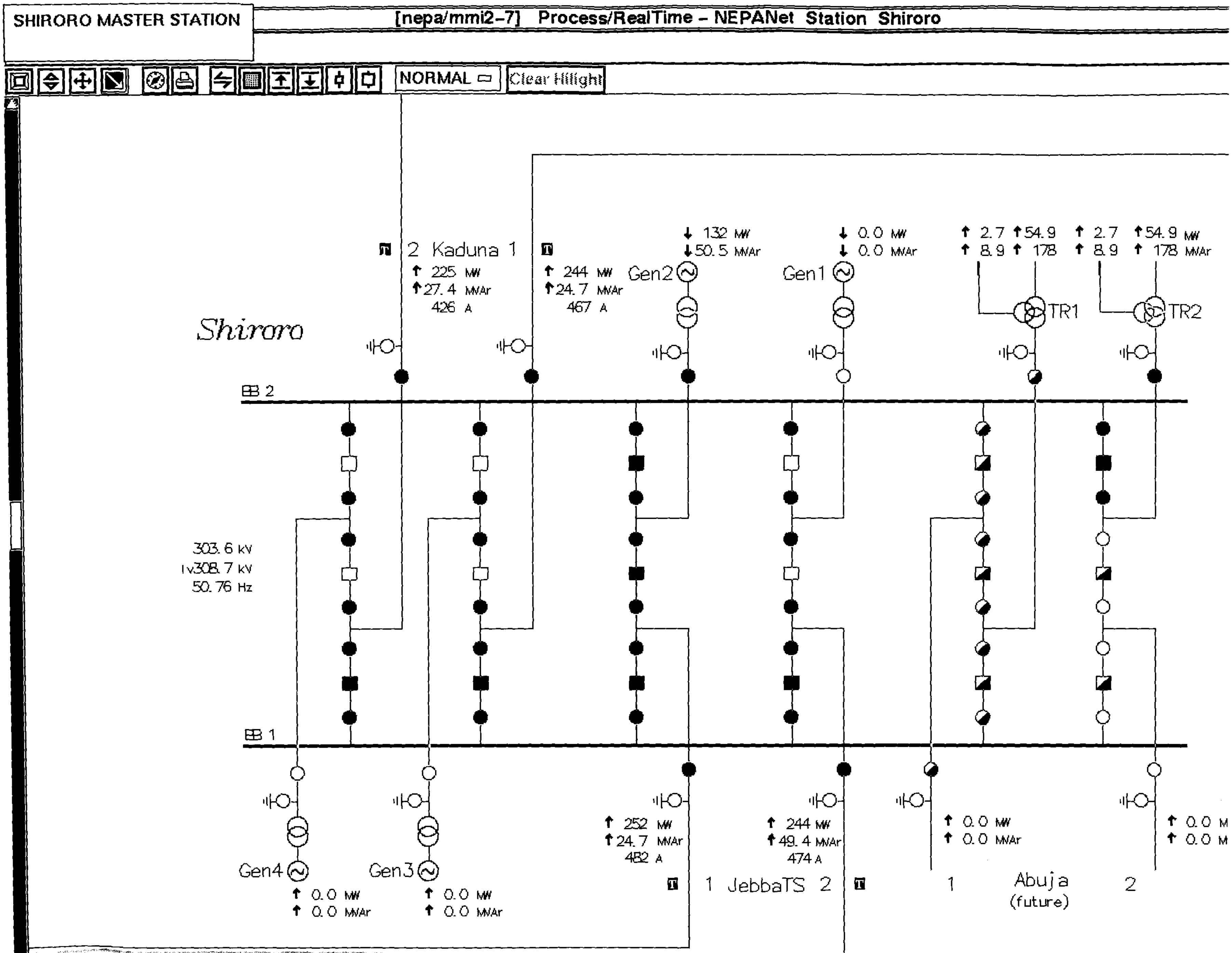
SHIRORO MASTER STATION | [nepa/mmi2-6] Process/RealTime – Message Retrieval Mask (list)

End

Filter | Page – | Page + | RequMore | DistDial | DistReco

Message Retrieval | date: from 10 4 2002 to 10 4 2002 | page 10 of 11 pages
Filter Shroro

10.04	22:05:45	Shroro	330	BB	50.9	51.0 Hz		disapp	U1
10.04	22:06:29	Shroro	330	BB	49.7	49.8 Hz		appear	L1
10.04	22:06:33	Shroro	330	BB	49.4	49.5 Hz		appear	L2
10.04	22:07:36	Shroro	330	BB	49.6	49.5 Hz		disapp	L2
10.04	22:08:05	Shroro	330	BB	49.9	49.8 Hz		disapp	L1
10.04	22:17:00	Shroro	330	BB	49.8	49.8 Hz		appear	L1
10.04	22:17:53	Shroro	330	BB	49.5	49.5 Hz		appear	L2
10.04	22:19:21	Shroro	330	BB	49.6	49.5 Hz		disapp	L2
10.04	22:20:13	Shroro	330	BB	49.9	49.8 Hz		disapp	L1
10.04	22:35:04	Shroro	330	BB	49.8	49.8 Hz		appear	L1
10.04	22:35:28	Shroro	330	BB	49.4	49.5 Hz		appear	L2
10.04	22:36:02	Shroro	330	BB	49.8	49.5 Hz		disapp	L2
10.04	22:36:07	Shroro	330	BB	50.2	49.8 Hz		disapp	L1
10.04	22:36:59	Shroro	330	BB	51.0	51.0 Hz		appear	U1
10.04	22:39:41	Shroro	330	Tie_2	CB		3208	open	
10.04	22:40:43	Shroro	330	BB	50.8	51.0 Hz		disapp	U1
10.04	22:40:50	Shroro	330	GTr_3	CB		3214	open	
10.04	22:40:59	Shroro	16	Gen_3	Gen. auto stop			appear	
10.04	22:40:59	Shroro	16	Gen_3	Exciter trouble			appear	
10.04	22:41:12	Shroro	16	Gen_3	Gen. auto stop			disapp	
10.04	22:41:24	Shroro	330	GTr_3	Iso Line		3211	open	
10.04	22:41:24	Shroro	16	Gen_3	voltage			open	
10.04	22:41:55	Shroro	330	BB	49.8	49.8 Hz		appear	L1
10.04	22:44:49	Shroro	330	BB	50.0	49.8 Hz		disapp	L1


SHIRORO MASTER STATION
[nepa/mmi2-7] Process/RealTime - NEPANet Station Shiroro
NORMAL
Clear Hilight
Shiroro
2 Kaduna 1
225 MW
27.4 MVAr
426 A
244 MW
24.7 MVAr
467 A
Gen2
132 MW
50.5 MVAr
Gen1
0.0 MW
0.0 MVAr
2.7 54.9
8.9 178
TR1
2.7 54.9 MW
8.9 178 MVAr
TR2
BB 2
BB 1
303.6 kV
lv308.7 kV
50.76 Hz
Gen4
0.0 MW
0.0 MVAr
Gen3
0.0 MW
0.0 MVAr
252 MW
24.7 MVAr
482 A
244 MW
49.4 MVAr
474 A
1 JebbaTS 2
0.0 MW
0.0 MVAr
1 Abuja 2
(future)
0.0 M
0.0 M