PLC Based Multipoint Yarn Monitoring System

PROJECT REPORT

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TO WHOMSOEVER IT MAY CONCERN

This is to certify that the project titled **"PLC BASED MULTIPOINT YARN MONITORING SYSTEM"** was sponsored by us and was developed by the following Students of Final Year B.E, (EEE Branch) of Kumaraguru College of Technology, Coimbatore with the assistance of our Research & Development Department from *December 15, 1997* to *March 20, 1998.*

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The above mentioned prototype was successfully completed with all the students actively participating in the development. During the period of development, their attendance and conduct were very good. We wish them all success in future.

For MILLTRONICS

[Partner]

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Dedicated to our Beloved Friends

Acknowledgement

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Synopsis

SYNOPSIS

In the fast and advanced scientific world, the basic needs of human being cannot be replaced by any innovative means. Of the three basic needs , textiles Play an essential role in the day-to-day life of human being and in the economy of the country. Thus it becomes imminently necessary to evolve modern techniques in the development of the machines and products in textiles.

The technology of textile plays a vital role in our day to day life. Textile and fashion goes hand in hand. Yarn is the product that forms the base of all textile outputs. It is responsible for all fashion and arts that can be performed in textiles.

The fiber, the natural product from cotton, is processed in many stages to reach the final stage of yarn in a textile mill.

The quality of the yarn plays an important role in textile fashion. Hence it is desirable to monitor the yam. More accuracy in the quality of yarn is achieved by Hi-Tech of the monitoring.

The objective of the 'PLC Based Multipoint Yarn Monitoring System' is

- To sense the presence of the yarn
- To indicate it at the output to measure the length of the yarn
- To activate a control circuit to stop the machine when the yarn in all the spindles are cut or when the required length has been reached.

In this project hardware is designed, fabricated and tested to realize the mentioned objectives.

The system takes over the existing monitoring system in various aspects. It has the advantages of using both PLC and PC. As per the name 'Multipoint Yarn Monitoring System', it is applicable in the places where more than one spindle has to be monitored.

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Introduction

CHAPTER 1

INTRODUCTION

One of the factors that differentiated man from animal is the fabric that he wears. The yarn is the main component of fabric. It plays an important role in the science of textile technology.

1.1 FIBRE TO FABRIC DETAILS:-

The flow chart for fiber to fabric conversion is given in fig 1.1 and 1.2.

1.1.1 GINNING

Process details:-

Cotton from the field is taken to merchandising house (trading house) from trading house, the buyers take the cotton fiber to ginning factory. In ginning factory cotton seeds are removed from the fiber. In addition to that husks, leaves, Vegetable particles are removed from the fibers. Now the fibers are ready for spinning.

1.1.2 SPINNING

The bales from ginning factory are taken to blow room section at the first instance.

1.2 CARDED YARN PRODUCTION

The process in fig 1.3 described below

1.2.1 Blow Room:-

The process that is taking place in blow room are

- Opening and cleaning the fibers.
- Removal of dust, dirt etc.
- Formation of lap.

1.2.2 Carding:-

The functions carried out in carding are

- Individualization of fibers.
- Formation of silver.

1.2.3 Drawing:-

The process of drawing comprises of

- Doubling and drafting of silver.
- Reduction in linear density.
- Fiber to Fiber parallelisation.

1.3 COMBED YARN PRODUCTION

The process in fig 1.4 described below

1.3.1 Silver lap machine

- Doubling and drafting of silver
- Formation of lap

1.3.2 Ribbon lap machine

- Formation of ribbon lap

1.3.3 Super lap machine

- Doubling and drafting
- Lap formation

1.3.4 Comber

- Removal of short fibers and fiber hooks

1.3.5 Simplex

- High amount of drafting
- Formation of roving
- Slight twist application and rowing

1.3.6 Ring frame

- High drafting
- Formation of Yarn
- Twisting

1.4 WEAVING

The yarn from spinning mill is taken to weaving preparatory and weaving departments for producing fabric/ cloth. The process flow diagram in weaving is given in fig 1.5

1.4.1 WINDING

It convert small packages(ring cop from spinning) into bigger packages(cones). It also removes objectionable yarn faults (thick, thin places, neps etc).

1.4.2 WARPING

The cone packages are converted into beams with long length of yarn.

1.4.3 SIZING

The size coat is applied on the yarn.

1.5 WEAVING SECTION

The process flow diagram in weaving is given in fig 1.6

1.5.1 Drawing-In

Drawing the yarns through drop wires, heald shafts and reed etc,

1.5.2 Tieing -In

Tieing the yarns with the previously run ends(yarn).

1.5.3 Loop gaiting

Making arrangements in the loom for running the machine.

1.5.4 Looming/Weaving

Interlacement of warp and weft yarns. The process diagram in weaving is given in fig 1.7

1.6 Wet Processing(chemical processing)

The process flow diagram in weaving is given in Fig 1.8

1.6.1 Grey cloth:-

The cloth obtained from the loom in grey condition (without any chemical treatment) is subjected to the list of treatments.

1.6.2 Sorting:-

Sorting out the fabrics for different chemical processes.

1.6.3 Stamping:-

Putting stamp (with details of fabric, chemical processes etc.) on the fabric for easy identification.

1.6.4 Stitching:-

Stitching (temporary stitch), the fabrics of same lot for continuous and long length.

1.6.5 Sinaeing:-

Removal of protruding threads from the fabric surface by burning it.

1.6.6 Desizing:-

Removed of size material (applied in weaving preparation process) for effective absorption of dyes and chemicals.

1.6.7 Scouring:-

Removal of wax, fats, oil etc from the fabric.

1.6.8 Mercerising:-

Providing more brightness or lustre and strength to the fabric.

1.6.9 Bleaching:-

Removal of natural coloring matter (yellowish white) and giving whiteness to the fabric.

1.6.10 Dyeing:-

Giving color shades for ornamentation purpose.

1.6.11 Printing:-

Producing desired design patterns for ornamentation purpose.

1.6.12 Finishing:-

Applying various finishes for durability and ornamentation.

1.6.13 Fabric inspection:-

Inspecting the fabric for defects and faults.

1.6.14 Packing:-

Packing the fabrics in different packages.

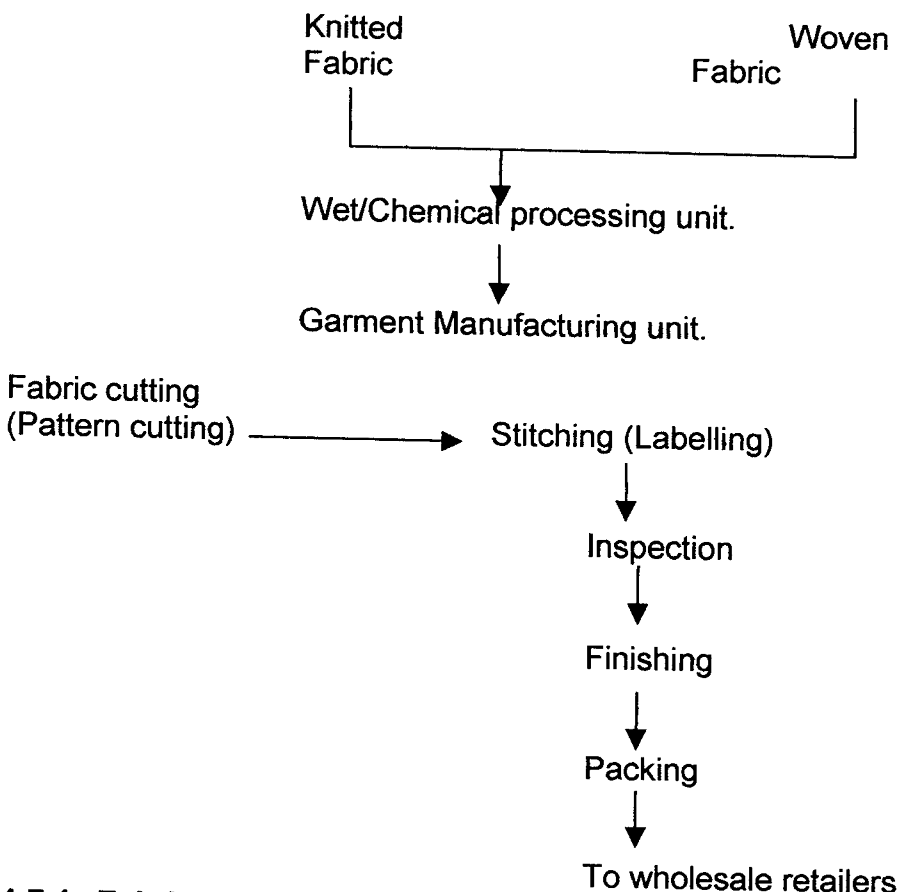
1.6.15 Bundling:-

Bundling the packages.

1.6.16 Baling:-

Arranging the packages in a bale and sending to consumers.

1.7. GARMENT MANUFACTURING UNIT:-



1.7.1 Fabric cutting:-

The fabrics from wet processing unit are taken to cutting section at the first instance. In cutting section, The fabric is cut according to the pattern of dress (using pattern cutting models) and taken to stitching department.

1.7.2 Stitching and Labelling:-

Here the cut pieces of fabric are stitched according to the requirement of fabric.

1.7.3 Inspection:-

After stitching the garment, it is inspected for defeats and faults. If ever defects are present, they are removed according.

1.7.4 Finishing:-

In this section, the garment is given for various treatments. The device which is designed, is used in winding process.

1.8 USE OF THE MONITORING SYSTEM IN TEXTILE MACHINERY:-

The monitoring system is used in the stage of production of yarn. It is used in the stage of yarn winding on the paper cone from the Ring cop. The device is placed near the paper cone, in the path of the yarn. The speed sensor is placed near the shaft axis since all the spindles are connected to the common shaft.

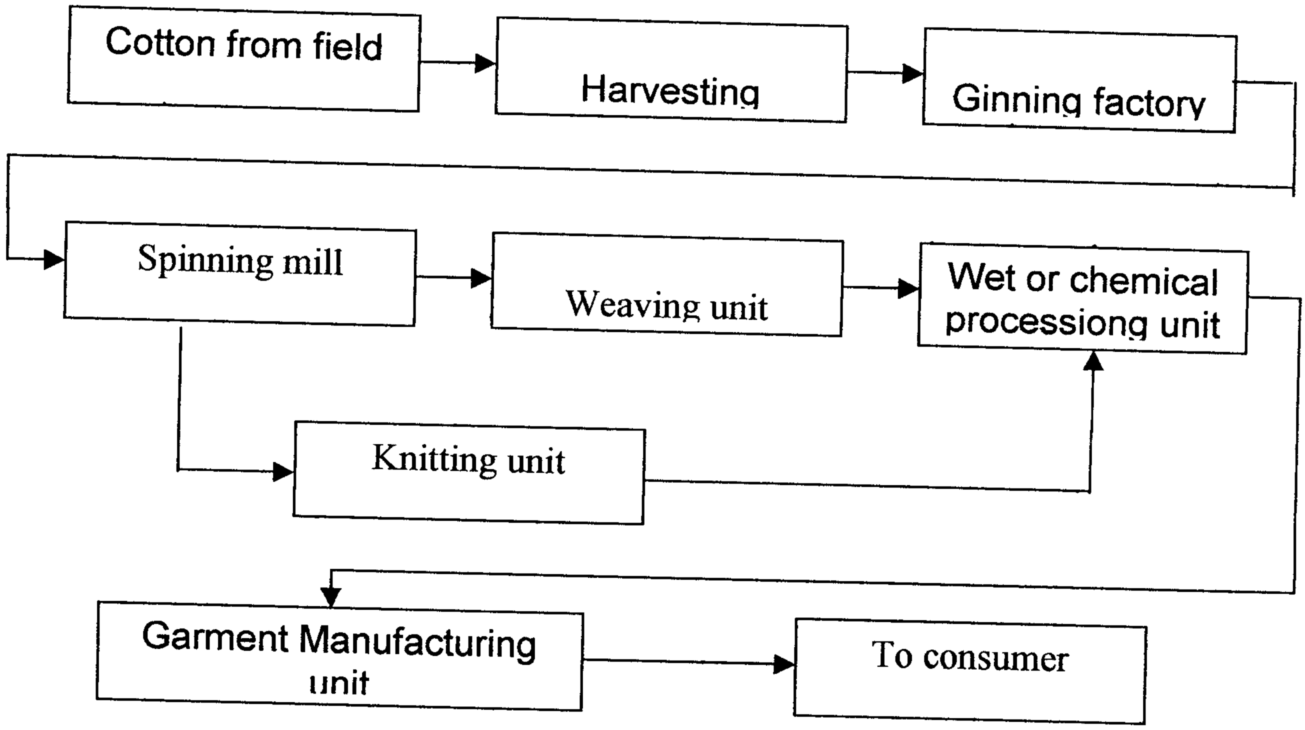


FIG 1.1 Cotton fabric production.

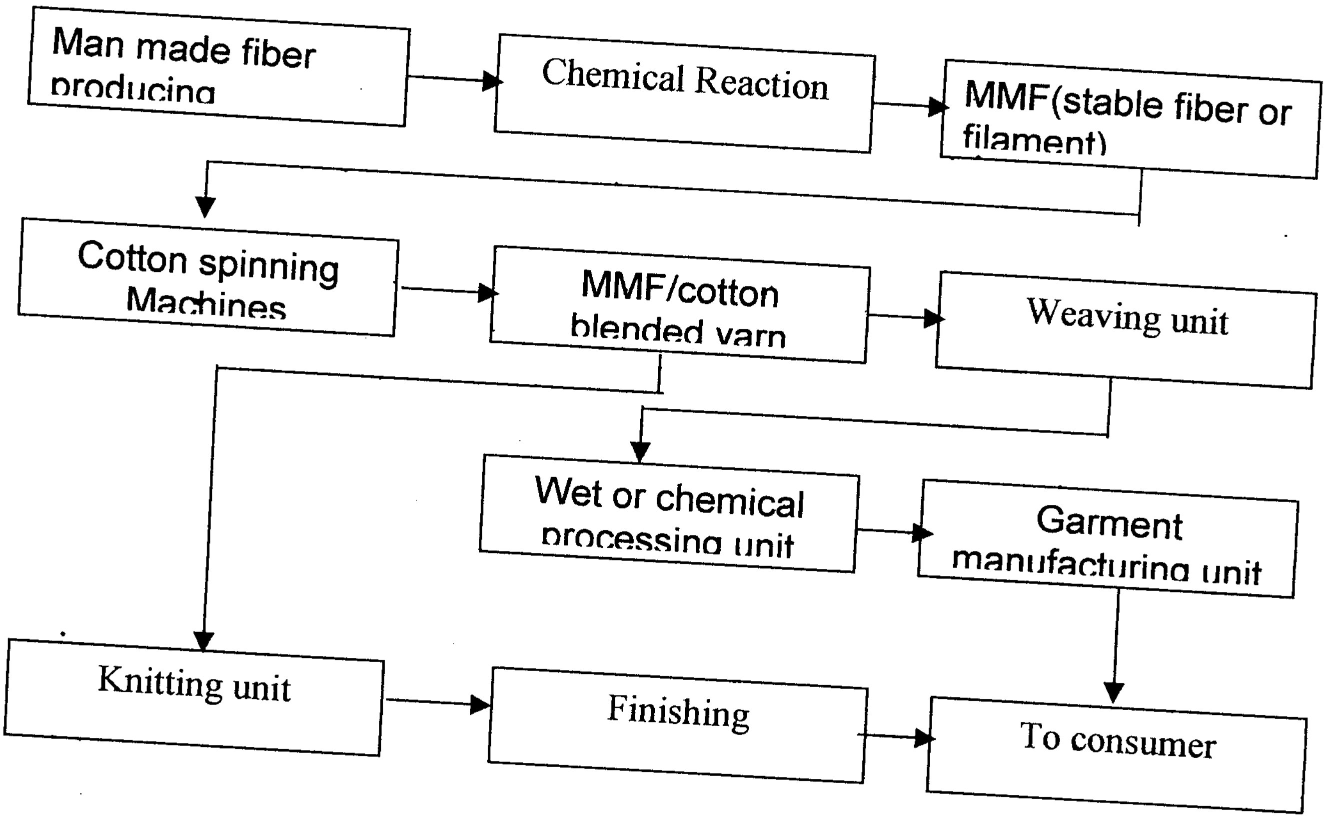


FIG 1.2 Man - Made-Fiber (MMF) fabric production.

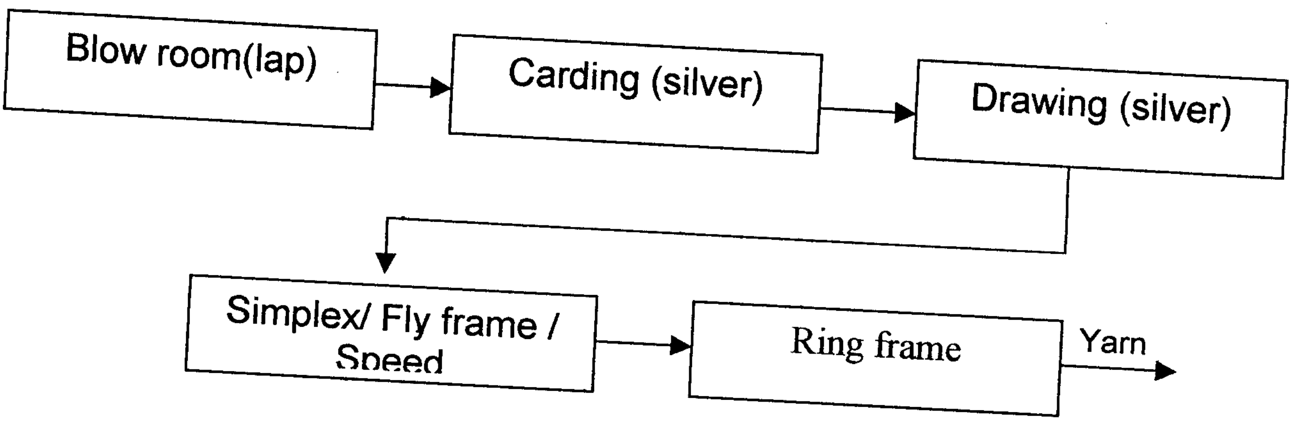


FIG 1.3 CARDED YARN PRODUCTION

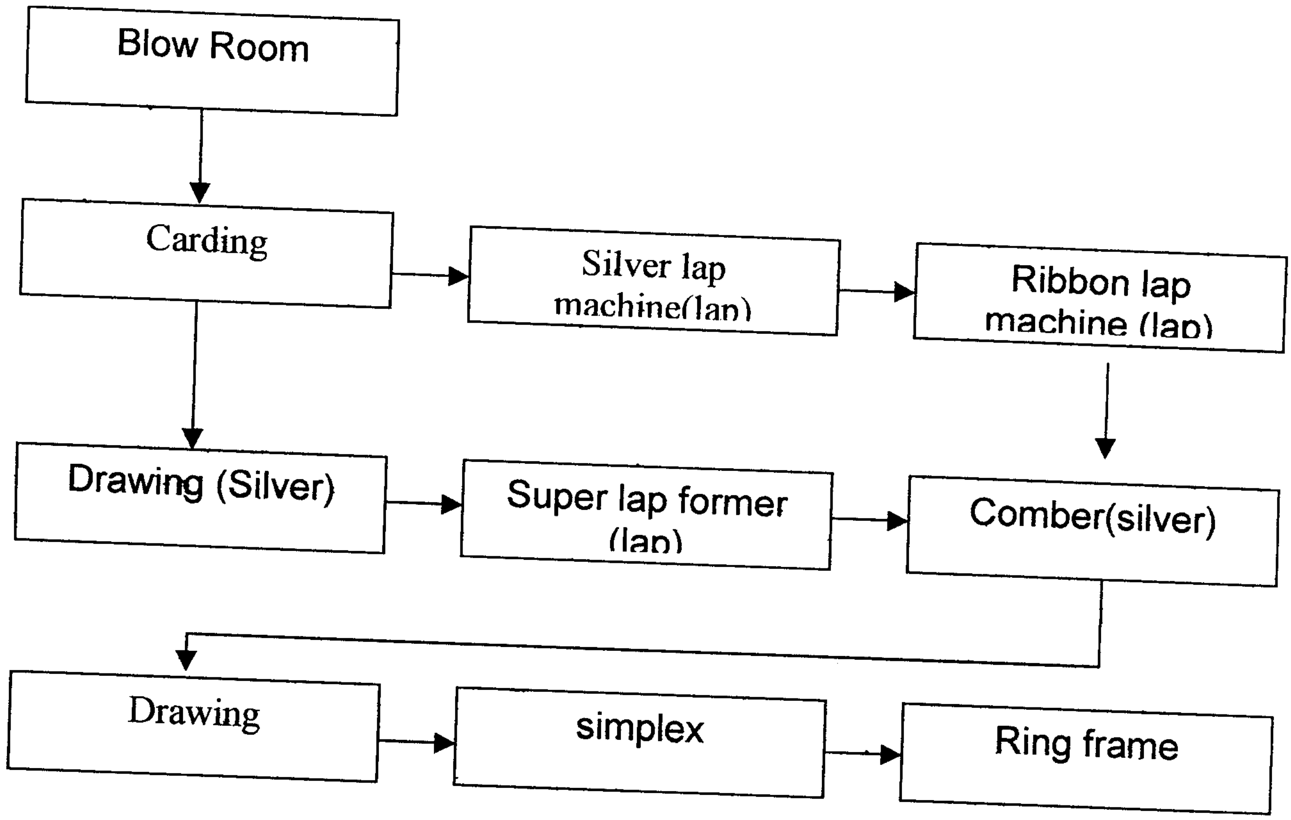


FIG 1.4 COMBED YARN PRODUCTION

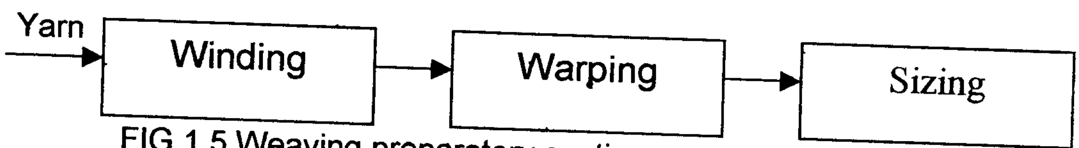


FIG 1.5 Weaving preparatory section

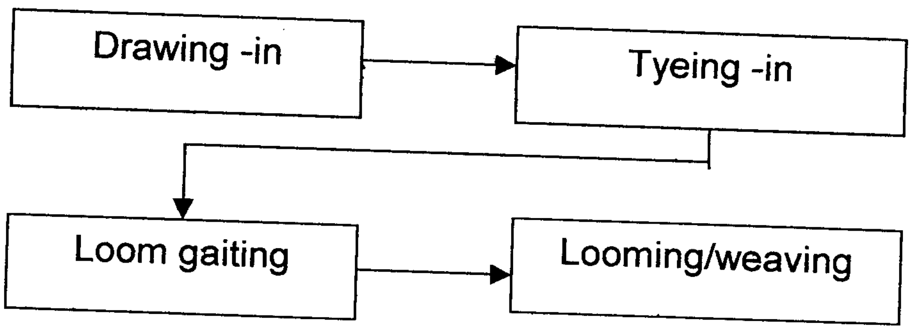


FIG 1.6 Weaving

CHAPTER 2

DESIGNING OF THE SYSTEM

This device is placed in the textile machineries in the stage of production of yarn.

The device senses the presence of yarn and helps in measuring the length of the yarn . The device is placed such that it is able to sense the yarn always. The yarn moves over the optical sensors. As long as the yarn is present over the sensor, the sensor produces a sufficient amount of voltage. This voltage is given as input to the amplifier. The amplified voltage is such that when given to the other op-amp and its associated circuits gets converted to a momentary pulse. When the yarn is cut, the pulse goes high. This pulse is given to the PLC for the purpose of counting. The proximity produces a pulse when it senses one rotation. For each rotation a pulse is generated. This pulse is also given to the PLC for counting the length of the yarn which is proportional to the rotations. When the count reaches the preset value, an indication is given at the output and when the yarn is cut, an indication is given at the input side.

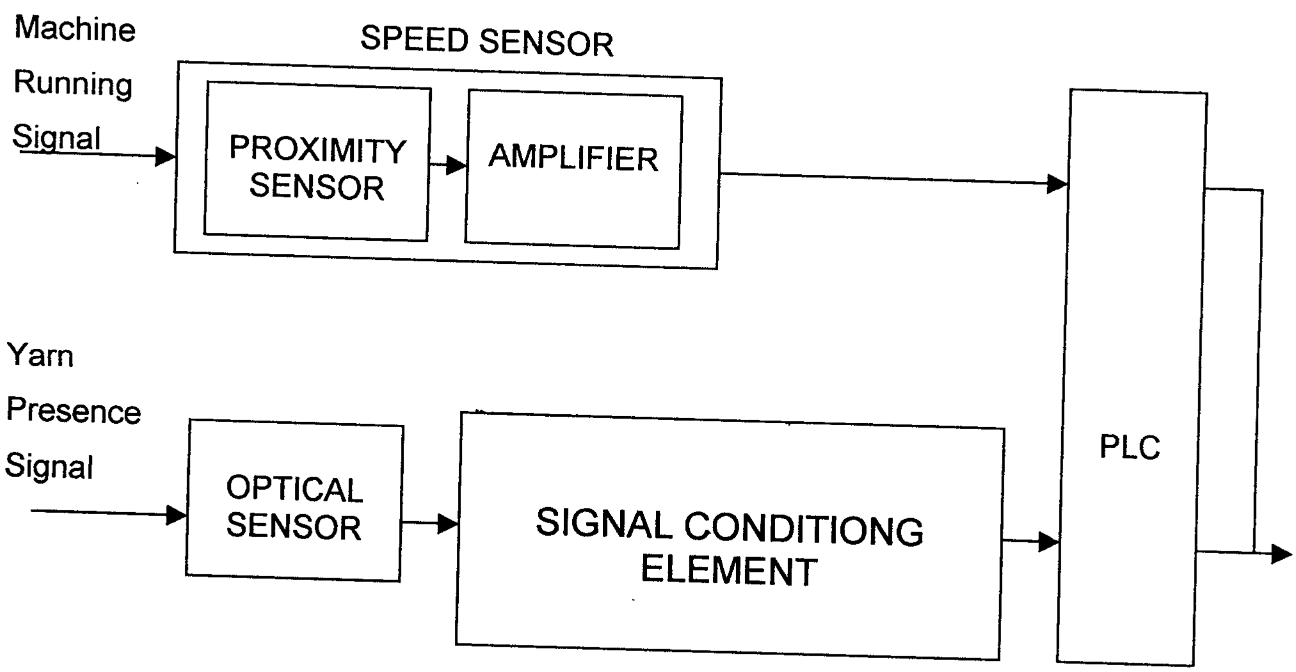


Fig 2.1 General Block Diagram

2.1 Description of general block diagram

The Figure 2.1 is the block diagram describes the monitoring system. The device is designed for the purposes stated below

- To sense the presence of yarn.
- To measure the length of yarn that is getting winded on the paper cone.

The whole unit is stopped when the full length is winded and when the yarn is absent in all the spindles.

2.1.1 SPEED SENSOR:

The speed sensor measures the number of revolutions that has been made by the shaft axis of the spindle. The length that is getting winded is proportional to the number of revolutions made. The length is calculated by knowing the number of revolutions. The revolutions with respect to the prescribed length is a predetermine value.

The speed sensor consists of a proximity sensor and an amplifier. The input to the proximity sensor is the motor running signal. The output of the proximity sensor is voltage signal. The voltage signal is amplified. Once the sensor senses one revolution, the sensor produces a pulse. The pulse is given to the interrupt count of the PLC. The counter gets incremented by one for each pulse. The counter value is compared with the preset value in the PLC. When both are equal, the counter is stopped and an indication is given, so that the user can stop the machine.

2.1.2 OPTICAL SENSOR:

The optical sensor that is used for the design of "Yarn Monitoring System" is reflector sensor. These sensors have in built light source. They need not have an external light source for their energization. when a surface is placed in front of it , the light gets reflected and is absorbed by the sensor, the amount of voltage produced depends on the intensity of light that is getting reflected. The intensity depends on the reflecting surface and the distance at which the surface is placed. The reflector sensors have an accuracy of upto 1mm .

The optical sensor consists of two reflector sensors. The reflector sensors are special type of sensors which does not requires an external light source. The optical sensor senses the presence of Yarn. Once the yarn is present, the light gets reflected and a small voltage is generated. This voltage is given to the signal conditioning element. The signal conditioning element produces,

- A high signal when it senses the absence of yarn.
- A low signal when it senses the presence of yarn.

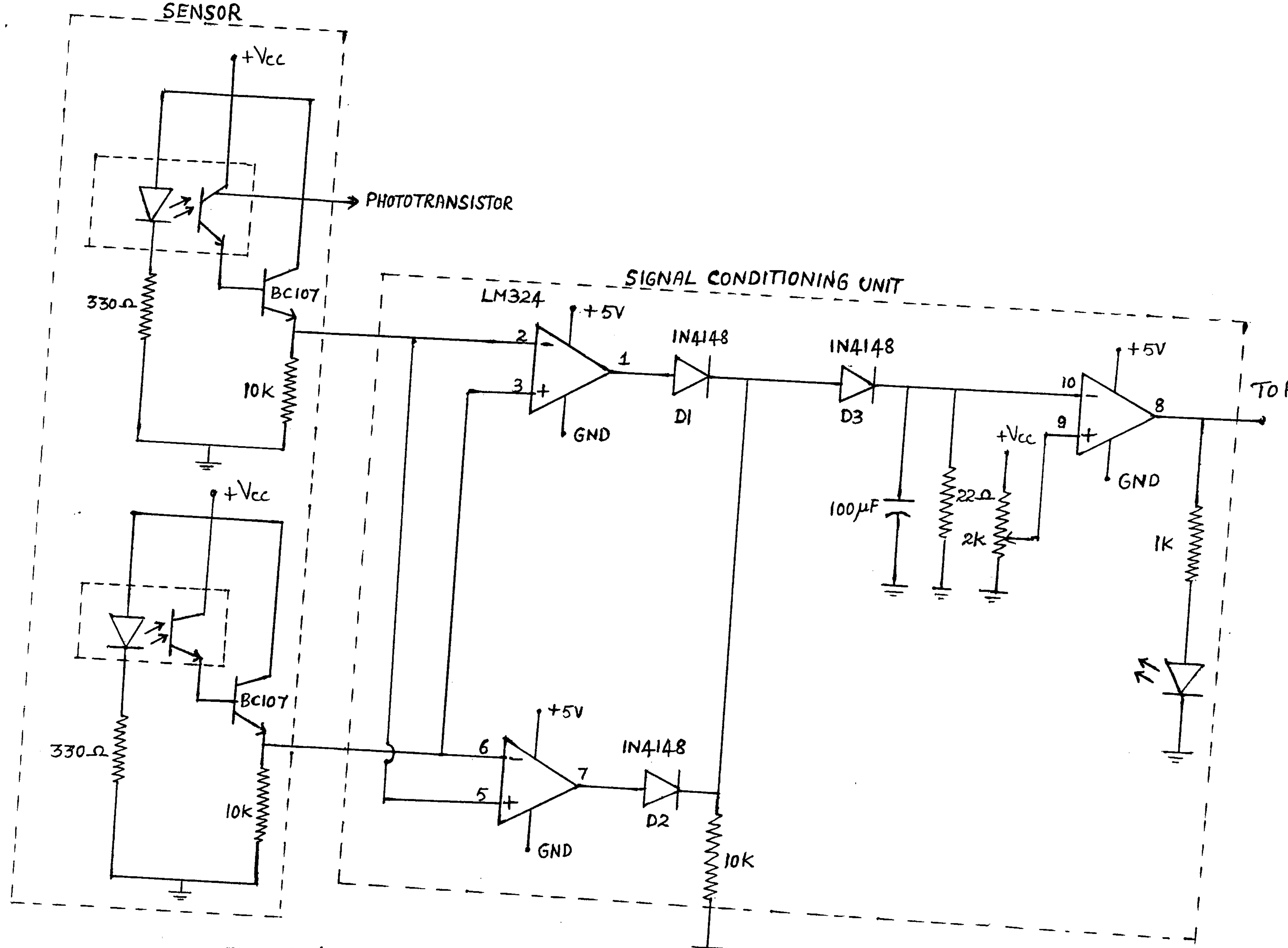


FIG 3·1 CIRCUIT DIAGRAM FOR YARN SENS…

The signal conditioning element consists of comparator and an op-amp associated with external components to produce a constant low signal when the yarn is present and a continuous high signal when the yarn has been cut. This signal is given as one of the input to PLC. The PLC stops the counter of that particular spindle and indicates that the yarn has been cut.

2.1.3 PROGRAMABLE LOGIC CONTROLLER :

The programmable logic controller has a relay output.

There are two options for programming PLC's:

- IBM PC based programming package-SA34AID.
- Hand Held Terminal(HHT).

The first option, IBM PC based programming package is used for the 'yarn monitoring system'.

This is a PC based software programming package running on IBM PC compatible. It is highly user friendly and can be used by any one with out prior knowledge of computer languages/programming. SA34AID can be used during program development, testing, debugging and documentation.

The package has two types of interfaces :

- OFFLINE
- ONLINE

In OFFLINE, the program development can be carried out without having the target system. The user program can be stored as a file in the IBM PC which can be downloaded to the SA, on later date.

In ONLINE the program development requires the target system and user can download the program develop in the OFFLINE mode.

OFFLINE FEATURES:

- Creating and documenting new programs.
- Modifying and documenting old programs.
- Powerful editing.
- Search as well as search and replace facility.
- Program verification.

ONLINE FEATURES:

- Creating and documenting new programs.
- Modifying and documenting existing programs.
- Transferring programs between PLC and PC.
- ONLINE monitoring of process variables and parameters.
- Forcing of process I/O channels.
- Search as well as search and replace facility.

- ONLINE modification of certain process parameters defined by 'D=xy' (xy are integers) which is used for time delays, counter preset values and limits for comparison etc.
- Program verification.

To achieve a particular operation to be done in a systematic way, the following steps have to be performed

1. Database allocation.
2. Preparation of control logic in paper.
3. Entering the logic programming aids.
4. Testing of logic.
5. Documentation.

The optical sensor that is used in this project is
With four pins.

The proximity sensor that is used is Inductive Proximity Switches manufactured by SALZER ELECTRONICS.

The Progammable Logic Controller that is under use is
SA3-BO1.

The SA3 consists of 12 inputs and 8 outputs.

The inputs are from DI1 to DI12 and the outputs are from DO1 to DO2.

The outputs of speed sensor is given to DI1 and the output of the dual amplifier is given to DI2. The count is given to the higher count. The count that is given in the form of pulses is counted in one of the integer register . Once the preset value is reached the binary register is set. The output is given to DO1 which is a latched output. The count gets incremented, when both the signals are high. The counter stops the count even when one of the input becomes low, Which means that when the yarn is cut, the counter stops the counting. Once the present value is reached, the output is latched. The user can observe this by the LED indication. On the output side. Since the output is a relay output, the can be used to stop the machine.

Testing of the System

CHAPTER 3

TESTING OF THE SYSTEM

The yarn moves over the optical sensor. The light from the optical sensor gets reflected and falls on the base of the transistor and produces a small emitter current. The output voltage is amplified using a transistor. This voltage is applied to the comparator. Since the reference voltage of the comparator is greater than the input voltage a low pulse is produced. The output is in the form of a square pulses. The output of the pulses is given to the diode to produce an unidirectional pulse. This pulse is given to the op-amp and associated circuits to produce a momentary pulse. This low pulse is given to one of the input of PLC.

The proximity sensor is attached to the common shaft to produce speed signals. This signal is also a low signal. When it senses the slot, it produce a high signal. This signal is given to the PLC. The counter in the PLC gets incremented only when the output of the proximity sensor produces a high output and the input from the sensing element is high. When the count is over or when the yarn to all the spindles are cut, the output is latched ,so that the control circuit is actuated.

The device is placed in the textile machinery in the ring cop to paper cone stage. The device is tested in the textile department of our college. The device senses perfectly upto 1mmof accuracy.

SAX Programming

CHAPTER 4

SAX PROGRAMMING

The programming of SAX is carried out using relay like ladder diagram. It closely resembles the hard wired relay logic.SAX is programmed using SA34AID, a software package which runs on the IBMPC compatible or using a hand held terminal. The software package which runs on the IBMPC compatible is highly user friendly and can be used by any person without any prior knowledge of computer languages/programming. The rich set of instructions backed by powerful editing feature make it possible to implement very complicated control logic easily in SAX.

Real world devices such as push buttons, limit switches and many others sensors are connected to SAX through its input terminal blocks. The input instruction simulates the actions of relay contacts inside the SAX. Accordingly the output instruction are energized which produced desired signals to drive loads such as motors, controllers, contactors, solenoid valves, lamps etc., via the output terminal blocks.

4.1 DATA TABLE ORGANISATION.

The data table contains the process input and output image tables. It also consists of the working area of the user program. The user program reads from the data table and writes back to the data table. SAX supports two data types namely binary and integer. The binary data represents true or false type signals. Integer data can represent any unsigned number in the range of 0-65535(16 bit word). The digital signals are handled by the binary data. The function block instructions like counter, timer etc. operate on integer and binary data.

The instructions and function block in the library handle different types of input and output data. Each parameter of an instruction has to be connected to a signal based on the data type. The user program can refer to status of the process I/Os by directly specifying the process I/O channel number. For holding the momentary results of the user program, general purpose registers are available which store binary and integer data types. The SAX has a non-volatile area.Some of the data table registers are located in the non-volatile memory area. The function elements can write their output to these registers for implementing non-volatile functions. The data table is illustrated below.

Table 4.1

GENERAL PURPOSE REGESTERS

BINARY REGISTER(BR) BR1........BR512
INTEGER REGISTER(IR) IR1........IR128

TIMER & COUNTER REGISTERS

TIMER REG ISTER(TI) TI1...............T364
COUNTER REGISTER(CO) CO1.......CO64

NON-VOLATILE REGISTERS

BINARY REGISTER(NB) NB1......NB64
INTEGER REGISTER(NI) NI1.......NI64

SIGNAL /REG. TYPE	SA3+EXP	SA4-56T/R	SA3-40T/R
DIGITAL INPUTS	DI1........DI28	DI1........DI32	DI1........DI24
DIGITAL OUTPUTS	DO1........DO18	DO1........DO24	DO1........DO16

4.2 INPUT SOURCE

There are two input sources for the instruction in SAX. Incase of function elements, there is a third input source, the constants. The various input source are given below:

- A process or field input/output signal (DI/DO)
- Any one of the internal storage registers (BR,IR,NB,IB)
- An user defined constant (D=X),'X' is an integer number.

All inputs of the function block instruction should be connected. The binary signals can be optionally inverted at the input of an instruction (ie) -DI1 implies the inverted value of DI1. If DI1 is 0 then for –DI1, the input value is taken as 1.

4.2.1 BINARY INPUTS:-

The binary inputs can be from any one of the following:

1.	Digital inputs	DI1-DI28
2.	Digital outputs	DO1-DO18
3.	Binary registers	BR1-BR512
4.	Binary constant	D=1/0
5.	Non–volatile binary registers	NB1-NB64

4.2.2 INTEGER INPUTS:-

The SAX handle only unsigned integer numbers which ranges from 0 to 65535. The integer input can be from any one of the following:

1. Integer registers IR1-IR128
2. Integer constant D=0-65535
3. Non–volatile binary registers NI1-NI64

4.2.3 OUTPUT DESTINATION:-

The result of an instruction can be stored in any one of a register(BR,IR,NB,NI) or to the processor output(DO).

4.2.4 BINARY OUTPUTS:-

The binary output can be written to any one of the following:

1. Digital outputs DO1-DO18
2. Binary registers BR1-BR499
3. Non-volatile binary register NB1-NB64

4.2.5 INTEGER OUTPUTS:-

The unsigned integer outputs can be written to any one of the following:

1. Integer register IR1-IR128
2. Non–volatile binary registers NI1-NI64

4.3 STORAGE REGISTERS IN SAX DATA TABLE:-

For holding temporary results of the application program, there are two types of registers are available in SAX.

- ❖ General purpose register
- ❖ Non–volatile register

4.3.1 GENERAL PURPOSE REGISTER:-

These registers are available for handling binary and integer data types. They are

- ❖ Binary register
- ❖ Integer register

In the case of power failure the content of these register are lost.

4.3.2 NON-VOLATILE REGISTER:-

Power failure is a common occurrence in the industry. For certain application (like batch processing) when power failure occurs, it is required that the controller must continue from where it had left at the time of power failure. This calls for preserving the status of certain process variables even in the case of power failure. For implementing these requirements, SAX has non- volatile registers in the data table.

They are

- Non-volatile binary register(NB)
- Non-volatile integer register(NI)

The user program can write into these non-volatile registers. The contents of these non-volatile register are not lost by power failure. So when power resumes, the user program can continue with the previous value which were present just before power interruption. This memory area can be cleared by giving a command from SA34AID/HHT.

4.3.3 SPECIAL PURPOSE REGISTERS:-

In addition to above mentioned registers SAX has certain register reserved for special usage. The register BR500,BR501 and BR502 can be used as time base or oscillator for timed operation. Two registers BR503 and BR504 are reserved to indicate important system operation like PLC changing mode from configuration to run and when the PLC is powered up respectively. The user can make use of the registers BR503 and BR504 to start predefined sequences when PLC is changed to run mode or when it is powered up. The binary registers BR505 sets when there is error in the check sum of non-volatile area.

1. The binary register 500 (BR500)

   This register gives a clock pulse of 1sec period.

2. The binary register501(BR501)

   This register gives a clock pulse of 0.1sec period.

3. The binary register 502 (BR502)

   This register gives a clock pulse of 0.01sec period.

4. The binary register 503 (BR503)

   This register becomes ON for 1 scan period when the system changes from configuration to run mode.

5. The binary register 504 (BR504)

   This register becomes ON for 1 scan period when the SAX is powered ON.

6. The binary register 505 (BR505)

   This register is set when SAX detects any check sum error in non-volatile area.

7. The integer register 128 (IR128)

   It counts the number of times the application program is scanned in 500msec.

Conclusion

CHAPTER 5

CONCLUSION

The "MULTIPOINT YARN MONITORING SYSTEM" has been designed and tested in Miltronics. Excellent sensitivity can be achieved, using this device. It can be used to sense all counts of yarn.. Since the output is light activated, it facilitates the operator to perform necessary observations and to perform the effective changes immediately, after the output is indicated. The production for a day, month & year are determined from the observed data's using a software. Since the yarn cut purely depends on the tension offered by the machine, by counting the no. of yarns that is cut, the efficiency of the machine is calculated.

FURTHER DEVELOPMENT:-

This project can be improved to an automatic switching device, when the relay outputs of the PLC is connected to the control circuit.

When the yarn in all the spindles are cut (or) when cone the required length has been wound on the cone, two outputs of PLC, one for yarn cut and other for the length are being latched. This latched output is connected to the control circuit, so that the control circuit gets activated even when one of the outputs is latched.

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Appendix

APPENDIX A

OPTICAL SENSORS

The internal diagram of optical sensors given in Fig A.1 consists of

1. Light Emitting Diode
2. Photo Transistors

A.1.1 Light Emitting Diode

The LED is one of the simplest opto electronic devices which has found important application as a display devices as well as an optical signal generator for optical communication.

The simplicity of the light emitting diode makes it very attractive device for display and communication applications. It gives way to the LASER diode in applications where modulation speeds above 5GHz are needed and where spectrally pure optical output is needed. The spectral width of the optical output of an LED is of the order of $\underline{KbT}$ which translates into a wavelength speed of 300 to 400 A at room temperature. Although this is a large value, the LED produces a single color to the human eye. Thus the LED's can be used very effectively in color displays.

The basic LED is a PN junction which is forward biased to inject electrons and holes into the P and N sides respectively. The injected minority charge recombines with the majority charge in the depletion region or the neutral region. In direct band semiconductors, this recombinations leads to light emission since radiative recombination dominates in high quality materials. There are many issues which govern the LED operation. They are

- Emission energy.
- Substrate availability.

A.1.2 LED performance issues

The LED depends upon the spontaneous emission process to provide light from the injected electrons and holes. As a result there are simplifications in the fabrication and design of the LED. For the LED the important performance issues are represented by the light current characteristics, the spectral purely of the light output, and the time response of the LED to external electrical signals.

A.1.3 Light current characteristics

When a current I is passing through the forward bias diode, a certain fraction of the current is converted to light. I ηtot represent the total ηof this conversion, the photon current that emerges from the diode is

Iph=Number of photon /seconds

= ηtot *1/e

In general ηtot depends upon the injected current since the carrier radiative lifetime Tr depends on the carrier injection level. In an LED this dependence is quiet weak so that the Iph-I characteristics are linear. At very high injection the light output starts to saturate as the device heats and the readiative recombination η decreases. The light current characteristics is given in Fig A.2.

A.1.4 Spectral purity of LED's

The spectral purity or the line width of the emitted radiation is an important characteristics of optical device. The important of the spectral purity of the emitted becomes critical in optical communication, high pulses of different wavelengths through an optical fiber at different speeds. Thus a signal gets distorted if the optical beam has a large wavelength spread. At low injection the width is the order of KBT . At high injection the width is of ΔE ~ (n/Nc)*KBT, Where Nc is the effective bandedge density of the states. A typical emission spectrum for an LED is shown in Fig A.3.

The line width is seen to be of the order of 20nm at room temperature. This is obviously a broad spectrum. However for many applications this width is adequate. LEDs are widely used in optical communication as long as the signal does not sent over long distances.

A.2 PHOTO TRANSISTOR

The photo transistor, the name for the bipolar device used for optical detection provides high gain due to the transistor action. The device is a low noise device.

The device is usually operated with its base open circuited. Focussing on the NPN photo transistor, the electrons and holes produce in the reverse bias base-collector junction are swept in the field to produce photo current Il. The holes are injected into the base and provide the base current, causing electrons to be injected from the emitter. The current having the following relation.

$$IE = \alpha IE + IL$$

Where α is the common base current gain. Since the base is open circuited, $Ic = IE$ and we have $Ic = \alpha\, Ic + IL$

$$Ic/IL = 1/(1-\alpha)$$

The phototransistor is in the open base mode. Holes generated in the Reverse biased base collector junction region provide a base current signal which causes the electrons to be injected from the emitter. Due to the transistor action a small photo current induced base current produces a large collector current.

Since alpha is close to unity , there is a large current gain because of the transistor action. It finds important use due to its low noise and high gain.

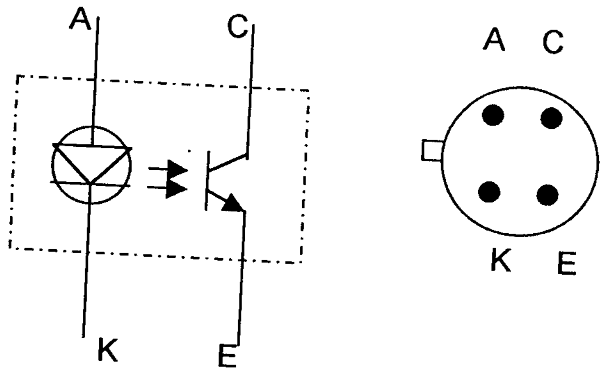


Fig A.1 Optical Sensor

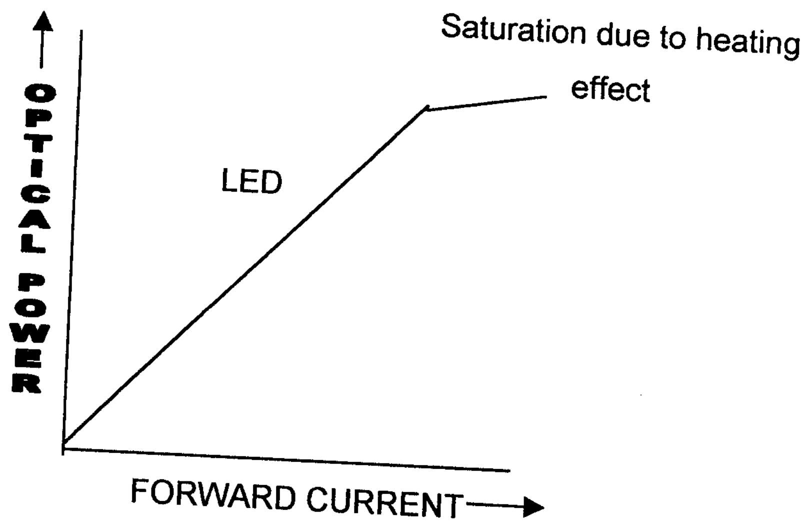


FIG A.2 Light current characteristics of LED

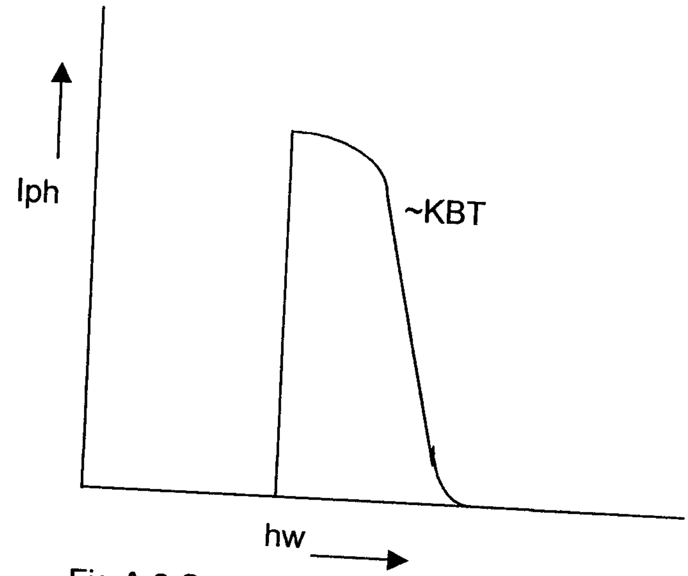


Fig A.3 Spectral purity of LEDs

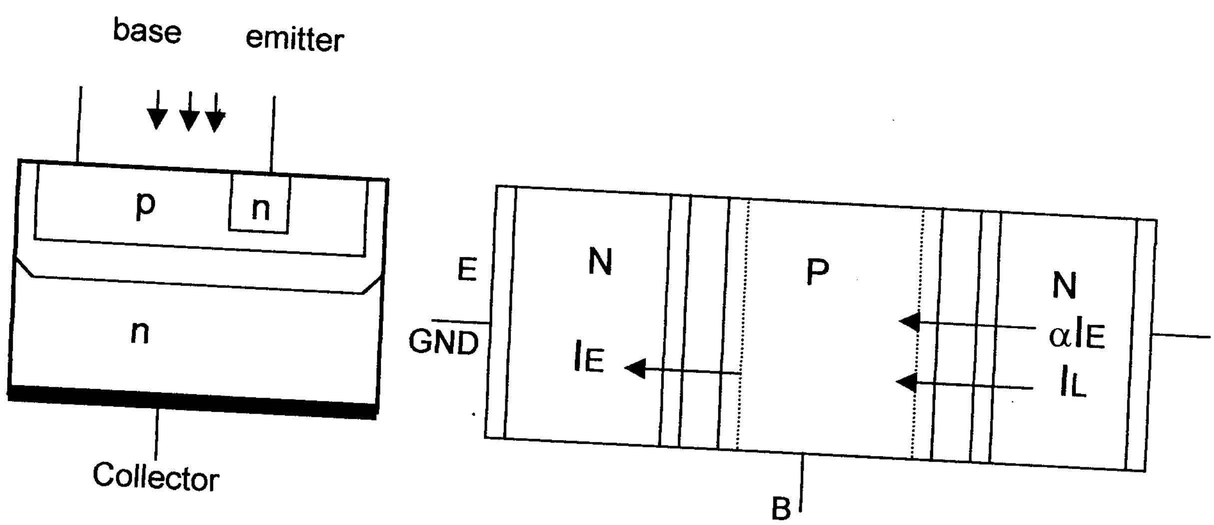
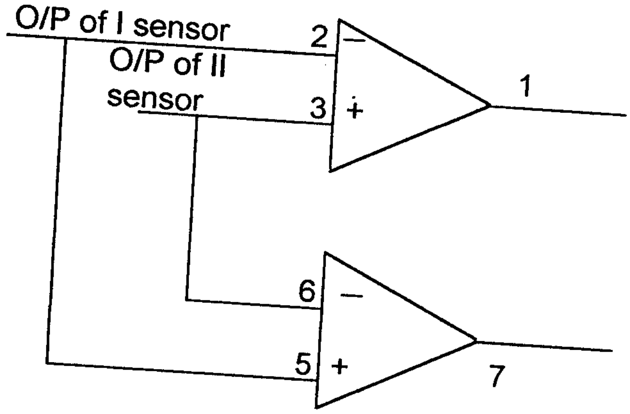


Fig A.4 Photo transistor

APPENDIX B

COMPARATOR

The LM 324 which is a high gain dual amplifier acts a comparator. The output of one of the sensors is given to the inverting input of one op-amp and non-inverting input of the other. The output of the other sensor is connected to the other terminal. The connection is shown below.



It is used in the open loop configuration. It compares the two voltages and produces the output voltage.

National Semiconductor

LM124/LM224/LM324, LM124A/LM224A/LM324A, LM2902 Low Power Quad Operational Amplifiers

General Description

The LM124 series consists of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, DC gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply systems. For example, the LM124 series can be directly operated off of the standard +5 V_{DC} power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional ±15 V_{DC} power supplies.

Unique Characteristics

- In the linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.
- The unity gain cross frequency is temperature compensated.
- The input bias current is also temperature compensated.

Advantages

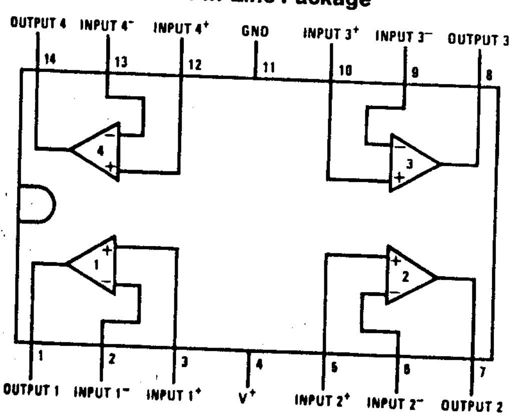
- Eliminates need for dual supplies
- Four internally compensated op amps in a single package
- Allows directly sensing near GND and V_{OUT} also goes to GND
- Compatible with all forms of logic
- Power drain suitable for battery operation

Features

- Internally frequency compensated for unity gain
- Large DC voltage gain 100 dB
- Wide bandwidth (unity gain) (temperature compensated) 1 MHz
- Wide power supply range:
  - Single supply 3 V_{DC} to 32 V_{DC}
  - or dual supplies ±1.5 V_{DC} to ±16 V_{DC}
- Very low supply current drain (700 μA)—essentially independent of supply voltage
- Low input biasing current (temperature compensated) 45 nA_{DC}
- Low input offset voltage 2 mV_{DC} and offset current 5 nA_{DC}
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0 V_{DC} to V^+ − 1.5 V_{DC}

Connection Diagram

Dual-In-Line Package



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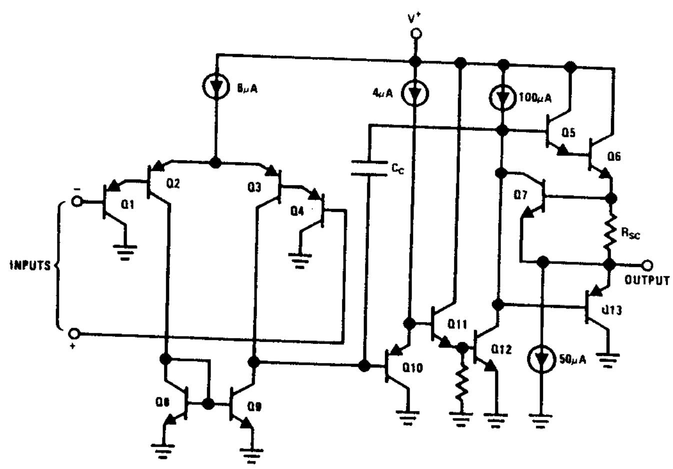
Top View

Order Number LM124J, LM124AJ, LM224J, LM224AJ, LM324J, LM324AJ, LM324M, LM324AM, LM2902M, LM324N, LM324AN or LM2902N
See NS Package Number J14A, M14A or N14A

Schematic Diagram (Each Amplifier)



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3

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications. (Note 9)

	LM124/LM224/LM324 LM124A/LM224A/LM324A	LM2902
Supply Voltage, V^+	32 V_{DC} or ±16 V_{DC}	26 V_{DC} or ±13 V_{DC}
Differential Input Voltage	32 V_{DC}	26 V_{DC}
Input Voltage	−0.3 V_{DC} to +32 V_{DC}	−0.3 V_{DC} to +26 V_{DC}
Input Current (V_{IN} < −0.3 V_{DC}) (Note 3)	50 mA	50 mA
Power Dissipation (Note 1)		
Molded DIP	1130 mW	1130 mW
Cavity DIP	1260 mW	1260 mW
Small Outline Package	800 mW	800 mW
Output Short-Circuit to GND (One Amplifier) (Note 2) $V^+ \le 15\ V_{DC}$ and T_A = 25°C	Continuous	Continuous
Operating Temperature Range		−40°C to +85°C
LM324/LM324A	0°C to +70°C	
LM224/LM224A	−25°C to +85°C	
LM124/LM124A	−55°C to +125°C	

	LM124/LM224/LM324 LM124A/LM224A/LM324A	LM2902
Storage Temperature Range	−65°C to +150°C	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	260°C	260°C
Soldering Information		
Dual-In-Line Package		
Soldering (10 seconds)	260°C	260°C
Small Outline Package		
Vapor Phase (60 seconds)	215°C	215°C
Infrared (15 seconds)	220°C	220°C

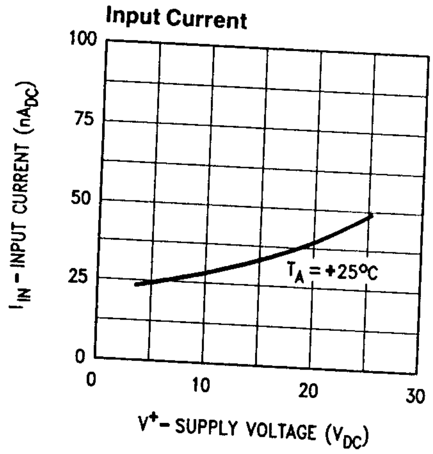
See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

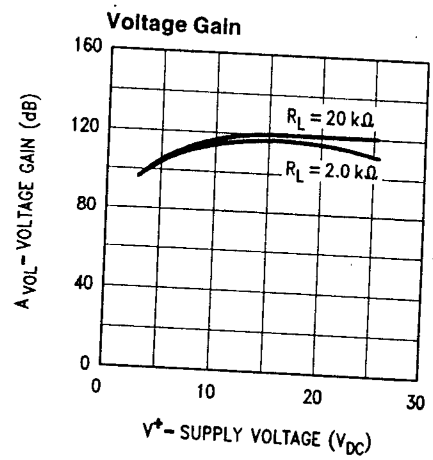
ESD Tolerance (Note 10)	250V	250V

Electrical Characteristics V^+ = +5.0 V_{DC}, (Note 4), unless otherwise stated

Parameter	Conditions	LM124A			LM224A			LM324A			LM124/LM224			LM324			LM2902			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	(Note 5) T_A = 25°C		±1	±2		±1	±3		±2	±3		±2	±5		±2	±7		±2	±7	mV_{DC}
Input Bias Current (Note 6)	$I_{IN(+)}$ or $I_{IN(-)}$, V_{CM} = 0V, T_A = 25°C		20	50		40	80		45	100		45	150		45	250		45	250	nA_{DC}
Input Offset Current	$I_{IN(+)} - I_{IN(-)}$, V_{CM} = 0V, T_A = 25°C		±2	±10		±2	±15		±5	±30		±3	±30		±5	±50		±5	±50	nA_{DC}
Input Common-Mode Voltage Range (Note 7)	V^+ = 30 V_{DC}, (LM2902, V^+ = 26 V_{DC}), T_A = 25°C	0		$V^+-1.5$	0		$V^+-1.5$	0		$V^+-1.5$	0		$V^+-1.5$	0		$V^+-1.5$	0		$V^+-1.5$	V_{DC}
Supply Current	Over Full Temperature Range $R_L = \infty$ On All Op Amps V^+ = 30V (LM2902 V^+ = 26V) V^+ = 5V		1.5 0.7	3 1.2		1.5 0.7	3 1.2		1.5 0.7	3 1.2		1.5 0.7	3 1.2		1.5 0.7	3 1.2		1.5 0.7	3 1.2	mA_{DC}
Large Signal Voltage Gain	V^+ = 15 V_{DC}, $R_L \ge 2\ k\Omega$, (V_O = 1 V_{DC} to 11 V_{DC}), T_A = 25°C	50	100		50	100		25	100		50	100		25	100		25	100		V/mV
Common-Mode Rejection Ratio	DC, V_{CM} = 0V to V^+ − 1.5 V_{DC}, T_A = 25°C	70	85		70	85		65	85		70	85		65	85		50	70		dB
Power Supply Rejection Ratio	DC, V^+ = 5 V_{DC} to 30 V_{DC} (LM2902, V^+ = 5 V_{DC} to 26 V_{DC}), T_A = 25°C	65	100		65	100		65	100		65	100		65	100		50	100		dB

Typical Performance Characteristics (LM2902 only)





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Application Hints

The LM124 series are op amps which operate with only a single power supply voltage, have true-differential inputs, and remain in the linear mode with an input common-mode voltage of 0 V_{DC}. These amplifiers operate over a wide range of power supply voltage with little change in performance characteristics. At 25°C amplifier operation is possible down to a minimum supply voltage of 2.3 V_{DC}.

The pinouts of the package have been designed to simplify PC board layouts. Inverting inputs are adjacent to outputs for all of the amplifiers and the outputs have also been placed at the corners of the package (pins 1, 7, 8, and 14).

Precautions should be taken to insure that the power supply for the integrated circuit never becomes reversed in polarity or that the unit is not inadvertently installed backwards in a test socket as an unlimited current surge through the resulting forward diode within the IC could cause fusing of the internal conductors and result in a destroyed unit.

Large differential input voltages can be easily accommodated and, as input differential voltage protection diodes are not needed, no large input currents result from large differential input voltages. The differential input voltage may be larger than V+ without damaging the device. Protection should be provided to prevent the input voltages from going negative more than −0.3 V_{DC} (at 25°C). An input clamp diode with a resistor to the IC input terminal can be used.

To reduce the power supply drain, the amplifiers have a class A output stage for small signal levels which converts to class B in a large signal mode. This allows the amplifiers to both source and sink large output currents. Therefore both NPN and PNP external current boost transistors can be used to extend the power capability of the basic amplifiers. The output voltage needs to raise approximately 1 diode drop above ground to bias the on-chip vertical PNP transistor for output current sinking applications.

For ac applications, where the load is capacitively coupled to the output of the amplifier, a resistor should be used, from the output of the amplifier to ground to increase the class A bias current and prevent crossover distortion.

Where the load is directly coupled, as in dc applications, there is no crossover distortion.

Capacitive loads which are applied directly to the output of the amplifier reduce the loop stability margin. Values of 50 pF can be accommodated using the worst-case non-inverting unity gain connection. Large closed loop gains or resistive isolation should be used if larger load capacitance must be driven by the amplifier.

The bias network of the LM124 establishes a drain current which is independent of the magnitude of the power supply voltage over the range of from 3 V_{DC} to 30 V_{DC}.

Output short circuits either to ground or to the positive power supply should be of short time duration. Units can be destroyed, not as a result of the short circuit current causing metal fusing, but rather due to the large increase in IC chip dissipation which will cause eventual failure due to excessive junction temperatures. Putting direct short-circuits on more than one amplifier at a time will increase the total IC power dissipation to destructive levels, if not properly protected with external dissipation limiting resistors in series with the output leads of the amplifiers. The larger value of output source current which is available at 25°C provides a larger output current capability at elevated temperatures (see typical performance characteristics) than a standard IC op amp.

The circuits presented in the section on typical applications emphasize operation on only a single power supply voltage. If complementary power supplies are available, all of the standard op amp circuits can be used. In general, introducing a pseudo-ground (a bias voltage reference of $V^+/2$) will allow operation above and below this value in single power supply systems. Many application circuits are shown which take advantage of the wide input common-mode voltage range which includes ground. In most cases, input biasing is not required and input voltages which range to ground can easily be accommodated.

APPENDIX C

INDUCTIVE PROXIMITY SWITCHES

Inductive proximity switches are solid state switching devices which causes switching action without physical contact. Any metal which comes with in the sensing zone causes damping of oscillator. The associated electronic circuitary detects the damping, triggers the switching action and amplifies the output to operate conventional control systems.

BASIC DEFINITIONS:-

SENSING DISTANCE:-

The sensing distance is the maximum distance between the target and the sensing case to be sure of obtaining a switching signal. This distance is measured using a square mild steel target 1 mm In thickness. The sides of the square should be equal to the diameter of the sensing face of the proximity switch.

REDUCTION FACTOR:-

It is necessary to be taken in to account, when the target is of material other than steel or having varied thickness and dimension

Material	Factor
Steel	1.0
Brass	0.35-0.5
Copper	0.25-0.45
Alluminium	0.35-0.5
Stainless Steel	0.6-1.0

SWITCH HYSTERESIS:-

The difference between switch on and switch off point when the target approaches and moves away from the sensing face respectively is called switch hysteresis.

TEMPERATURE DRIFT:-

The temperature drift is the change in switch point in micrometers due to variations in ambient temperature conditions when all other conditions remain constant.

ELECTRICAL CHARACTERISTICS:

- The operating voltage is the voltage, which can be used to operate the inductive proximity switch.
- The voltage drop is the voltage measured between the energized output and switched potential.

- The ripple voltage is the AC voltage superimposed on the mean DC voltage expressed as a percentage. The provision of a smooth DC supply within 10% maximum ripple is absolutely essential for the effective operation of DC switches.
- The load current is the maximum current at which the inductive proximity switch can be continuously operated.
- The no load current is the current consumed by the switch at the maximum operating voltage without there being any external load current.
- The residual current is the current which flows through the load even when the switch is in its blocked state.
- The switch frequency is the maximum number of switching functions/sec. This frequency is measured by means of placing the sensing face of the proximity at a distance of S/2 from the target, 'S' being the sensing distance.

SHORT CIRCUIT PROTECTION:-

Switches with built in short circuit and over load protection are protected against damage to the output stage. After elimination of the short circuit the switch resets automatically and is ready for operation.

REVERSE POLARITY PROTECTION:-

The inductive proximity switches are protected against damage due to inverted supply line connection.

TRANSIENT VOLTAGE PROTECTION:-

The inductive proximity switches are protected against damage caused by supply line transient voltages.

ADVANTAGES:-

- Complete solid state design.
- High degree of reliability.
- Water, dust and oil proof.
- High frequency operation.
- Contact less operation.
- High repeat accuracy.
- Maintenance free.
- Compact sizes.

The use of these switching devices has increased in recent times as machines in general have become more and more automated.

APPENDIX D

PROGRAMMABLE LOGIC CONTROLLERS

The SA3 micro PLCs are wall mountable type PLCs which can handle digital inputs and outputs.With their compact size feature pact software library and low cost, these PLCs become an ideal choice in machine tools and many other related industries.

The basic SA3 unit has 12 digital inputs and 8 digital outputs the expansion unit consists of 16 inputs and 10 outputs. It consists of 8K BBRAM and 8K backup memory. The current requirement is .7A at 24V DC of PLCs for the basic circuit functioning.

HARDWARE FEATURES

- Battery backing of RAM upto a certain number of days EPROM/EEPROM backup for application program.
- RS-232C port for programming/operator stations.
- Fast execution.
- Watch dog for CPU,self check for memory and I/Os.
- Status indication for power On, System OK, program status, RS-232C communication and I/O status .

* Three position mode switch for run, reset and emergency shutdown of the system.
* Real time clock facility can be provided optionally.
* Facility for write protection of the backup memory is provided.

The SA3 basic unit is built around a microcontroller and is compact in size. It consists of a single printed circuit board with all required components for processing digital inputs, executing application program and energizing digital outputs. This PCB is mounted on a base plate and enclosed in a cover to protect it from dust and soot. The Elmex connectors soldered on the PCB can be used to terminate the field signals. A Rs-232C serial port is available on the PLC, Which can be used to program it.

The front facia of SA3B01 is given in figure D.1.

The SA3 as the following hardware features.

- Status indicators.
- Three position mode switch
- RS-232c port.
- EPROM/EEPROM backup.
- Ni-Cd battery.

These features are briefly described below.

STATUS INDICATORS

1. PWR - stands for power.A red LED lights up when the +5v DC supply is present.
2. SYS - Stands for system OK. A green LED lights up when the processor and the subsystems are functioning normally.
3. RUN - Stands for execution of user program. A green LED lights up when the system is executing the user program.When the mode switch is in stop mode or when SA3 is in configuration mode, this LED is off.
4. TXD & RXD - Stands for Rs-232C serial communication in progress.The two Yellow LEDs blink when the system is communicating over the RS-232 link to other devices.
5. I1 to IX, O1 to OX - Stands for I/o status. The yellow LEDs lights up when the particular channel status changes from zero to one

THREE POSITION MODE SWITCH

The three position mode switch is used to reset the system and can be used for emergency shut down of the system. The STOP mode switch should be operated only for emergency shutdown of the system. When the system is in STOP mode, all the digital outputs are disabled and the I/O scanning is also brought to a halt. SAX is changed to RUN mode by placing this switch first in RESET position and then to RUN position.

The application program in BBRAM can be copied to EEPROM by placing the mode switch in STOP position and SA3 – micro PLC in configuration mode. Using SA34AID give command for copying application program from RAM to EEPROM.

It should be noted that if the RAM does not contain a valid program and EPROM or EEPROM backup contains a valid one, then putting the three position mode switch in STOP mode and recycling the power four times, firstly the RAM gets cleared and then the valid program in the backup memory gets copied to the RAM within a specified time period. After this, the mode switch has to be put in RESET mode and then to RUN mode for the PLC functioning when the mode switch is in RUN mode, EEPROM is write protected.

RS-232C Port

A 9 pin D shell connector labeled RS-232C port mounted on the printed circuit board is the communication port between the PLC and programming aids or operator stations.

EEPROM / EPROM

An EEPROM / EPROM is available as a backup for user program. In SA3, it can be accessed after opening the front cover. During the process of the copying of the contents of EEPROM/EPROM backup to the RAM, the system LED will be OFF, whereas the RUN LED will be ON. After the copying is finished the RUN LED goes OFF and the system LED becomes ON.

Ni-Cd Battery

Rechargeable Nickel – Cadmium battery with online trickle charge facility is provided. That is, no external charging or replacement of battery is required. In the fully charged condition, it gives backup for user program in BBRAM for a minimum of 100 days. Two jumper links are provided on both sides of the battery. By opening these links, the load to the battery will be disconnected. In this condition, the RAM contents are lost. This procedure can also be used to clear the RAM without using SA34AID.

I/O SPECIFICATION:-

DIGITAL INPUTS:-

The block diagram of the digital input circuit is shown in fig D.2

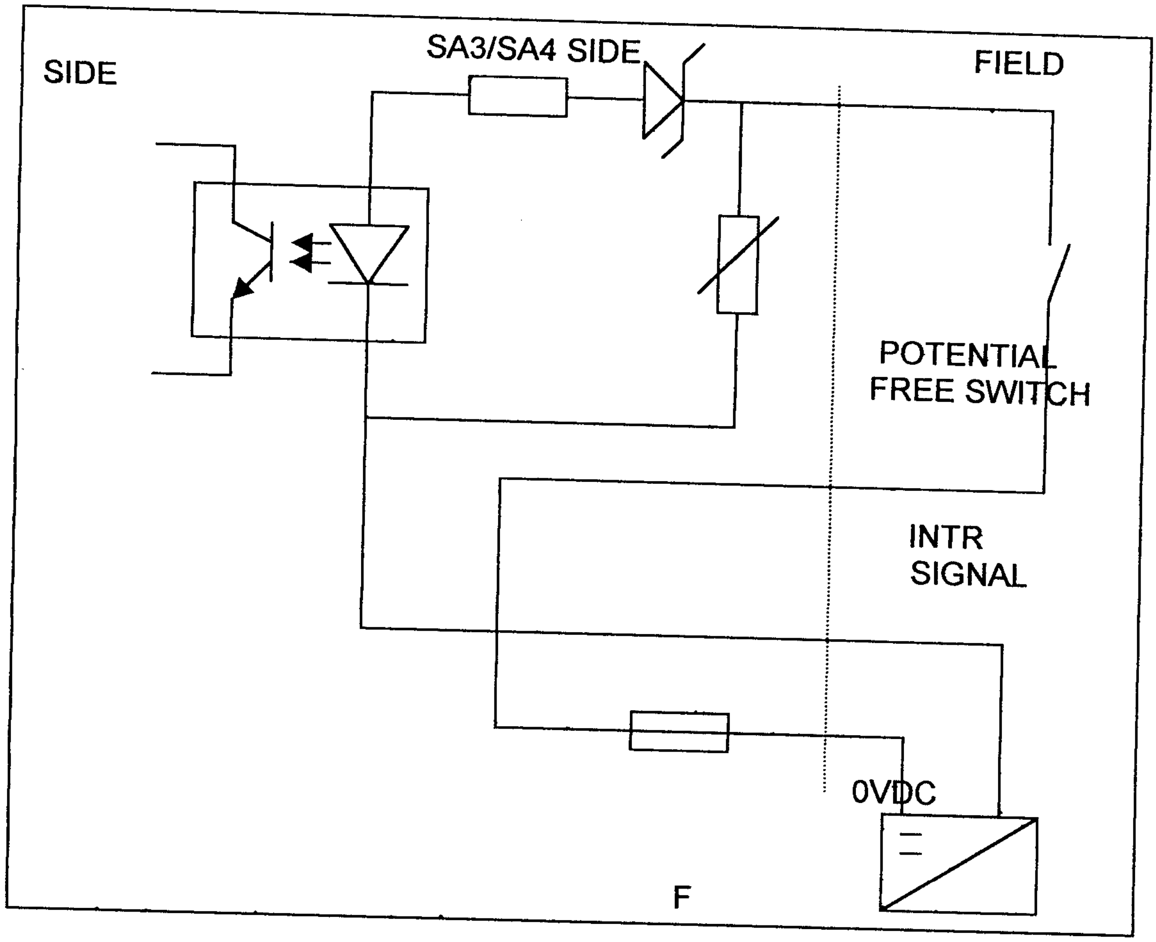


Fig D.3 Digital Input Block

SPECIFICATIONS:-

1. Rated voltage :+24V
2. Maximum voltage :+38V
3. Input voltage for logic 1 :+15V to +24V
4. Input voltage for logic 0 :-24V to +8V
5. Input current at logic 1 :8mA at 24V
6. Input impedance :approx. 2.2Kohm
7. Isolation level :2KV(by opto couplers)

FEATURES:-

- One common terminal is provided for sourcing all input channels
- +24V interrogation voltage can be sourced from external power supply.
- +24V interrogation voltage is protected with a 0.5A fast blow fuse.
- Input transient protection with MOV's.
- Status LED for each channel.

DIGITAL OUTPUTS:-

The two common types of digital outputs available are

- Potential free normally open (NO) relay contacts.
- Current sourcing transistor outputs.

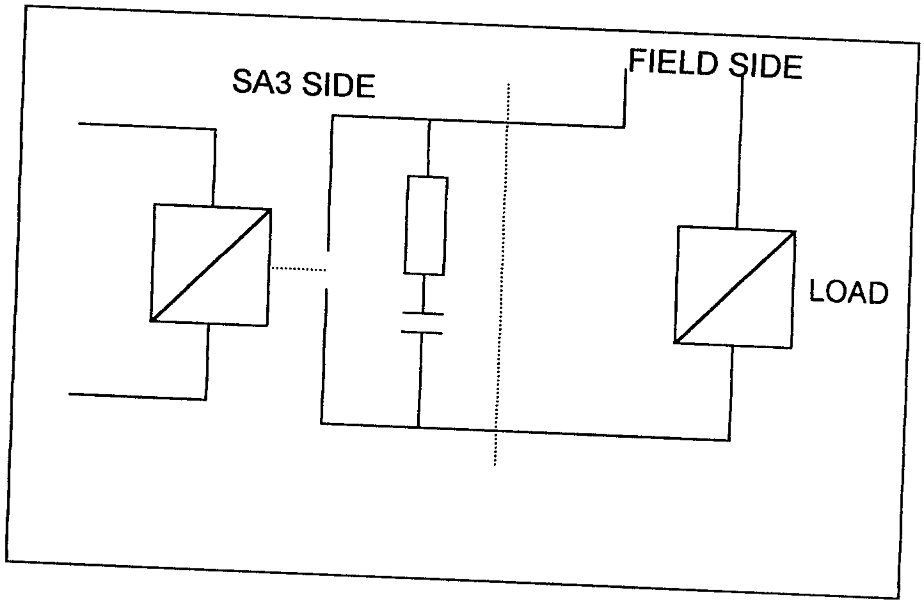


Fig D.4 .RELAY TYPE

RELAY TYPE:-

Each channel is controlled by a relay which is driven by suitable driver. The NO contacts are available at the terminals.

FEATURES:-

- Each channel is provided with a RC network for contact protection due to load transients.
- All channels are provided with status LED's

SPECIFICATIONS:-

No	Features	SA3
1.	Output	Relay
2.	Contact rating	230 Vac,2A(resistive)
3.	Isolation/dielectric constant	1000Vrms
4.	Switching frequency	2Hz
5.	Power dissipation	0.96W/channel.

BUILDING BLOCKS OF SA3 MICRO SYSTEM:-

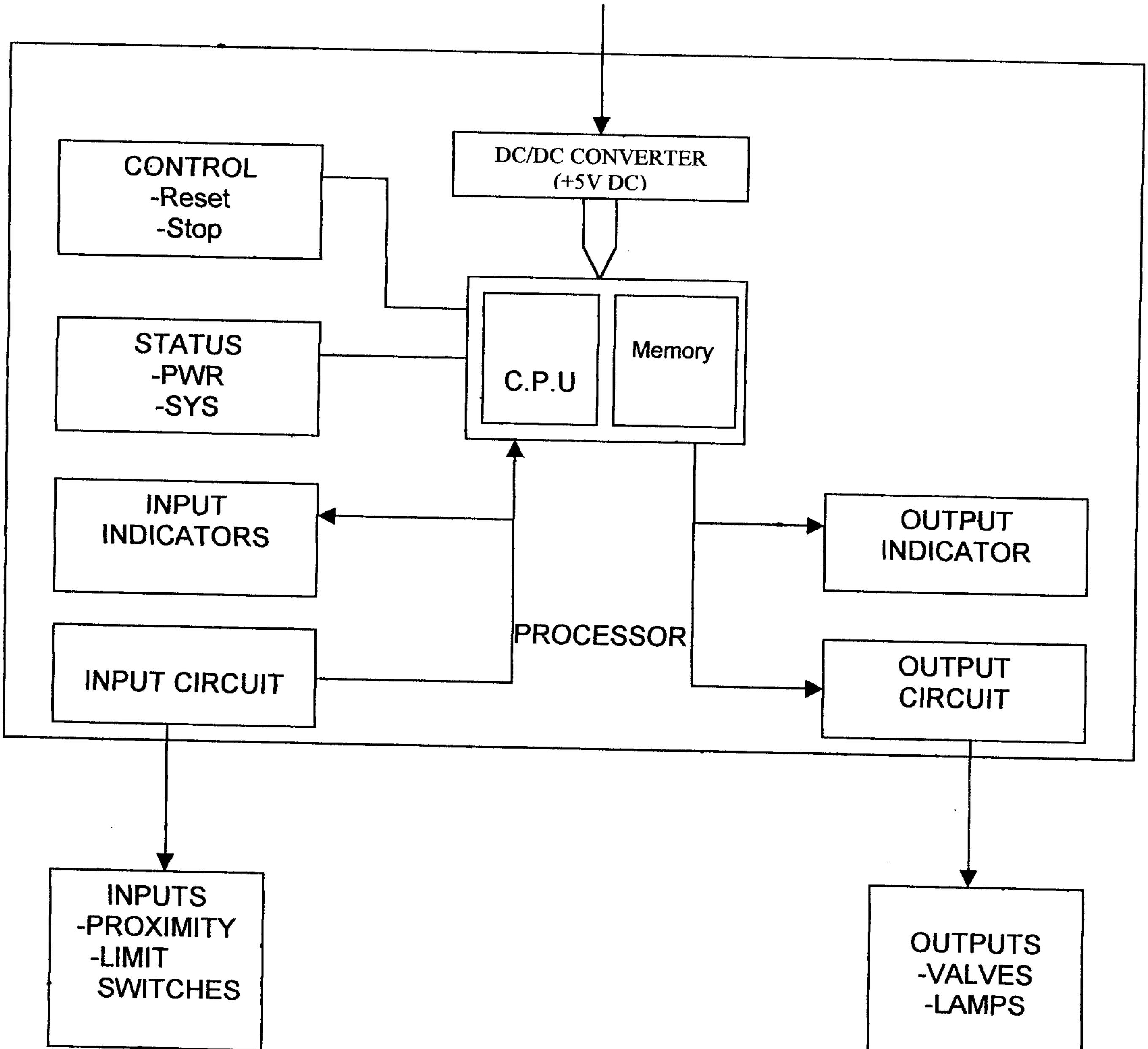


Fig D.5 Building Blocks of SA3 Micro System

The 24V dc unregulated power supply first enters the filter. After filtering out unwanted noise, it is given to dc to dc converter which gives out +5v dc to the SA3 micro system for its operation. The availability of 5v dc is indicated by a red 'power' LED. The mode selection block consists of a 3 position mode switch which is provided for emergency shutdown, resetting the system and to run the system in normal mode. The status block gives diagnostic indication like system OK, power availability and the mode of operation.

The input from various input devices like proximity sensors, limit switches and push buttons etc, is first optically isolated and fast on to the control block activates/deactivates output circuit which intern energises/ deenergises the output devices like solenoids, relays, lamps and contactors etc.

The input/ output indicators given an instruction of whether corresponding process input or output is ON or OFF. With the help of these indications can be easily isolated between the field and PLC.

SA3 MICRO SYSTEM FUNCTIONING:-

The processor unit is the brain of SAX. It consists of CPU, system EPROM and the scratch pad memory. The CPU built around the micro controller executes the system software as well as the instructions specified in the user program and performs logical and arithmetic operations.

The system EPROM consists of software routines for monitoring system status, initiating and controlling the PLC functions and a host of standard library functions. The system software :

- Monitors the SAX hardware operations, including self test routines such as checking the memory circuits and I/O circuits, for their normal functioning.
- Supervises the execution of application program, updates the database, makes the necessary 'software' connections between the PC program and I/O circuits and hence to the control system.

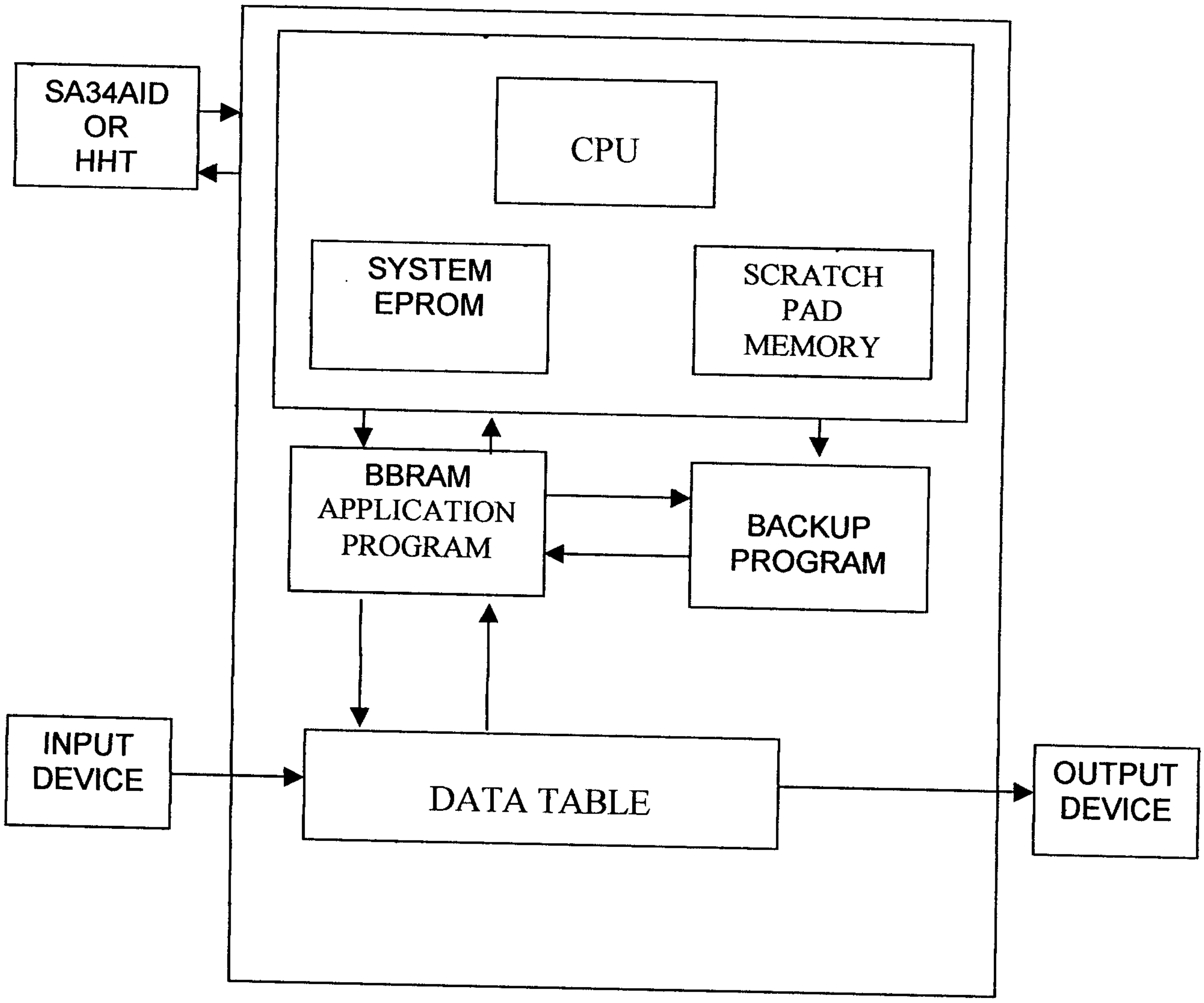


Fig D.6 Block diagram-SAX micro system

The SAX microsystem consists of a data table or database which contains the image of process input or output status. It also consists of the storage registers for storing the intermediate results of application program.

The application program is an user defined program which is stored in the Battery Backup RAM and hence application program is not lost by power failure.

There is a backup memory consists of EPROM or EEPROM which contains a copy of application program. The application can be copied from the backup memory to the battery back up RAM in case of memory erasure using SA34AID.

The field devices interact with the SA3 micro –PLC through the data table or database.

SA3 MICRO SCAN SEQUENCE:-

When the SA3 is executing the user program, it continously performs the read, execute, write cycles (ie) reads all the process inputs executes the user program and writes all the process outputs. The sequence of scanning is given below.

When the SA3 micro PLC is changed to RUN mode and mode switch is in RUN position, the CPU starts a cyclic operation. If first checks the validity of the application program and the PLC configuration, if it is found OK it scans the input and copies the input status to the data table. The CPU executes the application program rung by rung sequentially checking for input condition and writing the results in the outputs. when it encounters the end of the program, it copies all the outputs from the data table to process outputs. It then comes back to scanning the input and continuous the same operation. There is a watch dog timer which keeps a watch on the CPU operation. If the CPU takes more then 1.6 sec to complete one scan due to invalid jump instruction or invalid command then the watch dog timer times out and reset the output and PLC suspend all its operation.

The above sequences is a cyclic operation and gives a continuous control because of fast updation. This operation is called as 'scan' and duration of one scan is called the scan time. The scan time of the SAX is typically less then 3msec for 1K program. The successive updation of the outputs depends upon the length and complexity of the program.

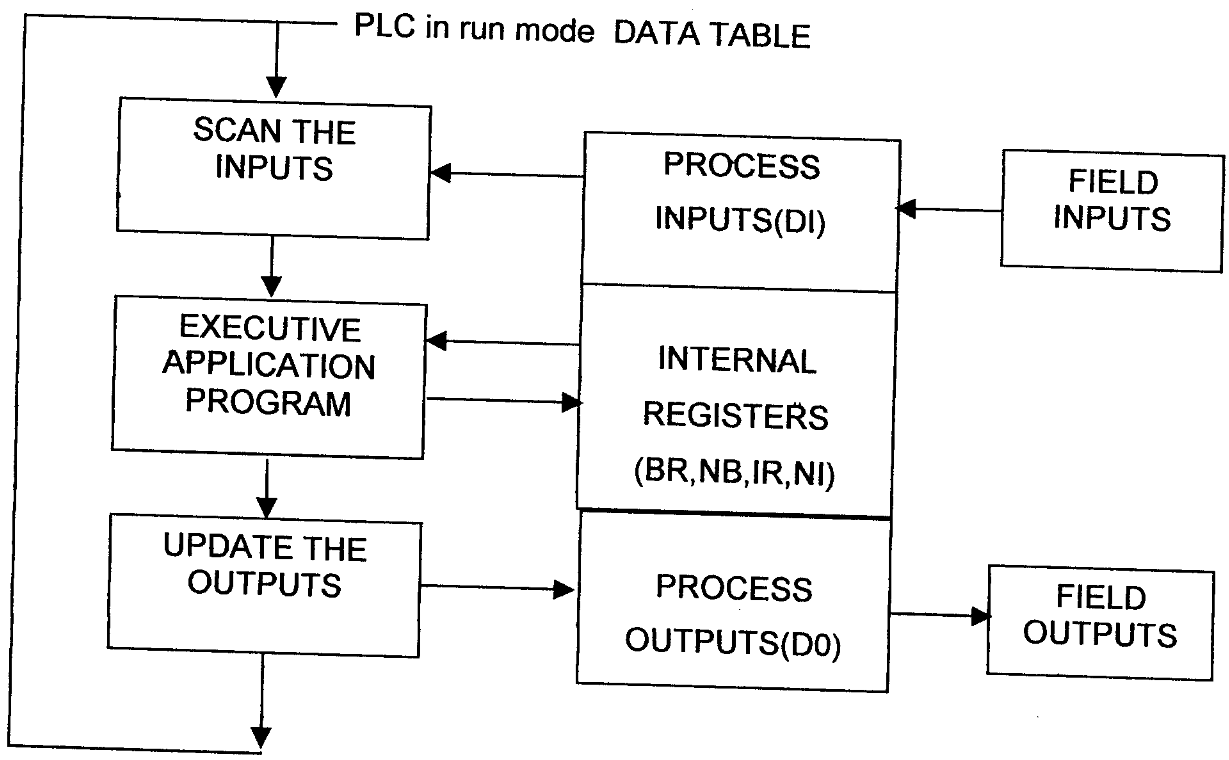


Fig D.7 SAX Scan Sequence

PROGRAMMING AID:-

The programming aid performs the following basic functions:

- Entering, retrieval and stoning of application programming.
- Editing of program, verification check for incomplete rungs, read only registers, write only registers, registers written more then ones, multiple defining of timers and counters.
- hanging of mode of operations, copied from EEPROM, clearing of memory, forcing or blocking of I/O's.
- Documentation of user program.

SA3 INSTRUCTION SET:

The instructions are the basic commends with which user can define his logic.SA3 instruction library is very rich and extensive. It consists of powerful instructions and function block which greatly reduces programming effort even for complicated control logic. The instructions are broadly classified into two groups.

4. Bit Instructions.
5. Function block instructions.

BIT INSTRUCTIONS

These instruction operate on one input or one output only. They check the input/output connected to it for a true or false condition.

Table D.1

S.No	Bit Instructions	Description
1	EXC	Examine if close
2	EXO	Examine if open
3	EO	Enable output
4	LO	Latch output
5	UO	Unlatch Output
6	JMP	Jump to specified lable
7	TRG	Trigger

FUNCTION BLOCKS:

The function block instructions has both inputs and outputs the number of inputs and output is variable.

TABLE D.2

S.No.	Function Block	Description
1	TON	On delay timer
2	TOFF	OFF delay timer
3	COUNT	16 bit up/down counter
4	SHIFT	8 bit forward /backward shift
5	BCD2INT	BCD to Integer converter
6	MOVE	Copies input data to outputs
7	MOVEI	Copies Integer input to output
8	COMP	Compares to Integer inputs
9	ADD	Adds to unsigned Integers
10	SUB	Subtracts to unsigned integers
11	MUX	Connects specified input to output
12	DEMUX	Connects input to specified output
13	SWIT-C	One input in a pair to corresponding output
14	MUL	Multiplies two unsigned integers
15	DIV	Divides to unsigned integers
16	SWIT-I	Connect 8 integer inputs to 8 outputs
17	INT2BCD	Converts integer data to BCD data
18	INT2BIN	Converts integer data to binary
19	DATE	Gives the date of real time clock
20	TIME	Gives the time of the real time clock
21	TIMER	Sets the output at a particular date and time

Appendix-E

```
1       DI2                                                       ┌─COUNT─────┐
] [──────]/[──────────────────────────────────────────────────────┤           ├────────────┤
                                                          1       │No     Cnt │IR1         │
                                                   D=0            │Rst    >=H │BR1         │
                                                   D=0            │Ld     <=L │            │
                                                   BR500          │Clk        │            │
                                                   D=1            │U/D        │            │
                                                   D=00020        │Hi         │            │
                                                   D=00000        │Lo         │            │
                                                   D=00000        │Inp        │            │
                                                                  └───────────┘            │
2                                                                                BR10      │
]/[──────────────────────────────────────────────────────────────────────────────(U)───────┤
1                                                                                DO1       │
] [──────────────────────────────────────────────────────────────────────────────(L)───────┤
1                                                                 ┌─TON───────┐            │
] [───────────────────────────────────────────────────────────────┤           ├────────────┤
                                                          1       │No     out │BR2         │
                                                     1   Sec      │Bas        │            │
                                                   D=00050        │Dly        │            │
                                                                  └───────────┘            │
2                                                                                DO1       │
] [──────────────────────────────────────────────────────────────────────────────(U)───────┤
2       DO1         DI1         DI2                               ┌─COUNT─────┐            │
] [──────]/[─────────] [─────────]/[──────────────────────────────┤           ├────────────┤
                                                          2       │No     Cnt │IR1         │
                                                   D=0            │Rst    >=H │BR1         │
                                                   D=0            │Ld     <=L │            │
                                                   BR500          │Clk        │            │
                                                   D=1            │U/D        │            │
                                                   D=00020        │Hi         │            │
                                                   D=00000        │Lo         │            │
                                                   D=00000        │Inp        │            │
                                                                  └───────────┘            │
L                                                                                DO1       │
] [──────────────────────────────────────────────────────────────────────────────(L)───────┤
                                                                  ┌─TON───────┐            │
] [───────────────────────────────────────────────────────────────┤           ├────────────┤
                                                          2       │No     out │BR4         │
                                                     1   Sec      │Bas        │            │
                                                   D=00050        │Dly        │            │
                                                                  └───────────┘            │
4                                                                                DO1       │
] [──────────────────────────────────────────────────────────────────────────────(U)───────┤
4       DO1         DI1         DI2                               ┌─COUNT─────┐            │
] [──────]/[─────────] [─────────]/[──────────────────────────────┤           ├────────────┤
                                                         11       │No     Cnt │IR1         │
                                                   D=0            │Rst    >=H │BR1         │
                                                   D=0            │Ld     <=L │            │
                                                   BR500          │Clk        │            │
                                                   D=1            │U/D        │            │
                                                   D=00020        │Hi         │            │
                                                   D=00000        │Lo         │            │
                                                   D=00000        │Inp        │            │
                                                                  └───────────┘            │
```

```
                                                                   DO1
| [------------------------------------------------------------------(L)----|
                                                                            |
                                                         -TON---------      |
| [----------------------------------------------------- |            |-----|
                                                    11   |No      out | BR12
                                                1   Sec  |Bas         |
                                                D=00050  |Dly         |
                                                          ------------
2                                                                  DO1
| [------------------------------------------------------------------(U)----|
                                                                            |
        BR2         BR12                                 -MOVEI-------      |
  [-------] [-------] [--------------------------------- |            |-----|
                                                D=00000  |Inp     Out | IR1
                                                         |            |
                                                          ------------
                                                         -COUNT-------
| [----------------------------------------------------- |            |-----|
                                                     3   |No      Cnt | IR4
                                                D=0      |Rst     >=H | BR6
                                                D=0      |Ld      <=L |
                                                BR1      |Clk         |
                                                D=1      |U/D         |
                                                D=00010  |Hi          |
                                                D=00000  |Lo          |
                                                D=00000  |Inp         |
                                                          ------------
        DI3                                              -COUNT-------
  [-------]/[------------------------------------------- |            |-----|
                                                     4   |No      Cnt | IR5
                                                D=0      |Rst     >=H | BR5
                                                D=0      |Ld      <=L |
                                                BR500    |Clk         |
                                                D=1      |U/D         |
                                                D=00020  |Hi          |
                                                D=00000  |Lo          |
                                                D=00000  |Inp         |
                                                          ------------
                                                                   DO2
  [------------------------------------------------------------------(L)----|
                                                                   BR11
 /[------------------------------------------------------------------(U)----|
                                                                            |
                                                         -TON---------      |
  [----------------------------------------------------- |            |-----|
                                                     3   |No      out | BR7
                                                1   Sec  |Bas         |
                                                D=00010  |Dly         |
                                                          ------------
                                                                   DO2
  [------------------------------------------------------------------(U)----|
```

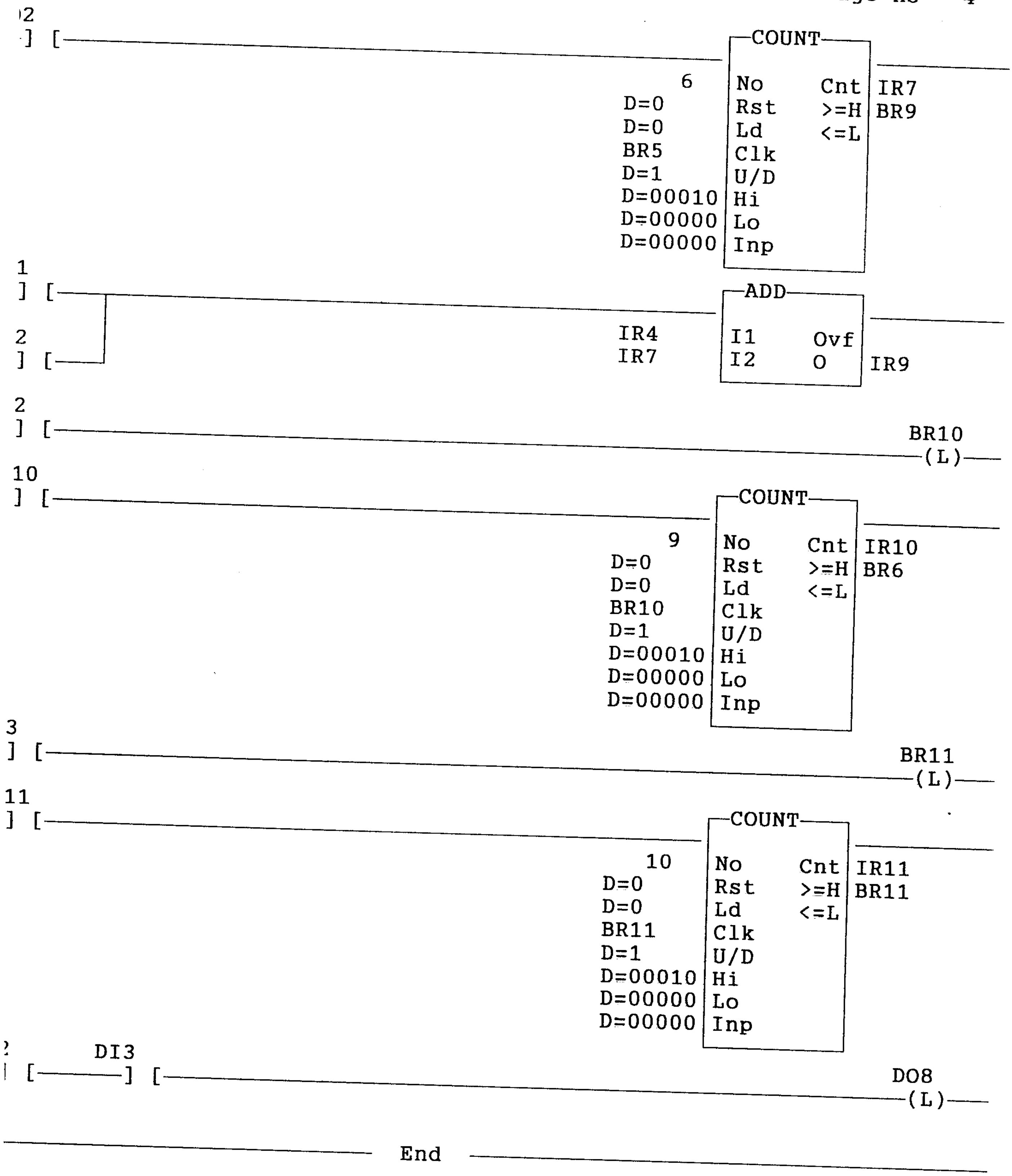
```
      DO2        DI1        DI3                                  ─COUNT──
 [──────]/[──────]  [──────]/[────────────────────────────────  ┌─────────┐  ─────────
                                                        5       │No    Cnt│ IR5
                                                   D=0          │Rst   >=H│ BR5
                                                   D=0          │Ld    <=L│
                                                   BR500        │Clk      │
                                                   D=1          │U/D      │
                                                   D=00020      │Hi       │
                                                   D=00000      │Lo       │
                                                   D=00000      │Inp      │
                                                                └─────────┘

 [──────────────────────────────────────────────────────────────────────────DO2
                                                                          ──(L)──

 [─────────────────────────────────────────────────────────────  ─TON──
                                                                ┌─────────┐  ─────────
                                                        4       │No    out│ BR8
                                                   1   Sec      │Bas      │
                                                   D=00010      │Dly      │
                                                                └─────────┘
3
| [─────────────────────────────────────────────────────────────────────────DO2
                                                                          ──(U)──
3     DO2        DI1        DI3                                  ─COUNT──
| [──────]/[──────]  [──────]/[────────────────────────────────  ┌─────────┐  ─────────
                                                       13       │No    Cnt│ IR5
                                                   D=0          │Rst   >=H│ BR5
                                                   D=0          │Ld    <=L│
                                                   BR500        │Clk      │
                                                   D=1          │U/D      │
                                                   D=00020      │Hi       │
                                                   D=00000      │Lo       │
                                                   D=00000      │Inp      │
                                                                └─────────┘
5
| [─────────────────────────────────────────────────────────────────────────DO2
                                                                          ──(L)──

 [─────────────────────────────────────────────────────────────  ─TON──
                                                                ┌─────────┐  ─────────
                                                       12       │No    out│ BR14
                                                   1   Sec      │Bas      │
                                                   D=00010      │Dly      │
                                                                └─────────┘
.4
 [──────────────────────────────────────────────────────────────────────────DO2
                                                                          ──(U)──

      BR8        BR14                                            ─MOVEI──
 [──────]  [──────]  [─────────────────────────────────────────  ┌─────────┐  ─────────
                                                   D=00000      │Inp   Out│ IR5
                                                                │         │
                                                                └─────────┘
```


2
] [
COUNT
6
D=0
D=0
BR5
D=1
D=00010
D=00000
D=00000
No
Rst
Ld
Clk
U/D
Hi
Lo
Inp
Cnt
>=H
<=L
IR7
BR9
1
] [
2
] [
ADD
IR4
IR7
I1
I2
Ovf
O
IR9
2
] [
BR10
(L)
10
] [
COUNT
9
D=0
D=0
BR10
D=1
D=00010
D=00000
D=00000
No
Rst
Ld
Clk
U/D
Hi
Lo
Inp
Cnt
>=H
<=L
IR10
BR6
3
] [
BR11
(L)
11
] [
COUNT
10
D=0
D=0
BR11
D=1
D=00010
D=00000
D=00000
No
Rst
Ld
Clk
U/D
Hi
Lo
Inp
Cnt
>=H
<=L
IR11
BR11
DI3
[ ] [
DO8
(L)
End

PROGRAM

```
#include <stdio.h>
#include<stdlib.h>
#include<conio.h>
#include<graphics.h>
typedef struct{
        int year;
        int month;
        int day;
      }date;
typedef struct{
        int empid;
        char empname;
        int mcno;
        int fno;
        int tcoen;
        char shift;
        date tdate;
       }report;
FILE *MAC;
main()
{
report mcdetail[100];
int zero,count,empcode,mcno,tcone,fno,con=0,press;
char empname,shift;
int month,day,year,select,sel,rdate,rmonth,ryear;
MAC=fopen("machine.dat","a+w");
clrscr();
 gotoxy(30,1);
printf(" MAIN TABLE                ");
gotoxy(30,3);
printf("SELECT 1 FOR UPDATION");
gotoxy(30,4);
printf("SELECT 2 FOR MODIFICATION");
gotoxy(30,5);
printf("SELECT 3 FOR REPORT");
gotoxy(30,7);
printf("\n\n SELECT 1(or)2(or)3----->");
scanf("%d",&select);
clrscr();
if (select==1)
  goto add;
```

```
else
 {
  if(select==2)
   goto modi;
  else
   goto report;
 }
count=0;
add:gotoxy(30,2);
printf("PRODUCTION REPORT DETAIL");
printf("\nPlease Enter Today's Date(mm/dd/yyyy)");
date1: gotoxy(50,3);
scanf("%d/%d/%d",&month,&day,&year);
if(month>=13 && month<=0)
  goto date1;
 else
 {
  if(day>=32 && day<=0)
   goto date1;
  else
  {
  if(year<=1997)
   goto date1;
  }
 }
loop:gotoxy(30,1);
   printf("FILE NUMBER");
   gotoxy(50,1);
   printf("%d",count);
gotoxy(1,4);
printf("Employee Id-Number-----------");
scanf("%d",empcode);
printf("Employee Name----------------");
scanf("%s",empname);
printf("Machine Number---------------");
scanf("%d",mcno);
printf("Frame Number-----------------");
scanf("%d",fno);
printf("Total Number of Cone winded--");
scanf("%d",tcone);
printf("Shift-----------------------");
scanf("%s",shift);
mcdetail[con].tdate.month=month;
```

```
mcdetail[con].tdate.day=day;
mcdetail[con].tdate.year=year;
mcdetail[con].empid=empcode;
mcdetail[con].empname=empname;
mcdetail[con].mcno=mcno;
mcdetail[con].fno=fno;
mcdetail[con].tcoen=tcone;
mcdetail[con].shift=shift;
fprintf(MAC,"%d/n",mcdetail[con].tdate.month);
fprintf(MAC,"%d\n",mcdetail[con].tdate.day);
fprintf(MAC,"%d\n",mcdetail[con].tdate.year);
fprintf(MAC,"%d\n",mcdetail[con].empid);
fprintf(MAC,"%s\n",mcdetail[con].empname);
fprintf(MAC,"%d\n",mcdetail[con].mcno);
fprintf(MAC,"%d\n",mcdetail[con].fno);
fprintf(MAC,"%d\n",mcdetail[con].tcoen);
fprintf(MAC,"%s\n",mcdetail[con].shift);
getch();
clrscr();
printf("If you want to continue press 0------>");
scanf("%d",&press);
if(press!=0)
  goto end;
 else{
  count=count+1;
  goto loop;
  }
modi:clrscr();
printf("          BYE            ");
getch();
report:clrscr();
gotoxy(30,2);
printf("SELECT 1 TO ENTER THE REPORT DATE------>");
gotoxy(30,3);
printf("\nSELECT 2 TO ENTER THE REPORT MONTH----->");
gotoxy(30,4);
printf("\nSELECT 3 TO ENTER THE REPORT YEAR------>");
scanf("%d",&sel);
if (sel==1)
      {clrscr();
      printf("ENTER THE DATE");
      scanf("%d",&rdate);
      goto dat;}
```